World Journal of Environmental Biosciences
All Rights Reserved Euresian Publication © 2015 **eISSN 2277- 8047**
Available Online at: **www.environmentaljournals.org**
Volume 4, Issue 2: 50-61

Open Access **Research Article**

The Reptiles of Bega Watershed of the Province of Agusan Del Sur in the Philippines

Marlon N. Balmores and Olga M. Nuñeza*

Department of Biological Sciences, College of Science and Mathematics, Mindanao State University – Iligan Institute of Technology, Andres Bonifacio Avenue, Iligan City, 9200, Philippines

***Corresponding author: olgamnuneza@yahoo.com**

Abstract:

Reptiles are important components of the food webs in most ecosystems where they fill a critical role both as predator and prey species. This study was conducted in Bega Watershed, Mabuhay, Prosperidad, Agusan del Sur to document species diversity, richness, and endemism of reptiles using a combination of cruising and pitfall trapping methods. Sixteen reptile species comprising 13 (81.25%) endemic species with one Mindanao endemic were recorded in Bega Watershed. A moderate species diversity (H'=2.514) with a more or less even distribution was also documented. Sampling Site 1 (Bega Falls) had the highest species richness. Bray-Curtis cluster analysis showed that site 1 (Bega Falls) and site 4 (Malipaga area) had the highest similarity index (40%) while Detrended Correspondence Analysis showed that site 1 is the most diverse among the four sampling sites. Results indicate the need for conservation action since despite low elevation, small land area, and relatively high disturbance, Bega Watershed still supports diverse assemblage of reptiles.

Keywords: Conservation, Diversity, Ecosystem, Endemic, Predator

1. Introduction:

The Philippine archipelago is one of the largest aggregations of islands in the world thus, not surprisingly the country supports a fauna that is exceptionally rich in unique species (Diesmos, 2008). It is also recognized as one of the most important centers of herpetofaunal diversity in Southeast Asia (Diesmos *et al.,* 2002). The reptilian fauna of the Philippines consists of 258 species of which 170 species or 66% are endemic (Diesmos *et al.,* 2002). This diverse and complex group is divided into 17 families and is represented by at least 83 genera (Diesmos *et al.,* 2002). Of the 258 species of reptiles recorded in the country, six species are terrestrial turtles, five species are marine turtles, 124 species are lizards, 106 terrestrial snakes species, 15 species of marine snakes species), and two species are crocodiles (Diesmos *et al.,* 2002).

Reptiles are important components of the food webs in most ecosystem where they fill a critical role both as predator and prey species (Endangered Species International, 2011). Thus, they are valuable bioindicators of environmental health (Giese *et al.,* 2012). However, the diverse reptilian fauna in the Philippines is principally threatened by burgeoning human population and continued deforestation (Heaney and Oliver, 1997). Despite the destruction of forests, there are still many new species of vertebrates that are being discovered (Alcala *et al.,* 2006). Recently, two new species of water monitor lizards were discovered by Dr. Rafe Brown and colleagues in Manila's wide-ranging black market (Siler *et al.,* 2014). They found that the two lizards were morphologically cryptic, meaning that they looked much alike to a known species of monitor lizard, but their genetic variation indicated they are evolutionary distinctive, qualifying them as unique species. The researchers named the lizards *Varanus dalubhasa* and *Varanus bangonorum* (Lynch, 2015).

Although more than 9000 species of reptiles have been described worldwide (Uetz, 2010), taxonomic, geographical, and biological knowledge of this group is still incomplete, particularly in the species-rich countries of developing world (Measey, 2006). According to Beukema (2011), the herpetofauna of the Mindanao Pleistocene Aggregate Island Complex (PAIC) consisting of Samar, Leyte, Biliran, Bohol, Mindanao, Dinagat, Siargao, and smaller associated islands, is still relatively poorly known. In addition, several

studies concerning reptiles and amphibians of this region have remained unpublished (Delima *et al.,* 2007). Some recent works were by Relox *et al.,* (2010) in Mt. Hamiguitan, Nuñeza *et al.,* (2010) in Mt. Malindang, Beukema (2011) in Mt. Kitanglad Range, Nuñeza *et al.,* (2012) in Mt. Diwata, Abantas and Nuñeza (2014) in Lanao del Norte, Nuñeza *et al.,* (2015) in Northern Mindanao and Nuñeza and Galorio (2015). There are still áreas in this región that have no herpetofaunal record especially the Bega Watershed of the province of Agusan del Sur which has not yet been explored. Thus, this study primarily aimed to determine the species diversity, abundance, endemism, species richness, and conservation status of reptiles of Bega Watershed, Prosperidad, Agusan del Sur.

