



Open Access

Research Article

Avian Community Analysis from the Vicinity of Morawane and Natuwadi Dams in Ratnagiri District (M. S.), India

Babar H. T., G. B. Rajee, P. V. Korochikar and ¹V. M. Gaikwad

Department of Zoology, D. B. J. College, Chiplun – 415 605

¹Department of Mathematics, D. B. J. College, Chiplun – 415 605

Corresponding author: harishbabar@gmail.com; drgbraje@rediffmail.com

Abstract:

The avian communities in the vicinity of two manmade medium sized reservoirs viz. Morawane dam and Natuwadi dam at Ratnagiri district of Maharashtra denoted by communities 'MDV' and 'NDV', respectively, were studied during the period of January 2012 to December 2012. This was to establish a bird species list and to provide essential information on the wild birds in the vicinity of study area. Avian survey was conducted by employing the quadrat method. The total 104 bird species belonging to 14 orders and 39 families were recorded. Order wise analysis of data was done for calculating the Shannon-Weiner Index (H) and Simpson's Index (D) for species diversity; and Sorensen's Index (IS_s) for similarity in both the communities. The results indicated that Shannon-Weiner Index of diversity was higher for the order Piciformes (0.5) followed by Galliformes (0.4422) and Ciconiformes (0.3281) in 'MDV' against 0.1790 for the order Ciconiformes followed by Passeriformes (0.1774) and Coraciformes (0.1686) in 'NDV'. The Simpson's Diversity Index was higher for the order Piciformes (0.75) followed by Galliformes (0.64) and Ciconiformes (0.4622) in 'MDV' against 0.2490 for the order Ciconiformes followed by Passeriformes (0.2467) and Coraciformes (0.2344) in 'NDV'. However, the Sorensen's Index of Similarity for two communities was 86.33%. Out of 14 orders, 8 showed 100% species similarity, and only one order showed 100% dissimilarity. Species wise Shannon-Weiner Index of Diversity for community 'NDV' (2.641) > 'MDV' (2.3851); and Simpson's Index for 'NDV' (0.7238) > 'MDV' (0.6664), indicated that the Morawane dam site was rather disturbed as compared to Natuwadi. It was, however, recommended that there is need to improve and manage the habitat in the vicinity of Morawane dam.

Keywords: Bird diversity, Simpson's Index, Sorensen's Index, Shannon-Weiner Index.

1.0 Introduction:

Diversity of avifauna is a very sensitive indicator of degree of pollution in terrestrial as well as aquatic ecosystem. In aquatic ecosystem, birds constitute important group as they feed on vegetation, larvae, insects, fishes and other animals living there in. In the rapidly advancing era unlimited anthropogenic activities tend to destruction of natural habitat, thereby decreasing bird diversity. Day by day avian foraging habitat and their nesting sites are getting narrowed down due to deforestation activity at an alarming rate for human welfare by overlooking various key components in the ecosystem.

According to Manjunath and Joshi (2012) there are approximately 9,990 bird species on our planet, distributed in 29 orders, 195 families and 2113

genera. The order Passeriformes include 58% of all extant bird species and among non-passerines, the Apodiformes in the most diverse order, totaling roughly 443 species, which is about 4% of the total of world bird species. India being a megadiversity centre, harbours 1200 species of birds which amounts 13% of the bird species of the world (9600 species)(Ali and Ripley, 1987) indicating rather good ecological health of the country. Uneven distribution of ecological pockets in India needs to be explored by understanding regional avian diversity study. Quality of natural habitat could be assessed with the diversity of avifauna as an ecological indicator. In the human intruded ecosystems avifaunal diversity has been decreasing irrespective of their nature derived roles in stabilizing ecosystems through pollination,

seed dispersal, pest control and scavenging waste. A number of bird species are facing threat to their existence (Newton *et. al.*, 1986 and Ghosal, 1995). Though all the birds are not aquatic they have to visit frequently freshwater bodies to overcome thrust. Therefore, adjoining natural areas of the aquatic bodies are the best places to study diversity of avifauna and to assess the community status there in, which compelled authors to undertake the present investigations.

