Importance of riparian forest in enhancing the avifaunal diversity of upland agricultural landscape

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ABSTRACT

To understand the importance of riparian forest in enhancing the avifaunal diversity in upland agricultural landscape, this study compared the avifaunal community of riparian forest strip to avifaunal community of a swidden farm and a nearby primary forest in Aborlan, Palawan, Philippines from August to November 2010. Results revealed that the riparian forest strip has the highest species richness, diversity index and abundance compared to swidden farm and primary forest. Moreover, the bird assemblage found in it has high index of community similarity when compared to swidden farm and primary forest. This indicates that the bird community in the riparian forest is comprised of an assortment of species that thrive in the primary forest and in the swidden farm. Meanwhile, the low abundance, species richness and diversity index together with the concurrent decline of endemic and conservation priority birds in swidden farm uncovered the vulnerability of these birds to habitat degradation. On the contrary, the high abundance, species richness, and diversity index alongside with the presence of high number of endemic and conservation priority species in the riparian forest strip unfolded its significance in enhancing the avifaunal diversity in upland agricultural landscape. Moreover, the presence of endemic and high conservation priority bird species that are restricted only to primary forest highlights the need to conserve the remaining tracts of primary forest in the area. Preserving the networks of riparian forests in upland agricultural vegetation matrix is also recommended to improve the avifaunal ecosystem functions in the area.

Keywords: avifauna, diversity, riparian forest, upland agriculture

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INTRODUCTION

The upland agricultural landscape is a complex vegetation matrix which consists of agroforests, fallow forests, grasslands, shrub lands, residual forest fragments and swidden farms which are planted with a variety of crops. Swidden or "slash and burn farming" is a traditional form of agriculture practiced by upland dwelling communities in the tropical region. In the Philippines, it is practiced by various indigenous groups such as the Hanunuo (Conklin 1957), Tagbanua (Warner 1981; Dressler 2005; Eder 2006), Ikalahan-Kalanguya (Banaticla et al. 2008), T'boli (Hyndman et al. 1994) and Batak (Eder 1987). This farming system is developed through centuries of experience by the ancestors of these mountain-dwelling indigenous people and is practiced in accordance with a handful of customs and traditions.

This traditional method of farming begins by cutting and burning of forest vegetation, followed by short period of cropping cycles and ends in a long fallowing phase. This typical pattern of cultivation and fallowing was confirmed to be practiced by Hanunuo tribe of Mindoro (Suarez and Sajise 2010), Ikalahans of Mount Pulog (Rice 1981) and Tagbanua of Palawan (Dressler 2005).

This practice was considered sustainable because long fallowing period allows sufficient time for the restoration of soil fertility (Brady 1999). The regenerating fallow forests are also essential in performing vital ecosystem functions which improves the overall resilience of the swidden agricultural landscape.

One of the consequences of having long fallow duration is the need to have considerably large expanse of swidden space to accommodate the adequate number of fallows. Thus, this farming system is only considered sustainable in places where large areas of free access land are still available and only a few people are doing it (Suarez and Sajise 2010). However, the growing population and the increasing economic opportunities significantly increase the swidden activities in almost all developed provinces in the Philippines. Cadiz and Buot (2009) confirmed this by describing that swidden farming intensified forest destruction in Cebu Island.

In Palawan, swidden farms are common along the foothills of the mountain ranges extending from north to south end of the central island. This form of agriculture is practiced not only by indigenous communities but also by settled migrants as well (Lacuna-Richman 2006; Sopsop and Buot 2011). The congestion brought by the expansion of upland farms resulted to

opening of more frontier areas in the primary forest and utilization of fallow forest before it has fully regenerated. The loss of primary forest and matured fallow forest in swidden landscape has detrimental effect to the bird community. Shankar Raman et al. (1998) described that the natural regeneration of fallow forests are important in bird diversity because the species richness, abundance and diversity of birds increase as the vegetation in the fallows recover. Considering the diverse ecosystem functions performed by birds, conserving the extant primary forest and maintaining matured fallows in an otherwise degraded upland agricultural matrix is vital in enhancing the resilience of this ecosystem.

