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Significance of Cloud Forests in Loolkandura Estate, Deltota for conservation of endemic bird Species in Sri Lanka

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ABSTRACT

The Loolkandura Estate (07^0 08' N, 80^0 42' E) is located in the central hills of Sri Lanka and is surrounded by patchy cloud forests. Since previous studies on avian endemism in Loolkandura are virtually lacking, the present study was designed to measure the endemic avifaunal diversity of cloud forests in this estate area and to compare it with that of adjoining tea plantations in order to justify its conservation value. A line transect method integrated with point counts with unlimited distance was used to count endemic birds. Peak counting hours were between 0600 h – 0900 h and 1500 h – 1800 h. Shannon Diversity Index (H) and Simpson's Index (1-D) were computed to compare the endemic bird diversity of two habitats. This study recorded 17 out of 33 endemic bird species (51.52 %) in Sri Lanka. Among them, ten bird species including one endangered species (Sri Lanka Whistling Thrush; *Myophonus blighi*) were restricted to the fragmented natural forests. The Sri Lanka White-Eye was the most commonly recorded species (25.68%). Natural forests had high 1-D and H values (1-D = 0.8625, H = 2.3439) than the tea plantation areas. Results of this study highlight the importance of remaining cloud forests of Loolkandura Estate for the survival of endemic bird species in Sri Lanka.

Keywords: Endemic Birds; Patchy forests; Central hills; Endangered species; Tea plantations; Conservation

INTRODUCTION

Sri Lanka is a continental island located in the Indian Ocean (79° 39' E - 81° 53' E; 5° 54' N- 9° 52' N.) closer to the Southern part of India. It has a land area of 65,610 km^2. Together with the Western Ghats of India, Sri Lanka is considered as one of the 35 biodiversity hotspots of the world (Mittermeier *et al*., 2011). Even though Sri Lanka is a small island, its avifaunal diversity is significantly high. According to the National Red List (MOE, 2012), 453 bird species are found in Sri Lanka including 240 breeding residents and 213 migratory species. Especially, Sri Lanka is recognized as a one of the world's Endemic Bird Areas (BirdLife International, 2015). The generally accepted number of endemic bird species in Sri Lanka ranges from 27 – 33 (Weerakoon & Gunawardena, 2012).

Kotagama (1993) has divided Sri Lanka into six major avifaunal zones, namely Northern or Indian zone, Low Country Wet Zone, Mid Country Wet Zone, Hill Country Wet Zone, Dry Zone, and the Uva Zone, based on the distribution patterns of the resident bird species. According to Kotagama (1993), the mid country wet zone and hill country wet zone are home to most of the endemic and threatened bird species (Weerakoon & Gunawardena, 2012).As the temperature of the hill zone varies significantly and sharp frosts are frequent in the highest altitudes during December and January, distribution of flora and fauna are also extremely influenced by this climatic patterns and elevation (Wijesundara & De Silva, 2005).

Loolkandura estate (07^0 08'N, 80^0 42'E; elevation 1320 m above sea level) is located in central hills of the Island and it is said to be the first tea estate in Sri Lanka, commenced by James Taylor in 1865 (Wickramasinghe *et al.,* 2015). Loolkandura estate comprises of heavily fragmented forest areas, especially in upper parts of the estate. These forest patches support an extremely diverse avifauna including winter visitors and common and rare breeding residents. Areas with large numbers of endemic species are important in conservation since loss of such areas may cause the extinction of such important species, especially restricted range species. A significant correlation in habitat selection by tropical birds with their food resources and microhabitat features of their nesting sites has been recorded previously (Borges & Stouffer, 1999). As a result, the presence of some specific bird species can be used as indicators for assessing forest condition. As birds respond quickly to changes in the environment, their distribution is directly affected by habitat fragmentation (Wijesundara & Wijesundara, 2014). No previous studies have been carried out to measure the endemic avifaunal diversity of Loolkandura area (Chathuranga *et al*., 2016). At present, Loolkandura area is subjected to destruction of forests and resulting habitat