Therefore, we selected vicinities of two freshwater dams *viz.* Morawane (Chiplun Tehsil) and Natuwadi (Khed Tehsil) embraced by the Western Ghats in Ratnagiri district of Maharashtra. The status of ecosystems at the Morawane and Natuwadi could be assessed by calculating the Index of Species Diversity as Shannon-Weiner Index, $H = -\sum_{i=1}^S P_i \log_2 P_i$ and Simpson's Index, $D = 1 / \sum_{i=1}^S P_i^2$, that gives more weight to the bird species common to both the habitats, along with the Sorensen's Index of Similarity, $IS_s = 2C / (A+B) \times 100$. Such type of community evaluation has not been done so far in Ratnagiri district of Maharashtra; hence, the attention was paid to the present study.

2.0 Materials and Methods:

The present study was conducted from January 2012 to December 2012 in the vicinity of two manmade medium sized reservoirs, namely, Morawane dam (MDV) and Natuwadi dam (NDV) at Ratnagiri district of Maharashtra, India. The Morawane site is located at the Latitude 17°32'55" N and the Longitude 73°36'40" E; and Natuwadi at the Latitude 17°50'00" N and the Longitude 73°54'00" E. The avian survey was conducted in 1 sq. km quadrates by monthly visit to the study area.



Photo showing Morawane Dam and its vicinity



Photo showing Natuwadi Dam and its vicinity

The bird observation was done with the binocular (10 x 50, Berkut) and wherever possible photography was done with the digital camera (Canon SX 20). The identification of birds was done as per the photographic guides to the birds of India (Ali and Ripley, 1996; Ali Salim, 1997; Grimmett *et. al.*, 1999 and 2011; Grewal. *et. al.*, 2002).

The analysis of data was done as per Aery (2010) to calculate Shannon-Weiner Index (H) and Simpson's Index (D) for species diversity; and Sorensen's Index (IS_s) for similarity in both the communities.

3.0 Results and Discussion:

Birds occupy almost all habitat types and diversity of birds often serves as a good indication of overall diversity of a given area (Furness and Greenwood, 1993). Determining the species diversity, richness and evenness are major aspects of bird species as it indicates variation, richness and distribution of different bird species in a particular habitat (Zakaria and Rajpar, 2013). Birds are known to be responsive to any kind of changes to their ambient conditions hence can be used as bioindicators (Schwartz and Schwartz, 1951). Estimation of avian diversity helps in preparation of checklists of birds (Charvarthi and Shridhar, 1995; Roy *et.al.*, 2011, 2012, Ekhande *et.al.*, 2012., Raje *et. al.*, 2013). In the present investigation 104 species of birds belonging to 14 orders and 39 families were recorded (Table No. 1). Of the total 104 bird species 89 were reported from the Morawane Dam Vicinity (MDV) and 94 from Natuwadi Dam Vicinity (NDV) with 76 species common to both study areas (Table No. 2).

Manjunath *et. al.*, (2005) recorded 42 species of birds; 58 species of birds belonging to 9 orders and 29 families were recorded by Arun (2012); 117 species of birds belonging to 42 families by Roy *et. al.* (2012); 58 species by Ekhande *et. al.*, (2012); 102 species by Zakazria and Rajpar (2013) and 183 species belonging to 15 orders and 48 families by Raje *et. al.*, (2013). Passeriformes is the largest order followed by Ciconniformes and Coraciformes with total number of bird species 53, 15 and 8, respectively. The maximum bird species (53) belonging to 14 families of order Passeriformes were reported in the present study (Table No. 1).