One of the remaining matured forest fragments in the upland agricultural landscape is the network of riparian forests growing along the tributary streams. Located in steep slopes with shallow and rocky soil, these forested areas are not suitable for swidden agriculture use. Being spared from cultivation, these forest fragments are left intact with large trees and thick understory vegetations which may support wide array of birds including habitat specific forest dwellers and endemic species that are already gone in disturbed swidden areas. The riparian forest is connected to the primary forests at higher elevation and follows the meandering path of the tributary streams that cuts across the swidden farms and other disturbed habitats in the foothills, the birds thriving in it might improve the overall avifaunal diversity in the upland agricultural landscape. However, the avifaunal community thriving in the riparian forest strips in Palawan is not yet documented and thereby not fully understood. Hence, the study was conducted to understand the attributes of the avifaunal community found in the riparian forest and compare it with the bird communities in pristine primary forest and in a much disturbed swidden agricultural area.

METHODOLOGY

Time and Place of the Study

This study was conducted in the eastern slopes of the Victoria-Anipahan mountain range, specifically in the swidden landscape of Sagpangan, Aborlan, Palawan, Philippines from August to November 2010.

Description of the Study Sites

The three study sites are located in the swidden landscape of Sagpangan, Aborlan, Palawan. Site 1 is narrow riparian forest that is approximately 40 meters across in its narrowest segment while about 70 meters across in its widest section. It consists of relatively intact forest vegetation thriving along the steep and rocky banks of the cascading tributary stream that meanders through various habitats which includes swidden farms, grasslands, brush lands, secondary forests and residual forest. Although some economically important species of trees are already eliminated, this site is still dominantly covered by large trees. Site 2 is a swidden farm which is generally covered by various crops such as “gabi”, string beans, “kadios”, ginger, banana, jackfruit, “ube”, papaya, cashew and coconuts. Some pioneering species of trees were also found sparsely growing in the area. Site 3 is an old stand of primary forest with massive trees and tall emergent layer. The flourishing vegetation belongs to the climax species of trees. Anthropogenic activities taking place in this part of the forest are gathering of rattan, wild fruits, honey and other non timber forest products.

Data Collection

Data gathering was conducted from August to November 2010. Point count method of bird survey was used in this study because one of the sites (primary forest) has dense vegetation with a lot of cryptic, shy, and skulking species (Gibbons and Gregory 2006). Although the study aimed to obtain only the relative abundances, point count method was chosen because other much easier methods such as the Mackinnon list or timed species count generate relative abundances based only on how many times the species occur on the lists but the actual number of individuals in each species is not taken into account (Cavarzere et al. 2012).

Four point count stations were established in a transect line laid in each site. The transect line in site 2 (swidden farm) was purposely laid at the center of this farm to cover all the representative vegetations and at the same time to reduce the possibility of the edge effects. On the other hand, the transect line in site 1 (riparian forest strip) was laid following the meandering bank of the stream. Meanwhile, in the nearest primary forest, an area as wide as site 2 was delineated and considered as the site 3 (primary forest). A transect line was also laid at the center of the site 3.

The four point count stations were positioned at 100 meters interval to maximize the distance between point count stations and to lessen the

chance of double counting the same bird at different stations (Harvey et al. 2006).

Each point count station used for counting birds was a circular plot with a radius of 25 meters (Gibbons and Gregory 2006; Sutherland 2000). The perimeter of the point count stations was marked with ribbons to help the researcher to identify the boundaries easily. The counting of birds was done twice each day, one during early in the morning (6:00-10:00) and another during late in the afternoon (3:00-5:00) because birds were most active during these periods of the day (Bibby et al. 1998).

A 10-minute settling time was allowed to pass before starting each bird count; this is to allow the return of bird activities that was interrupted by the arrival of the researcher. All birds detected using visual and auditory cues within 10 minutes inside the circular plot were recorded (Bibby et al. 1998). Any individual bird was recorded only once during the 10 minute counting period. Counting of birds was repeated four times in all stations, reaching a total bird count of 160 minutes per study area. The number of sampling repetitions for this study was based on the results of the species discovery curve.

Classification, Endemism and Conservation Status

Taxonomy of birds was based from the International Ornithological Committee World Bird List version 7.2 (Gill and Donsker 2017) while the level of endemism and conservation status of birds were based from International Union for Conservation of Nature (IUCN) Red List of Threatened Species version 2016-3 (IUCN 2017).

Data Analysis

The avifaunal communities between sites were compared using standard measures of biodiversity such as species richness, abundance, Shannon's diversity index and evenness. Changes in any of these parameters are important indicators of habitat degradation (Chapman and Reich 2007; Carete et al. 2009; Barzan et al. 2015). The degree of similarity of bird communities across the different sites were compared using the Horn's Information Theoretic Index of Similarity. The presence of endemic and high conservation priority species in different sites were also compared using species richness of target species.

