INVENTORY AND ASSESSMENT OF BIODIVERSITY RESOURCES OF MOUNT TAPULAO, ZAMBALES, LUZON ISLAND, PHILIPPINES

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DILIMAN SCIENCE RESEARCH FOUNDATION INC.

In Partnership with

Protected Areas and Wildlife Bureau

New Conservation Areas in the Philippines Project

In Cooperation with the

Municipalities of Iba, Masinloc and Palauig, Zambales

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Executive Summary

An inventory and assessment of the biodiversity (flora and fauna) of Mount Tapulao were conducted from 9-15 August 2012 and 20 September to 25 October 2012. Seven elevational gradients across different major forest types were surveyed. The study sites were located in three municipalities on the western side of Mount Tapulao: the municipality of Palauig, where five study sites were located, and the municipalities of Iba and Masinloc, with one site each.

Plants and Forest Types

Inventory of flora and habitat assessment were undertaken using the variable transect method developed by Foster et al. 1998. Seven variable transects were established across different elevational gradients to characterize the forest types in Mt. Tapulao, where the fauna sampling was conducted. Using Fernando et al (2008b) as guide and based on the data generated (e.g. the family to which the dominant tree species belonged to), five forest types were identified. These include: (i) tropical semi-evergreen rainforest; (ii) tropical lowland evergreen rainforest; (iii) tropical lower montane rainforest, including the pine forest; (iv) tropical upper montane rainforest; and (v) tropical sub-alpine forest.

Additional plant collections were made in the vicinity of transects to complement the data from each transect.

In terms of plant diversity, a total of 304 species and morpho-species of plants were recorded using the variable transect method, of which 34% (102 species) were identified to the species level. Of the 102 species identified to the species level, 40% (41 species) are endemic to the Philippines, of which 6% (6 species) are restricted only to Luzon Island. Another 33 species of plants were collected in the vicinity of transects. Of these, six species are Philippine endemics and another four species are Luzon endemics. The figures on Philippine and Luzon endemics are likely to go higher once the identification of the morphospecies is finalized and their endemicity is determined as well.

Furthermore, a total of 14 species in the transects and another three species in its vicinity are listed as threatened based on Department of Environment and Natural Resources Administrative Order (DAO) 2007-1 (Fernando et al. 2008a), with one species (*Tristaniopsis decorticata*) being critically endangered (CR). Of these threatened species, 11 species are endemics, of which two are found outside the transects.

Pitcher plants and orchids abound in the sampling areas and they are species of interest as they are highly valued by plant collectors and enthusiasts. Specific conservation measures should be put in place to ensure that their utilization will not lead to over-exploitation.

Animals

A combination of various methods was used to sample vertebrate taxa such as mist netting for birds and bats, line transect surveys for birds, amphibians and reptiles and cage trapping of small mammals. These methods were used to document species richness and diversity. Relative abundance was computed for each taxon per elevational gradient by dividing the total number of individuals per species by the total number of mist net, trap or hours spent for each elevation.

A total of 142 species of amphibians, reptiles, birds and mammals were recorded in Mt Tapulao, of which 55% are endemic to the country. Among these, two species of murid rodents are found only in Mount Tapulao (e.g. *Rhyncomys tapulao* and *Apomys brownorum*). The former was caught only in the tropical upper montane rainforest between 1820m and 2035m while the latter was caught over a wider range of elevation, from 600 m to 2035 m.

Among the bats, *Desmalopex leucopterus* (Mottled winged flying fox) and *Myotis rufopictus* (Orange-fingered myotis) were the two bat species that were collected for the first time on Mt. Tapulao. The mottled winged flying fox was caught in the tropical lowland evergreen rainforest of Iba and tropical semi-evergreen rainforest (forest fragment) in Masinloc municipality while *M. rufopictus* was caught in the tropical upper montane rainforest at 2035 m of Palauig. The capture of both species represents new distribution record for Zambales province while the capture of the *M. rufopictus* represents new elevational distribution for the species.

Among the bird assemblage, we documented three species categorized as Vulnerable by the IUCN (*Ptilinopus marchei, Bubo philippensis* and *Zoothera cinerea*). None of the species of amphibians and reptiles recorded was under any of the IUCN threat category. Furthermore, we suspect that some species could represent new species or new records for Luzon Island such as the snake under the genus *Oxyrhabdium* and the forest frog of the genus *Platymantis*, subject to final identification.

Species richness and relative abundance varied between taxa. Species richness of birds, bats, amphibians and reptiles was highest in the tropical lowland evergreen rainforest between 600m and 896m while species richness of small mammals, such as rodents, increased with elevation. However, one notable exception was that of a bat species, *Otopteropus cartilagonodus*, where their relative abundance increased with elevation. Another exceptional pattern was also observed in *Platymantis* cf *montanus*, where the species was found only in the tropical lower montane rainforest at 1600 m.

Of the 43 endemic species of birds, six species are restricted in the tropical lower montane, upper montane rainforest and sub-alpine forest while 17 are found only in the in the tropical lowland evergreen rainforest. Although bird species richness was high in the tropical semi-evergreen rainforest (forest fragment), the number of endemic species and non-endemic was greater in the tropical lower and upper montane rainforest and tropical sub-alpine forest, with the highest number of endemics recorded in the tropical lowland evergreen rainforest.

A similar pattern was also observed in small mammals where endemicity was greatest in the tropical upper montane rainforest and tropical sub-alpine forest than in the tropical semi-evergreen rainforest (forest fragment) despite the fact that species richness remained the same.

Insights and Recommendations

The results of the inventory and assessment demonstrate that different species have different habitat preferences, as some species were observed to be abundant in certain habitat/elevations than others while other species are restricted to certain elevations or habitats. Consequently, when developing management programs for Mt Tapulao, it means that all forest types should be given equal importance as different forest types will protect a specific assemblage of plants and animals. There is a risk that survival of certain assemblage of plants and animals might be jeopardized if the implication of these results is not realized at the onset.

Hence, the urgent need to place the various forest types under some form of conservation cannot be overstated. Setting conservation priorities is also important in the management of the conservation area. Species richness and the quality of species in each habitat type also need to be established in the identification of priority areas for protection and conservation actions.

Furthermore, our data on the diversity and abundance of small mammals in Mt Tapulao support the prediction that the presence of native non-volant mammals in old growth or disturbed forest habitats prevents the intrusion of non-native non-volant mammals into the forest. Although non-native small mammals were recorded at 1400 m and 1700m where tropical lower montane rainforest is relatively intact, its presence at higher elevation was limited to areas where man-made disturbance such as the mining road is present. But none of the non-native rodents were caught inside the forest where native species are abundant. This further emphasizes the importance of maintaining the different forest types within the mountain range. It is therefore recommended that all forest areas above 800m should be placed under protection to prevent further degradation of the forest brought by unsustainable anthropogenic activities whereas forest fragments and remnant lowland forests between 600 and 800 m should be placed as habitat restoration zone and forest restoration activities should be a priority activity.

Finally and more importantly, awareness on the importance and benefits of Mt Tapulao by offsite and onsite local communities should be enhanced to prevent hunting and the gathering of wild plants as well as increase the community's appreciation of the importance of the forests of Mount Tapulao and its flora and fauna as well as their participation in its protection and conservation.

ASSESSMENT AND INVENTORY OF BIODIVERSITY RESOURCES OF MOUNT TAPULAO, ZAMBALES, LUZON ISLAND, PHILIPPINES

I. Introduction

Zambales Mountains is considered a high priority conservation area (Mallari et al., 2001; Ong et al., 2002; Conservation International, 2006). It is also a sub-center of mammalian diversity on Luzon Island (Balete et al., 2009). The highest peak in the mountain range is Mount Tapulao at 2,037 meters above sea level (masl). Mt. Tapulao is located in the eastern portion of Zambales between 15˚24'25" and 15˚31'22" latitude and 120˚02'00' and 120˚12'04" longitude. Currently, there is a proposal to declare it as a protected area, with a total land area of 15,690.15 hectares within three municipalities, Palauig, Botolan and Iba. The proposed area encompasses many forest types as well as agricultural areas.

Previously, a study was conducted on the birds of Mt. Tapulao by the National Museum of the Philippines and Cincinnati Museum of Natural History in the early 90s and recorded a total of 67 species (ICBP, n. d.).