Out of total 89 species reported in MDV 49 (55.05%), 11 (12.35%) and 07 (7.86%) were from order Passeriformes, Ciconiformes and Coraciformes, respectively (Table No. 2), similar trend was observed in NDV. Raje *et. al.*, (2013) also reported 11 species of birds in each of family Accipitridae and Ardeidae.

Samples of bird species from communities collected at the same or different locations at different times are always different (Colwell and Coddington, 1994; Lande, 1996). Even parallel samples from the same locality taken at the same time differ because many species tend to be rare in the samples, so that their presence is a stochastic event (Magurran, 2004). The result of the present investigation well synchronizes with the above findings as out of total 104 species of birds 89 were reported from the MDV and 94 from the NDV with 79 bird species common to both the study areas. The study clearly indicated that there is difference in the number of bird species belonging to the study areas. This might be due to variations in time of bird observations in two study areas and seasonal variations accomplished with the changes in availability of food.

Out of 14 Orders 8 Orders viz. Anseriformes, Gruiformes, Turniciformes, Columbiformes, Psittaciformes, Cuculiformes, Stringiformes and Upupiformes showed 100% species similarity in MDV and NDV with Sorenson's Similarity Index 86.33% (Table 2). Jayson and Mathew (2000) also reported that out of 137 species recorded in the evergreen forest of Salient valley and moist deciduous forest of Mukkali, only 56 species were common to both the sites. Of the three similarity indices computed by them, Jaccard and Sorenson's quantitative shows a similarity above 40% and Sorenson's Index shows a

similarity of 57% between Salient valley and Mukkali. Rajan *et. al.*, (2013) calculated Sorenson's quotient of similarity (Q/S), deciduous and scrubby area. According to them the highest values of Q/S was 79.12%. Results pertaining to the Sorenson's similarity index of the present investigation revealed that the two study areas, to some extent, have same level of ecological condition.

Table No. 1: Bird Diversity in the vicinity of Morawane dam and Natuwadi dam during January 2012 to December 2012

Order	Family	Common and scientific name of bird species	Status / Occurrence	Dam	Months												
					Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	
1. GALLIFORMES	Phasianidae	Common Quail <i>Coturnix coturnix</i>	RM, N	M													
				N						√	√						
		Jungle Bush Quail <i>Purdicula asiatica</i>	R, O	M						√	√						
				N						√	√						
		Red Spur fowl <i>Galloperdix spadicera</i>	R, N	M						√	√						
				N		√					√	√					
		Grey Jungle fowl <i>Gallus sonneratti</i>	R, C	M		√	√	√	√								
				N	√	√	√	√	√	√	√	√					
		Indian Peafowl <i>Pava cristatus</i>	R, C	M													
				N	√	√	√										
2. ANSERIFORMES	Dendrocygnidae	Lesser Whistling-duck <i>Dendrocygna javanica</i>	R, O	M											√		
				N				√									
3. CICONIFORMES	Ardeidae	Indian Pond heron <i>Ardeola graii</i>	R, C	M	√	√		√							√	√	
				N				√	√								
		Grey Heron <i>Ardea cinerea</i>	RM, C	M													
				N				√	√								
		Cattle Egret <i>Bubulcus ibis</i>	RM, C	M		√	√								√		√
				N	√			√	√	√					√	√	√
		Little Egret <i>Egretta garzetta</i>	R, C	M		√	√	√							√		
				N		√				√							√
		Phalacrocoracidae	Great Egret <i>Casmerodius albus</i>	RM, C	M		√	√									
					N	√	√			√							
		Phalacrocoracidae	Little Cormorant <i>Phalacrocorax niger</i>	RM, C	M				√			√		√	√		
					N	√	√	√	√	√	√		√			√	√
		Accipitridae	Black-winged Kite <i>Elanus caeruleus</i>	R, C	M			√	√								
					N												
		Black Kite <i>Milvus migrans</i>	R, C	M													
				N				√	√								
		Brahminy Kite <i>Haliastur indus</i>	R, C	M	√		√	√	√								
				N	√			√	√								