2. Materials and Methods:

2.1. Study Area and Sampling Sites:

The assessment of reptiles was done mainly in the lowland forest of Barangay Mabuhay, Prosperidad, Agusan del Sur on May 8-14, 2014 (Fig. 1). Four sampling sites were established in the riparian areas of: (1) Bega falls, (2) Enchanted falls, (3) Tiger falls, and (4) Malipaga area (Fig. 2). The camp site was located at 8º69'38"N and 125º97'49", 258 meters above sea level (masl).

Fig. 1. Map of the world (A) and the Philippines (B) showing the location of Prosperidad Agusan del Sur (highlighted in red) (Google Maps, 2015).

Fig. 2. The four sampling sites in Bega Watershed: (A) Bega Falls, (B) Enchanted Falls, (C), Tiger falls, and (D) Malipaga area.

Table 1 shows a summary of habitat description of the four sampling sites. Ferns, mosses, orchids, rattan, and liana were the canopy epiphytes. *Ficus* sp. was found to be abundant along the stream of the four sampling sites. About 15 meters (m) from the Enchanted Falls is a degraded area and about 25 m from the falls is a slash-and-burn area.

Table 1: Tabulated description of the four sampling sites of Bega Watershed

	Site 1 Bega Falls	**Site 2 Enchanted Falls**	**Site 3 Tiger Falls**	**Site 4 Malipaga area**
Coordinates: North	8º69’76.2”	8º42’9.4”	8º70’43.5”	8º42’20.7”
Coordinates: East	125º97’39.1”	125º58’49.4”	125º98’21.1”	125º54’2.6”
Elevation	250 masl	267 masl	321 masl	338 masl
Vegetation type	secondary	secondary	secondary	secondary
Slope	20-30°	Flat to undulating	Flat to undulating	Flat to undulating
Exposed Rocks	Abundant	Abundant	Abundant	Abundant
Soil Type	Loam	Clay	Clay	Clay, Rocky
Leaf Litter (depth)	2.5 mm	3.1 mm	2 mm	1.5 mm
Fallen Logs	Present	Present	Present	Present

Canophy Epiphytes	Present	Present	Present	Present
Canopy Vines	Present	Present	Present	Present
Ground Cover Plants	Present	Present	Present	Present
Pandan Density	Present	Present	Present	Present
Ficus Density	Present	Absent	Present	Present
Distance to Anthropogenic Clearing	1-1.5 km	15 m *	none	2 m *
On-site Disturbance	Present	Absent	Absent	Present

Legend: *Slight landslide

2.2. Sampling Techniques:

Samples were collected using a combination of pitfall trapping and cruising methods. Samples encountered were captured and placed in sample bags with leaf litter for suitable moisture. Cruising method was done during the peak activity of reptiles which is late in the morning and early in the afternoon as well as in the evening for nocturnal species (Nuñeza *et al.,* 2012). Ninety-nine man hours were spent in the field sampling consisting of 42 hours for site 1, 27 hours for site 2, 12 sampling hours for site 3, and 18 hours for site 4. Pitfall trapping was also established close to feeding grounds and possible pathways for surface-active reptiles to fall into a pit-like trap in the ground. Traps were made of plastic containers partly buried in the ground so that the mouth of the trap is at a level with the ground surface. The traps were checked regularly (Heyer *et al.,* 1994).

2.3. Identification of Specimens:

The following morphometrics were taken: head length (HL), head breadth (HB), eye diameter (ED), tympanum distance (TD), and snout-vent length (SVL) using a vernier calliper. Body weights (BW) were taken using a Pesola spring balance. Significant traits such as color, head shape, snout shape, bands, or collars were also noted. Identification was based on Brown *et al.,* (2013) and and the Photographic Guide to Amphibians and Reptiles of Mindanao, Philippines by Nuñeza (2012). Dr. Rafe Brown of the University of Kansas, an expert in herpetology, verified the identification of the species. The distribution and conservation status of of reptiles was checked using IUCN Red List of Threatened Species (2014).

2.4. Biodiversity Indices:

Species richness, species diversity, relative abundance, and evenness were determined. Species diversity refers to the number (species richness) and relative abundance of species in a biological community. Shannon-Wiener Index (H) is determined by both the number of species and the even distribution of individuals among species (relative dominance). It indicates the degree of uncertainty of predicting the species of a given individual picked at random from the community (Nowak, 2005).

Species richness is based solely on the number of species found in the given area and does not reflect the relative dominance of the species (Nowak, 2005). The number of species is the most frequently used and easily understood measure of biological diversity (Purvis and Hector, 2000). Relative abundance is the abundance of species divided by the total abundance of all species combined. For comparison, species composition is a list of all species in this defined unit, along with some measure of abundance, often relative abundance (Ludwig *et al.,* 1988). Evenness is the measure of how similar the abundance of different species/categories are in a community. Evenness ranges from zero to one. When evenness is close to zero, it indicates that most of the individuals belong to one or a few species/categories. When evenness is close to one, it indicates that each species/categories consists of the same number of individuals (Kumar *et al.,* 2014).