Recent studies (1996 to 2005) in the mountain range were mostly taxa based. A survey on amphibians and reptiles in 1992 recorded a total of 13 frogs and 39 reptiles (Brown et al., 1996). This resulted to the rediscovery of *Sphenomorphus beyeri* (Brown et al 1995) while a survey on mammals in 2005 by the Field Museum accounted 11 mammals and the discovery of a new species of shrew rat (*Rhyncomys tapulao*) (Balete et al 2007; 2009). Inventory on the flora of Mt Tapulao was limited and only to plants encountered along the trail with only a total of 66 species of trees, herb, vines and orchids documented (DENR PASA undated).

Although these studies provided a glimpse on the diversity of flora and fauna of Mt Tapulao, its value had been limited. A systematic sampling at different elevations and habitat is warranted to fill in the gaps of the previous studies. The data generated from this inventory and assessment can be used in the development of a management plan for the proposed Mount Tapulao Local Conservation Area.

II. Study Sites and Methodology

Prior to the field survey, a series of meetings with DENR Region 3 personnel were conducted as well as to coordinate the various activities on the ground and to process the necessary permits from the Local Government Units (LGUs). A kick-off meeting was also conducted last July 31, 2012 with the concerned LGUs of Masinloc, Iba and Palauig and other stakeholders wherein the objectives and activities of the biodiversity inventory and assessment were discussed.

The survey on the flora and fauna was originally planned from 6 to 15 August 2012 in Mt Tapulao, Zambales. The team arrived in Palauig municipality on 6 August 2012 and presented to the local government units the project and activities that were planned and would be undertaken.

The survey commenced on 7 August 2012. Unfortunately, the team was only able to climb the mountain on 10 August 2012 because of the continuous heavy rains due to the Habagat phenomenon. Between 10 and 15 August, we were only able to do survey work equivalent to two days' work because of continuous heavy rains. For safety reasons, the team was forced to evacuate from the camp site and abandon the scheduled survey. Thus during this period, we effectively lost 10 working days and managed to get limited information only in the 1820 meters above sea level (masl) elevation for the fauna and only the 1600 masl was covered by the flora team.

Between 19 September and 25 October 25, 2012, the survey was completed as originally planned. The survey sampled seven elevational gradients covering different habitat types (Table 2).

Surveys were conducted in seven sites with varying elevations: five in Palauig Municipality, one each in Iba and in Masinloc, all in Zambales (Table 2, Figure 1). The three municipalities were located along the western slope of Mount Tapulao facing the China Sea.

To characterize the vegetation types found in Mt Tapulao, the variable transect method developed by Foster et al. 1998 was used. Seven transects were established along different elevations from 213 m to 2035m (Table 3). Each transect consisted of six different classes according to plant type. The classes were: Class I - larger trees (transect width 20 m), Class II - medium-sized trees (transect width 10 m), Class III - treelets and saplings (transect width 2 m), Class IV - erect pandan and Arecaceae (transect width 5 m), Class V - herbaceous plants (transect width 5 m), and Class VI - plants attached to trees in Classes I and II (proto-terrestrial herbs, vines, epiphytes, hemi-epiphytes).

Table 1 summarizes the different habitat types in each elevation sampled (see Figure 2 for photos of each habitat types). The top 5 dominant tree family and species recorded in each of the transect line established was used as indicators of habitat types based on habitat description by Fernando et al. (2008b). Detailed results of the transect and habitat description of each sites sampled is presented in Annex 1 of this report.

Sampling of vertebrate fauna (Amphibians, Reptiles, Birds and Mammals,) was also conducted along the different elevational gradient and habitat types covered by the flora survey. Various capture methods were used to record the different vertebrate species. A combination of mist netting for birds and bats, line transect for amphibians and reptiles and birds and trapping of small mammals were used to document the various vertebrate species in each elevation (Table 3). Interviews with local community were also conducted whenever they are encountered to gather additional information about the fauna in the area, specifically on the hunting activities in the area. Timber poaching, hunting and gathering of wild plants were the common repeated man-made disturbance encountered in the area.

Mist nets for birds and bats and Victor rat traps for small mammals were continuously operated for 24 hours for six consecutive days and nights in each elevation sampled and every three days and nights of operation, the traps and nets were transferred to another location.

For amphibians and reptiles, a series of five 100 m line transect were set up in all possible habitat types within each elevation gradient and traversed twice, once in the morning and another in the evening between 09:00 to 11:00 am and 07:00 to10:00 pm, respectively. All

species encountered are collected for documentation purposes and later release collecting only a few specimens for vouchers. A 1-kilometre transect line for birds were set along existing trails and traversed every morning for an hour by two observers for the duration of the survey in each elevation. General observations and collections were also done to survey other areas not covered by the transects.

Geographic locations of fauna survey sites are summarized in Table 2.

The adequacy of our sampling efforts per elevation were computed using "species accumulation curves", whereby sampling effort (in terms of trap-nights or the number of traps set for one night or number of hours of observation) is cumulatively plotted against the cumulative number of species documented at a given site. Once a curve reaches a plateau, the sampling effort was sufficient.

Figure 1. Map showing the location of the different study sites.

Table 1. Summary of transects along different elevational gradient and top 5 dominant tree families and species in Mt. Tapulao, Zambales.

Transect	I	II	III	IV	V	VI	VII
Locality	Mt. Tapulao, Palauig, Zambales	Mt. Tapulao, Palauig, Zambales	Mt. Tapulao, Palauig, Zambales	Mt. Tapulao, Palauig, Zambales	Mt. Tapulao, Palauig, Zambales	Bo. Amungan, Iba, Zambales	Bo. Sta. Rita, Masinloc, Zambales
Elevation (m)	1600-1650	1990-2010	1750-1800	1250-1300	780-800	880-920	200-220
Ave. Height of Emergent Trees (m)	4 to 9	3 to 7	6 to 22	6 to 22	8 to 21	9 to 19	5 to 18
Ave. Diameter at breast height (cm)	15-32	15-40	21-85	20-49	25-55	30-65	25-73
Forest Type	Tropical lower montane forest	Tropical upper montane forest Tropical sub-alpine forest (towards the summit)	Tropical lower montane forest (Pine forest)	Tropical lower montane forest	Tropical lowland evergreen forest	Tropical lowland evergreen forest	Tropical lowland semi-evergreen forest (Forest Fragment)
Dominant Family	Fagaceae	Myrtaceae	Pinaceae	Myrtaceae	Dipterocarpaceae	Dipterocarpaceae	Moraceae
	Magnoliaceae	Fagaceae		Theaceae	Fagaceae	Myrtaceae	Dipterocarpaceae
	Proteaceae	Melastomataceae		Phyllanthaceae	Hamamamelidaceae	Lamiaceae	Rubiaceae
	Myrtaceae	Illiciaceae		Symplocaceae	Theaceae	Fagaceae	Euphorbiaceae
	Theaceae	Lauraceae		Memecylaceae	Myrtaceae	Theaceae	Myrtaceae
Dominant Species	*Lithocarpus sp.4, Magnolia sp., Helicia sp., Gordonia luzonica, Dacrycarpus imbricatus*	*Lithocarpus sp.3, Syzygium sp.1, Syzygium mainitense, Astronia pulchra, Illicium philippinense*	*Pinus kesiya*	*Syzygium congestum, Aporosa sphaeridiophora, Neolitsea sp., Symplocos cochinchinensis var. philippinensis, Mastixia pentandra ssp. philippinensis*	*Shorea polysperma, Lithocarpus sp.3, Sycopsis dunnii, Gordonia luzonica, Teijsmannioden dron ahernianum*	*Shorea polysperma, Teijsmannio dendron ahernianum, Syzygium sp.9, Lithocarpus sp.3, Camellia megacarpa*	*Anisoptera thurifera, Calophyllum blancoi, Nauclea sp., Syzygium sp.3, Ficus sp.1*

Table 2. Summary of geographic locations of fauna survey sites.