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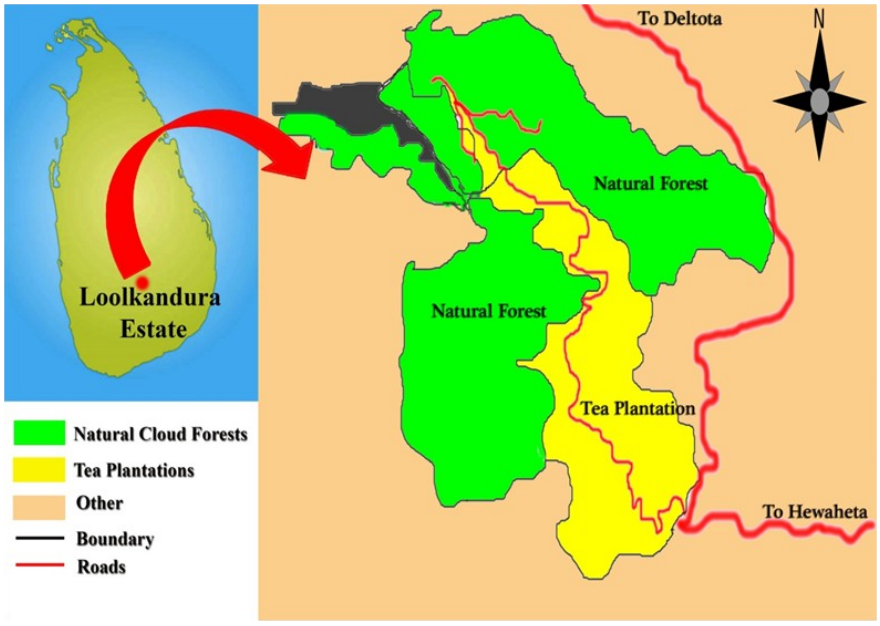

Figure 1. Loolkandura estate showing major habitat types

fragmentation. Hence, the overall objective of the present study was to measure the endemic avifaunal diversity in fragmented forest patches in Loolkandura estate and compare it with that of adjoining tea plantations in order to justify the conservation significance of the area.

MATERIALS AND METHODS

The Loolkandura Estate comprises of heavily fragmented forest areas, especially in upper parts of the estate (Fig. 1). For counting endemic birds, a line transect method integrated with point counts with unlimited distance (Variable Circular Plot Method or VCPM) was used in both the forest fragments and tea plantations (Fig. 2A & 2B). We followed Sutherland (2006) and Bibby *et al*. (2000) for our line transects and point counts. Transects were selected according to the local road network with randomly selected starting points. Double counting was avoided as far as possible by maintaining a minimum distance of about 250 m between two counting stations. Data were collected every other week from November 2014 to July 2015. Peak counting hours were between 0600 h – 0900 h and 1500 h – 1800 h. Fifteen minutes were spent at each point and all individual birds seen were recorded. Before starting to count at each station a few seconds were spent without counting in order to reduce the effect of disturbance on counting.

A few night sampling sessions were conducted to identify nocturnal endemic birds, if any. Standard birding binoculars (Nikon Action Extreme 8 × 40) were used for direct identification of diurnal birds. Birds were identified to the species level using standard field guides, e.g. Harrison (2011) and Warakagoda *et al*. (2012). Shannon Diversity Index (H) and Simpson's Index of Diversity (1-D) were used to compare the bird diversity in the two habitats. The Shannon Diversity Index (H) was selected as a measure of the bird diversity of the two habitat types, as it is useful for both species richness and abundance. Simpson's Diversity Index (D) was also calculated to compare any faults that originate from the Shannon Diversity Index with respect to errors associated with the size of the sample. Species accumulation curves were drawn to check the adequacy of sampling. Foraging guilds of the endemic birds were also reported to identify the conservation importance of natural forests and tea plantations.

Figure 2A. Tea Plantation

Figure 2B. Cloud Forest

Figure 2. Tea plantations (A) and Fragmented Natural cloud forests (B) of Loolkandura estate (Photographs by W.G.D. Chathuranga)

Table 1. Endemic avifauna of Loolkandura estate, their distribution and feeding habits