RESULTS AND DISCUSSION

Species Diversity and Abundance

The avifaunal survey discovered 82 species of birds from 40 families across the three sites compared (Table 1). Fifteen species were found to be endemic to Palawan, four species were endemic to Philippines, nine were resident species with endemic race, nine were migratory species and the remaining 45 were resident species.

Table 1. Distribution, level of endemism, conservation status, and names of birds recorded in the entire study area. (**Level of Endemism:** R - Resident species; RPER - Resident species with Palawan endemic race; PES - Palawan endemic species; PHES – Philippine endemic species; M – Migrant; **Distribution in the study area**: P – Primary forest; R – Riparian; S – Swidden farm; (+) – Present)

Family	Scientific Name	English Name	Conservation Status (IUCN)	Level of Endemism	Distribution in the Study Area		
					P	R	S
Accipitridae	*Spilornis cheela palawanensis*	Crested Serpent-Eagle	Least concern	RPER	+		+
Accipitridae	*Nisaetus cirrhatus*	Changeable Hawk-Eagle	Least concern	R	+	+	+
Aegithinidae	*Aegithina tiphia*	Common Iora	Least concern	R	+	+	+
Alcidinidae	*Alcedo atthis bengalensis*	Common Kingfisher	Least concern	M		+	
Alcidinidae	*Alcedo meninting meninting*	Blue-Eared Kingfisher	Least concern	R		+	
Alcidinidae	*Ceryx erithaca*	Oriental Dwarf Kingfisher	Least concern	R		+	
Alcidinidae	*Todiramphus chloris collaris*	Collared Kingfisher	Least concern	R		+	+
Apodidae	*Collocalia esculenta*	Glossy Swiftlet	Least concern	R	+	+	+
Apodidae	*Collocalia troglodytes*	Pygmy Swiftlet	Least concern	PHES		+	
Apodidae	*Hirundapus giganteus*	Brown-Backed Needletail	Least concern	R	+	+	+
Ardeidae	*Egretta garzetta*	Little Egret	Least concern	M		+	+
Ardeidae	*Butorides striata*	Striated Heron	Least concern	M		+	
Ardeidae	*Bubulcus coromandus*	Eastern Cattle Egret	Least concern	M		+	+
Ardeidae	*Egretta intermedia*	Intermediate Egret	Least concern	M		+	+

Family	Scientific Name	English Name	Conservation Status (IUCN)	Level of Endemism	Distribution in the Study Area		
					P	R	S
Artamidae	*Artamus leucorynchus*	White-Breasted Wood-Swallow	Least concern	R			+
Bucerotidae	*Anthracoceros marchei*	Palawan Hornbill	Vulnerable	PES	+	+	
Campephagidae	*Coracina striata difficilis*	Bar-Bellied Cuckoo-Shrike	Least concern	RPER	+		
Campephagidae	*Lalage nigra*	Pied Triller	Least concern	R		+	+
Campephagidae	*Pericrocotus igneus*	Fiery Minivet	Near threatened	R	+	+	
Chloropseidae	*Chloropsis palawanensis*	Yellow-Throated Leafbird	Least concern	PES	+	+	
Columbidae	*Treron curvirostra*	Thick-Billed Green-Pigeon	Least concern	R	+	+	+
Columbidae	*Treron vernans*	Pink-Necked Green-Pigeon	Least concern	R	+	+	+
Columbidae	*Ptilinopus leclancheri*	Black-Chinned Fruit Dove	Least concern	R	+	+	
Columbidae	*Ducula aenea*	Green Imperial Pigeon	Least concern	R	+	+	
Columbidae	*Macropygia tenuirostris*	Reddish Cuckoo-Dove	Least concern	R	+	+	
Columbidae	*Spilopelia chinensis*	Spotted Dove	Least concern	R		+	+
Columbidae	*Geopelia striata*	Zebra Dove	Least concern	R		+	+
Columbidae	*Chalcophaps indica*	Common Emerald-Dove	Least concern	R	+	+	
Coraciidae	*Eurystomus orientalis*	Oriental Dollar Bird	Least concern	R	+	+	+
Corvidae	*Corvus enca*	Slender-Billed Crow	Least concern	R		+	+
Cuculidae	*Cacomantis merulinus*	Plaintive Cuckoo	Least concern	R	+	+	
Cuculidae	*Eudynamys scolopaceus*	Asian Koel	Least concern	R	+	+	
Cuculidae	*Phaenicophaeus curvirostris*	Chestnut-Breasted Malkoha	Least concern	R	+	+	
Cuculidae	*Centropus sinensis*	Greater Coucal	Least concern	R			+
Cuculidae	*Centropus bengalensis*	Lesser Coucal	Least concern	R			+

