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Assessment of the Diversity of Animals in the Forest Ecosystems of Baler Forest Reserve and Dibut River Watershed

Annie Melinda Paz-Alberto, Shirly C. Serrano, and Daryl A. Juganas
Institute for Climate Change and Environmental Management, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines

The diversity of animals in the forested area of Baler Forest Reserve and Dibut River Watershed was assessed. The four major groups of animals such as birds, mammals, reptiles, and amphibians were observed, described, identified, and classified. Birds and volant mammals were observed through standard mist netting and either sight or sounds. On the other hand, nonvolant mammals were observed or caught by traps and searched along their possible habitat. Amphibians were caught by hands, and the reptiles were observed through sightings.

A total of 40 animal species were observed in the area under 30 Families, where Families Alcedenidae, Pteropodidae, Muridae, and Ranidae are the most represented. Of the observed animals, 40 species were identified up to genus and species level.

A mammalian species Greater Musky Fruit Bat (*Ptenochirus jagori*) got the highest importance value index of 62.67% and biodiversity indicator value of 88%. It is also the most common and the most dominant animal species surveyed in the forest ecosystem. Baler Forest Reserve and Dibut River Watershed exhibited low to very low diversity among animals.

One species was listed as vulnerable and five species as near threatened by the IUCN Red List of Threatened Species. There were 24 native species recorded. Furthermore, there were no introduced species recorded in Baler Forest Reserve and Dibut River Watershed.

Human activities such as timber poaching posed major impact on environmental degradation. Soil erosion, kaingin farming, mining, charcoal making, fires, and hunting posed small to moderate impacts on the area.

INTRODUCTION

The Philippines is one of the few nations that are, in its entirety, both a hotspot and a megadiversity country, placing it among the top priority hotspots for global conservation. Most of the islands are covered in rain forest. The bulk of the country is blanketed by lowland rainforests dominated by towering Dipterocarps, beautiful and straight hardwood. At higher elevations, the lowland forests are replaced by montane and mossy forests that consist mostly of smaller trees and vegetation.

The patchwork of isolated islands, the tropical location of the country, and the once extensive areas of rainforest have resulted in high species diversity in some groups of organisms and a very high level of endemism. There are over 530 bird species found in the Philippine hotspot; about 185 of these are endemic (35%) and over 60 are threatened. At least 165 mammal species are found in the Philippines, and over 100 of these are endemic (61%). Reptiles are represented by about 235 species, some 160 of which are endemic (68%). There are nearly 90 amphibian species in the hotspot, almost 85% of which are endemic. These continue to increase, with the continuing discovery and description of new species (McGinley, 2013).

This project aimed to determine the exploitation and conservation status of forest biodiversity in Central Luzon. Specifically, it aimed to conduct assessment of the diversity of animals in the selected forest ecosystems of Central Luzon, to identify indicators of biological diversity in the forest ecosystems of Central Luzon, to determine sources of all levels of impacts of environmental problems/degradation of forest ecosystems in Central Luzon, to identify alien/introduced species in the forest ecosystems and their impact to biodiversity, and to determine the ecological/economic role/functions of animals in the forest ecosystems of Central Luzon.

METHOD

Study Area

The Baler Forest Reserve in Brgy. Zabali, Baler, Aurora covers 310 hectares

of mountainous forest while Dibut River Watershed in Brgy. Dibut, San Luis, Aurora has a total land area of 1,341.24, 93% of which is used for timberland. The two watersheds were divided into ten (10) stations. Of these, two stations were selected in Dibut River Watershed and eight stations in Baler Forest Reserve. In each station, ten (10) quadrats were chosen and designated as study areas and were delineated and digitally mapped. The delineated study area was divided into grid with a scale dimension of 10 m × 12 m. The numbers of grids were determined, and a simple lottery method was used to represent the random sampling technique.

Data Gathering and Documentation

The four major groups of animals such as birds, reptiles, amphibians, and mammals were surveyed, monitored, and recorded in each quadrat. The animals were recorded by monitoring the number of sightings. The following information was gathered: common name, habitat, locality, altitude, province, morphological description of the animal, and ethnobiological information (benefits/uses, values, associated beliefs and practices, etc.). Ethnobiological/ethnopharmaceutical/ethnomedicinal information of the recorded and observed animals was gathered through interview with the local people living in the protected area who are knowledgeable about local wildlife and resource use.