Methodology	213 m ASL	600-800 m ASL	1200-1400m ASL	1600- 1669 m ASL	1800-2025 m ASL
Transect (Herps)	N-15 30'28.5	N-15 27'30.2	N-15 27'34.4	N-15 27'57.8	N-15 28'51.8
	E-120 00'56.1	E-120 03'44.7	E-120 05'16.0	E-120 06'34.9	E-120 07'15.9
	N-15 30'26.9	N-15 27'30.2	N-15 27'24.9	N-15 28'00.8	N-15 28'49.0
	E-120 00'59.1	E-120 30'41.7	E-120 05'17.8	E-120 06'34.2	E-120 07'15.6
	N-15 30'20.2	N-15 27'30.6	N-15 27'34.9	N-15 28'00.9	N-15 28'48.4
	E-120 01'03.4	E-120 03'40.9	E-120 0521.1	E-120 06'33.9	E-120 07'17.8
	N-15 30'19.0	N-15 27'31.8	N-15 27'32.5	N-15 27'59.4	N-15 28'45.4
	E-120 01'00.4	E-120 43.2	E-120 05'18.5	E-120 06'33.5	E-120 07'17.5
	N-15 30'18.2	N-15 27 '31.9	N-15 27'31.7	N-15 27'58.6	N-15 28'44.4
	E-120 00'54.4	E-120 03'50.4	E-120 05'15.7	E-120 06'33.4	E-120 07'17.2
	N-15 30'20.1	N-15 27'34.4	N-15 27'31.7	N-15 27'55.8	N-15 28'41.7
	E-120 00'31.4	E-120 03'51.5	E-120 05'15.0	E-120 06'32.3	E-120 07'16.2
	N-15 30'21.0	N-15 27'36.2	N-15 27'34.8	N-15 27'54.2	N-15 28'40.5
	E-120 00'38.7	E-120 03'51.1	E-120 05'13.1	E-120 06'31.9	E-120 07'14.4
	N-15 30'21.2	N-15 27'37.8	N-15 27'33.9	N-15 27'56.9	N-15 28'38.2
	E120 00'42.2	E-120 03'48.3	E-120 05'10.6	E-120 06'29.6	E-120 07'11.5
	N-15 25'00.4	N-15 27'13.6			N-15 28'37.8
	E-120 04'30.0	E-120 04'05.2			E-120 07'11.2
	N-15 24'59.0	N-15 27'12.5			N-15 28'35.4
	E-120 04'30.1	E-120 04'04.9			E120 07'10.1
	N-15 24'54.5	N-15 27'26.8			N-15 28'35.0
	E-120 04'30.2	E-120 04'06.3			E-120 07'08.8
	N-15 24'54.6	N-15 27'27.9			N-15 28'33.0
	E-120 04'28.6	E-120 04'04.1			E120 07'10.4
	N-15 24'54.4	N-15 24'56.9			N-15 28'32.0
	E-120 04'27.9	E-120 04'32.3			E-120 07'07.2
	N-15 24'51.9	N-15 25'00.3			N-15 28'30.0
	E-120 04'26.9	E-120 04'31.6			E-120 07'06.7
Mist-netting (birds and bats) and trapping (small mammals)	N-15 30'32.7	N-15 27'15.4	N-15 27'35.0	N-15 27'35.0	N-15 27'56.6
	E-120 00'44.0	E-120 04'21.7	E-120 05'07.9	E-120 05'07.9	E-120 06'27.8
		N-15 24'54.5	N-15 27'53.7	N-15 27'98.7	N-15 28'29.2
		E-120 04'38.2	E-120 05'54.7	E-120 06'49.2	E-120 07'06.7
					N-15 28'32.6
					E-120 07'07.3
					N-15 28'33.2
					E-120 07'07.6
					N-15 28'51.9
					E-120 07'15.8
					N-15 28'56.6
					E-120 07'16.2
Transect line (birds)	N-15 30'32.7	N-15 27'15.4	N-15 27'32.5	N-15 27'98.7	N-15 28'26.5
	E-120 00'44.0	E-120 04'21.7	E-120 05'09.6	E-120 06'492	E-120 07'03.5
		N-15 27'31.2	N-15 27'98.7	N-15 28'26.5	N-15 28'52.3
		E120 03'44.7	E-120 06'49.2	E-12007'03.5	E-120 07'14.6
		N-15 24'54.5			
		E-120 04'38.2			

Table 3. Summary of fauna survey sites in Mt Tapulao, Zambales.

Municipality	Sites	Elevation (m)	Habitat	No. of days	Trap nights	Net nights (Bats)	Net days (Birds)	Bird Transect efforts (hours)	Amphibians and Reptiles transect efforts (hours)
Palauig	Site 1	1600 and 1669	Tropical lower montane	6	-	100	118	-	11
	Site 2	2035	Tropical sub-alpine forest	6	1122	135	135	5	11
	Site 3	1820	Tropical upper montane	6	995				
	Site 4	1200 and 1403	Tropical lower montane	5	1305	190	190	6	17
Palauig	Site 5	600 to 800	Tropical lowland evergreen	4	800	190	170	5	22
Iba	Site 6	896	Tropical lowland evergreen	5	675	175	175	5	13
Masinloc	Site 7	218	Tropical semi-evergreen forest (Forest Fragment)	4	804	140	175	4	10
			Total	36	5701	930	963	25	91

Figure 2. Different habitat types in Mt. Tapulao, Zambales; A. Tropical Sub-Alpine Forest; B. Tropical Upper Montane Forest; C. Tropical Lower Montane Forest; D. Pine Forest; E. Tropical Lowland Semi-Evergreen Forest, and F. Tropical Lowland Evergreen Forest.

III. Results

Amphibians and Reptiles

Our sampling effort for amphibians and reptiles varied per elevation (Figure 2). Line transects were established to cover all possible microhabitats. Only sampling sites at 1901 m, 1690 m and 1290 m were deemed sufficient. The three elevations have more than 10 hours of sampling effort. However, sampling sites at 835 and 845 m did not reach a plateau despite sampling effort was more than 10 hours. This is expected as species richness for amphibians and reptiles is greater in the lowland forest and decreases with elevation (Diesmos and Brown 2010). Sampling effort at 218m was only 10 hours because of the limited size of the sampling area and all possible microhabitats were already covered.

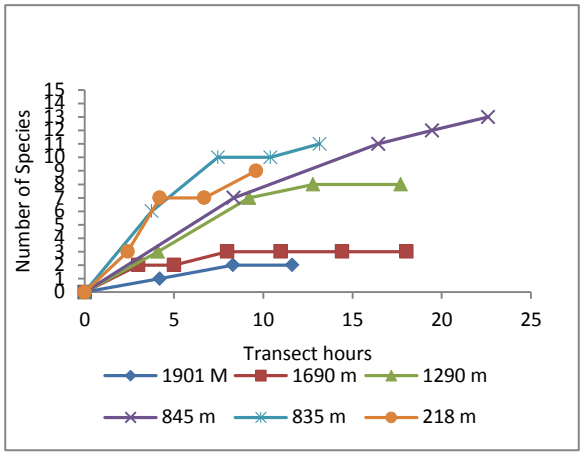

Figure 3. Species effort curve for Amphibians and Reptiles.

Amphibian Species Richness and Relative Abundance

A total of nine species of amphibians were collected. Of these, only two were not endemic to the Philippines, while three species are Philippine endemic and another four species are confined only to Luzon Island (Table 4). Species richness was highest at 835 and 845 m and decreased with elevation (Figure 3). The most common species encountered was *Hylarana similis* and *Limnonectes macrocephalus*. Both species were found only in elevation between 218 and 845 m and associated with water bodies. *Philautus cf montanus* was captured/observed only at 1290 and 1690m while *Kaloula kalingensis* was found from 845 m to 1901 m.

Table 4. Summary of number of species of amphibians recorded in Mount Tapulao, Zambales.

Family/Species	English Name	Endemicity
Rhacophoridae		
1. Polypedates leucomystax	White-lipped Tree Frog	non endemic
2. Platymantis cf. montanus	Mountan Forest Frog	Philippine endemic
Microhylidae		
3. Kaloula kalingensis	Kalinga Narrowmouth Frog	Philippine endemic
Ranidae		
4. Occidozyga laevis	Common Puddle Frog	non endemic
5. Platymantis mimulus	Diminutive Forest Frog	Luzon endemic
6. Platymantis corrugatus	Rough-backed Forest Frog	Philippine endemic
7. Limnonectes macrocephalus	Luzon Fanged Frog	Luzon endemic
8. Hylarana similis	Luzon Stream Frog	Luzon endemic
9. Sanguirana luzonensis	Luzon Slender Stream Frog	Luzon endemic