Family	Scientific Name	English Name	Conservation Status (IUCN)	Level of Endemism	Distribution in the Study Area		
					P	R	S
Dicaeidae	*Prionochilus plateni*	Palawan Flowerpecker	Least concern	PES	+	+	+
Dicaeidae	*Dicaeum pygmaeum palawanorum*	Pygmy Flowerpecker	Least concern	RPER	+	+	+
Dicruridae	*Dicrurus leucophaeus leocophaeus*	Ashy Drongo	Least concern	R	+	+	+
Dicruridae	*Dicrurus hottentottus palawanensis*	Hair-Crested Drongo	Least concern	RPER	+	+	
Estrildidae	*Lonchura leucogastra*	White-Bellied Munia	Least concern	R	+	+	+
Estrildidae	*Lonchura atricapilla*	Chestnut Munia	Least concern	R		+	+
Estrildidae	*Lonchura punctulata*	Scaly Breasted Munia	Least concern	R		+	+
Hirundinidae	*Hirundo rustica*	Barn Swallow	Least concern	M	+	+	+
Irenidae	*Irena puella tweeddalii*	Asian Fairy-Bluebird	Least concern	RPER	+	+	
Laniidae	*Lanius cristatus lucionensis*	Brown Shrike	Least concern	M		+	+
Monarchidae	*Terpsiphone cyanescens*	Blue-Paradise Flycatcher	Near threatened	PES	+	+	+
Monarchidae	*Hypothymis azurea*	Black-Naped Monarch	Least concern	R	+	+	+
Motacillidae	*Motacilla cinerea*	Grey Wagtail	Least concern	M		+	+
Muscicapidae	*Cyornis lemprieri*	Palawan Blue Flycatcher	Near threatened	PES	+		
Muscicapidae	*Muscicapa griseisticta*	Grey-Streaked Flycatcher	Least concern	M	+	+	+
Muscicapidae	*Copsychus niger*	White-Vented Shama	Least concern	PES	+	+	+
Nectariniidae	*Arachnothera dilutior*	Pale Spiderhunter	Least concern	PES	+	+	+
Nectariniidae	*Cinnyris jugularis*	Olive-Backed Sunbird	Least concern	R	+	+	+
Nectariniidae	*Anthreptes malacensis paraguae*	Brown-Throated Sunbird	Least concern	RPER	+	+	+
Nectariniidae	*Aethopyga shelleyi shelleyi*	Lovely Sunbird	Least concern	PHES	+	+	
Oriolidae	*Oriolus xanthonotus*	Dark-Throated Oriole	Near threatened	R	+		

Family	Scientific Name	English Name	Conservation Status (IUCN)	Level of Endemism	Distribution in the Study Area		
					P	R	S
Oriolidae	*Oriolus chinensis*	Black-Naped Oriole	Least concern	R	+	+	
Paridae	*Periparus amabilis*	Palawan Tit	Near threatened	PES	+	+	
Passeridae	*Passer montanus*	Eurasian Tree Sparrow	Least concern	R			+
Phasianidae	*Gallus gallus*	Red Jungle Fowl	Least concern	R	+	+	
Phasianidae	*Polyplectron napoleonis*	Palawan Peacock-Pheasant	Vulnerable	PES	+		
Phasianidae	*Excalfactoria chinensis*	Blue-Breasted Quail	Least concern	R			+
Picidae	*Mullerripicus pulverulentus*	Great Slaty Woodpecker	Vulnerable	R	+	+	
Picidae	*Chrysocolaptes erythrocephalus*	Red-Headed Flameback	Endangered	PES	+	+	
Picidae	*Dinopium everetti*	Spot-Throated Flameback	Near threatened	PES	+	+	
Pittidae	*Erythropitta erythrogaster*	Red-Bellied Pitta	Least concern	PHES	+		
Pittidae	*Pitta sordida*	Hooded Pitta	Least concern	R	+	+	
Psittaculidae	*Tanygnathus lucionensis*	Blue-Naped Parrot	Near threatened	R (Near Endemic)	+	+	
Psittaculidae	*Prioniturus platenae*	Blue-Headed Racquet-Tail	Vulnerable	PES	+	+	
Pycnonotidae	*Pycnonotus atriceps*	Black-Headed Bulbul	Least concern	R	+	+	+
Pycnonotidae	*Pycnonotus cinereifrons*	Ashy-Fronted Bulbul	Least concern	PES	+	+	+
Pycnonotidae	*Alophoixus frater*	Palawan Bulbul	Least concern	PES	+	+	+
Rallidae	*Amaurornis phoenicurus*	White Breasted Water Hen	Least concern	R		+	+
Rhipiduridae	*Rhipidura nigritorquis*	Philippine Pied Fantail	Least concern	PHES		+	+
Sittidae	*Sitta frontalis palawana*	Velvet-Fronted Nuthatch	Least concern	RPER		+	
Sturnidae	*Gracula religiosa*	Common Hill Myna	Least concern	R	+	+	
Sturnidae	*Aplonis panayensis*	Asian Glossy Starling	Least concern	R		+	+
Cisticolidae	*Orthotomus sericeus*	Rufous-Tailed Tailorbird	Least concern	R	+	+	+
Locustellidae	*Megalurus palustris*	Striated Grassbird	Least concern	R			+