2.5. Statistical Analysis:

Paleontological Statistics (PAST) Software, a free statistical software package for paleontological data analysis which enables measures of diversity to be calculated (Hammer, 2012) was used to calculate biodiversity indices and perform Bray-Curtis Cluster Analysis and Detrended Correspondence Analysis.

3. Results and Discussion:

3.1. Species Richness and Abundance:

Sixteen species of reptiles belonging to seven families and 13 genera were recorded from the four sampling sites of Bega Watershed (Table 2). Ten species were documented in sampling site 1 (Bega falls), three species in sampling site 2 (Enchanted falls), four species in sampling 3 (Tiger falls), and four species in sampling site 4 (Malipaga area). Thirteen endemic species were documented consisting of 12 Philippine endemic and one Mindanao endemic species, *Tropidophorus misaminius,* which was only recorded in sampling sites 3 and 4. The vegetation cover, leaf litter, and the rocks in stream of sites 3 and 4 were observed as the factors for the presence of *T. misaminius* in the area. As observed by Brown and Alcala (1980) this species can be found in moist soil under rotting logs and rocks, and also among rocks of stream beds within forested areas. Sampling site 1 (Bega falls) had the highest relative abundance (39.39%) while sampling sites 2 and 3 had the least abundance (18.18%). The abundance of species in the sampling sites could be due to the low elevation of Bega Watershed. This result concurs with the findings of Beukema (2011) and Relox *et al.,* (2010) who found that forested lowland areas could contain high species richness and diversity of reptiles as well as amphibians. Moreover, Alcala (1986) stated that reptiles like snakes are ectothermic which prefer lower elevated areas because there is a higher temperature in which the condition for their survival is optimum. The high abundance of reptiles especially snakes in Site 1 (Bega falls) is due to the boulders and rocks as well as trees and other vegetation near the falls and stream which serve as conducive habitats for reptile species. According to Neel *et al.,* (2012,) rocks and crevices provide important microhabitats for reptiles which enable them to thermoregulate, create suitable nests, and escape from predators. Moreover, the presence of disturbance in the area indicates that the species present tolerate moderate degree of disturbance (Grismer *et al.,* 2012; Diesmos *et al.,* 2009; Delima *et al.,* 2014; Gonzalez and Diesmos, 2009; Brown, 2009).

The Philippine endemic species, *Rhabdophis lineatus* (Zigzag-lined Water Snake) was the most abundant and only found in sampling sites 1 and 4 which are both aquatic areas. Diesmos *et al.,* (2009) reported that this water snake is associated with streams and rivers in forested areas and is persistent in disturbed sites.

3.2. Species Endemism and Conservation Status

High endemism (81.25%) was recorded in Bega Watershed despite being a lowland area. Sampling site 1 had the highest endemism (61.54%) while sites 2 and 3 had the lowest endemism (23.08%). Jansson (2003) reported that more number of endemic species are expected when more species are present. This result concurs with the findings of Nuñeza and Galorio (2015) who found high endemism of reptiles in the lowland areas of Siargao Island while Nuñeza *et al.,* (2015) recorded a 44% endemicity of herpetofauna in the lowland caves of Northern Mindanao. Thus, more intensive surveys could result in a higher number of endemic species. In addition, nine reptile species have least concern status according to IUCN Red List of Threatened Species (2014) of which seven are Philippine endemic and one Mindanao endemic species indicating the need for protection and conservation of both species and the habitats. Moreover, Nuñeza *et al.,* (2012) reported the importance of habitats of restricted-range species and the need to protect the habitats.

All species were caught using the cruising method except for *B. boulengeri* which was the only one caught in pitfall trap. The established traps were found inefficient mainly for three reasons, first, due to the capability of reptiles like lizard to climb back enabling them to escape or avoid capture (Stebbins and Cohen, 1995). Another reason is the location of the sampling sites, they are located near waterfalls and water forms, thus destroying some of the set-up when water accumulated through the ground hole causing the traps to float. Lastly, the high occurrence of rain during the latter part of the sampling period also destroyed the set traps as they were filled with rain water which may have also facilitated the escape of the captured reptiles. Fig. 3 shows some endemic reptile species documented in the riparian areas of Bega Watershed.