		Crested Serpent Eagle <i>Spilornis cheela</i>	R, C	M		√	√			√					√			
		N	√			√	√	√										
		Crested Hawk Eagle <i>Nisaetus cirrhatus</i>	R, C	M					√							√		
		N		√		√												
		Scolopacidae	Shikra <i>Accipitor badius</i>	R, C	M													
			N						√	√	√							
		Scolopacidae	Common Sandpiper <i>Actitis hypoleucos</i>	RM, C	M	√	√	√	√							√	√	
			N															
		Charadriidae	Red-wattled Lapwing <i>Vanellus indicus</i>	R, C	M	√	√	√	√				√		√	√	√	√
			N	√	√		√	√										
	Laridae	River Tern <i>Sterna aurantia</i>	R, O	M														
		N	√	√	√	√	√									√		
4. GRUIFORMES	Rallidae	White-breasted Water hen <i>Amaurornis phoenicurus</i>	R, C	M						√	√							
		N							√	√								
5. TURNICIFORMES	Turnicidae	Small button Quail <i>Turnix sylvaticus</i>	R, N	M			√	√										
		N					√	√										
6. COLUMBIFORMES	Columbidae	Common Pigeon <i>Columba livia</i>	R, C	M					√	√	√							
		N						√	√	√								
		Yellow-footed Green Pigeon <i>Treron phoenicopterus</i>	R, C	M					√	√	√							
		N							√	√								
		Emerald dove <i>Chalcophaps indica</i>	R, O	M									√	√				
		N											√	√				
			Spotted Dove <i>Stigmatopelia chinensis</i>	R, C	M		√	√	√									
			N					√	√	√	√							
7. PSITTACIFORMES	Psittacidae	Rose – Ringed Parakeet <i>Psittacula finschii</i>	R, C	M			√	√	√									
		N					√	√										
8. CUCULIFORMES	Cuculidae	Jacobin Cuckoo (Pied) <i>Clamator jacobinus</i>	RM, O	M						√	√							
		N						√	√	√								
		Asian Koel <i>Eudynamys scolopaceus</i>	R, C	M				√	√	√								
		N					√	√	√									
	Centropodidae	Southern Coucal <i>Centropus parroti</i>	R, C	M						√	√	√						
		N							√	√	√							

9. STRIGIFORMES	Strigidae	Indian Scops Owl <i>Otus bakkamoena</i>	R, O	M			√		√								
				N					√								
	Caprimulgidae	Jungle Nightjar <i>Caprimulgus indicus</i>	RM, O	M				√									
				N		√			√								
		Indian Nightjar <i>Caprimulgus asiaticus</i>	R, C	M			√	√	√								
				N				√	√								
	Hemiprocnidae	Crested Tree Swift <i>Hemiprocne coronata</i>	R, C	M			√	√	√								
				N				√	√	√							
	Little Swift (House swift) <i>Apus affinis</i>	RM, C	M					√							√	√	
			N														
10. UPUIFORMES	Upupidae	Common Hoopoe <i>Upupa epops</i>	RM, C	M			√										
				N						√							
11. CORACIFORMES	Coracidae	Indian Roller <i>Coracias benghalensis</i>	R, C	M		√	√										
				N													
	Halcyonidae	White Throated Kingfisher <i>Halcyon smyrnensis</i>	R,C	M		√	√									√	√
				N					√	√	√	√		√			
		Black Capped Kingfisher <i>Halcyon pileata</i>	R,O	M						√	√						
				N						√	√						
	Alcedinae	Oriental Dwarf Kingfisher <i>Ceyx erithaca</i>	R, O	M					√	√	√						
				N					√	√	√						
		Blue-eared Kingfisher <i>Alcedo meninting</i>	R, C	M						√	√	√	√				
				N													
		Common Kingfisher <i>Alcedo atthis</i>	R, C	M			√	√		√	√		√	√			
				N	√						√		√				
	Cerylidae	Pied Kingfisher <i>Ceryle rudis</i>	R, C	M	√	√	√	√						√	√	√	√
				N				√	√				√				
	Meropidae	Green Bee-eater <i>Merops orientalis</i>	R, C	M			√							√			
				N						√							
12.BUCEROTIFORMES		Indian Grey Hornbill <i>Ocyrceros birostris</i>	R, R	M													
				N					√	√	√						
		Malabar Pied Hornbill <i>Anthracoceros</i>	R, C	M													
	N			√	√	√	√	√	√					√	√		