Family	Scientific Name	English Name	Conservation Status (IUCN)	Level of Endemism	Distribution in the Study Area		
					P	R	S
Pellorneidae	*Malacocincla cinereiceps*	Ashy-Headed Babbler	Least concern	PES	+	+	+
Timaliidae	*Macronous gularis woodi*	Pin-Striped Tit-Babbler	Least concern	RPER	+	+	
Turnicidae	*Turnix suscitator haynaldi*	Barred Buttonquail	Least concern	RPER		+	+

Based on the results, the riparian forest strip has the highest avifaunal species richness (70), followed by primary forest (54) and swidden farm (46) (Table 2). Similarly, bird abundance follows the same trend with the following abundance values of 267, 255 and 176 respectively. As abundance and species richness influenced the diversity index, the computed Shannon's diversity index also follows the same trend. Riparian forest strip has the highest Shannon's diversity index value of (1.73), followed by primary forest (1.64) and swidden farm (1.58) (Table 2). Evenness values across the sites compared were almost the same.

Table 2. Diversity and evenness values of bird communities in swidden farm, riparian forest and primary forest.

Location	Number of Bird Species	Number of Individual Birds	Shannon's Diversity Index	Evenness
Swidden Farm	46	176	1.58	0.95
Riparian Forest	70	267	1.73	0.94
Primary Forest	54	255	1.64	0.95

The high species richness and abundance of birds in the riparian forest strip were due to the combined presence of both forest dwelling and open dwelling species in the area. The similarity of vegetation characteristics between riparian forest strip and adjacent primary forest possibly attracted the forest dwelling species. Posa and Sodhi (2006) disclosed that bird species richness is positively correlated with vegetation characteristics such as the canopy size, tree density and ground cover. Similarly, Sallabanks et al. (2006) reported that the canopy cover was the best predictor of variation in abundance of numerous bird species. Moreover, the presence of native forest vegetation along the riparian forest strip could be another factor that possibly attracted the forest dwelling bird species. Rotenberg (2007) divulged that native vegetation played significant role in enhancing bird species richness in the plantation habitat. Meanwhile, the close proximity of riparian forest strip to open habitat such as grasslands and swidden farms

could have attracted open dwelling generalist bird species which resulted to further increase in the species richness and abundance of birds at this site.

Avifaunal Community Similarity

The similarity index of the avifaunal community between swidden farm and the primary forest had the lowest value (Ro=0.48) (Figure 1). This suggests that the assemblage of birds in the primary forest was less similar to those found in the swidden farm. This disparity could have been attributed to the loss and decline of forest dwelling species and the increased presence of open dwelling generalist species in the swidden farm. Thiollay et al. (2005) subscribe to this idea by declaring that the rapid decrease in the number of forest species in plantations was offset by an increase in the number of open habitat species.