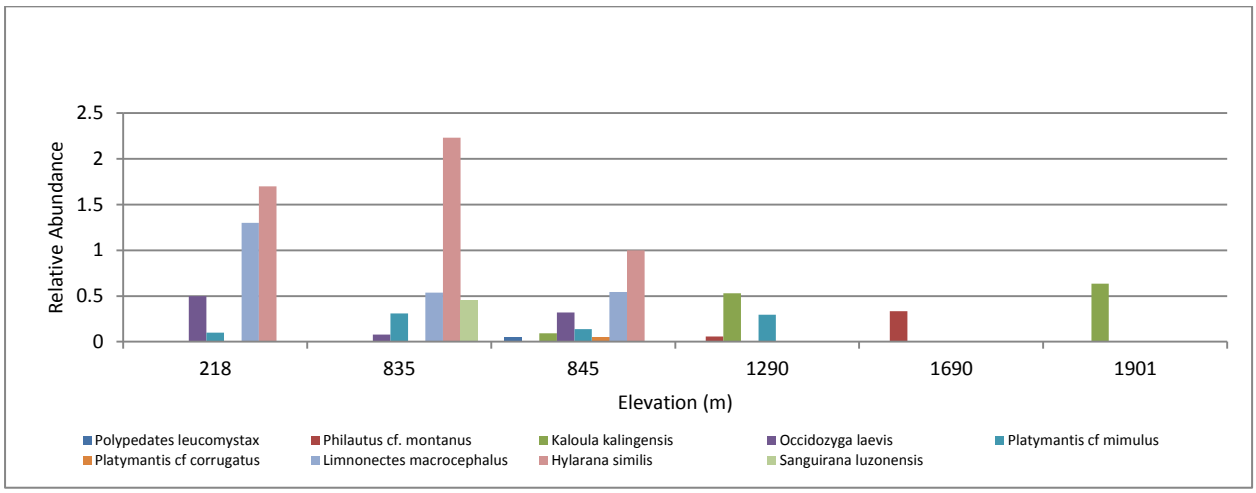

Figure 4. Relative abundance of amphibians along the different elevational gradient surveyed in Mt. Tapulao.

Reptiles Species Richness and Relative Abundance

A total of 19 species of reptiles were documented. Of these, three are non-endemic, 11 are Philippine endemics to the country while another two species are found only on Luzon Island (Table 5). Three species of snakes needs further identification by comparing it with existing known species in the country. It was not possible to estimate the relative abundance of snakes and lizard because of the small sample size. Instead, we plotted the number of individual encountered per elevation to determine species richness along different elevation (Figure 4 and Figure 5). Among the Lizards and skinks, the most common was *Parvoscincus decipiens* and *Parvoscincus boyingi* while for snakes, the most commonly encountered was *Oxyrhabdium sp.* The most number of lizards was observed at elevation between 840 m and 1290 m and at 217 m while species richness of snake was highest in the tropical lower montane forest at 1286 m.

Table 5. Summary of reptiles recorded in Mount Tapulao, Zambales.

Family/ Species	English Name	Endemicity
Varanidae		
1. Varanus marmoratus	Monitor Lizard	Luzon endemic
Scincidae		
2. Parvoscincus decipiens	Black-sided Sphenomorphus	Philippine endemic
3. Parvoscincus boyingi	Boying's Zambales Mountain skink	Luzon endemic
4. Eutropis multicarinata		non endemic
5. Eutropis cumingi	Cuming's Mabuya	Philippine endemic
6. Pinoyscincus jagori	Jagor's Sphenomorphus	Philippine endemic
Gekkonidae		
7. Cyrtodactylus philippinicus	Philippine Bow-fingered Gecko	Philippine endemic
Agamidae		
8. Draco bimaculatus	Two-spotted Flying Lizard	Philippine endemic
Typhlopidae		
9. Typhlops sp.	Blind Snake	
Lamprophiidae		
10. Oxyrhabdium sp	Shrub Snake	
Viperidae		
11. Trimeresurus flavomaculatus	Philippine pit viper	Philippine endemic
Colubridae		
12. Tropidonophis dendrophiops	Spotted Water Snake	Philippine endemic
13. Cyclocorus lineatus	Reinhardt's Lined Snake	Philippine endemic
14. Calamaria gervaisi	Philippine Dwarf Snake	non endemic
15. Hologerrhum cf philippinum	Philippine Stripe-lipped Snake	Philippine endemic
16. Dryophiops cf philippina	Philippine Whip Snake	Philippine endemic
17. Lycodon sp.		
Elapidae		
18. Hemibungarus calligaster	Barred Coral Snake	Philippine endemic
19. Elaphe erythrura	Philippine Rat Snake	Non endemic

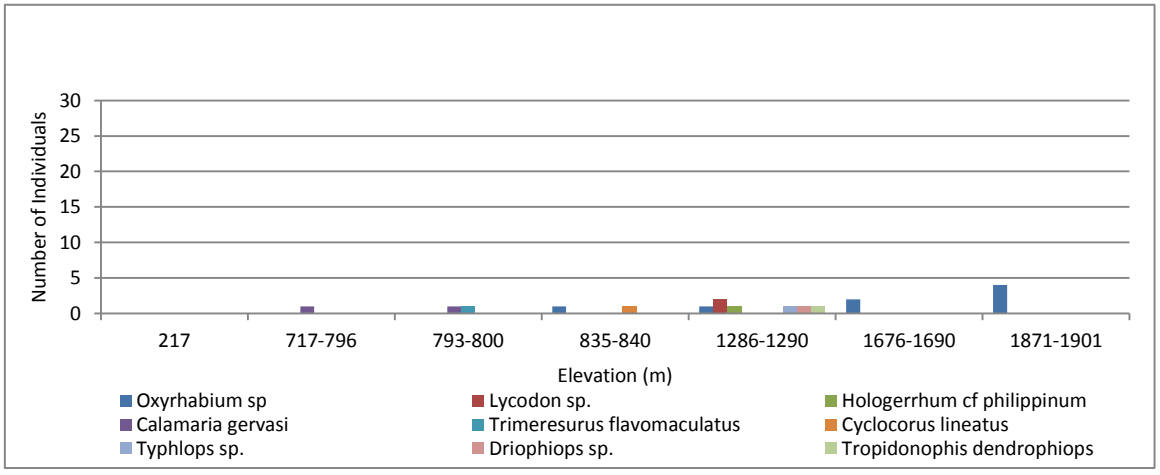

Figure 5. Graph showing the number of individuals per species of snakes along different elevation gradient in Mount Tapulao, Zambales.

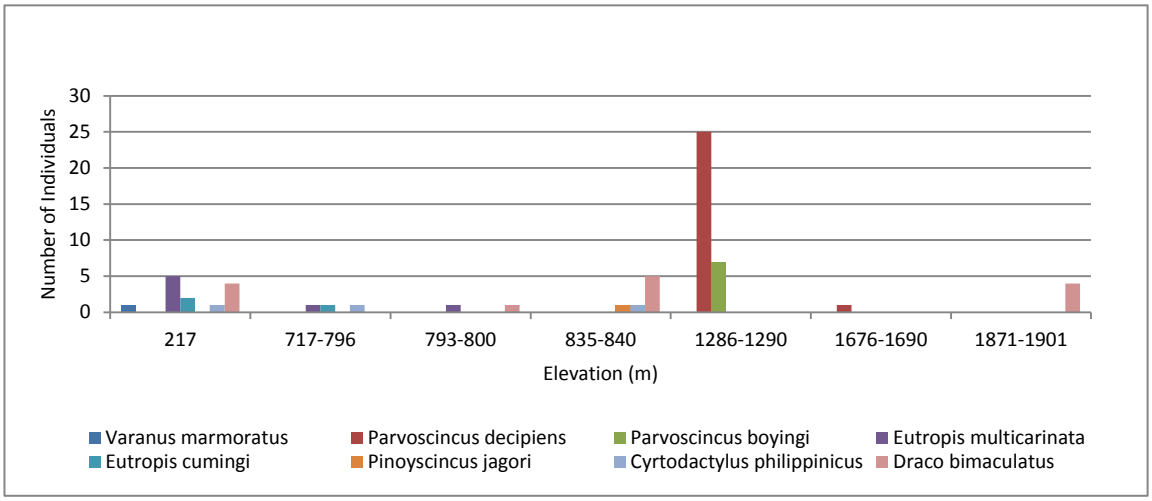

Figure 6. Graph showing the number of individuals per species of lizards and skinks along different elevation gradient in Mount Tapulao, Zambales.

Mammals

Adequacy of sampling

Our sampling for small mammals was deemed sufficient as all of our efforts reached an asymptote except for our trapping effort at 2005 m (Figure 6). However, we do not expect additional species to be recorded as we have already captured all possible species present at the given elevation (see Balete et al 2009). The sudden increase of the species effort curve in the last night of transect was the addition of *Rhyncomys tapulao*. The last species that we expect to capture in this elevation.