		<i>coronatus</i>																	
13. PICIFORMES	Megalaimidae	Brown Headed Barbet	R, C	M															
		<i>Megalaima Zeylanica</i>		N			√	√	√	√									
		White-cheeked Barbet	R, R	M					√	√	√								
		<i>Megalaima viridis</i>		N				√	√	√									
		Coppersmith Barbet	R, C	M					√		√	√							
		<i>Megalaima haemacephala</i>		N				√	√	√	√								
	Picidae	Lesser Goldenback	R, C	M															
		<i>Dinopium benghalense</i>		N							√	√							
14. PASSERIFORMES	Pittidae	Indian Pitta	R, C	M					√	√	√								
		<i>Pitta brachyura</i>		N					√	√	√								
	Lanidae	Bay- backed Shrike	R, O	M			√												
		<i>Lanius vittatus</i>		N				√	√										
	Corvidae	Common Iora	R, C	M							√	√							
		<i>Aegithina tiphis</i>		N						√	√	√							
		White- bellied Drongo	R, O	M		√	√												
		<i>Dicrurus caerulescens</i>		N			√	√	√										
		Black Drongo	R, C	M					√	√									
		<i>Dicrurus macrocercus</i>		N			√	√	√	√									
		Indian Golden Oriole	RM, C	M					√	√	√								
		<i>Oriolus kundoo</i>		N															
		Black-hooded Oriole	R, C	M					√	√	√								
		<i>Oriolus xanthornus</i>		N					√	√	√								
		White-spotted Fantail	R, C	M					√	√									
		<i>Rhipidura albogularis</i>		N					√	√	√								
		White browed Fantail	R, N	M					√	√	√								
		<i>Rhipidura aureola</i>		N					√	√	√								
		Asian Paradise-flycatcher	RM, C	M	√														
		<i>Tersiphone paradisi</i>		N													√	√	√
		Black-naped Monarch	R, C	M															
		<i>Hypothymis azurea</i>		N								√	√						
	Rufous Treepie	R, C	M					√	√	√									
	<i>Dendrocitta vagabunda</i>		N		√			√	√	√	√								
	Indian Jungle Crow	R, C	M					√	√	√									
	<i>Corvus culminatus</i>		N					√	√	√	√								