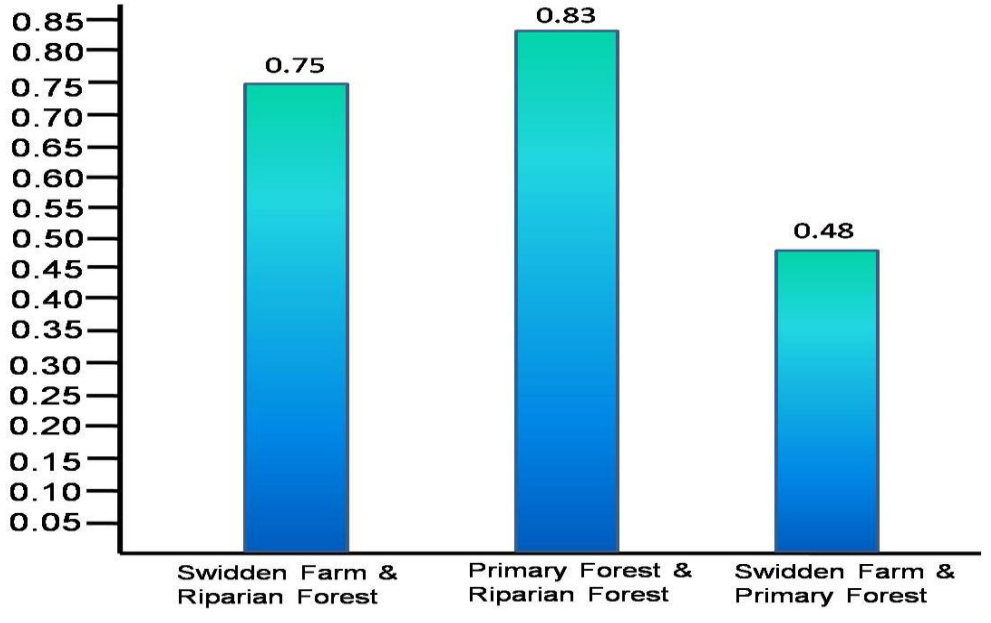

Figure 1. Degree of similarity (Horn's Information Theoretic Index) of avifaunal communities in swidden farm, riparian forest and primary forest.

In contrast, the similarity index between the bird communities of primary forest and riparian forest (Ro=0.83) was the highest among all compared sites. Similarly, the similarity index between bird communities of riparian forest strip and swidden farm was also comparably high (Ro=0.75). This suggests that the bird community in the riparian forest was similar to those found in the primary forest and to those found in the swidden farm. Chan et al. (2008) confirmed the importance of riparian forest ecosystem in forest birds when they observed distribution patterns of birds and insect prey in a tropical riparian forest. They disclosed that more birds (both number of individuals and species) were recorded in the riparian zone than in upland forest during wet season due to the availability of adult aquatic insects. The presence of strict forest dwellers in the riparian forest strip magnifies its importance in enhancing the localized movements of forest dwelling species between forest fragments. According to the study conducted by Mosley et al. (2006), the riparian forest strip functions as movement corridors during breeding and fall migration periods of birds in boreal mixed wood forest in Northeastern Ontario, Canada. Another factor that could have attracted the forest dwelling birds in the riparian forest strip was the presence of the remnant native vegetation. In some studies it was observed that native vegetation enhances the presence of avifaunal species in a given area (Rotenberg 2007; Haslem & Bennett 2008; Manhood et al. 2012). Aside from the forest dwelling bird species, diverse open dwelling birds found in the swidden farm also visit the riparian forest strip as indicated by the high similarity index value between these two sites. Some open dwelling species could have been attracted by the availability of more food in the riparian forest strip. Open dwelling generalist species that can tolerate forest edges and other species that visits the streams were common visitors recorded in the riparian forest. It was also observed that some members of the family Columbidae that prefers open habitat such as the Spotted Dove (*Spilopelia chinensis*) and Zebra Dove (*Geopelia striata*) and some members of family Estrildidae such as the White-Bellied Munia (*Lonchura leucogastra*) and Chestnut Munia (*Lonchura atricapilla*) used trees along the edges of riparian forest as nesting places.

Level of Endemism of Birds

All the Palawan endemic bird species (15) recorded in the study area were also found in the primary forest. Among these, 13 species were also found in the riparian forest while only seven species were also recorded in the swidden farm (Figure 2). Equally high number of resident species (7 species) with Palawan endemic race was recorded in both the primary forest and riparian forest strip. On the other hand, only four species of birds with Palawan endemic race was found in the swidden farm. Finally, out of the

four Philippine endemic bird species recorded across the habitat surveyed, two were found in the primary forest, three were found in the riparian forest and only one was found in the swidden farm.

