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Comparison of the Seasonal Occurrence of Birds at the Teknaf Wildlife Sanctuary, Inani Reserve Forest and Chittagong University Campus, Bangladesh

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Abstract

Teknaf Wildlife Sanctuary (TWS), Inani Reserve Forest (IRF) and Chittagong University Campus (CUC) are quite different types of habitat for birds but climatic and weather conditions of these areas are more or less the same because they lie on the same subtropical region. A comparative study on the seasonal occurrence of birds was conducted in TWS, IRF and CUC of Bangladesh from January to December 2015. Data were collected through both strip transect samplings and opportunistic findings. Birds were searched in transects of the existing roads, trails, streams and bridle paths. Twenty-three transects were established to record data: 9 in TWS, 7 in IRF and 7 in CUC.A total of 249 bird species belonging to 50 families were recorded during the study period. TWS was found to be the most diversified area (210 species), followed by IRF (187 species) and CUC (182 species). Among seasons, winter was found to be the most diversified season (240 species) in all areas, followed by summer (176 species), post-monsoon (164 species) and monsoon (138 species). Finally, new information on the seasonal occurrence was recorded for 22 species of non-resident birds in Bangladesh.

1. Introduction

Birds are one of the most important ecological indicators to evaluate natural conditions (Johnston & Odum 1956; Morrison 1986; Welsh 1987; Temple & Weins 1989; Browder *et al.* 2002). They react to changes of habitat rapidly due to their flying ability (Hilden 1965; Morrison 1986; Fuller *et al*. 1995). Bangladesh is home to 711 species of birds (Khan 2015), which is about 50% of the total species of the Indian subcontinent and about 7% of the world (Harvey 1990; Khan 2008). Works on birds in the study areas are very limited. Khan *et al.* (1994) reported that there were 286 species of birds reported from Teknaf Wildlife Sanctuary (TWS) and later Khan (2013) annotated a list of 243 species. Ahsan & Khanom (2005) recorded 92 bird species from the Chittagong University campus. Though comparative study is very essential to find occurrence of birds in different habitats as well as to justify the habitat quality, only one comparative study on birds of five protected areas (namely, Lawachara, Satchori, Rema-Kalenga, Chunati and Teknaf) was done in Bangladesh (e.g. Khan & Aziz 2014) with no comparative study on the seasonal occurrence of birds.

TWS is peninsular landmass protected as a Wildlife Sanctuary and one of the Ecologically Critical Areas (ECAs) of Bangladesh. Inani Reserve Forest (IRF) has not yet been included in protected area of the country but is being conserved by legal administration. On the other hand, Chittagong University Campus (CUC) is

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a semi-urbanized area. Therefore, TWS, IRF and CUC are quite different habitats with similar climatic and weather conditions in the subtropical region. This study was taken to compare the seasonal occurrence of birds in TWS, IRF and CUC.

2. Materials and Methods

2.1. Study areas

Climatic condition of TWS, IRF and CUC are more or less the same as they lie on the subtropical region while the longest aerial distance is 150 km (between TWS and CUC) (Fig. 1).

Teknaf Wildlife Sanctuary (TWS) is located in the Teknaf peninsula of Cox's Bazar district at the southeast corner of Bangladesh (20°52′ to 21°09′ N and 92°08′ to 92°18′ E). It is bounded by IRF in the north, the Bay of Bengal in the west, the Naf River in the east and plain lands of Teknaf peninsula in the south. It lies about 50 km south of the Cox's Bazar city and runs along with the longest beach of the world (Cox's Bazar Beach). This sanctuary comprised of 10 administrative units (Forest Beat Offices) under three forest ranges of Cox's Bazar (south) Forest Division. It is a hilly mixed-evergreen sub-tropical forest with the secondary plantations covering an area of 11,615 ha. The length of TWS is about 32 km (north-south), and its width is 5 km at the north and 3 km at the south. The highest elevation of TWS is about 284 m (800 ft) msl at Toingya of Shilkhali Forest Range. The area is consisted of intervals of steppe hills and valleys. This sanctuary is very rich in flora and represents different ecosystems, including hill forest, mangrove forest and sand-dune (Uddin *et al.* 2013). Feeroz (2013) recorded a total of 538 plant species from 102 families and 370 genera in TWS, of which 143 are tree species, 113 shrubs, 184 herbs, 87 climbers, 10 epiphytes and 1 parasite.

Inani Reserve Forest (IRF) is located in Ukhiya of Cox's Bazar (21°09′ to 21°17′ N and 92°02′ to 92°11′ E). It is surrounded by Himchari National Park in the north, TWS in the south, suburb area in the east and the Bay of Bengal in the west. It lies about 22 km south of the Cox's Bazar city and also runs along with the longest beach of the world, the Cox's Bazar. It comprises four Forest Beats under Inani Range of Cox's Bazar (south) Forest Division. IRF is a hilly area with the mixed evergreen forest and secondary plantations (Jashimuddin 2010), covering an area of 8,200 ha with about 22 km length and maximum 5 km width. The area of IRF was covered by natural low and high forests in the past but now it has changed to scattered grasslands and agricultural lands with scattered trees (DeCosse 2007) but there are still some good forests supporting rich biodiversity (Kabir 2012).

Chittagong University Campus (CUC) is situated at Hathazari upazila (sub-district) in Chittagong district of Bangladesh (22°27′30" to 22°29′0" N and 91°46′30" to 91°47′45" E). It lies about 22 km north of the city of Chittagong, 3 km south-west of Hathazari headquarter and about 6 km east of the Bay of Bengal, supporting an area of 709.82 ha of the land. The CUC is surrounded by hills of northern Chittagong and bounded by two hill streams flowing in the south and the north. The CUC is a quite large area with rich biodiversity compared to other universities of the country. The highest altitude of CUC is about 61 m.s.l. near the Faculty of Biological Sciences. The vegetation of CUC is semi-evergreen (Ahsan & Khanom 2005). A total of 665 plant species from 126 families and 404 genera are found in CUC (550 species of dicotyledons and 115 species of monocotyledons) (Alam & Pasha 1999).