Family	Common name	Scientific name	NCS*	NF/ TP*	Feeding habit*	TP* (%)	NF* (%)
Columbidae	Sri Lanka Wood pigeon	*Columba torringtoniae* (lesson, 1831)	VU	**NF**	IN/NE	-	3.42
Psittacidae	Sri Lanka Hanging Parrot	*Loriculus beryllinus* (Forster, 1781)	LC	NF/ TP	IN/FR	4.45	1.37
	Layard's Parakeet	*Psittacula calthropae* (Blyth, 1849)	NT	**NF**	GR/FR	-	1.03
Ramphasti-dae	Yellow-fronted Bar-bet	*Megalaima flavifrons* (Cuvier, 1816)	LC	NF/ TP	IN	1.37	4.79
	Crimson-fronted Barbet	*Megalaima rubricapillus* (Gmelin, 1788)	LC	NF/ TP	FR	0.34	1.03
Picidae	Crimson-backed Goldenback	*Chrysocolaptes lucidus* (Scopoli, 1786)	LC	NF/ TP	FR/NE	0.34	2.05
Pycnonotidae	Yellow-eared Bulbul	*Pycnonotus penicillatus* (Blyth,1851)	VU	**NF**	IN	-	12.33
	Black-capped Bul-bul	*Pycnonotus melanicterus* (Gmelin,1789)	LC	**NF**	IN	-	1.37
Timaliidae	Brown-capped Bab-bler	*Pellorneum fuscocapillus* (Blyth,1849)	LC	**NF**	IN	-	4.45
	Sri Lanka Scimitar Babbler	*Pomatorhinus melanurus* (Blyth,1847)	LC	NF/ TP	GR/FR	1.71	7.19
Sturnidae	Sri Lanka Myna	*Gracula ptilogenys* (Blyth,1846)	VU	NF/ TP	IN	2.05	8.90
Muscicapidae	Dull Blue Flycatcher	*Eumyias sordidus* (Walden, 1870)	VU	**NF**	IN	-	5.82
Zosteropidae	Sri Lanka White-Eye	*Zosterops ceylonensis* (Holdsworth, 1872)	NT	**NF**	IN/FR	-	25.68
Phasianidae	Sri Lanka Jungle-fowl	*Gallus lafayetii* (Lesson, 1831)	LC	**NF**	IN/GR	-	1.37
Hirundinidae	Sri Lanka Swallow	*Hirundo hyperythra* (Blyth, 1849)	LC	NF/ TP	IN	1.03	0.34
Turdidae	Sri Lanka Whistling Thrush	*Myophonus blighi* (Holds-worth, 1872)	EN	**NF**	FR	-	2.05
	Spot winged Thrush	*Geokichla spiloptera* (Blyth, 1847)	VU	**NF**	FR	-	5.48

***NF**-Natural forests, **TP**-Tea plantations, **IN**-Insectivore, **NE**-Nectarivore, **FR**-Frugivore, **GR**-Granivore, **NCS** – National Conservation Status, **VU**-Vulnerable, **LC**-Least concern, **NT**-Non threatened, **EN**-Endangered

RESULTS

The present study recorded 17 endemic bird species belonging to 12 families (Table 1). It is significant that 17 out of 33 endemic bird species in Sri Lanka (51.52 %) were recorded in the area. Relative abundance of endemic bird species is considerably high in natural forests than the tea plantation areas (Figure 3). It is interesting to note that ten endemic species (58.82%) were restricted to the fragmented natural forests (Table 1). The Sri Lanka white-eye (*Zosterops ceylonensis*) was the most commonly recorded endemic bird species and Sri Lanka Junglefowl (*Gallus lafayetii*), Sri Lanka Swallow (*Hirundo hyperythra*), Layards' Parakeet (*Psittacula calthropae*), Crimson-fronted barbet (*Megalaima rubricapillus*) and Black-capped Bulbul (*Pycnonotus melanicterus*) were the least commonly recorded endemic bird species (Table 1). According to the National Conservation Status (NCS) of endemic birds, 53 % in Loolkandura area were in Least Concern (LC) category. Vulnerable (VU) species accounted for 29 % and one endangered species (Sri Lanka Whistling Thrush-*Myophonus blighi*) were recorded (Figure 4). The endemic birds in the loolkandura area were mostly insectivores and seven species were exclusively insectivorous (Figure 5). According to the observations, majority of the frugivorous and insectivorous were recorded in the natural forest areas than the tea plantations (Figure 6). Natural forests had high 1-D and H values (1-D = 0.8625, H = 2.3439) than the tea plantation areas (Table 2). These diversity indices indicate that natural forests had higher endemic bird diversity.

Table 2. Endemic avifaunal diversity differences in natural forests and tea plantations of Loolkandura area

	Natural forest	Tea plantation
Number of species	17	7
Shannon diversity index **(H)**	2.3439	1.77337
Simpson index of diversity **(1-D)**	0.8625	0.7869