The results indicate that the riparian forest strip has the capacity to support both endemic bird species and races. Conserving this forest strip within the swidden vegetation matrix will improve the overall abundance and richness of endemic bird species and races at a landscape level. However, the data also exposed that the primary forest supports some Palawan endemic birds that were not recorded in the riparian forest such as the Palawan Peacock-Pheasant (*Polyplectron napoleonis*) and Palawan Blue Flycatcher (*Cyornis lemprieri*). Mallari et al. (2011) corroborates with this observation by declaring that old growth forest has the highest conservation value for Palawan's endemic birds. Similarly, Riley (2003) come up with a similar finding by asserting that endemic and threatened birds in Karakelang, Talaud Islands, Indonesia were encountered more frequently or occurred at higher densities in the primary forest. This strongly suggests that maintaining the stands of primary forest fragments within the upland agricultural vegetation matrix is important for the conservation of endemic birds.

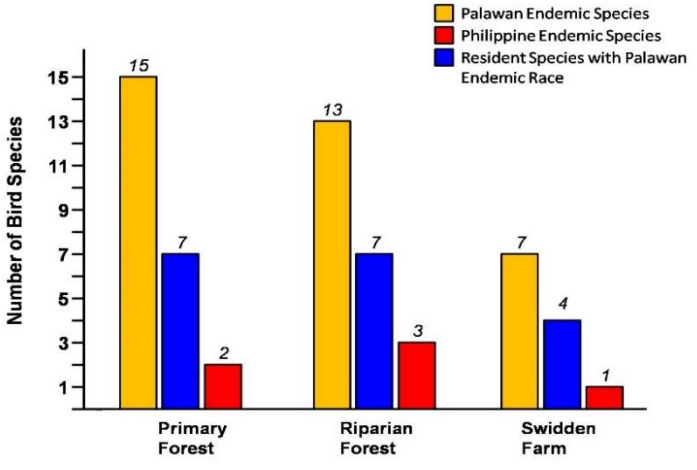

Figure 2. Number of endemic species and races found in swidden farm, riparian forest and primary forest sites.

On the other hand, the swidden farm has little value in conserving both the endemic bird species and endemic bird races. Expanding the area used for upland agriculture will not only compromise the overall species richness and abundance of birds, but will also have undesirable consequences to the population of endemic birds. The sensitivity of forest

dwelling endemic birds to habitat modifications highlights their vulnerability to habitat degradation (Wijesinghe and Brooke 2005).

Presence of Conservation Priority Bird Species

Out of the total number of bird species recorded, 12 species were included in the 2016 Red List of Globally Threatened Species set by the International Union for the Conservation of Nature (IUCN 2017). Among the red listed birds, seven species were classified in the category near-threatened, four species were classified in the category vulnerable and one was listed in the category endangered. More importantly, four out of the seven near-threatened, three out of the four vulnerable and the only endangered bird species were also endemic to Palawan. These bird species have narrow geographical distribution and most of them are forest specific which are vulnerable to forest degradation (Posa and Sodhi 2006).

Primary forest has the highest number of conservation priority species followed by the riparian forest strip and swidden farm (Figure 3). All the near-threatened (7), vulnerable (4) and endangered (1) birds recorded in all the sites were also found in the primary forest while only five near-threatened, three vulnerable and one endangered species were recorded on riparian forest strip. Meanwhile, only one near- threatened species and no vulnerable and endangered species were recorded in the swidden farm. The results unveiled that although primary forest harbors the highest number of conservation priority bird species, the riparian forest also supports many conservation priority bird species. In contrast, the swidden farm provides less support to conservation priority bird species. This finding explicitly exposed that most of the conservation priority bird species in the study area are forest dependent and are sensitive to habitat degradation. In a much wider scale, it was confirmed that 75% of the threatened birds globally are dependent to forest (Simberloff 2001).

Among the seven species of near-threatened birds found in the primary forest, four were Palawan endemic species. These are the Palawan Tit (*Periparus amabilis*), Palawan Blue Flycatcher (*Cyornis lemprieri*), Blue Paradise-Flycatcher (*Terpsiphone cyanescens*) and Spot-Throated Flameback (*Dinopium everetti*). Likewise, three out of the four vulnerable birds recorded in the primary forest were also Palawan endemic species. These are the Palawan Hornbill (*Anthracoceros marchei*), Palawan Peacock-Pheasant (*Polyplectron napoleonis*) and Blue-Headed Racquet-Tail (*Prioniturus platenae*). Finally, the only endangered endemic bird species recorded in the study area, the Red-Headed Flameback (*Chrysocolaptes erythrocephalus*) was also recorded in the primary forest. These data

highlight the importance of primary forest habitat in the conservation of threatened endemic birds.