For bats, species effort curve was plotted only for fruit bats as the number of insectivores captured were too low to discern any pattern and that we only used mist nets which could have affected our capture success of insectivorous bats (Figure 7).

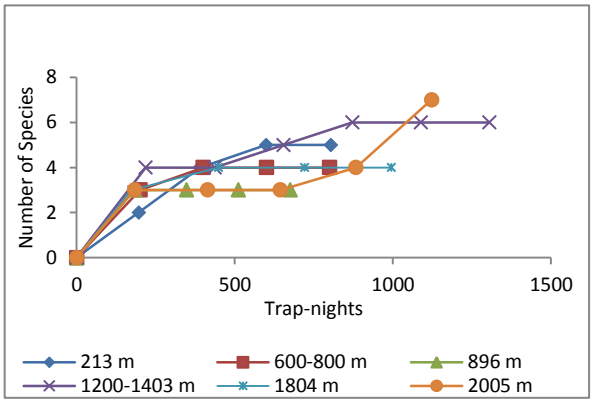

Figure 8. Species effort curve for small mammals along different elevational.

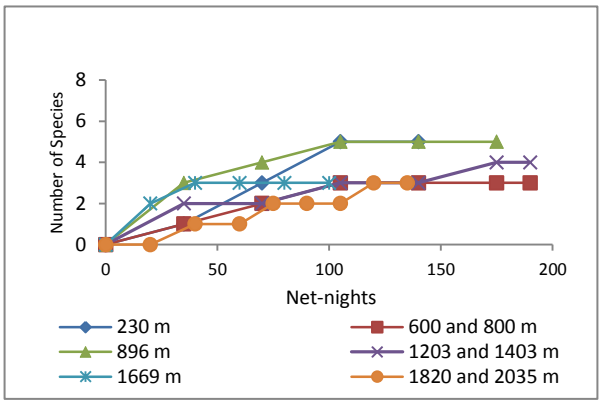

Figure 7. Species effort curve for fruit bats along different elevational gradient.

We documented a total of 28 species of mammals which included 2 species of shrews, 9 species of rodents, 7 species of fruit bats, 7 species of insectivorous bats, 1 deer, 1 civet cat and 1 wild pig, (Table 6). Among these, 61% are endemic to the Philippines where four species (3 rodents and 1 fruit bat) are endemic to Luzon Island and two rodents endemic to Mount Tapulao. Species richness of native rodents (Muridae) was observed to increase with elevation. This observation is consistent with other studies on elevational gradient on native mammals on Luzon island (Heaney et al 2011, Duya et al 2011, Rickart et al 2011, Balete et al 2011).

Relative Abundance of small mammals

Relative abundance of small mammals was computed by dividing the total number of individuals of each species by the total number of trap nights. Relative abundance of small mammals was observed to increase as elevation increased (Figure 8). The most common species of small mammals was *Apomys brownorum* and was found from 600 m to 2005 m. The least common was *Rhyncomys tapulao* represented only by one individual and was caught only at 2005m. Both species are found only in Mount Tapulao. *Bullimus luzonicus* was only found at 600 m to 1403m and was most common at 896m while *Rattus everetti* has a much wider range and was found from 213 m to 1820m. The latter species is a Luzon endemic while the former is Philippine endemic. *Chrotomys mindorensis*, another Philippine endemic was found at 213m and 600 m. Although the species was recorded at 1600 m (Balete et al 2009) thus its elevational distribution overlaps with *Rattus everetti* and *Bullimus luzonicus*.

Table 6. Summary of mammals recorded during the survey in Mount Tapulao, Zambales.

	Species	English Name	Endemicity
Soricidae			
1	*Crocidura grayi*	Luzon Shrew	Philippine endemic
2	*Suncus murinus*	Asian house shrew	Non endemic
Muridae			
3	*Apomys microdon*	Small Luzon forest mouse	Luzon endemic
4	*Apomys musculus*	Least Philippine forest mouse	Luzon endemic
5	*Apomys brownorum*	Brown's forest mouse	Site endemic
6	*Bullimus luzonicus*	Large Luzon forest rat	Luzon endemic
7	*Chrotomys cf mindorensis*	Lowland striped shrew rat	Philippine endemic
8	*Rattus everetti*	Common Philippine Forest rat	Philippine endemic
9	*Rattus exulans*	Polynesian rat	Non endemic
10	*Rattus tanezumi*	Oriental house rat	Non endemic
11	*Rhyncomys tapulao*	Tapulao shrew rat	Site endemic
Pteropodidae			
1	*Cynopterus brachyotis*	Short nosed fruit bat	Non endemic
2	*Haplonycteris fischeri*	Fischer's pygmy fruit bat	Philippine endemic
3	*Macroglossus minimus*	Dagger toothed flower bat	Non endemic
4	*Otopteropus cartilogonodus*	Luzon Pygmy Fruit bat	Luzon endemic
5	*Ptenochirus jagori*	Musky Fruit bat	Philippine endemic
6	*Desmalopex leucopterus*	Mottled winged flying fox	Philippine endemic
7	*Rousettus amplexicaudatus*	Common rousette	Non endemic
Rhinolophidae			
8	*Rhinolophus virgo*	Yellow faced horseshoe bat	Philippine endemic
9	*Rhinolophus arcuatus*	Arcuate horseshoe bat	Non endemic
10	*Rhinolophus philippinensis*	Enormous-eared horseshoe bat	Philippine endemic
Vespertilonidae			
11	*Myotis cf horsefieldii*	Common Asiatic Myotis	Non endemic
12	*Myotis rufopictus*	Orange Fingered Myotis	Philippine endemic
13	*Miniopterus schreibersi*	Common bent winged bat	Non endemic
14	*Tylonycteris pachypus*	Lesser bamboo bat	Non endemic
Cervidae			
15	*Cervus marianus*	Philippine deer	Philippine Endemic
Viveridae			
16	*Paradoxurus hermaphroditus*	Common palm civet	Non endemic
Suidae			
17	*Sus philippinensis*	Philippine warty pig	Philippine Endemic

Non-native species of rodents, *Suncus murinus* and *Rattus exulans* were recorded at 213m and 1403 m. An individual *Suncus murinus* was caught by hand at 1700m along an old mining road and individuals caught at 1403m were in traps placed at the edge of the forest. The presence of these non-native species in these elevations can be attributed to the presence of the old mining roads.

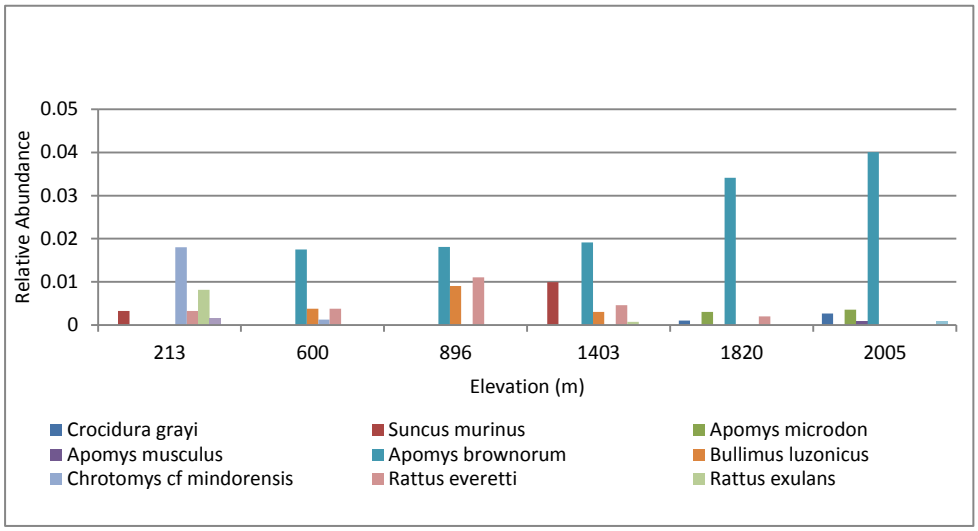

Figure 9. Relative abundance of small mammals along different elevational gradient in Mount Tapulao, Zambales.

Fruit Bats

Unlike rodents, species richness of bats and relative abundance of fruit bats decreased with elevation except for *Otopteropus cartilagonodus* where species abundance increased with elevation (Figure 9). The later species is a Luzon endemic and was recorded in Mount Tapulao between 1200 m and 2035m. A Philippine endemic species of bat, *Ptenochirus jagori* was found between 213m and 1200 m while *Haplonycteris fischeri*, another Philippine endemic was found only at 896m.