Table 2: Species richness, relative abundance, and endemism in Bega Watershed, Prosperidad, Agusan Del Sur

Family and Species Name	Conservation Status IUCN (2014)	Sampling Sites				TOTAL
		1 Bega Falls	2 Enchanted Falls	3 Tiger Falls	4 Malipaga Area	
Agamidae						
Draco bimaculatus [PE] (Two-spotted Flying Lizard)	LC	0	2 (33.3)	0	0	2
Draco cyanopterus [PE] (Flying Lizard)	LC	0	2 (33.3)	0	0	2
Calamariidae						
Calamaria lumbricoidea (Variable Reed Snake)	LC	1 (7.69)	0	0	0	1
Colubridae						
Boiga dendrophila (Mangrove Snake)		1 (7.69)	0	0	0	1
Psammodynastes pulverulentus (Common Mock Viper)		0	0	2 (66.7)	0	2
Gekkonidae						
Pseudogekko pungkaypinit [PE] (Southern Philippine False Gecko)		1 (7.69)	0	0	0	1
Natricidae						
Rhabdophis auriculata [PE] (White-lined Water Snake)	LC	0	0	1 (25.0)	0	1
Rhabdophis lineatus [PE] (Zigzag-lined Water Snake)	LC	3 (23.1)	0	0	4 (50.0)	7
Pseudoxyrhophiidae						
Oxyrhabdium modestum [PE] (Philippine Shrub Snake)	LC	1 (7.69)	0	0	0	1
Scincidae						
Brachymeles boulengeri [PE] *(Boulenger's Short-legged Skin)*	LC	1 (7.69)	0	0	0	1
Eutropis cumingi [PE] (Cuming's Mabuya)		2 (15.4)	0	0	1 (12.5)	3
Lipinia pulchella [PE] (Beautiful Lipinia)	LC	1 (7.69)	0	0	0	1
Sphenomorphus cumingi [PE] (Cuming's Sphenomorphus*)*		0	0	0	1 (12.5)	1
Pinoyscincus coxi [PE] (Cox's Sphenomorphus)		1 (7.69)	0	0	0	1
Pinoyscincus jagori [PE] (Jagor's Sphenomorphus)		1 (7.69)	2 (33.3)	2 (33.3)	0	5
Tropidophorus misaminius [ME] (Misamis Waterside Skink)	LC	0	0	1 (25.0)	2 (25.0)	3
Total no. of individuals		13	6	6	8	33
Total no. of species		10	3	4	4	16
Total no. of endemic species		8	3	3	4	13
Relative abundance (%)		39.39	18.18	18.18	24.24	
Endemism		61.54	23.08	23.08	30.77	81.25

Legend: [PE] – Philippine Endemic; [ME] - Mindanao Island Endemic; () Relative Abundance; LC- Least Concern

Fig. 3. Philippine endemic species identified in the riparian areas of Bega Watershed, Agusan del Sur: (A) *Brachymeles boulengeri*, (B) *Eutropis cumingi*, (C) *Sphenomorphus cumingi,* (D) *Tropidophorus misaminius*, (E) *Lipinia pulchella,* (F) *Pinoyscincus jagori*

3.3. Biodiversity Indices:

Sampling site 1 had the highest species diversity (H'=2.205) among the four sampling sites (Table 3). Site 1 was observed to have more favorable habitat for reptiles due to the presence of boulders, large trees, leaf litter, and other vegetation, aside from being a riparian area. According to Klaus *et al.,* (2006), wood debris or fallen logs are important, directly or indirectly, in maintaining both habitat and diversity of herpetofauna. Moreover, the presence of food like amphibians and insects which serve as prey for reptiles especially snakes was observed in site 1 which partly explains the high diversity of reptiles in the area. Ngilangil *et al.,* (2014) stated that food resource in the area is a contributing factor to species abundance as well as diversity.

Table 3: Biodiversity indices of the four sampling sites in Bega watershed.

	Number of Individuals	Species Richness (S)	Dominance	Species Diversity (H')	Evenness
Sampling Site 1 (Bega Falls)	13	10	0.1243	2.205	0.9068
Sampling Site 2 (Enchanted Falls)	6	3	0.3333	1.04	1
Sampling Site 3 (Tiger Falls)	6	4	0.2778	1.33	0.9449
Sampling Site 4 (Malipaga Area)	8	4	0.3438	1.213	0.8409
Total	**33**	**16**	**0.1038**	**2.514**	**0.7722**

Reptiles in Bega Watershed had more or less even distribution. Ngilangil *et al.,* (2014) reported that a more or less even distribution is likely caused by the same parameters, such as elevation range, habitat type, and availability of food. No single species dominated a sampling site. Hamilton and Perrot (1981) hypothesized that environmental conditions might be more favorable for life at low to middle elevations, thus allowing for a greater number of species to exist there, but that fewer species can persist under harsher conditions at higher elevations. Moreover, Edgar *et al.,* (2010) found that areas with diverse vegetation structure and intricate mosaic of vegetation are more suitable as microhabitats for reptiles especially during their breeding period. The suitable microhabitat and favorable conditions such as low elevation, diverse vegetation structure, rocks in streams, and food availability are seen as factors for the even distribution of reptiles in Bega Watershed.