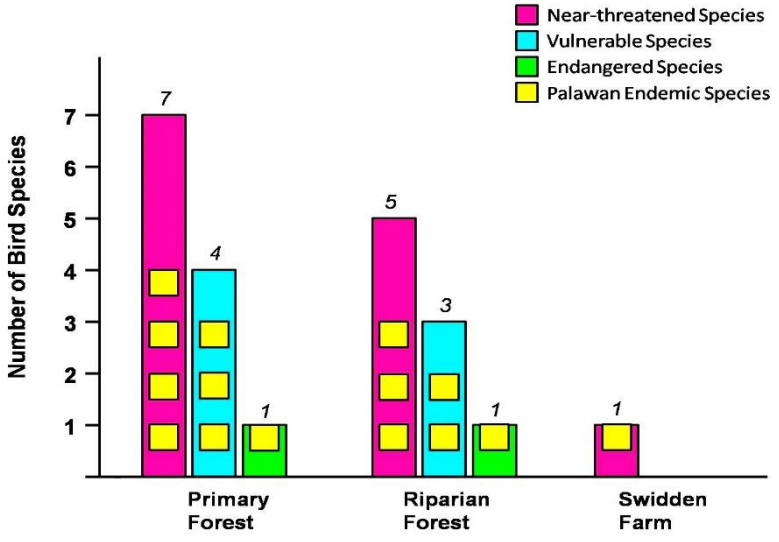

Figure 3. Number of species and endemism of conservation priority birds found in swidden farm, riparian forest and primary forest based on the IUCN Red List of Globally Threatened Species (2016).

Most of the conservation priority endemic bird species found in the primary forest were also recorded in the riparian forest. Three out of the four near-threatened, two out of the three vulnerable and the only endangered endemic bird species recorded in the primary forest also thrive in riparian forest strip. This result clearly indicates that the riparian forest strip is also important in supporting the conservation priority endemic bird species. On the contrary, only one near-threatened bird species was found in the swidden farm. This suggests that the disturbance in the swidden farm causes significant changes in its bio-physical features that end up losing its ability to support the conservation priority endemic species.

CONCLUSIONS AND RECOMMENDATIONS

The riparian forest strip that grows along the steep slopping banks of the meandering tributary streams in the upland agricultural landscape is an important habitat and feeding ground for a wide array of bird species as

shown by high species richness, abundance and diversity index values. The high community similarity index between bird communities of riparian forest strip and primary forest suggests that most birds found in the primary forest are also found in the riparian forest strip. Likewise, the high community similarity index between bird communities of riparian forest strip and swidden farm also suggests that most birds found in the swidden farm are also visiting the riparian forest strip. Despite the dissimilarity of bird assemblage that thrive in the primary forest and swidden farm as reflected by the low community similarity index, these birds congregate in riparian forest strip. One of the possible reasons for the attraction of forest birds in the riparian forest strip is the presence of indigenous large trees and thick understory vegetation which is much similar to the ambient environment of the primary forest. On the other hand, open dwelling species thriving in the upland agricultural areas are possibly attracted by the food supply and nesting sites in the riparian forest strip. Furthermore, riparian forest fragment is also an important habitat for endemic and threatened birds in highly degraded vegetation matrix.

As the conversion of forest to swidden farms and other upland development considerably decreased the avifaunal species richness, abundance, diversity, number of endemic and high conservation priority species, having a well preserved network of riparian forest strip connected to the primary forest stands closed to it will generally enhance the existing bird community at the landscape level.

An information and education campaign must be conducted to educate the local people about the significance of riparian forest fragments in the conservation of endemic and high conservation priority bird species. It must effectively disseminate the importance of riparian forest strips in enhancing the depauperate avifaunal diversity in the upland agricultural vegetation matrix and at the same time convey information on the invaluable ecosystem functions and services done by different birds.

The local government unit must come up with a management plan which aims to limit further expansion of swidden agriculture in the remaining primary forest and at the same time address the welfare of the people living in the area by providing low impact sustainable livelihood options. Additionally, it is suggested that a well monitored and guided co-management scheme between upland swidden farmers and responsible government units leading to the protection and conservation of riparian forest strips be implemented.

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