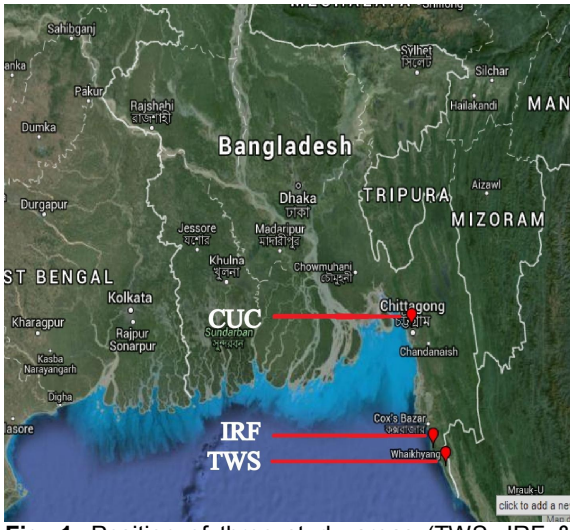

Fig. 1. Position of three study areas (TWS, IRF & CUC) in Bangladesh

2.2. Methods

The present study was conducted from January to December 2015. A total of 72 days were spent for field observations (2 days a month and 24 days in each study area). Field observations were carried out throughout the day while emphasis was given to the morning (6:00 to 10:00 hrs) and evening (16:00 to 19:00 hrs) (when birds are more active than other times). Data were collected through Strip transect sampling (Buckland *et al.* 2001) and opportunistic findings have also been considered. Birds were searched through the existing roads, trails, streams and bridle paths as transects and 23 transects were established to record data: 9 in TWS, 7 in IRF and 7 in CUC (Table 1).

Field observations were carried out by using a pair of binoculars (Vixen: 8×32 magnification) during the day time. Photographs were also taken using a set of camera (Canon 600D with 75-300 mm lens) wherever it was necessary to identify birds accurately to the species level. Nocturnal and a few diurnal birds were identified by their call and songs. Identification of species was done with the help of standard field-guides (Ali & Ripley 1995; Kazmierczak & van Perlo 2006; Grimmet *et al.* 2013). The study period was categorized into four seasons, viz. winter (December−February), summer (March−May), monsoon (June−August) and post-monsoon (September−November). The birds were categorized according to their status as resident or migratory, followed by Siddiqui *et al.* (2008). Birds were considered as residents (R) when they were sighted in all seasons of the year during the study period or known to breed in the country. Some birds sighted occasionally during a particular season of the study period but known to breed in the country were either rare or local migrants. Other seasonally observed birds were considered as migrants in winter or summer, passage migrants or vagrants. Those birds mostly inhabiting in forested areas but usually not observed outside forest areas were considered as forest indicator. The World Bird List by Gill & Donsker (2016) was followed for English and scientific names as well as IUCN Bangladesh (2015) for the status of each species in the country (Table 2). The number of sighted individuals observed in a particular area and/or in a particular season has been mentioned. In case of common birds, an estimation of minimum sighted number of these species was provided (Table 2).

3. Results

A total of 249 species of birds belonging to 50 families were recorded in these three study areas during January to December 2015. However, 126 species (50.6%) of birds were seen in all four seasons, of which 121 species (96%) of birds were observed in TWS and 119 (94%) in IRF and CUC equally. There were only 22 species (8.8%) of birds observed in three seasons and 34 species (13.6%) of birds were observed in two seasons only (Table 2).

There were 11 species of birds (Large Hawk Cuckoo *Hierococcyx sparverioides*, Green Sandpiper *Tringao ochropus*, Black-headed Gull *Chroicocephalus ridibundus*, Ashy Drongo *Dicrurus leucophaeus*, Lesser Racket-tailed Drongo *Dicrurus remifer*, Black Redstart *Phoenicurus ochruros*, Common Stone Chat *Saxicola torquatus*, Red-rumped Swallow *Cecropis daurica*, Greenish Warbler *Phylloscopus trochiloides*, Grey Wagtail *Motacilla cinerea* and Citrine Wagtail *Motacilla citreola*) considered as winter visitor to Bangladesh (Siddiqui *et al.* 2008). These species stayed in Bangladesh up to April (summer) during the study period.

There were nine species of birds resident in Bangladesh but rare in the study areas. They came to the study areas from other countryside. Among them, the Asian Drongo Cuckoo *Surniculus lugubris* and Oriental Honey Buzzard *Pernis ptilorhyncus* were seen at all these three study areas and the Scarlet Minivet *Pericrocotus flammeus* at TWS and CUC, Oriental Pratincole *Glareola maldivarum* at IRF, Large Woodshrike *Tephrodornis gularis* at TWS, Jungle Babbler *Turdoides striatus* at CUC in winter; the Orange-headed Thrush *Zoothera citrine* at CUC and the White-browed Wagtail *Motacilla maderaspatensis* at TWS in post-monsoon.

The common resident birds (126 species) of the study areas were recorded at each site over the year (121 in TWS, 119 in IRF and CUC). Overall, winter was most diversified season for birds in these three study areas (240 species), followed by summer (176 species) and post-monsoon (164 species). Monsoon was the least diversified season (138 species) (Fig. 3). In winter, 194 species of birds were recorded in TWS, 178 in IRF and 173 in CUC. In monsoon, 130 species were found in TWS, 126 in IRF and 120 in CUC (Fig.3). The highest diversity was observed in TWS in all seasons, followed by IRF and CUC (Fig. 3).

The diversity of migratory birds was also the highest in winter (63 species) but none was seen in monsoon. Similarly, the diversity of wading birds was the highest in winter (52 species). Even the forest indicator bird species were also mostly available in winter (52 species) and the least in monsoon (33 species) (Fig. 4). The diversity of migratory, wading and forest indicator birds in the different seasons shows that winter is mostly diversified with migratory birds while other three seasons (summer, monsoon and post-monsoon) are mostly diversified with forest indicator bird species (Fig. 4).

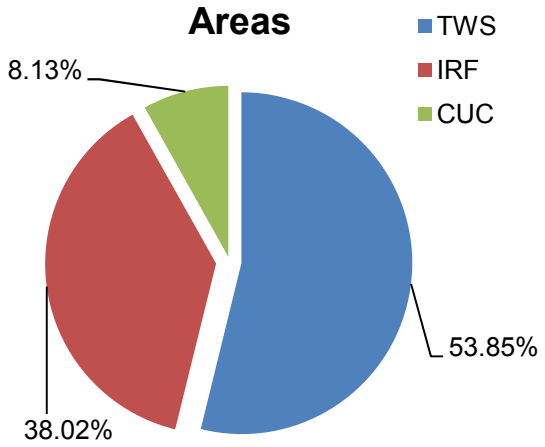

Fig. 2. Proportion of size of the three study areas (%) in 2015.