3.4. Distribution of Species:

Detrended Correspondence plot (Fig. 4) shows the distribution of reptiles in the Bega Watershed across the four sites. *Brachymeles boulengeri, Lipinia pulchella, Pseudogekko pungkaypinit, Calamaria lumbricoidea, Oxyrhabdium modestum,* and *Boiga dendrophila,* were found only in site 1. According to Delima *et al.,* (2014); Brown (2009), *L. pulchella* and *O. modestum* are species common in secondary forest that have high tolerance to habitat modification while Gonzalez and Diesmos (2009) found that *B. boulengeri* is a species commonly found underneath rotting logs, in leaf litter and among similar ground cover. This indicates that the abundant leaf litter and fallen logs in site 1 which can be microhabitats for the species present in this site and its vegetation type which is a secondary forest make this site a favorable microhabitat for the reptile species. *Pinoyscincus jagori* was found in sites 1, 2, and 3. *Draco cyanopterus* and *Draco bimaculatus* both belonging to family Agamidae were only seen in the degraded area of sampling site 2 which was recently cleared by burning. The result is in agreement with the report of Brown *et al.,* (2009a; 2009b) that these species are tolerant of habitat modification and originally found at the forest edge and forest clearings.

3.5. Similarity of Sampling Sites:

Cluster analysis (Fig. 5) shows sites 1 and 4 forming the first clade which means that these sites shared mostly the same reptilian species, namely, *Rhabdophis lineatus, Eutropis cumingi, Sphenomorphus cumingi* and *Tropidophorus misaminius* which are all endemic. Site 2 (riparian area of Enchanted Falls) and site 3 (riparian area of Tiger Falls) are less related to sites 1 and 4, and this is probably due to the anthropogenic activities in the area, such as slash-and-burn activity, observed in site 2. According to Hawksworth and Bull (2007), cluster analysis of reptile species indicates the uniqueness of the reptile fauna. Moreover, the presence of disturbance in an area could cause a shift and fluctuation in the presence of reptile species because of their limited dispersal abilities which make them susceptible to the effects of habitat modification (Edgar *et al.,* 2010).

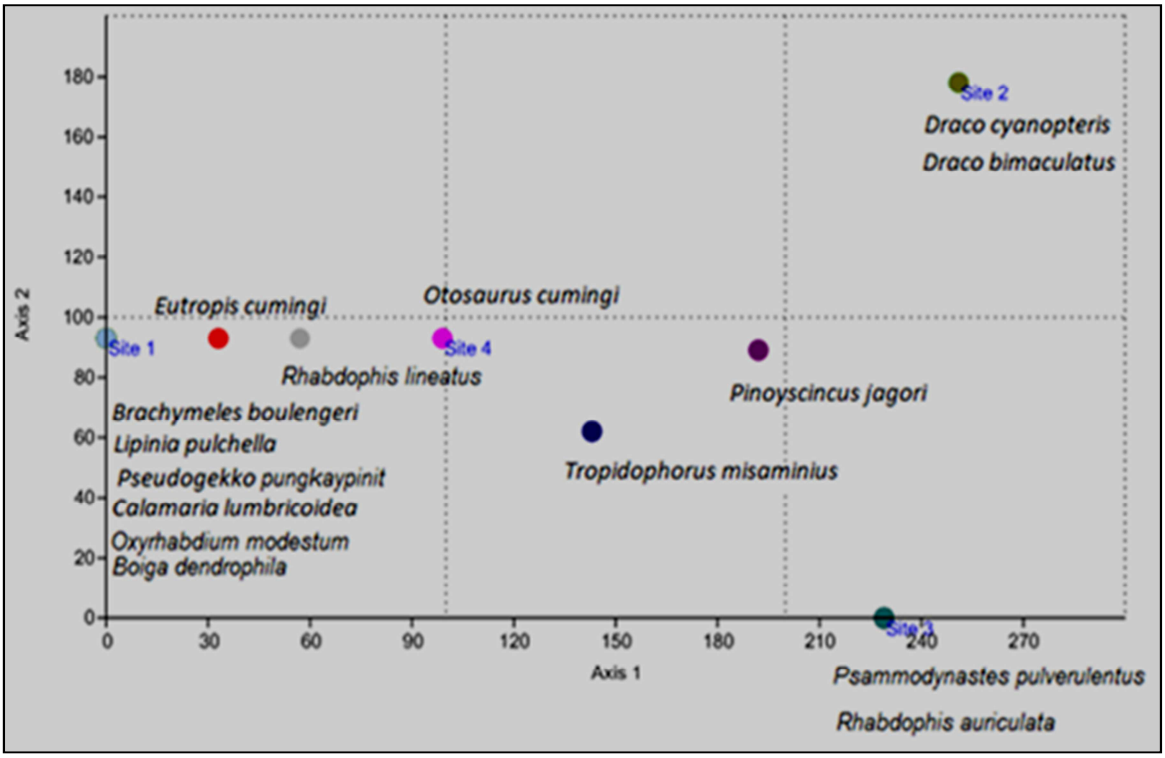

Fig. 4. A plot showing the distribution of reptile species in the four sampling sites.