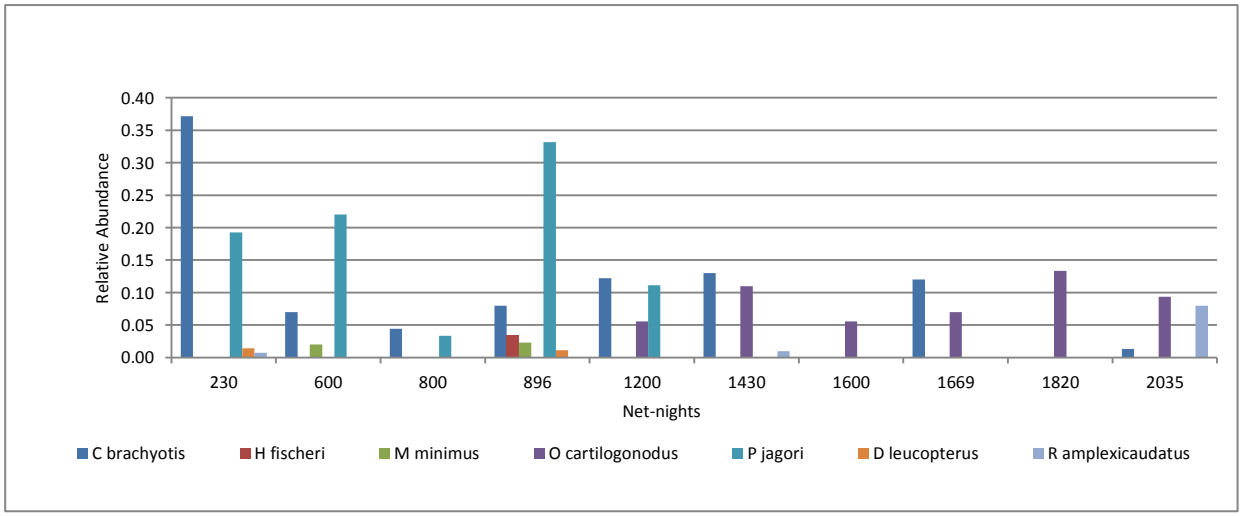

Figure 10. Relative abundance of small mammals along different elevational gradient.

We also captured *Desmalopex leucopterus* at 230m and 896 m. This represents a new distribution record for the species. Non-endemic species of fruit bats such as *Cynopterus brachyotis* and *Rousettus amplexicaudatus* was more wide spread. Both species were captured at 230m to 2035m. *Macroglossus minimus* were found only at 600 m and 896m.

Insectivorous Bats

We did not plot relative abundance for insectivorous bats due to low capture rate. Nevertheless, *Myotis rufopictus* was captured. This is an endemic species of insectivorous bats that is poorly known and found only at elevations between 50 m and 1465m. During the survey, two individuals were captured at 1800m. This represents a new elevational range distribution for the species.

Birds

Adequacy of Sampling

We measured the adequacy of sampling by plotting the number of species encountered over the number of hours spent by the observer in each of the site sampled and/or the number of nets days for mist netting.

Sampling was deemed sufficient when the curve approaches a plateau. Our transect at 1200 to 1400m was the only one that met this criterion. Our transect at 600 to 800 m and 896m almost reached the plateau as fewer species were added to the list and the curve started to reach a plateau unlike in our transect at 213m and 1820 to 2035m where an abrupt increase in the number of species was observed towards the end of the sampling (Figure 10 and 11).

To supplement transect data, we set mist nets at different elevations encompassing the five habitat types from tropical sub-alpine forest down to tropical semi-evergreen forest (forest fragment) at 213 m. After 150 net days of trapping, the number of species being added to the list began to taper off and we predict that a plateau will be reached sometime around 175 net days. The graph also showed that there were more species observed at 213m, 600-800m, 896m than in sites 1200-1400m and 1820 to 2035m. Both transect and mist netting graph showed that there were more species in the tropical lowland evergreen forest than in tropical lower montane and tropical upper montane forest.

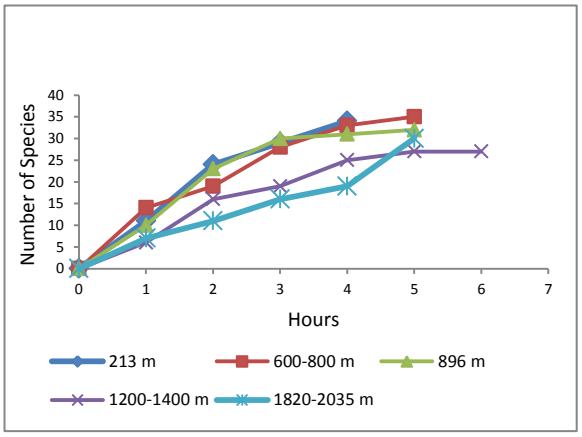

Figure 12. Species effort curve for birds along different elevational gradient based on netting data.

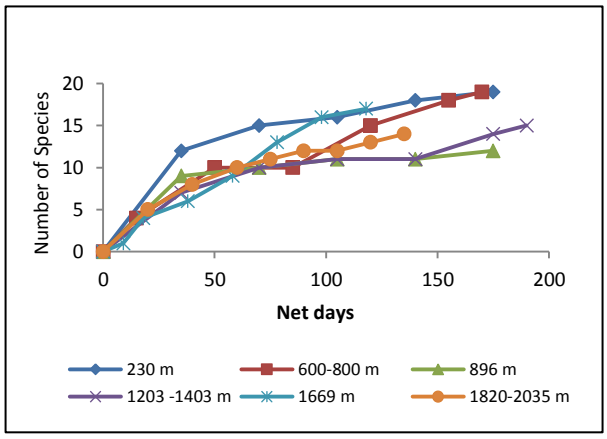

Figure 11. Species effort curve for birds along different elevational gradient based on transect data.

Species Richness

Species lists provide a simple measure of bird species diversity in an area. We recorded a total of 86 species of birds along the different elevational gradient sampled from 213 m to 2035m. This included 34 Philippine endemic species and another 7 Luzon endemic species, which comprise 48% of the total species recorded. Table 6 shows a summary of number of species recorded in each elevation sampled. Among the species recorded, three species were categorized by IUCN as vulnerable (*Ptilinopus marchei, Zoothera cinerea* and *Bubo philippensis*) and one near threatened species (*Buceros hydrocorax*). Endemicity was highest in the tropical lowland evergreen rainforest. This comprise between 54% and 72% of the total species observed, respectively (Figure 12).

Relative abundance

Relative abundance of endemic bird species per elevation was computed by dividing the total number of individuals recorded for each species in an elevation by the total number of transect-hours in each elevation. The most abundant species across all the study sites was *Hypsipetes philippinus,* a Philippine endemic, while the abundance of other species varied per elevation. *Centropus viridis*, another Philippine endemic, was the second most common in the lowland tropical semi evergreen forest (forest fragment) at 213 m while *Orthotomus castaneiceps* and *Dicrurus balicassius* were the second most common in the tropical lowland evergreen forest between 600 and 896 m. *Pachycephala albiventris* and *Parus elegans* were the second most common in the tropical lower and upper montane and sub-alpine forest, respectively. *Buceros hydrocorax*, a near threatened species, was found only in the tropical lowland evergreen forest between 600 and 896 m while *Ptilinopus marchei*, a vulnerable species, was found only in the tropical lower montane forest between 1200 and 1400 m.

Table 7. Summary of bird species observed along the transect in each elevation sampled. No transect was done at Site 3 (1600-1669m). Species in bold face indicates endemic species.