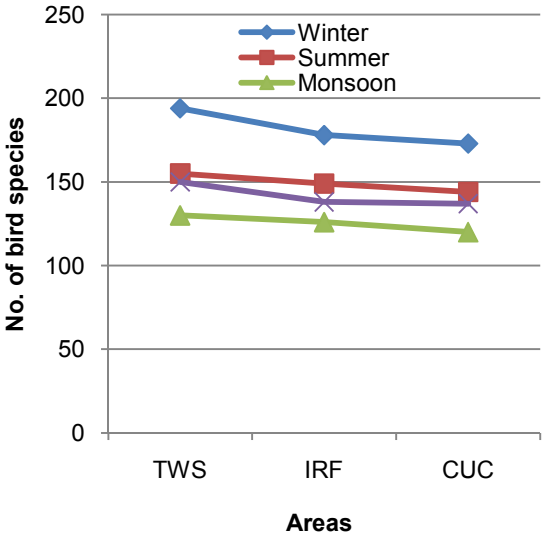

Fig. 3. Seasonal diversity of birds (species) in three study areas in 2015.

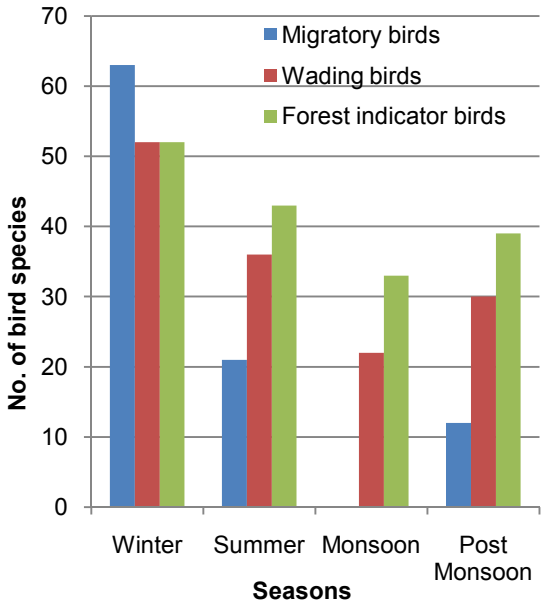

Fig. 4. Diversity of migratory, wading and forest indicator birds (species) in the different seasons in 2015.

Table 1. Transects in TWS, IRF and CUC in 2015.

SL no.	Name of transect	GPS coordination	Length (km)
		Transects in TWS	
01	Netong Hill	20° 52' 52.68" to 20° 53' 9.6" N & 92° 17' 49.344" to 92° 17' 39.408" E	0.70
02	Keruntoli Hill	20° 53' 52.044" to20° 53' 49.056" N & 92° 16' 54.12" to 92° 16' 45.048" E	0.55
03	Keruntoli stream	20° 54' 1.44" to 20° 53' 55.5" N & 92° 16' 48.324" to 92° 16' 19.92" E	1.167
04	West of Teknaf Port	20° 54' 34.74" to20° 54' 38.268" N & 92° 16' 28.56" to 92° 16' 4.008" E	0.941
05	Nature park	20° 56' 6.18" to 20° 55' 46.308" N & 92° 15' 33.84" to 92° 15' 36.036" E	0.902
06	Hnila I	20° 1' 7.824" to 20° 1' 19.236" N & 92° 13' 22.836" to 92° 12' 54.648" E	1.00
07	Hnila II	20° 1' 6.024" to 20° 1' 34.032" N & 92° 13' 24.384" to 92° 13' 16.032" E	0.782
08	Whykeong	20° 5' 24.108" to 20° 5' 3.408" N & 92° 9' 29.016" to 92° 10' 2.568" E	1.806
09	Shilkhali	21° 1' 22.872" to 21° 1' 22.728" N & 92° 11' 13.848" to 92° 11' 36.42" E	0.667
		Transects in IRF	
10	Holar Chara	21° 14' 6.108" to 21° 13' 45.264" N & 92° 3' 21.42" to 92° 3' 52.776" E	1.418
11	Narkella Jhira	21° 13' 48.936" to 21° 14' 19.464" N & 92° 4' 6.024" to 92° 3' 44.1" E	2.839
12	Boro Khal	21° 13' 29.208" to 21° 13' 33.384" N & 92° 3' 22.14" to 92° 4' 4.188" E	1.642
13	Patar Ghona	21° 13' 28.416" to 21° 13' 6.78" N & 92° 3' 17.424" to 92° 3' 46.224" E	1.465
14	Choto Khal	21° 12' 28.944" to 21° 12' 13.356" N & 92° 3' 16.74" to 92° 3' 41.688" E	1.385
15	Dakchara	21° 12' 3.564" to 21° 12' 1.836" N & 92° 3' 9.252" to 92° 3' 34.992" E	1.078
16	Swankhali	21° 10' 50.34" to 21° 10' 51.528" N & 92° 3' 7.236" to 92° 3' 44.388" E	1.486
		Transects in CUC	
17	Rail Line	22° 28' 14.736" to 22° 28' 10.56" N & 91° 47' 40.164" to 91° 47' 50.208" E	1.344
18	Dola Smarani to Forestry	22° 28' 4.008" to 22° 27' 38.268" N & 91° 47' 38.292" to 91° 47' 34.692" E	1.034
19	Shaheed Minar to Botanical Garden	22° 28' 15.636" to 22° 27' 33.156" N & 91° 47' 12.3" to 91° 47' 16.944" E	1.505
20	Hill Bottom Colony to the south	22° 28' 11.316" to 22° 27' 38.736" N & 91° 46' 59.016" to 91° 47' 8.88" E	1.14
21	Biological Faculty to the south	22° 28' 11.028" to 22° 27' 37.296" N & 91° 46' 59.016" to 91° 46' 48.68" E	1.217
22	Shaheed Abdur Rab Hall to the north	22° 28' 25.572" to 22° 28' 56.244" N & 91° 47' 8.268" to 91° 47' 5.532" E	2.00
23	Security Office to the Sluice Gate	22° 28' 27.588" to 22° 29' 7.44" N & 91° 47' 30.012" to 91° 47' 32.496" E	1.445

Table 2. List of birds in three study areas with their seasonal diversity in 2015. Key to symbols: *TWS= Teknaf Wildlife Sanctuary, IRF= Inani Reserve Forest, CUC= Chittagong University Campus, **W=Winter, S= Summer, M= Monsoon, PM= Post-monsoon.