Collection and observation of the representative animals that were not known or not identified were conducted through the use of mist nets and binoculars for flying mammals and birds, improvised traps for reptiles and birds, cast nets of small mesh size for small animals, and hand-picking for other animals. All animals were photographed and released thereafter.

Pertinent information regarding their habitat, sex, behavior, and economic and ecological importance were also noted. All observed animals were identified and classified based on available Taxonomic Keys, and authentication was done by an expert in Taxonomy of Animals at the National Museum, Manila.

Quantitative descriptions of animals were gathered to compute for the various ecological parameters such as frequency, relative frequency, density, relative density and dominance, and importance value index. Species diversity was computed and determined using Shannon's Diversity Index (Smith & Smith, 1998). Furthermore, biodiversity indicator was also

determined using the formula, IndValij = Aij × Bij × 100, adapted from Dufrene and Legendre (1997).

Rare, endangered, depleted, endemic, and economically important species of animals were identified. Indicators of biological diversity as well as introduced species were also identified, and their impact to biodiversity was also determined.

RESULTS AND DISCUSSION

Assessment of the Diversity of Animals

A total of 40 animals were observed in the Baler Forest Reserve and Dibut River Watershed. Of these, 17 are birds, 10 are mammals, seven are reptiles and six are amphibians (Table 1). All of them were identified up to species level.

Birds

Birds were the most numerous group of vertebrates in the area. Based on the identified species of birds, Order Passeriformes is well represented with nine species. Birds of the Order Coraciiformes are represented with four species while Order Caprimulgiformes are represented with two species. Birds of the Orders Falcociiformes and Apodiformes are represented with one species each.

Mammals

The captured mammals are grouped under four Orders. Orders Chiroptera, Rodentia, Primata, and Carnivora. The ten species of mammals belonging to five Families include four volant mammals from the Family Pteropodidae and one species from the Family Hipposideridae, three rodents (Muridae), one macaque (Cercopithecidae), and one civet cat (Viverridae).

Table 1. Computed ecological parameters of the surveyed animals in Baler Forest Reserve, Baler, Aurora and Dibut River Watershed, San Luis, Aurora.

Local Name/Scientific Name	No. of Individuals	F	RF (%)	D	RD (%)	Do	R Do (%)	IVI (%)
Birds								
Penelopides manillae	20	0.8	5.555555556	0.001667	4.694835681	0.002098868	1.878584141	12.128975
Pycnonotus urostictus	12	0.7	4.861111111	0.001	2.816901408	0.00072908	0.652560807	8.3305733
Lanius cristatus	11	0.7	4.861111111	0.000917	2.582159624	0.000607567	0.543800672	7.9870714
Dicaeum austral	9	0.5	3.472222222	0.00075	2.112676056	0.00039768	0.355942258	5.9408405
Haliastur indus	6	0.6	4.166666667	0.0005	1.408450704	0.0001657	0.148309274	5.7234266
Copsychus luzoniensis	6	0.4	2.777777778	0.0005	1.408450704	0.0001657	0.148309274	4.3345378
Terpsiphone cinnamonea	4	0.4	2.777777778	0.000333	0.938967136	6.628E−05	0.05932371	3.7760686
Aerodramus inquietus	4	0.3	2.083333333	0.000333	0.938967136	6.628E−05	0.05932371	3.0816242
Motacilla cinerea	3	0.3	2.083333333	0.00025	0.704225352	3.314E−05	0.029661855	2.8172205
Stachyrisdennistouni	4	0.2	1.388888889	0.000333	0.938967136	6.628E−05	0.05932371	2.3871797
Rhipidura cyaniceps	2	0.2	1.388888889	0.000167	0.469483568	1.10467E−05	0.009887285	1.8682597
Alcedo atthis	2	0.2	1.388888889	0.000167	0.469483568	1.10467E−05	0.009887285	1.8682597
Actenoides lindsayi	2	0.2	1.388888889	0.000167	0.469483568	1.10467E−05	0.009887285	1.8682597
Alcedo meninting	2	0.2	1.388888889	0.000167	0.469483568	1.10467E−05	0.009887285	1.8682597
Hypsipetis philippinus	2	0.2	1.388888889	0.000167	0.469483568	1.10467E−05	0.009887285	1.8682597
Caprimulgus jotaka	1	0.1	0.694444444	8.33E−05	0.234741784	0	0	0.9291862
Batrachostomus septimus	1	0.1	0.694444444	8.33E−05	0.234741784	0	0	0.9291862
Mammals								
Ptenochirus jagori	88	0.6	4.166666667	0.007333	20.657277	0.042286661	37.84852679	62.67247
Cynopterus brachyotis	84	1	6.944444444	0.007	19.71830986	0.038508699	34.46707534	61.12983