	Species	Site 1(1800m) and 2 (2035m)	Site 4 (1200 to 1403m)	Site 5 (896 m)	Site 6 (600-800)	Site 7 (213 m)
Accipitridae						
1	Crested Serpent Eagle *Spilornis cheela*	-	-	+	-	+
2	Brahminy Kite *Haliastur indus*	-	+	-	-	-
Turnicidae						
3	Spotted Buttonquail ***Turnix ocellata***	-	-	-	+	-
Rallidae						
4	Barred Rail *Gallirallus torquatus*	-	-	-	-	+
5	White-Breasted Waterhen *Amaurornis phoenicurus*				+	+
Scolopacidae						
6	Bukidnon Woodcock ***Scolopax bukidnonensis***	+	+	-	-	-
Columbidae						
7	White-eared Brown Dove ***Phapitreron leucotis***	-	-	+	+	+
8	Common Emerald Dove *Chalcophaps indica*					+
9	Zebra Dove *Geopelia striata*	-	-	-	-	+
10	Flame-Breasted Fruit Dove ***Ptilinopus marchei***	+	+	-	-	-
11	Pink bellied Imperial Pigeon ***Ducula poliocephala***	-	-	+	-	-
Psittacidae						
12	Guaibero ***Bolbopsittacus lunulatus***	-	-	+	+	-
Cuculidae						
13	Scale-Feathered Malkoha ***Phaenicophaeus cumingi***	-	+	+	-	+
14	Red-Crested Malkoha ***Phaenicophaeus superciliosus***	-	-	-	-	-
15	Rufous Coucal ***Centropus unirufus***	-	-	+	-	-
16	Philippine Coucal ***Centropus viridis***				+	+
17	Lesser Coucal *Centropus bengalensis*	-	-	-	+	-
18	Brush Cuckoo *Cacomantis variolosus*	-	-	+	-	-
Strigidae						
19	Luzon scops-owl ***Otus longicornis****	-	+	-	-	-
20	Philippine Scops Owl ***Otus megalotis****	+	-	+	+	+
21	Philippine Hawk-Owl ***Ninox philippensis****	-	-	+	+	+
22	Philippine Eagle Owl ***Bubo philippensis****	+	-	-	-	-
Podargidae						
23	Philippine frogmouth ***Batrochostomus septimus****	-	+	-	-	-
Caprimulgidae						
24	Philippine Nightjar *Caprimulgus manillensis*	+	-	-	-	+
25	Great-Eared Nightjar *Eurostopodus macrotis*	-	-	-	-	+
Apodidae						
26	Island Swiftlet *Collocalia vanikorensis*	+	-	-	-	-
Hemiprocnidae						
27	Lesser Tree-Swift *Hemiprocne comata*	-	-	-	+	+
Trogonidae						
28	Philippine Trogon ***Harpactes ardens***	-	-	+	-	+

Coraciidae						
29	Dollarbird *Eurystomus orientalis*	-	-	-	+	-
Alcedinidae						
30	Indigo-Banded Kingfisher ***Alcedo cyanopecta***	-	-	-	-	+
31	Spotted wood kingfisher ***Actenoides lindsayi***	-	-	+	-	+
32	White-throated kingfisher *Halcyon smyrnensis*	-	-	-	-	+
Meropidae						
33	Blue-throated bee-eater *Merops viridis*	-	-	-	-	+
34	Blue-tailed bee-eater *Merops philippinus*	-	-	-	-	+
Bucerotidae						
35	Rufous hornbill ***Buceros hydrocorax***	-	-	+	-	-
36	Tarictic hornbill ***Penelopides panini***	-	-	+	-	-
Capitonidae						
37	Coppersmith barbet ***Megalaima haemacephala***	-	-	-	-	+
Picidae						
38	Sooty woodpecker ***Mulleripicus funebris***	-	-	+	+	-
39	Greater flamebacked *Chrysocolaptes lucidus*	-	+	+	-	+
40	Philippine pygmy woodpecker ***Dendrocopos maculatus***	-	+	-	-	-
Hirundinidae						
41	Pacific swallow *Hirundo tahitica*	-	+	-	-	-
Campephagidae						
42	Bar-bellied cuckoo-shrike *Coracina striata*	-	-	+	+	+
Pycnonotidae						
43	Yellow-vented bulbul *Pycnonotus goiavier*	+	-	-	+	+
44	Philippine bulbul ***Hypsipetes philippinus***	+	+	+	+	+
Dicruridae						
45	Balicassiao ***Dicrurus balicassius***	-	-	+	+	+
Paridae						
46	Elegant tit ***Parus elegans***	+	+	+	+	+
Sittidae						
47	Velvet-fronted nuthatch *Sitta frontalis*	+	+	+	-	-
Rhabdornithidae						
48	Stripe-headed rhabdornis ***Rhabdornis mystacalis***	-	-	-	+	-
Turdidae						
49	White-browed shrotwing *Brachypteryx montana*	+	+	+	-	+
50	White-browed shama ***Copsychus luzonensis***	-	-	+	+	+
51	Pied bushchat *Saxicola caprata*	-	-	-	+	-
52	Blue rock-thrush *Monticola solitarius*	+	-	-	-	-
53	Ashy ground-thrush ***Zoothera cinerea***	+	-	-	-	-
54	Scaly ground-thrush *Zoothera dauma*	-	+	-	-	-
55	Isalnd thrush *Turdus poliocephalus*	+	+	-	-	-
Sylviidae						
56	Bright-capped cisticola *Cisticola exilis*	-	-	-	+	-
57	Lemon-throated leaf-warbler ***Phylloscopus cebuensis***	+	+	+	-	-
58	Tawny grassbird *Megalurus timoriensis*	-	+	-	+	+
59	Striated grassbird *Megalurus palustris*	+	-	-	-	-

60	Gray's grasshopper-warbler *Locustella fasciolata*	-	-	-	+	+
61	Philippine Tailorbird ***Orthotomus castaneiceps***	-	-	+	+	+
62	Grey-backed tailorbird ***Orthotomus derbianus***	-	-	+	+	-
63	Mountain tailorbird ***Orthotomus cucullatus***	+	+	+	-	-
Muscicapidae						
64	Mountain verditer-flycatcher *Eumyias panayensis*	+	+	-	-	-
65	Snowy-browed flycatcher *Ficedula hyperythra*	+	+	+	+	+
66	Furtive flycatcher ***Ficedula disposita***	-	-	-	-	+
67	Little pied flycatcher *Ficedula westermanni*	+	-	-	-	-
68	Mangrove blue flycatcher *Cyornis rufigastra*	-	-	-	-	+
69	Blue-headed fantail ***Rhipidura cyaniceps***	+	+	+	+	+
70	Black-naped monarch *Hypothymis azurea*	-	-	-	-	+
71	Grey-streaked flycatcher *Muscicapa griseisticta*	+	+	-	+	-
Pachycephalidae						
72	Green-backed whistler ***Pachycephala albiventris***	+	+	+	+	+
73	Yellow -bellied whistler ***Pachycephala philippinensis***	-	-	-	-	+
Motacillidae						
74	Grey wagtail *Motacilla cinerea*	+	+	-	-	-
Artamidae						
75	White-breasted wood swallow *Artamus leucorhynchus*	-	-	-	-	+
Laniidae						
76	Long-tailed shrike *Lanius schach*	-	-	-	+	-
77	Mountain shrike ***Lanius validirostris***	+	+	-	-	-
78	Brown shrike *Lanius cristatus*	+	+	+	+	+
Dicaeidae						
79	Pgymy flowerpecker ***Dicaeum pygmaeum***	-	-	+	+	+
80	Buzzing flowerpecker ***Dicaeum hypoleucum***	-	-	-	+	-
Zosteropodidae						
81	Mountain white-eye *Zosterops montanus*	+	+	-	-	-
82	Yellowish white-eye ***Zosterops nigrorum***	-	-	-	+	-
Estrildidae						
83	Tawny-breasted parrotfinch *Erythrura hyperythra**	+	+	+	-	-
84	White-bellied munia *Lochura leucogastra*	-	-	-	+	-
85	Chestnut munia *Lonchura mallaca*	-	-	-	+	-
Fringillidae						
86	White-cheeked bullfinch ***Pyrrhula leucogenis***	+	-	-	-	-
Number of species observed		28	28	32	35	41
Total number of transect hours		5	6	5	5	4

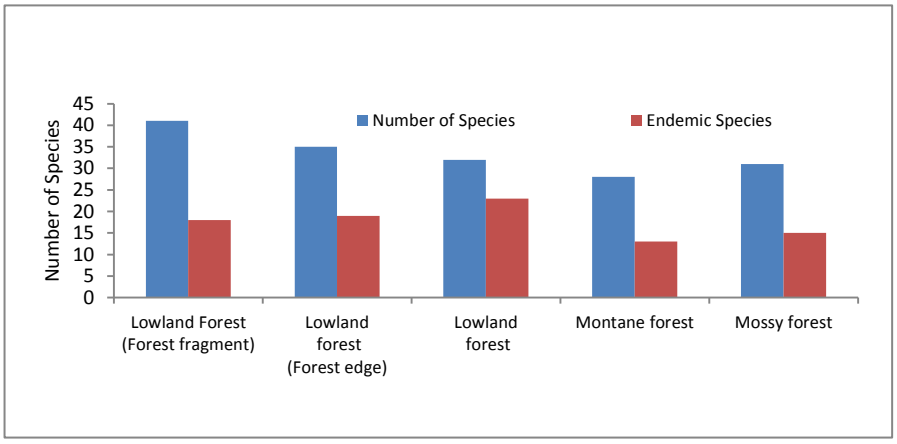

Figure 13. Total species observed and endemic species per habitat type sampled.