Scientific Name	Common Name	Distribution*			Seasonal Diversity**				Status in country
		TWS	IRF	CUC	W	S	M	PM	
Dendrocygna javanica	Lesser Whistling Duck	>50		8	>50	4	4	3	LC
Anser indicus	Bar-headed Goose			2	2				LC
Gallus gallus	Red Jungle Fowl	6	3	6	8	9	10	14	LC
Lophura leucomelanos	Kalij Pheasant	4		5	5	2	1	4	VU
Tachybaptus ruficollis	Little Grebe	5	3	5	10	2	2	4	LC
Anastomus oscitans	Asian Openbill	14	12	>30	14	13	14	>30	LC
Threskiornis melanocephalus	Black-headed Ibis	5		2	7				VU
Ixobrychus sinensis	Yellow Bittern	1	2		1	1	2		LC
Ixobrychus cinnamomeus	Cinnamon Bittern	12	14	12		12	14	10	LC
Nycticorax nycticorax	Black-crowned Night Heron	4		1			5	1	LC
Butorides striata	Striated Heron	2					1	1	LC
Ardeola grayii	Indian Pond Heron	>80	>60	>40	>80	>100	>100	>80	LC
Bubulcus ibis	Western Cattle Egret	>100	>100	>60	80	>120	>120	>100	LC
Ardea cinerea	Grey Heron	5			2	3			LC
Ardea alba	Great Egret	>20	>20	8	>20	>40	>40	>20	LC
Egretta intermedia	Intermediate Egret	12	15		12	>20	>25	>20	LC
Egretta garzetta	Little Egret	>80	>80	>40	>100	>100	>120	>120	LC
Microcarbo niger	Little Cormorant	>40	>30	>20	>50	>50	>50	>50	LC
Elanus caeruleus	Black-winged Kite	2					1	2	LC
Pernis ptilorhyncus	Crested Honey Buzzard	2	3	2	7				LC
Aviceda jerdoni	Jerdon's Baza	2	5	2	3	2	2	5	LC
Aviceda leuphotes	Black Baza	2			2				LC
Gyps fulvus	Eurasian Griffon	4			4				-

Scientific Name	Common Name	Distribution*			Seasonal Diversity**				Status in country
		TWS	IRF	CUC	W	S	M	PM	
Spilornis cheela	Crested Serpent Eagle	10	9	6	>10	>10	>10	>10	LC
Accipiter badius	Shikra	7	6	6	10	8	7	8	LC
Accipiter virgatus	Besra	5	4	5	8	9	8	6	LC
Milvus migrans	Black Kite	>50	>40	>40	>120	>120	>100	>100	LC
Haliastur indus	Brahminy Kite	12	10	12	>20	12	13	>20	LC
Haliaeetus ichthyaetus	Grey-headed Fish Eagle	6	7	5	10	12	8	14	NT
Buteo buteo	Common Buzzard			3	3				LC
Amaurornis phoenicurus	White-breasted Waterhen	>30	>20	>20	>40	>30	>40	>30	LC
Gallicrex cinerea	Watercock			2		2			LC
Gallinula chloropus	Common Moorhen			9	9	6			LC
Turnix suscitator	Barred Buttonquail		1				1		LC
Vanellus cinereus	Grey-headed Lapwing	>30			>30				LC
Vanellus indicus	Red-wattled Lapwing	>50	>40	>40	>100	>100	>60	>80	LC
Pluvialis fulva	Pacific Golden Plover	6	8	2	16				LC
Charadrius dubius	Little-ringed Plover	10	8		18				LC
Charadrius alexandrinus	Kentish Plover	5	6		11				LC
Charadrius mongolus	Lesser Sand Plover	12	8		20				LC
Charadrius leschenaultii	Greater Sand Plover	5	4		9				LC
Rostratula benghalensis	Greater Painted-Snipe	>20	>20	>30	>50	>50	>60	>50	LC
Metopidius indicus	Bronze-winged Jacana	>30	>30	>20	>50	>60	>60	>70	LC
Gallinago stenura	Pintail Snipe	5	6	2	13				LC
Gallinago gallinago	Common Snipe	>30	>30	6	>60				LC
Tringa totanus	Common Redshank	>20			>20				LC
Tringa nebularia	Common Greenshank	3			3				LC
Tringa ochropus	Green Sandpiper	>30	>30	3	>60	>60			LC
Tringa glareola	Wood Sandpiper	>20	>20	6	>40				LC
Xenus cinereus	Terek Sandpiper	2			2				LC
Actitis hypoleucos	Common Sandpiper	>100	>100	>30	>230				LC
Arenaria interpres	Ruddy Turnstone	1			1				LC
Calidris alba	Sanderling	2			2				LC
Calidris minuta	Little Stint	4			4				LC
Calidris temminckii	Temminck's Stint	2			2				LC
Glareola maldivarum	Oriental Pratincole		2		2				LC
Chroicocephalus brunnicephalus	Brown-headed Gull	>200	>200		>400	>300		>300	LC
Chroicocephalus ridibundus	Black-headed Gull	>200	>200		>400	>400			LC
Ichthyaetus ichthyaetus	Pallas's Gull	>20	>20		>40				LC
Sternula albifrons	Little Tern	>30	>30		>60	>60			LC
Chlidonias hybrida	Whiskered Tern	>40	>40		>80	>80	>60	>60	LC
Columba livia	Rock Dove	>20	>20	>40	>60	>60	>60	>80	LC
Streptopelia orientalis	Oriental Turtle Dove	4	6	4	8	10	4	10	LC
Streptopelia decaocto	Eurasian Collared Dove	>20	>20	>20	>60	>60	>60	>60	LC
Streptopelia tranquebarica	Red Turtle Dove	8	6	4	6	12	14	18	LC
Spilopelia chinensis	Spotted Dove	>300	>200	>200	>700	>700	>700	>700	LC
Spilopelia suratensis	Western Spotted Dove		4		3	4		1	-
Chalcophaps indica	Common Emerald Dove	2			2	2			LC
Treron bicinctus	Orange-breasted Green Pigeon		8		2	8	4	2	LC
Treron pompadora	Sri Lanka Green Pigeon		4		4			2	-
Treron curvirostra	Thick-billed Green Pigeon	2	1			1		3	LC
Treron phoenicopterus	Yellow-footed Green Pigeon	>100	>100	>60	>200	>200	>200	>250	LC
Centropus sinensis	Greater Coucal	>40	>40	>20	>100	>100	>100	>100	LC
Centropus bengalensis	Lesser Coucal	>20	>20	>15	>50	>50	>50	>50	LC
Phaenicophaeus tristis	Green-billed Malkoha	>60	>50	>30	>100	>100	>120	>100	LC
Clamator coromandus	Chestnut-winged Cuckoo			1		1			LC
Clamator jacobinus	Jacobin Cuckoo	2		1		2		1	LC