Rattus everetti	21	0.8	5.555555556	0.00175	4.929577465	0.002319801	2.07632984	12.561463
Macroglossus minimus	14	0.7	4.861111111	0.001167	3.286384977	0.001005247	0.899742931	9.047239
Macaca fascicularis philippinensis	6	0.6	4.166666667	0.0005	1.408450704	0.0001657	0.148309274	5.7234266
Bullimus luzonicus	7	0.5	3.472222222	0.000583	1.643192488	0.00023198	0.207632984	5.3230477
Haplonycteris fischeri	4	0.4	2.777777778	0.000333	0.938967136	6.628E-05	0.05932371	3.7760686
Paradoxurus hermaphroditus	3	0.3	2.083333333	0.00025	0.704225352	3.314E-05	0.029661855	2.8172205
Coelops hirsutus	3	0.2	1.388888889	0.00025	0.704225352	3.314E-05	0.029661855	2.1227761
Apomys datae	1	0.1	0.694444444	8.33E-05	0.234741784	0	0	0.9291862
Reptiles								
Varanus marmoratus	3	0.3	2.083333333	0.00025	0.704225352	3.314E-05	0.029661855	2.8172205
Draco spilopterus	2	0.2	1.388888889	0.000167	0.469483568	1.10467E-05	0.009887285	1.8682597
Python reticulatus	2	0.2	1.388888889	0.000167	0.469483568	1.10467E-05	0.009887285	1.8682597
Gonocephalus sophiae	1	0.1	0.694444444	8.33E-05	0.234741784	0	0	0.9291862
Dendrelaphis pictus	1	0.1	0.694444444	8.33E-05	0.234741784	0	0	0.9291862
Boiga cynodon	1	0.1	0.694444444	8.33E-05	0.234741784	0	0	0.9291862
Trimeresurus flavomaculatus	1	0.1	0.694444444	8.33E-05	0.234741784	0	0	0.9291862
Amphibians								
Hylarana similis	61	0.7	4.861111111	0.005083	14.31924883	0.02021541	18.09373146	37.274091
Limnonectes macrocephalus	20	0.2	1.388888889	0.001667	4.694835681	0.002098868	1.878584141	7.9623087
Fejervarya vittigera	7	0.7	4.861111111	0.000583	1.643192488	0.00023198	0.207632984	6.7119366
Platymantiscornutus	2	0.2	1.388888889	0.000167	0.469483568	1.10467E-05	0.009887285	1.8682597
Polypedates sp.	2	0.1	0.694444444	0.000167	0.469483568	1.10467E-05	0.009887285	1.1738153
Rana luzonensis	1	0.1	0.694444444	8.33E-05	0.234741784	0	0	0.9291862
TOTAL	426		100		100		100	300

(Herpetofauna) **Reptiles and Amphibians**

Herpetofaunal assessment was also conducted in Baler Forest Reserve and Dibut River Watershed. A total of 13 species of reptiles and amphibians were recorded and identified. Seven species of reptiles belonging to five Families were identified; two Colubridae and two Agamidae. One species each from Pythonidae, Varanidae, and Viperidae was also identified. A total of six species of amphibians were also recorded. The six species were identified up to genus and species level belonging to three Families, four species from Ranidae Family and one species each for Families Ceratobatrachidae and Rhacoporidae.