In addition, another 17 endemic bird species are restricted only to the tropical lowland evergreen forest from 213m to 896m and 6 species found only in the tropical lower and upper montane and sub-alpine forest. Other species found across all sites included *Pachycephala albiventris, Rhipidura cyaniceps* and *Parus elegans*. Bird diversity and endemism were greatest in the mid elevation where there is a relatively good stand of forest. Although the number of species of birds in the tropical lowland semi-evergreen (forest fragment) at 213 m was greater compared to all other sites, endemicity was generally low and most of the species present are either widespread endemics or non-endemic species while the number of endemic species in the tropical lower and upper montane and sub-alpine forest was low, but some species are restricted only to either tropical lower and upper montane or sub-alpine forest as *Orthotomus cuculatus* and *Ptilinopus marchei*.

IV. Discussion

Species Richness and Relative Abundance

A total of 142 wildlife species were recorded during the survey. This included nine amphibians, 19 reptiles, 28 mammals and 86 Birds (see Table 8). Among these, 55% are endemic to the country, of which 17 species are endemic to Luzon Island and another two species found only in Mount Tapulao and nowhere else in the world.

Table 8. Summary of wildlife encountered in the different elevations of Mt. Tapulao.

Taxa	Non endemic	All Philippine Endemics			Genus Only	Total	% All Philippine Endemics	% Whole Philippines Endemic	% Luzon Endemics	% Tapulao Endemics
		Whole Philippines	Luzon Only	Tapulao Only						
Amphibians	2	3	4	0	0	9	78%	33.3%	44.4%	0%
Reptiles	3	11	2	0	3	19	68%	57.9%	10.5%	0%
Birds	45	34	7	0	0	86	48%	39.5%	8.1%	0%
Mammals	11	11	4	2	0	28	61%	39.3%	14.3%	7%
Total	61	59	17	2	3	142	55%	41.5%	12.0%	1%

This study is consistent with predictions on small mammal species richness and relative abundance along elevational gradient. Studies on patterns of species richness and relative abundance of small mammals shows an increasing species richness and relative abundance as elevation increases and decreases towards the peak. (Balete et al., 2009; Heaney, 2001; Heaney et al., 2011; Rickart et al., 1991, 1993, 2011a, Duya et al 2011, Alviola et al 2011, Balete et al 2011, Sedlock et al 2011).

On the other hand, species richness and relative abundance of fruit bats decreases as elevation increases (Heaney et al 1999, 2006). Similarly, distribution patterns for birds, amphibians and reptiles also conform to the current observations on species richness and relative abundance. Unlike small mammals, species richness and abundance of birds was highest in the lowland forest and decrease with elevation (Goodman and Gonzales 1990, Goodman, Willard and Gonzales 1995), amphibians and reptiles (Diesmos and Brown 2010) are greater in lower elevations and decrease as elevation increases.

Distribution of Species and Endemicity

We have also noted that some mammal species that are locally endemic or island endemic tend to increase its abundance as elevation increase such as in the case of two species of mammals, *Otopteropus cartilagondus* (Luzon Pygmy Fruit Bat) and *Apomys brownorum* where abundance is high at mid to higher elevations. For the four vertebrate taxa, endemicity was low in the higher elevations however, majority of these endemics are confined only to that particular elevations or have a very limited elevation distribution and mostly confined to tropical lower and upper montane forest or tropical sub-alpine forest such as *Orthotomus cuculatus* (Mountain tailor bird), *Platymantis cf montanus*, *Otopteropus cartilagonodus*, and *Rhyncomys tapulao*. Other species such as the *Haplonycteris fischeri* (Fischer's pygmy fruit bat) is confined only to the tropical lowland evergreen forest at 896m while other species are confined only to the tropical lowland evergreen forest such as *Ptenochirus jagori* (Musky fruit bat), the threatened species of bird *Bubo philippensis* (Philippine Eagle Owl), the near threatened *Buceros hydrocorax* (Rufous hornbill), and *Ficedula disposita* among others. The threatened species *Ptilinopus merrilli* (Flame breasted fruit dove) is confined only to the tropical lower montane forest.

Species Richness and Endemicity

The most number of bird species recorded was at elevation 218 m, a tropical semi-evergreen albeit in forest fragments while the highest number of endemics was recorded in the tropical lowland evergreen forest at 896m. While species diversity was low in the tropical lowland evergreen, lower and upper montane and sub-alpine forest compared to the tropical semi-evergreen forest (forest fragment), the percentage of endemic species was higher compared to the forest fragment (Figure 12), a pattern evident in our small mammal data (Table 9). Five species of small mammals were recorded in the tropical semi-evergreen (forest fragment), which is equivalent to that recorded in the tropical upper montane and sub-alpine forest but greater than the tropical lowland evergreen forest. As in birds, the number of endemic species was greatest in the tropical lowland evergreen forest, lower and upper montane and sub-alpine forest forest compared to the lowland semi-evergreen (forest fragment). This suggests that species richness alone could not provide an adequate basis for the prioritization of areas to be protected. The quality of the species found in a particular area should to be considered as well.

Exotic species are a serious threat to biidoveristy as they have the potential to become invasive species and negatively impact on the native species in a particular area. Our data on small non-volant mammals demonstrate the contribution of habitat disturbance to the expansion of exotic rodent species and the importance of maintaining a relatively good contiguous forest. As discussed above, species richness and abundance of native species of rodents increased with elevation. Of the eleven species of small non-volant mammals documented during the study, three were exotic or commensal species (Table 9). This includes *Suncus murinus, Rattus tanezumi* and *Rattus exulans*. *Suncus murinus* was caught at 213 m and 1700m while *Rattus tanezumi* and *Rattus exulans* were caught at 213m and 1400m. None were caught inside the forest and were captured mostly at the forest edge. The presence of these species at higher elevation is due to the presence of old mining road. This pattern supports the prediction that the presence of native non volant mammals in old growth or disturbed forest habitats prevents the intrusion of non-native non volant mammals to the forest (Heaney et al 1999; Balete et al 2009).

Table 9. Distribution of native and non-native small mammals along the different elevational gradient surveyed in Mt. Tapulao, Zambales.

Species	Elevation (m)					
	213	600	896	1403	1820	2005
Soricidae						
Crocidura grayi					+	+
Suncus murinus	+			+	+*	
Muridae						
Apomys microdon					+	+
Apomys musculus						+
Apomys brownorum		+	+	+	+	+
Bullimus luzonicus		+	+	+		
Chrotomys cf mindorensis	+	+				
Rattus everetti	+	+	+	+	+	
Rattus exulans	+			+		
Rattus tanezumi	+			+		
Rhyncomys tapulao						+
Number of native species	3	4	3	4	4	5
Number of native and non-native species	5	4	3	6	4	5

*Caught by hand along an old mining road at 1700m

V. Conclusion and Recommendation

These results confirm the relationship between the quality of species assemblages and the different forest types and elevational gradients where they are found. This should be a key input in the management planning process in the development of Mt. Tapulao as a local conservation area.

The distribution patterns observed along the different elevational gradient and the corresponding forest types clearly suggest that there is habitat preference by each species. The survival and persistence of these species depend entirely on the availability of these habitats. Despite the high degree of forest disturbance especially in elevations between 213m and 800m, there still remains endemic species of vertebrates in these areas. Considering also that majority of the endemic species of birds, amphibians, and reptiles are in the tropical lowland evergreen forest, which is the most vulnerable habitat because of its accessibility and distance from human settlements, it is therefore important that;

1. Remaining relatively intact forest from 800 m and above should be placed under protection. This will help maintain the integrity of the mountain range as well as prevent further intrusion of non-native species into the area.
2. Tropical lowland semi-evergreen and lowland evergreen forest fragments between 600 and 800 m should be placed as habitat restoration zone and forest restoration activities should be a priority in the management plan.
3. Enhance awareness of local community on the importance and benefits of Mt Tapulao to prevent hunting and the gathering of wild plants as well as increase the community's appreciation of the importance of the forests of Mount Tapulao and its flora and fauna and their participation in its protection and conservation.

VI. LITERATURE CITED

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