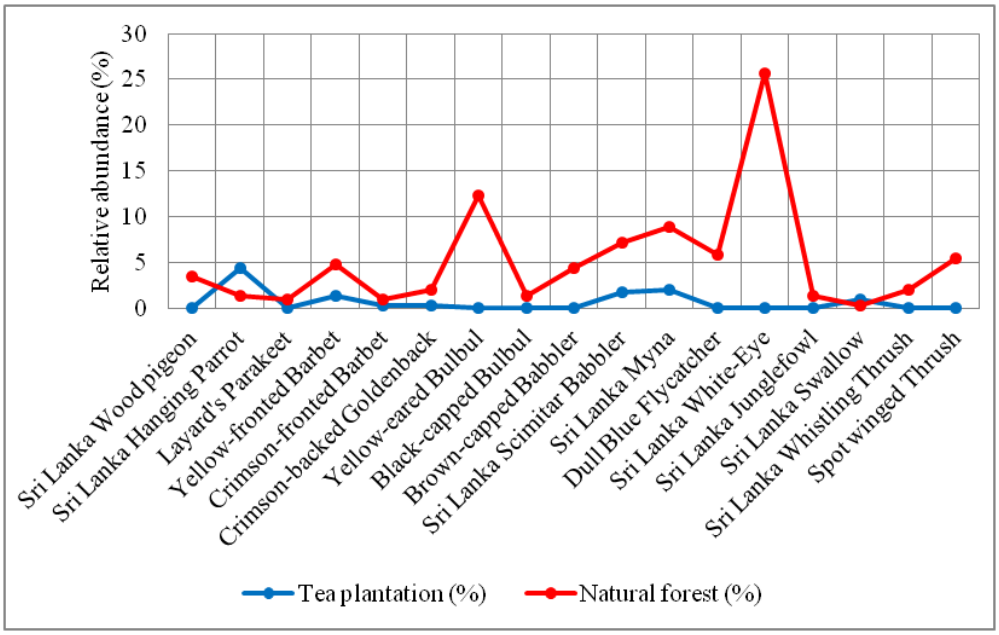

Figure 3. Relative abundance of endemic bird species at natural forests and tea plantations

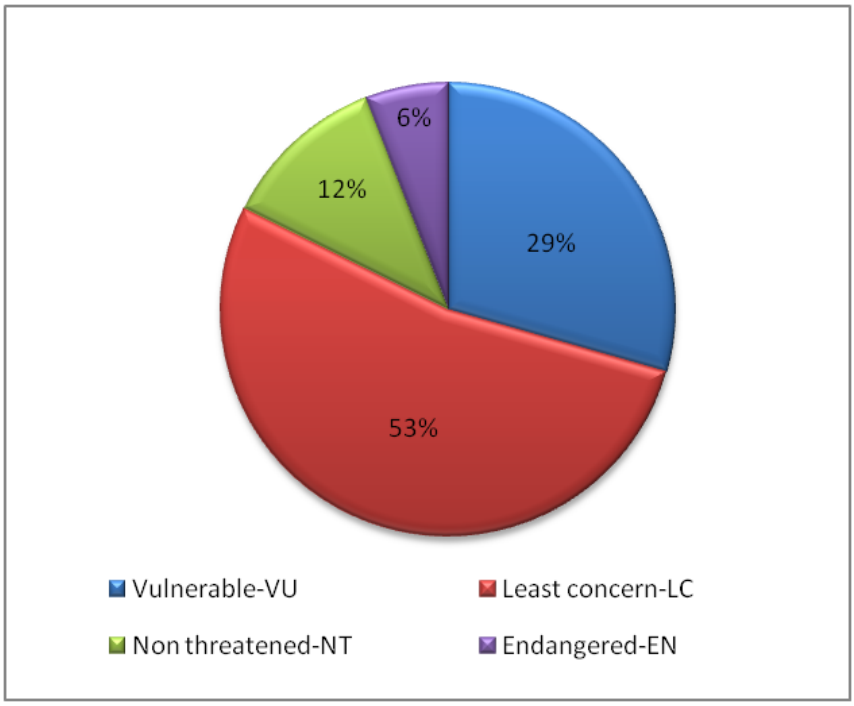

Figure 4. Conservation status of endemic birds in Loolkandura area, Central Sri Lanka

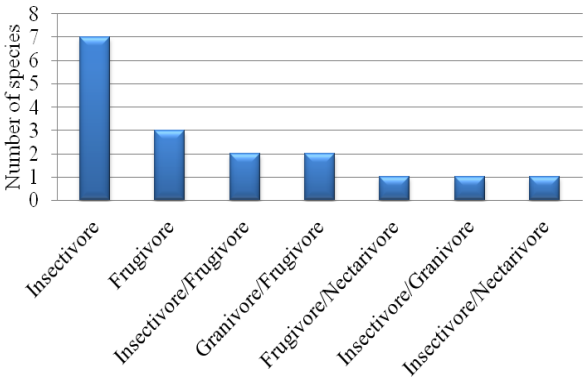

Figure 5. Foraging guilds of endemic birds in Loolkandura area, Central Sri Lanka