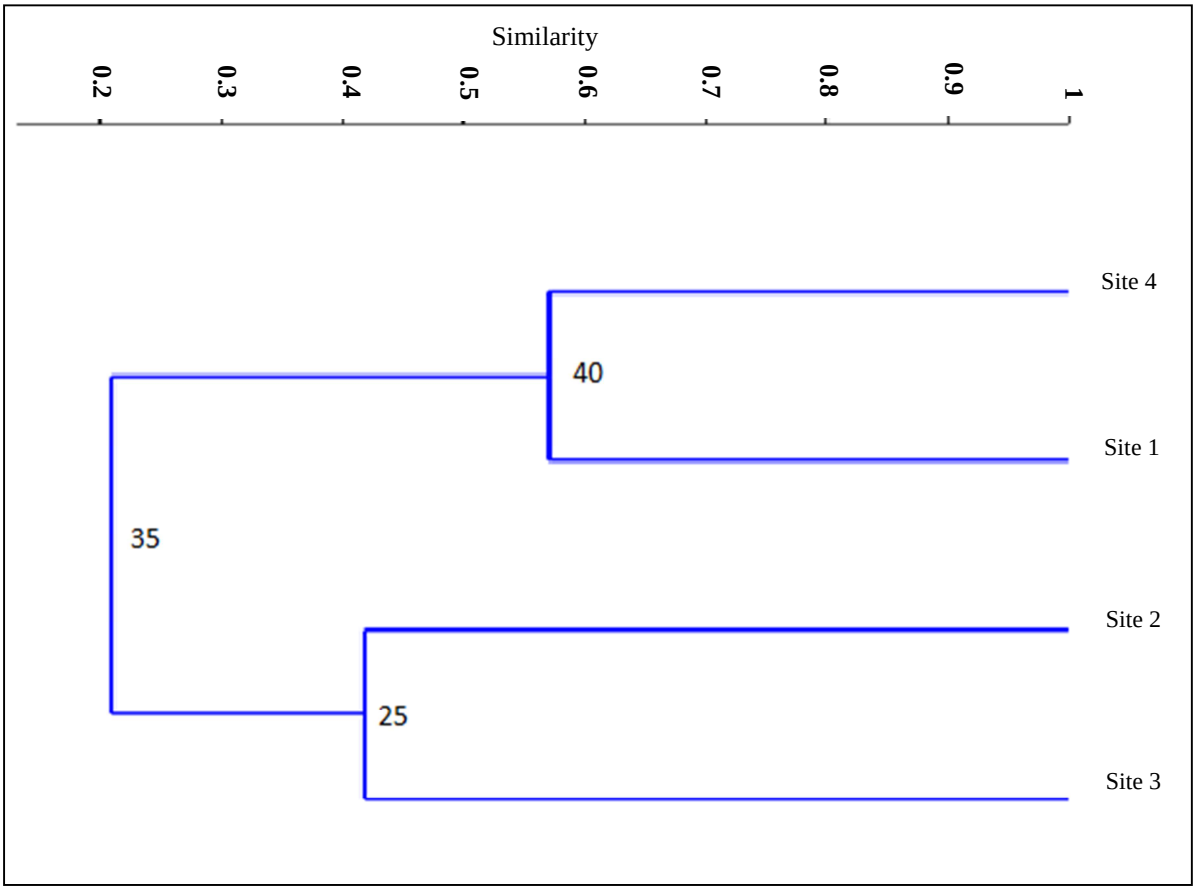

Fig. 5. Similarity of species composition of reptiles across four sampling sites in Bega Watershed (Bray-Curtis Cluster Analysis – single link).

4. Conclusion:

The Bega Watershed of Prosperidad, Agusan del Sur had moderate species diversity (H=2.514) with a more or less even distribution. Among the sites surveyed, sampling site 1 (Bega Falls) had the highest species richness, diversity and endemism. The Philippine endemic, Zigzag-lined Water Snake, *Rhabdophis lineatus,* was the most abundant species. Despite being a relatively disturbed lowland area, Bega Watershed can still support diverse population of reptiles because of its diverse vegetational structure and presence of water system which serves as favorable microhabitat for reptile species. A high endemism (81.25%) observed in the watershed suggests that Bega Watershed is a key conservation site.

5.0 Acknowledgment:

We acknowledge the funding support of the Local Government Unit of Prosperidad, Agusan del Sur through Mayor Albin D. Magdamit and the logistical support of the Municipal Tourism Office through Ms. Noradel Martinez. We greatly acknowledge the help of Dr. Rafe Brown for the identification of the species.