Importance Value Index (IVI) of Animals Surveyed

Table 2 presents the animals with the highest importance value index (IVI) for each class.

Table 2. Animals with the highest number of importance value index (IVI) present in Baler Forest Reserve and Dibut River Watershed.

Class	Species Name	Importance Value Index (IVI)
Birds	*Penelopides manillae*	12.13
Mammals	*Ptenochirus jagori*	62.67
Reptiles	*Varanus marmoratus*	2.81
Amphibians	*Hylarana similis*	37.27

Results revealed that *Ptenochirus jagori* obtained the highest importance value index of 62.67%. The Greater Musky Fruit Bat (*P. jagori*) is endemic in the Philippines. This frugivorous tree and cave roosting species, which occurs from sea level to at least 1,950 m, is abundant in primary forest and common in secondary forest (Ong et al., 2008). This is followed by an amphibian *Hylarana similis,* with 37.27% IVI. The True Frog (*H. similis*) inhabits in undisturbed and disturbed streams and rivers in lower montane and lowland forests. It breeds and lays its eggs in clean streams and rivers, and the larvae develop in quiet side pools. This species is native in the Philippines and listed as near threatened because its extent of occurrence and quality of its habitat are probably declining, thus making the species close to qualifying for vulnerable status (Diesmos et al., 2004).

On the other hand, Penelopides manillae got 12.13% IVI while Varanus marmoratus obtained 2.81% IVI. P. manillae is also native in the Philippines, found commonly in moist lowland forest and wetlands of permanent rivers, streams, and creeks. The population of this species is suspected to be in decline locally because of habitat destruction and hunting for food and trade (Birdlife International, 2012). Furthermore, V. marmoratus is widely distributed in Luzon island occurring in protected areas and is having a large population. This species is tolerant of habitat degradation and is regularly recorded from secondary forest, disturbed forest, and agricultural areas. The major threats to V. marmoratus are heavy trading of the species for food and pet purposes and the capture of their hatchlings and juveniles (Gaulke et al., 2009).

Species Diversity

Table 3 shows the various diversity indices of vertebrates in Baler Forest Reserve and Dibut River Watershed. Shannon's Diversity Index shows that the ten (10) stations observed in the watersheds have low avian diversity, with a value of 2.48. Shannon's Index of Diversity also shows that mammals, reptiles, and amphibians have very low diversity, with values of 1.53, 1.84, and 1.01, respectively. Still, these values imply low diversity with regard to the three groups of vertebrates. This is because of the low number in species observed and low number of individuals recorded. Many of the vertebrates observed had only one to two individuals in all of the 10 stations observed in Baler Forest Reserve and Dibut River Watershed. The low diversity of the animals in the forest ecosystem of Baler Forest Reserve and Dibut River Watershed may also be the result of human activities such as wildlife hunting and habitat destruction caused by timber poaching, mining, and kaingin farming system.

Table 3. Diversity indices of four groups of animals in Baler Forest Reserve and Dibut River Watershed.

Group	# of Species	# of Individuals	Diversity Index	Interpretation
Birds	17	91	2.48	Low
Mammals	10	231	1.53	Very Low
Reptiles	7	11	1.84	Very Low
Amphibians	6	93	1.01	Very Low

Biodiversity Indicators

Greater Musky Fruit Bat (*Ptenochirus jagori*) obtained the highest biodiversity indicator value of 88% followed by Philippine Tailless Leaf-nosed Bat (*Coelops hirsutus*) with 8.82% and True Frog (*Hylarana similis*) with 61% biodiversity indicator values (Table 4). The findings could be because of the high number of individuals of the species observed and their wide spread distribution. The other groups of animals (mammals, reptiles, and amphibians) showed very few numbers of individuals and were less distributed (Table 4).

Mammals and birds had high biodiversity indicator value with more than 80% indicator value. Biodiversity indicators are quantitative data to measure aspects of biodiversity, ecosystem condition, ecosystem services, and drivers of change. They help explain how biodiversity is changed over time and space (UNEP, 2013). These are species whose presence or absence affects the biodiversity of a particular area. They can serve as important sources of food for the other species, and they can serve as indicators of habitat/ecosystem conditions. Species with more than 80% biodiversity indicator values are considered as biodiversity indicator species.