Scientific Name	Common Name	Distribution*			Seasonal Diversity**				Status in country
		TWS	IRF	CUC	W	S	M	PM	
Eudynamys scolopaceus	Asian Koel	>50	>40	>30	>100	>120	>100	>100	LC
Cacomantis merulinus	Plaintive Cuckoo	>20	>20	5	>30	>40	>30	>30	LC
Surniculus lugubris	Square-tailed Drongo Cuckoo	4	4	2	10				LC
Hierococcyx sparverioides	Large Hawk Cuckoo			2	2	1			LC
Hierococcyx varius	Common Hawk Cuckoo			4	2	4	1	1	LC
Cuculus micropterus	Indian Cuckoo	>40	>30	>20	>50	>120	>100	>60	LC
Tyto alba	Western Barn Owl	6	5	6	17	15	10	12	LC
Otus bakkamoena	Indian Scops Owl	4	6	4	14	12	8	10	LC
Otus sunia	Oriental Scops Owl	12	10	8	20	17	8	16	LC
Ketupa zeylonensis	Brown Fish Owl	6	6	8	20	18	12	14	LC
Glaucidium cuculoides	Asian Barred Owlet	2	4	1	6	7	4	5	LC
Athene brama	Spotted Owlet	>50	>40	>40	>120	>130	>80	>100	LC
Ninox scutulata	Brown Hawk Owl	3	3	2	5	8	2	2	LC
Caprimulgus macrurus	Large-tailed Nightjar	8	6	8	20	22	14	20	LC
Cypsiurus balasiensis	Asian Palm Swift	>150	>150	>100	>400	>400	>400	>400	LC
Apus affinis	Little Swift			>50	>50	>50	>50	>50	LC
Apus nipalensis	House Swift	>100	>100	>100	>300	>300	>300	>300	LC
Harpactes erythrocephalus	Red-headed Trogon	2			2				LC
Coracias benghalensis	Indian Roller	>30	>20	>20	>60	>70	>60	>60	LC
Eurystomus orientalis	Oriental Dollarbird	12			12	10		10	LC
Pelargopsis capensis	Stork-billed Kingfisher	>40	>30	>30	>100	>100	>100	>100	LC
Halcyon smyrnensis	White-throated Kingfisher	>150	>100	>100	>350	>350	>350	>350	LC
Halcyon pileata	Black-capped Kingfisher	4			4				LC
Todiramphus chloris	Collared Kingfisher	4			4	2			LC
Alcedo atthis	Common Kingfisher	>200	>150	>100	>450	>450	>450	>450	LC
Ceryle rudis	Pied Kingfisher	>30	>20	>20	>70	>70	>70	>70	LC
Nyctyornis athertoni	Blue-bearded Bee-eater		4			2	4		LC
Merops orientalis	Green Bee-eater	>40	>30	>20	>90	>90	>90	>90	LC
Merops philippinus	Blue-tailed Bee-eater	>20	>20	>15	>60	>60	>60	>60	LC
Merops leschenaulti	Chestnut-headed Bee-eater	>80	>60	>50	>190	>190	>190	>190	LC
Upupa epops	Eurasian Hoopoe	>15	8	8	>30	>30	>30	>30	LC
Anthracoceros albirostris	Oriental Pied Hornbill	8	6		12	14	10	12	LC
Psilopogon lineata	Lineated Barbet	>30	>25	>25	>80	>80	>80	>80	LC
Psilopogon asiaticus	Blue-throated Barbet	6	8		10	14		8	LC
Psilopogon haemacephalus	Coppersmith Barbet	12	10	4	20	>25	15	16	LC
Jynx torquilla	Eurasian Wryneck	4	4	1	9				LC
Dendrocopos macei	Fulvous-breasted Woodpecker	>40	>40	>30	>100	>100	>80	>110	LC
Chrysophlega flavinucha	Greater Yellownape	5			5	2		2	LC
Picus chlorolophus	Lesser Yellownape	4	2		6	5	2		LC
Picus xanthopygaeus	Streak-throated Woodpecker	>20	>15	8	>40	>40	>40	>40	LC
Picus canus	Grey-headed Woodpecker		4	3	6	7		3	LC
Dinopium javanense	Common Flameback			5	1	5			LC
Dinopium benghalense	Black-rumped Flameback	>30	>30	>20	>80	>80	>80	>80	LC
Chrysocolaptes guttacristatus	Greater Flameback	3	2		5	5	3		LC
Microptemus brachyurus	Rufous Woodpecker	10		12	12	14	15	22	LC
Mulleripicus pulverulentus	Great Slaty Woodpecker	1				1			NT
Falco tinnunculus	Common Kestrel	2	1	3	6				LC
Falco amurensis	Amur Falcon			2	1	2			LC
Falco peregrinus	Peregrine Falcon	1			1				LC
Psittacula alexandri	Red-breasted Parakeet	>50	>50	>30	>120	>120	>100	>130	LC
Psittacula krameri	Rose-ringed Parakeet	>60	>80	>80	>200	>200	>150	>220	LC