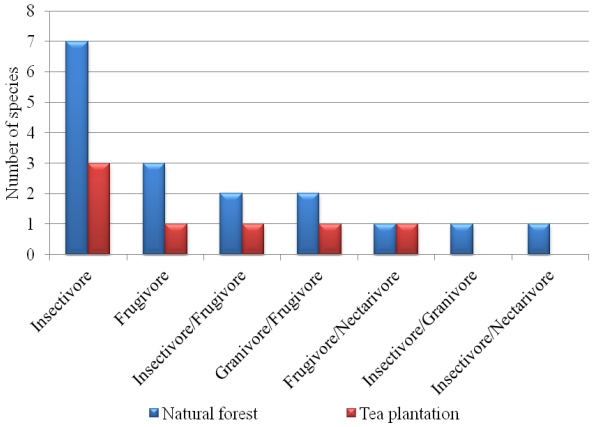

Figure 6. Foraging guilds of endemic birds at natural forests and tea plantations in Loolkandura estate, Central Sri Lanka

DISCUSSION

Doumenge *et al*. (1995) have shown the values of tropical montane cloud forests in terms of their diversity, endemism, and the functions they provide. The present study also highlights the importance of protecting remaining forest patches of Loolkandura area in order to maintain the high endemic avifaunal diversity. In the present study, the vegetation structures were different in the two habitat types (cloud forest and tea plantation). According to our observations, natural forests had densely packed large trees with stratification and contained more invertebrate food resources for birds. In contrast, the tea plantation areas mainly contained closely-packed, short tea plants. These structural differences between the two habitat types seem to have a considerable impact on the diversity of endemic bird species. For example, ten endemic bird species were restricted to the natural forest areas and none were restricted to tea plantation areas. This may be due to the habitat variations and availability of food sources.

The Sri Lanka White-Eye (*Zosterops ceylonensis*) and the Yellow-eared Bulbul (*Pycnonotus penicillatus*) are commonly found from mid hills up to higher hills in Sri Lanka. These two species had relatively high abundances and they were the most commonly found bird species in the forest patches in the study area. It is interesting to note that these species were restricted to natural patches and none were observed in tea plantation areas. According to Gaston (1996), locally abundant species tend to be widespread and locally uncommon species tend to be limited in their distribution. The fact that common species can be observed very easily than the rare species (difference in noticeability) may have disguised the presence of rare species. The Sri Lanka Whistling Thrush (*Myophonus blighi*), is an endangered and rare species that was regularly encountered in the forest fragments of Loolkandura Estate.

The Sri Lanka Wood Pigeon (*Columba torringtoniae*), Yellow-eared Bulbul (*Pycnonotus penicillatus*), Sri Lanka Myna (*Gracula ptilogenys*), Dull-blue Flycatcher (*Eumyias sordidus*), and Spotted-winged Thrush (*Geokichla spiloptera*), which are vulnerable species, were also encountered regularly in the forest patches. Patchy forests of Loolkandura Estate provide shelter for all these important species. These results highlight the high conservation significance of remaining forest patches of Loolkandura Estate. According to the feeding habits of endemic birds in Loolkandura area, insectivores and frugivores were the most dominant feeding guilds. The high abundance of endemic birds in natural forests may be partly due to the abundance of insects and fruits. It is interesting to note that all endemic species which were recorded in this area have been found in natural forest areas and only seven of them were recorded in the tea plantation areas. Diversity indices indicate that natural forest areas had a higher diversity. It shows the importance of natural forests for survival of endemic birds in Loolkandura area. Wijesinghe & Brook (2005) have previously recorded that endemic bird species in Sri Lanka encounter complications in tolerating modified landscapes. In this study, we observed that deforestation, extraction of fire wood, expanding tea plantations, habitat fragmentation, and habitat alteration caused major damages to this ecologically sensitive area. To prevent these from continuing, we recommend that this area be declared as a protected area for the conservation of endemic and endangered bird species.

CONCLUSION

According to the diversity indices, the natural forest and the tea plantation habitats were totally different in richness of endemic avifauna. The natural forests were the habitats with highest endemic bird species richness, whereas tea plantations were very poor in endemic species diversity. Furthermore, the present study highlights the importance of remaining natural forest patches in the conservation of common, rare, and endangered endemic bird species in Sri Lanka.

Declarations

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request

Authors' contributions

WGDC and CSW conceived the research project and led

the writing. WGDC, NS and MHKA collected the data. WGDC and CSW analyzed the data. All authors read and approved the final manuscript.

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