The presence of these species is important in determining the habitat/ecosystem condition and the disturbances experienced in the area. The absence of these species may mean that the area is disturbed or is not in good condition anymore. Hence, biodiversity indicator may form as an essential part of monitoring and assessment to give the status of biodiversity in the area.

Table 4. Animals in Baler Forest Reserve and Dibut River Watershed with high biodiversity indicator values.

Species	Indicator value (%)
Ptenochirus jagori	88
Coelops hirsutus	84
Hylarana similis	61
Rattus everetti	21
Limnonectes macrocephalus	20
Penelopides manillae	20

Ecological Status of Animal Species in the Forest Ecosystem of Baler Forest Reserve and Dibut River Watershed

Table 5 presents the ecological status of animal species in the forest ecosystem of Baler Forest Reserve and Dibut River Watershed. Based on the latest IUCN Red List (2014.2), one species of amphibian was evaluated as vulnerable species. These species also have decreasing population trend; thus, they are very much threatened by habitat loss and other ecological disturbances. There was also one near threatened species of bird, one near threatened species of mammal, and three near threatened species of amphibians. Two (2) species had not yet been evaluated, and four species were data deficient. There were also 15 bird species, eight mammalian species, three reptiles, and two amphibians which were observed in Baler Forest Reserve and Dibut River Watershed and were listed as least concern. Some of these species have stable and unknown trend population. However, 11 species were evaluated with decreasing population. In the future, these animals may therefore become threatened and vulnerable because of the threats in their habitat. Furthermore, based on the DAO 2004-15 lists of threatened species, brahminy kite (*Haliastur indus*), a bird, was evaluated as endangered species. Moreover, Macaca fascicularis philippinensis and Python reticulatus were also listed as other threatened species.

Table 5. Ecological status of animal species observed
in Carranglan Watershed, Carranglan.

Fauna	*Scientific Name*	Conservation Status and Population Trend	
Birds		**IUCN 2013.1**	**DAO 2004-15**
Golden-crowned Babbler	*Stachyris dennistouni*	Near-threatened (D)	—
Red Keeled Flower pecker	*Dicaeum australe*	Least Concern (S)	—
Yellow-wattled Bulbul	*Pycnonotus urostictus*	Least Concern (S)	—
Grey Nightjar	*Caprimulgus jotaka/ indicus*	Least Concern (S)	—
Rufous Paradise Flycatcher	*Terpsiphone cinnamonea*	Least Concern (S)	—
Grey Wagtail	*Motacilla cinerea*	Least Concern (S)	—
Philippine Bulbul	*Hypsipetis philippinus*	Least Concern (S)	—

Blue-headed Fantail	*Rhipidura cyaniceps*	Least Concern (S)	—
Brown Shrike	*Lanius cristatus*	Least Concern (D)	—
Blue-eared Kingisher	*Alcedo meninting*	Least Concern (D)	—
White-browed shama	*Copsychus luzoniensis*	Least Concern (D)	—
Brahminy kite	*Haliastur indus*	Least Concern (D)	Endangered
Philippine Frogmouth	*Batrachostomus septimus*	Least Concern (D)	—
Luzon Tarictic Hornbill	*Penelopides manillae*	Least Concern (D)	—
Common Kingfisher	*Alcedo atthis*	Least Concern (U)	—
Spotted Kingfisher	*Actenoides lindsayi*	Least Concern (U)	—
Island Swiftlet	*Aerodramus inquietus*	Not Evaluated (U)	—
Mammals			
Philippine Long-tailed Macaque	*Macaca fascicularis philippinensis*	Near-threatened (D)	Other Threatened Species
Phil. Pygmy Fruit Bat	*Haplonycteris fischeri*	Least Concern (S)	—
Long-tongued Nectar Bat	*Macroglossus minimus*	Least Concern (S)	—
Greater Musky Fruit Bat	*Ptenochirusjagori*	Least Concern (S)	—
Philippine Forest Rat	*Rattus everetti*	Least Concern (S)	—
Common Palm Civet	*Paradoxurus hermaphroditus*	Least Concern (S)	—
Lesser short-nosed fruit bat	*Cynopterus brachyotis*	Least Concern (U)	—
Large Luzon Forest Rat	*Bullimus luzonicus*	Least Concern (U)	—
Luzon Montane Forest Mouse	*Apomys datae*	Least Concern (U)	—
Philippine Tailless Leaf-nosed Bat	*Coelops hirsutus*	Data Deficient (U)	—
Reptiles			
Dog-toothed cat snake	*Boiga cynodon*	Least Concern (S)	—
Philippine Pit Viper	*Trimeresurus flavomaculatus*	Least Concern (S)	—