Scientific Name	Common Name	Distribution*			Seasonal Diversity**				Status in country
		TWS	IRF	CUC	W	S	M	PM	
Loriculus vernalis	Vernal Hanging Parrot		6		4	4		6	LC
Hydornis nipalensis	Blue-naped Pitta			1	1				LC
Tephrodornis virgatus	Large Woodshrike	2			2				LC
Tephrodornis pondicerianus	Common Woodshrike		1			1			LC
Artamus fuscus	Ashy Woodswallow	>300	>200	>100	>500	>500	>500	>500	LC
Aegithina tiphia	Common Iora	>30	>30	>20	>80	>80	>80	>80	LC
Coracina macei	Large Cuckooshrike	>20	>20	>15	>60	>60	>60	>60	LC
Coracina melaschistos	Black-winged Cuckooshrike	4	4	2	10			8	LC
Coracina melanoptera	Black-headed Cuckooshrike	8	7	4	19	16	12	16	LC
Pericrocotus roseus	Rosy Minivet			>15	>15				LC
Pericrocotus cantonensis	Swinhoe's Minivet			>30	>30	>20			LC
Pericrocotus divaricatus	Ashy Minivet	>40		>20	>60				LC
Pericrocotus cinnamomeus	Small Minivet	>50	>40	>40	>130	>120	>80	>100	LC
Pericrocotus flammeus	Orange Minivet	6		2	8				LC
Lanius cristatus	Brown Shrike	>30	>30	>20	>80	>80		>60	LC
Lanius schach	Long-tailed Shrike	>40	>40	>30	>110	>110	>110	>110	LC
Lanius tephronotus	Grey-backed Shrike	4	7	2	13				LC
Oriolus oriolus	Eurasian Golden Oriole	2			2				LC
Oriolus chinensis	Black-naped Oriole	4	2	8	14	10		6	LC
Oriolus xanthornus	Black-hooded Oriole	>60	>50	>40	>150	>150	>150	>150	LC
Dicrurus macrocercus	Black Drongo	>120	>120	>100	>240	>240	>240	>240	LC
Dicrurus leucophaeus	Ashy Drongo	7	4	8	19	16			LC
Dicrurus annectans	Crow-billed Drongo		2	12	14			10	DD
Dicrurus aeneus	Bronzed Drongo	>30	>20	>20	>70	>70	>70	>70	LC
Dicrurus remifer	Lesser Racket-tailed Drongo	10	6	3	19	12			LC
Dicrurus hottentottus	Spangled Drongo	>30	>30	>20	>80	>80	>80	>80	LC
Dicrurus paradiseus	Greater Racket-tailed Drongo	>30	>20	>15	>65	>65	>60	>65	LC
Rhipidura albicollis	White-throated Fantail	>25	>20	>20	>55	>55	>55	>55	LC
Hypothymis azurea	Black-naped Monarch	>40	>40	>30	>110	>100	>100	>110	LC
Terpsiphone paradisi	Indian Paradise Flycatcher			2	1			2	LC
Cissa chinensis	Common Green Magpie	>20	>15	>15	>50	>50	>50	>50	LC
Dendrocitta vagabunda	Rufous Treepie	>50	>40	>40	>130	130	>130	>130	LC
Dendrocitta formosae	Grey Treepie	2			2	4	2		LC
Corvus splendens	House Crow	>800	>500	>800	>2100	>2100	>2100	>2100	LC
Corvus macrorhynchos	Large-billed Crow	>300	>200	>200	>700	>700	>700	>700	LC
Culicicapa ceylonensis	Grey-headed Canary Flycatcher	>25	>20	>15	>60				LC
Parus major	Great Tit	>30	>30	>20	>80	>80	>80	>80	LC
Pycnonotus atriceps	Black-headed Bulbul	8	9		12	15	16	17	LC
Pycnonotus flaviventris	Black-crested Bulbul	>30	>30	4	>60	>60	>60	>60	LC
Pycnonotus jocosus	Red-whiskered Bulbul	>80	>80	>50	>210	>210	>210	>210	LC
Pycnonotus cafer	Red-vented Bulbul	>150	>150	>100	>400	>400	>400	>400	LC
Alophoixus flaveolus	White-throated Bulbul	>30	>40	10	>80	>80	>80	>80	LC
Iole virescens	Olive Bulbul	5	4		9	8		8	LC
Riparia riparia	Sand Martin		8	10	18				LC
Hirundo rustica	Barn Swallow	>50	>50	>40	>140	>140		>140	LC
Cecropis daurica	Red-rumped Swallow			>20	>20	>20			LC
Phylloscopus fuscatus	Dusky Warbler	>40	>30	>20	>90			>90	LC
Phylloscopus trochiloides	Greenish Warbler	>20	>20	>15	>55	>40			LC
Phylloscopus reguloides	Blyth's Leaf Warbler		1		1				LC
Phylloscopus cantator	Yellow-vented Warbler			1	1				LC
Acrocephalus stentoreus	Clamorous Reed Warbler			4	4				LC
Acrocephalus dumetorum	Blyth's Reed Warbler		2	2	4				LC
Megalurus palustris	Striated Grassbird	>30	>25	>15	>70	>70	>70	>70	LC