References:

1) Abantas, A. D. and Nuñeza, O. M. (2014): Species diversity of terrestrial vertebrates in Mighty Cave, Tagoloan, Lanao del Norte, Philippines. *Journal of Biodivesrity and Environmental Sciences,* 5(6): 122-132.
2) Alcala, A. C. (1986): Guide to Philippine Flora and Fauna - Amphibians and Reptiles. JMC Press Philippines, 1-195.
3) Alcala, A. C., Alcala, E. L., Buot, I. E. Jr., Diesmos, A., Dolar, M. L., Fernandos, E. S., Gonzalez, J. E. and Tabaranza, B. (2006): Philippine Biodiversity: Ecological Roles, Uses, and Conservation Status. *Trans. Natl. Acad. Sci. Tech. Philippines*, 28:203-214.
4) Beukema, W. (2011): Herpetofauna of disturbed forest fragments on the lower Mt. Kitanglad Range, Mindanao Island, Philippines. *Salamandra*, 47(2): 90-98.
5) Brown, R. (2009): *Lipinia pulchella*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 05 April 2015.
6) Brown, W.C. and Alcala, A. C. (1980): Philippine Lizards of the Family Scincidae. Silliman University Press, Dumaguete City, Philippines, 1-264.
7) Brown, R., Linkem, C., Diesmos, A., Gaulke, M. and Delima, E. M. (2009a): *Draco cyanopterus*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 05 April 2015.
8) Brown, R., Sy, E., Gaulke, M. and Ledesma, M. (2009b): *Draco bimaculatus*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 05 April 2015.
9) Brown, R. M., Siler, C. D., Oliveros, C. H., Welton, L. J., Rock, A., Swab, J., Van Weerd, M., Van Beijnen, J., Jose, E., Rodriguez, D., Jose, E. and Diesmos, A. C. (2013): The amphibians and reptiles of Luzon Island, Philippines, VIII: the herpetofauna of Cagayan and Isabela Provinces, northern Sierra Madre Mountain Range. *ZooKeys*, 266: 1-120.
10) Delima, E. M. M., Diesmos, A. C. and Ibañez, J. C. (2007): The herpetofaunal importance of Mt. Hamiguitan Range, Mindanao Island, Philippines. *Banwa,* 4: 27-40.
11) Delima, E. M., Tampos, G., Gonzalez, J. C., Diesmos, A. C. and Jose, R. (2014): *Oxyrhabdium modestum*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 05 April 2015.
12) Diesmos, A. C. (2008): Ecology and diversity of herpetofaunal communities in fragmented lowland rainforests in the Philippines. PhD Thesis, National University of Singapore, Singapore, 1-112.
13) Diesmos, A. C., Brown, R. M., Alcala, A. C., Sison, R. V., Afuang, L. E. and Genevieve, V. A. (2002): Philippine Amphibians and Reptiles: An Overview of Species Diversity, Biogeography and Conservation. In: Ong, P., Afuang, L., Rosell-Ambal, R. (Eds.). Philippine biodiversity conservation priorities: a second iteration of the national biodiversity strategy and action plan. Foundation for the Philippine Environment, Quezon City, Philippines, 26-44.
14) Diesmos, A., Gonzalez, J. C., Delima, E. M. and Tampos, G. (2009): *Rhabdophis auriculata*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 05 April 2015.
15) Endangered Species International. (2011): Ecological Roles of Reptiles. Retrieved April 5 2015 from http://www.endangeredspeciesinternational.org/reptiles3.html
16) Edgar, P., Foster, J. and Baker, J. (2010): Reptile Habitat Management Handbook. Amphibian and Reptile Conservation, Bournemouth, 1-73.