Philippine Flying Dragon	*Draco spilopterus*	Data Deficient (U)	—
Reptiles			
Negros Forest Dragon	*Gonocephalus sophiae*	Data Deficient (U)	—
Marbled Water Monitor	*Varanus marmoratus*	Data Deficient (U)	—
Reticulated Python	*Python reticulatus*	Not Evaluated (U)	Other Threatened Species
Painted Bronzeback	*Dendrelaphispictus pictus*	Least Concern (U)	—
Amphibians			
Horned Forest Frog	*Platymantiscornutus*	Vulnerable (U)	—
True Frog	*Hylaranasimilis*	Near Threatened (D)	—
Luzon Fanged Frog	*Limnonectes macrocephalus*	Near Threatened (D)	—
Everett's Frog			
Rana luzonensis	*Near Threatened (D)*	—	
Luzon Wart frog	*Fejevarya vittigera*	Least Concern (S)	—
Common Tree Frog	*Polypedates sp.*	Least Concern (S)	—

Major Sources of Environmental Degradation

Illegal logging or timber poaching posed a major impact on environmental degradation in Baler Forest Reserve and Dibut River Watershed. Mining, kaingin, soil erosion/silt runoff, and charcoal making got moderate impacts on the degradation of the watershed. Fires and wildlife hunting done by the local people posed small impacts on the Baler Forest Reserve and Dibut River Watershed (Table 6).

These threats and problems present in the forest ecosystem had great impacts on the biodiversity of the forest ecosystems especially to those species which had been listed in the IUCN Red List and DAO 2004-15. If the area loses valuable floral diversity, the fauna will also be threatened. The loss of biodiversity thus threatens the balance of the ecosystem and the available resources for all the living things associated with the forest ecosystem. Furthermore, a disruption of this biodiversity will also disrupt the normal cycle of nutrients, organic substances, and water and energy flow in the forest ecosystem.

Table 6. Sources of environmental degradation in the three forest ecosystem of Baler Forest Reserve and Dibut River Watershed.

Sources of Environmental Degradation	Computed Value	Interpretation
Illegal logging/timber poaching	3.26	Major impact
Mining	3.25	Moderate impact
Kaingin	2.97	Moderate impact
Soil erosion/silt runoff	2.69	Moderate impact
Charcoal making	2.63	Moderate impact
Fires	2.39	Small impact
Hunting	2.18	Small impact

CONCLUSION

There were only a few species of animals recorded in Baler Forest Reserve and Dibut River Watershed. The status of the diversity of fauna in the forest ecosystem of Baler Forest Reserve and Dibut River Watershed ranges from low to very low. This could be because of the environmental threats which posed major, moderate, and small impacts on the forest ecosystems and the disturbances made by the people living near and inside the forest ecosystems such as illegal logging/timber poaching, soil erosion, kaingin farming, mining, wildlife hunting, and quarrying. These major sources of environmental degradation present in the forest ecosystem had great impacts on the biodiversity of the forest ecosystems.

RECOMMENDATIONS

Based on the results of the study, the following are being recommended:

1. Biodiversity assessment studies should be undertaken in other forest ecosystems in Central Luzon which have not been studied yet in order to complete the Biodiversity Information System (BIS) in the area.

2. Local ordinances pertaining to "Biodiversity Conservation" should be done by the local community to preserve and conserve wildlife and those plants that are now critically endangered, endangered, threatened, and vulnerable.

3. Biodiversity monitoring should be regularly conducted specifically

to monitor the status of biodiversity and the status of the identified biodiversity indicators in this study.

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