Scientific Name	Common Name	Distribution*			Seasonal Diversity**				Status in country
		TWS	IRF	CUC	W	S	M	PM	
Prinia rufescens	Rufescent Prinia	1	2					3	LC
Prinia inornata	Plain Prinia	>15	>15	>8	>35	>35	>30	>35	LC
Orthotomus sutorius	Common Tailorbird	>50	>50	>40	>140	>140	>140	>140	LC
Orthotomus atrogularis	Dark-necked Tailorbird	8	5	3	13	10	8	11	LC
Pomatorhinus hypoleucos	Large Scimitar Babbler		2		2				LC
Pomatorhinus schisticeps	White-browed Scimitar Babbler		1		1				NT
Macronous gularis	pin-striped Tit Babbler	>40	>40	>30	>100	>100	>100	>100	LC
Timalia pileata	Chestnut-capped Babbler	4	5		9	7		4	LC
Malacocincla abbotti	Abbott's Babbler	>35	>30	>15	>80	>80	>80	>80	LC
Pellorneum ruficeps	Puff-throated Babbler	>40	>35	>25	>100	>100	>100	>100	LC
Turdoides earlei	Striated Babbler		6	12	15	18	14	14	LC
Turdoides striatus	Jungle Babbler			6	6				LC
Garrulax leucolophus	White-crested Laughingthrush	2						2	LC
Garrulax monileger	Lesser Necklaced Laughingthrush	12		8	>20	>20	>20	>20	LC
Garrulax pectoralis	Greater Necklaced Laughingthrush	>80	>70	>50	>200	>200	>200	>200	LC
Garrulax ruficollis	Rufous-necked Laughingthrush	>30	>30	>40	>100	>100	>100	>100	LC
Chrysomma sinense	Yellow-eyed Babbler	3						3	VU
Zosterops palpebrosus	Oriental White-Eye	>25	>20	>15	>60	>60	>60	>60	LC
Irena puella	Asian Fairy-bluebird	2	4		6	6	3	4	LC
Aplonis panayensis	Asian Glossy Starling	>20				>20	>20	>20	LC
Gracula religiosa	Common Hill Myna	>20	>20		>40	>40	>40	>40	LC
Acridotheres fuscus	Jungle Myna	>80	>80	>60	>220	>220	>220	>220	LC
Acridotheres tristis	Common Myna	>140	>140	>120	>400	>400	>400	>400	LC
Gracupica contra	Pied Myna	>150	>150	>120	>420	>420	>420	>420	LC
Sturnia malabarica	Chestnut-tailed Starling	>120	>120	>100	>240	>240	>240	>240	LC
Geokichla citrina	Orange-headed Thrush			3				3	LC
Turdus unicolor	Tickell's Thrush	1			1				LC
Copsychus saularis	Oriental Magpie Robin	>180	>180	>150	>510	>510	>510	>510	LC
Copsychus malabaricus	White-rumped Shama	>40	>35	>25	>100	>100	>100	>100	LC
Muscicapa muttui	Brown-breasted Flycatcher			3		3			LC
Cyornis unicolor	Pale Blue Flycatcher			1	1				LC
Cyornis poliogenys	Pale-chinned Flycatcher	1		3	3			1	LC
Cyornis rubeculoides	Blue-throated Blue Flycatcher	2	5	2	9				LC
Eumyias thalassinus	Verditer Flycatcher	>15	>15	>10	>40			>30	LC
Enicurus immaculatus	Black-backed Forktail	>15	>15	4	>30	8			LC
Myophonus caeruleus	Blue Whistling Thrush	2	3	2	7				LC
Ficedula albicilla	Taiga Flycatcher	>50	>50	>35	>135	>120		>120	LC
Ficedula westermanni	Little Pied Flycatcher			2	2				LC
Phoenicurus ochruros	Black Redstart		3	1	3	1			LC
Monticola solitarius	Blue Rock Thrush		5	2	7				LC
Saxicola torquatus	African Stone Chat	>15	>15	>10	>40	>30			LC
Saxicola caprata	Pied Bush Chat	6			6	2		6	LC
Chloropsis cochinchinensis	Blue-winged Leafbird	7				7	4		LC
Chloropsis aurifrons	Golden-fronted Leafbird	>15	>20	>10	>45	>40	>40	>40	LC
Dicaeum agile	Thick-billed Flowerpecker	>20	>15	>10	>40	>45	>30	>40	LC
Dicaeum trigonostigma	Orange-bellied Flowerpecker		3					3	LC
Dicaeum erythrorynchos	Pale-billed Flowerpecker	>20	>15	>15	>50	>50	>40	>50	LC
Dicaeum cruentatum	Scarlet-backed Flowerpecker	>40	>30	>20	>90	>90	>90	>90	LC

Scientific Name	Common Name	Distribution*			Seasonal Diversity**				Status in country
		TWS	IRF	CUC	W	S	M	PM	
Chalcoparia singalensis	Ruby-cheeked Sunbird	>15	>20		>35	>35	>30	>30	LC
Leptocoma zeylonica	Purple-rumped Sunbird	>40	>40	>30	>110	>110	>110	>110	LC
Leptocoma sperata	Purple-throated Sunbird	6	>20	8	>30	>25	>25	>30	LC
Cinnyris asiaticus	Purple Sunbird	>30	>30	>20	>80	>80	>80	>80	LC
Aethopyga siparaja	Crimson Sunbird	>15	>15		>30	>30	>30	>30	LC
Arachnothera longirostra	Little Spiderhunter	>80	>80	>20	>80	>80	>50	>60	LC
Passer domesticus	House Sparrow	>500	>300	>200	>1000	>1000	>1000	>1000	LC
Ploceus philippinus	Baya Weaver	>100	>50	>50	>200	>200	>200	>200	LC
Eudice malabarica	Indian Silverbill	>25	>20	>15	>50	>50	>50	>50	LC
Lonchura striata	White-rumped Munia	>15	>30	2	>45	>40		>30	LC
Lonchura punctulata	Scaly-breasted Munia	>60	>60	>50	>160	>160	>160	>160	LC
Lonchura malacca	Tri-colored Munia	5	6	4	15	15	12	13	LC
Lonchura atricapilla	Chestnut Munia	8	12	6	>25	>25	>25	>25	LC
Dendronanthus indicus	Forest Wagtail			3				3	LC
Motacilla citreola	Citrine Wagtail	>20	5	5	30	17			LC
Motacilla cinerea	Grey Wagtail	>50	>50	>30	>130	>120			LC
Motacilla alba	White Wagtail	>60	>50	>40	>150			>120	LC
Motacilla maderaspatensis	White-browed Wagtail	1						1	LC
Anthus rufulus	Paddyfield Pipit	>20	>20	>15	>50	>50	>55	>55	LC
Anthus hodgsoni	Olive-backed Pipit	>40	>30	>30	>100	>80		>80	LC

Table 3. New information about seasonal occurrence of 22 non-resident species of birds in Bangladesh in 2015.

No.	Species	Previous consideration	New information about seasonal occurrence
01	*Tringa ochropus*	winter visitor	24 April (summer)
02	*Chroicocephalus brunnicephalus*	winter visitor	3 October to 27 April (post-monsoon to summer)
03	*Chroicocephalus ridibundus*	winter visitor	24 April (summer)
04	*Clamator jacobinus*	summer visitor	9 October (post-monsoon)
05	*Hierococcyx sparverioides*	winter visitor	17 April (summer)
06	*Coracina melaschistos*	winter visitor	16 October (post-monsoon)
07	*Pericrocotus cantonensis*	rare in winter	17 April (summer)
08	*Lanius cristatus*	winter visitor	7 September to 26 May (post-monsoon to summer)
09	*Oriolus chinensis*	winter visitor	7 November to 12 April (winter & summer)
10	*Dicrurus leucophaeus*	winter visitor	10 April (summer)
11	*Dicrurus remifer*	winter visitor	17 April (summer)
12	*Cecropis daurica*	winter visitor	10 October to 17 April (post-monsoon to summer)
13	*Phylloscopus fuscatus*	winter visitor	9 October (post-monsoon)
14	*Phylloscopus trochiloides*	winter visitor	24 April (summer)
15	*Eumyias thalassinus*	winter visitor	19 September (post-monsoon)
16	*Ficedula albicilla*	winter visitor	14 September to 19 May (post-monsoon to summer)
17	*Phoenicurus ochruros*	winter visitor	24 April (summer)
18	*Saxicola torquatus*	winter visitor	17 April (summer)
19	*Motacilla citreola*	winter visitor	10 April (summer)
20	*Motacilla cinerea*	winter visitor	17 April (summer)
21	*Motacilla alba*	winter visitor	2 October (post-monsoon)
22	*Anthus hodgsoni*	winter visitor	21 September to 19 May (post-monsoon to summer)

Table 4. List of rare resident birds at the study areas observed in only one or two season(s) in 2015.