17) Giese, C. L. A., Greenwald, D. N. and Curry T. (2012): Petition to List 53 Amphibians and Reptiles in the United States as Threatened or Endangered Species under the Endangered Species Act. The Center for Biological Diversity, 1-454.
18) Gonzalez, J. C. and Diesmos, A. (2009): *Brachymeles boulengeri*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 05 April 2015.
19. Google Maps. 2015. Agusan del Sur, Philippines. http://maps.google.com. [Accessed 19th June 2015].
20) Grismer, L., Chan-Ard, T. and Inger, R. F. (2012): *Calamaria lumbricoidea*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 05 April 2015.
21) Hammer, O. (2012): PAST Paleontological Statistics Version 2.17. Reference Manual, Natural History Museum, University of Oslo, 1-229.
22) Hamilton, A. C. and Perrott, R. A. (1981): A study of altitudinal zonation in the montane forest belt of Mt. Elgon, Kenya/Uganda. *Vegetatio*, 45:107–125.
23) Hawksworth, D. L. and Bull, A. T. (2007): Vertebrate Conservation and Biodiversity. Springer Science & Business Media, Netherlands, 896-899.
24) Heaney, L. R. and Oliver, W. L. R. (1997): Biodiversity and Conservation in the Philippine Red Data Book. Philippine Wildlife Conservation Society Bookmark Inc., 3-7.
25) Heyer, W. R., Donnelly, M. A., McDiarmid, R. W., Hayek, L. A. C. and Foster M. S. (1994): Measuring and Monitoring Biological Diversity, Standard Methods for Amphibians. Smithsonian Institution Press, Washington DC.
26) IUCN Red List of Threatened Species. (2014): IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 05 April 2015.
27) Jansson, R. (2003): Global patterns in endemism explained by past climatic change. Proceedings of the Royal Society of London. Series B: Biological Sciences. *The Royal Society,* 270(1515): 583-590.
28) Klaus, I., Ward, J. V., Tockner, K. and Baumgartner, C. (2006): Amphibian diversity and nestedness in dynamic floodplain river (Tagliamento, NE-Italy). *Hydrobiologia*, 187(1):121-133.
29) Kumar, J., Pathak, N., Tripathi, R. K., Shukla, A., Dubey. S. (2014): Biodiversity índices. http://aquafind.com/articles/Biodiversity-Indices.php. [Accessed 10th April 2015]
30) Ludwig, H., Bode, L. and Gosztonyi, G. (1988): Borna disease: a persistent virus infection of the central nervous system. *Progress in Medical Virology*, 35: 107-151.
31) Lynch, B. M. (2015): Undercover researchers expose two new species of lizard for sale on Philippine black market. http://news.ku.edu/2015/01/12/undercover-researchers-expose-two-new-species-lizard-sale-philippine-black-market. [Accessed 4th March 2015]
32) Measey, G. J. (2006): Surveying biodiversity of soil herpatofauna: towards a standard quantitative methodology. *European Journal of Soil Biology*, 42: S103-S110.
33) Neel, L., Sjoberg, J., Richards, L, Siegel, S., Vargas, K., Moilola, T., Wolff, P., Dellen, C. V. and Herrick, T. (2012): Nevada Wildlife Action Plan. Nevada Department of Wildlife, Reno, 304-343.
34) Ngilangil, M. M., Boyles, L. Z. and Sularte, R. P. (2014): Abundance, Distribution and Conservation Status of Reptiles in Agusan Marsh, Bunawan, Agusan del Sur, Philippines. *International Journal of Advances in Chemical Engg., & Biological Sciences*, 1(2): 2349-1507.
35) Nowak, R. M. (2005): Walker's Carnivores of the World. Johns Hopkins University Press, Baltimore, Maryland, 1-313.
36) Nuñeza, O. M., Ates, F. B. and Alicante, A. A. (2010): Distribution of endemic and threatened herpetofauna in Mt. Malindang, Philippines. *Biodiversity and Conservation*, 19 (9):503-518.
37) Nuñeza, O. M., Fabricante, K. M. B., Alicante, A. A., Sucaldito, M. P. and Ponce, A. G. (2012): The herpetofauna of Mounts Sambilikan, Ararat and Berseba of the Diwata Range, Agusan del Sur, Philippines. *Asia Life Sciences*, 21 (1): 203-216, 2012.
38) Nuñeza, O. M. (2012): Guide to Amphibians and Reptiles of Mindanao, Philippines. Office of Publication and Information OVCRE, Mindanao State University - Iligan Institute of Technology, Iligan City, Philippines, 1-72.
39) Nuñeza, O. M. and Galorio, A. H. N. (2015): Cave Herpetofauna of Siargao Island Protected Landscape and Seascape, Philippines. *World Journal of Environmental Biosciences*, 4(1): 26-35.
40) Nuñeza, O.M., Calizo-Enguito, M.R., Labajo-Villantes, Y. and Ponce A. G. (2015): Species richness and endemism of cave herpetofauna in Northern Mindanao, Philippines. *ELBA Bioflux*, 7(1):10-24.

41) Purvis, A. and Hector, A. (2000): Getting the measure of biodiversity. *Nature International Weekly Journal*, 405: 212-219.
42) Relox, R. E., Leańo, E. P. and Ates-Camino, F. B. (2010): Herpetofaunal Endemism and Diversity in Tropical Forests of Mt. Hamiguitan in the Philippines. *Herpetological Conservation and Biology*, 6(1):107−113.
43) Siler, C. D., Welton, L. J., Davis, D. R., Watters, J. L., Davey, C. S., Diesmos, A. C., Diesmos, M. L. and Brown, R. M. (2014): Taxonomic revision of the Pseudogekko compresicorpus complex (Reptilia: Squamata: Gekkonidae), with descriptions of three new species. *Herpetological Monographs*, 28: 110–139.
44) Stebbins, R. C. and Cohen, N. W. (1995): A natural history of amphibians.Princeton University Press, 336. ISBN 13: 978-0-691-03281-8.
45) Uetz, P. (2010): The original descriptions of Reptiles. *Zootaxa,* 2334: 59-68.