No.	Species	Location	Season(s)	No. of individuals
01	*Nycticorax nycticorax*	TWS, CUC	monsoon & post-monsoon	4
02	*Butorides striata*	TWS	monsoon & post-monsoon	1
03	*Ardea cinerea*	TWS	winter & summer	5
04	*Elanus caeruleus*	TWS	monsoon & post-monsoon	2
05	*Pernis ptilorhyncus*	TWS, IRF, CUC	winter	7
06	*Gallicrex cinerea*	CUC	summer	2
07	*Turnix suscitator*	IRF	monsoon	1
08	*Charadrius dubius*	TWS, IRF	winter	18
09	*Chalcophaps indica*	TWS	winter & summer	2
10	*Treron pompadora*	IRF	winter & monsoon	4
11	*Treron curvirostra*	TWS, IRF	winter & monsoon	3
12	*Harpactes erythrocephalus*	TWS	Winter	2
13	*Todiramphus chloris*	TWS	winter & summer	4
14	*Nyctyornis athertoni*	IRF	summer & monsoon	4
15	*Dinopium javanense*	TWS	winter & summer	5
16	*Mulleripicus pulverulentus*	TWS	summer	1
17	*Hydornis nipalensis*	CUC	winter	1
18	*Oriolus oriolus*	TWS	winter	2
19	*Terpsiphone paradise*	CUC	winter & monsoon	2
20	*Acrocephalus stentoreus*	CUC	winter	4
21	*Acrocephalus dumetorum*	IRF, CUC	winter	4
22	*Prinia rufescens*	TWS, IRF	post-monsoon	3
23	*Pomatorhinus hypoleucos*	IRF	winter	2
24	*Pomatorhinus schisticeps*	IRF	winter	1
25	*Garrulax leucolophus*	TWS	post-monsoon	2
26	*Chrysomma sinense*	TWS	post-monsoon	3
27	*Enicurus immaculatus*	TWS, IRF, CUC	winter& summer	>30
28	*Chloropsis cochinchinensis*	TWS	summer & monsoon	7
29	*Dicaeum trigonostigma*	IRF	post-monsoon	3

4. Discussion

Observation of birds in a particular season(s) may depend on their availability and rarity. There were 16 species of resident birds in the study areas that were observed in a single season only due to their rarity, although they may occur round the year. Among them, nine species were observed in winter, two species in summer, one species in monsoon and four species in post-monsoon (Table 4). There were 13other species of rare birds that were seen in any of two seasons though they may also occur throughout the year (Table 4).

New information about the seasonal occurrence was recorded for 22 species of non-resident birds in Bangladesh during the present study (Table 3). The Black-naped Oriole *Oriolus chinensis* was mentioned as winter visitor to Bangladesh (Islam & Kamruzzaman 2008) but juveniles were seen three times during this study; twice in CUC (7 November and 14 December) and once in the Nature Park of TWS (19 November). Its adult was also observed in summer (April). The Jacobin Cuckoo *Clamator jacobinus* was considered as uncommon summer visitor to Bangladesh (Haque & Chakma 2008a) but it was observed in early winter (October). The Swinhoe's Minivet *Pericrocotus cantonensis* was considered as winter visitorto Bangladesh (Haque & Chakma 2008b) and it also stayed in CUC up to summer (November−April). The Brown Shrike *Lanius cristatus* is a common winter visitor to Bangladesh (Islam & Chakma 2008) that stayed in all three study areas almost round the year (September−May) except for its breeding season in monsoon (June−August). Thus, it may be considered as non-breeding resident bird in Bangladesh. The Taiga Flycatcher *Ficedula albicilla* and Olive-backed Pipit *Anthus hodgsoni* are also mentioned as common winter visitors to Bangladesh (Haque

& Kamruzzaman 2008a; Haque & Kamruzzaman 2008b) but they also stayed in all three study areas all over the year (September−May) except monsoon (June−August) but they do not breed here.

Nine major threats (namely habitat loss, unsustainable harvesting, forest firing, agriculture and aquaculture, hunting and trapping, introduction of exotic tree species, hill cutting, human settlement, and urbanization and infrastructural development) were identified during the present study. In addition, habitat of birds in TWS and IRF are disturbed by the Rohingya refugees from Myanmar for their temporary settlement in forest areas since 1993.Also, their livelihoods are fully and/or partially dependent on forest resources. Besides the above threats, fishing in hill streams, use of pesticides in crop lands, hunting wild birds, collection of sun grasses and grazing of domestic animals within forests are additional concerning factors for birds in all these three sites. Collection of stones from hill streams and slopes is an additional threat which influences the hill sliding in TWS and IRF. Finally, tourism activities in and around TWS and IRF are yet not meaningfully eco-friendly.

There are several programmes to minimize the biodiversity loss ongoing in TWS and IRF by the Bangladesh Forest Department and several NGOs but these programmes seems to be less effective to minimize the problems. Plantation of exotic plants and monoculture in the study areas under secondary plantation and social forestation programmes are posing negative rather than positive impacts on forests (as well as birds and other animals). The supports provided by both governmental and non-governmental organizations, for the community people to change their occupations under cooperative management programmes are also not sufficient. Development of ecotourism in the forest areas is always controversy in the study sites, like other parts of Bangladesh that ecotourism is still not actually eco-friendly. On the other hand, lack of proper implementation of rules and regulations, legal complications, political issues and lack of pertinent awareness among the community people about biodiversity conservation and management are most concerning issues. All the above factors will together determine the future diversity of birds in TWS, IRF and CUC.

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