		House Crow <i>Corvus spendens</i>	R, C	M		√	√	√	√	√							
		N						√	√	√							
Hirundinidae		Dusky Crag Martin <i>Ptyonoprogne concolor</i>	R, C	M						√	√						
		N							√	√				√	√		
		Wire-tailed Swallow <i>Hirundo smitti</i>	R, C	M			√										
		N	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
		Red-rumped Swallow <i>Cecropis daurica</i>	RM, C	M	√	√	√							√	√	√	
		N	√					√	√	√					√	√	
Alaudidae		Rufous-tailed Lark <i>Ammomanes phoenicura</i>	R, C	M			√	√									
		N	√			√		√								√	
Pycnonotidae		Red-whiskered Bulbul <i>Pycnonotus jocosus</i>	R, C	M					√	√	√						
		N						√	√	√							
		Red-vented Bulbul <i>Pycnonotus cafer</i>	R, C	M	√	√	√	√	√	√					√	√	
		N	√	√	√	√	√	√						√	√		
Cisticolidae		Jungle Prinia <i>Prinia sylvatica</i>	R, C	M			√	√									
		N							√	√							
		Ashy Prinia <i>Prinia prinia</i>	R, C	M			√	√									
		N						√	√	√							
		Plain Prinia <i>Prinia inornata</i>	R, O	M			√								√		
		N		√	√												
Sylviidae		Common Tailor bird <i>Orthotomus sutorius</i>	R, C	M				√									
		N							√	√				√			
		Common Babbler <i>Turdoides caudata</i>	R, C	M	√		√										
		N					√	√		√							
		Large Grey Babbler <i>Turdoides malcolmi</i>	R, C	M		√											
		N								√	√						√
		Jungle Babbler <i>Turdoides striata</i>	R, C	M				√	√	√					√		
		N			√	√	√	√	√								√
Zosteropidae		Oriental White-eye <i>Zosterops palpebrosus</i>	R, C	M													
		N						√									
Sturnidae		Jungle Myna <i>Acridotheres fuscus</i>	R, C	M	√					√	√					√	
		N	√							√	√	√		√			
		Common Myna <i>Acridotheres tristis</i>	R, C	M			√	√							√	√	
		N							√	√	√						
		Brahminy Starling	R, O	M				√			√						

		<i>Staurnia pagodarum</i>		N					√	√							
		Rosy Starling <i>Paster roseus</i>	M, O	M	√	√	√	√									√
				N													
	Mucicapidae	Orange-headed Thrush <i>Zoothera citrina</i>	RM, O	M					√	√	√	√					
				N					√	√	√	√					
		Eurasian Blackbird <i>Turdus merula</i>	RM, C	M					√	√	√						
				N					√	√	√						
		Oriental Magpie Robin <i>Copsychus saularia</i>	R, C	M					√	√	√						
				N					√	√	√						
		Indian Robin <i>Saxicoloides fulicatus</i>	R, C	M				√	√	√							
				N					√	√	√						
		Tickells Blue Flycatcher <i>Cyornis tickelliae</i>	R, C	M						√	√						
				N						√	√						
	Irenidae	Jerdens Leafbird <i>Chloropsis jerdoni</i>	R, O	M						√							
				N					√	√							
	Nectariniidae	Pale-billed Flowerpecker <i>Dicaeum erythrorhynchos</i>	R, C	M				√									
				N						√	√						
		Purple-rumped Sunbird <i>Leptocoma zeylonica</i>	R, C	M							√	√					
				N							√	√					
		Crimson-backed Sunbird <i>Leptocoma minima</i>	R, C	M					√	√	√						
				N						√	√						
		Purple Sunbird <i>Cinnyris asiaticus</i>	R, C	M		√	√	√									
				N													
		Loten's Sunbird <i>Cinnyris lotenia</i>	R, O	M				√	√	√							
				N				√	√								
		Crimson Sunbird <i>Aethopyga siparaja</i>	R, C	M								√	√				
				N								√	√				
	Passeridae	House Sparrow <i>Passer domesticus</i>	R, C	M			√	√	√	√							
				N			√		√	√							
		Baya Weaver <i>Ploceus philippinus</i>	R, C	M					√	√	√						
				N					√	√							
		Indian Silverbill <i>Euodice malabarica</i>	R, C	M			√	√									
				N													

	White-rumped Munia <i>Lonchura striata</i>	R, C	M					√	√	√	√				
			N						√	√	√				
	Scaly-breasted Munia <i>Lonchura punctulata</i>	R, C	M				√	√							
			N												
	Black-headed Munia <i>Lonchura malcca</i>	R, O	M				√	√	√						
			N					√	√						
	Yellow Wagtail <i>Motacilla flava</i>	RM, C	M			√									
			N												
	White-browed Wagtail <i>Motacilla maderaspatensis</i>	R, C	M	√	√		√						√	√	√
			N	√	√		√			√				√	√
	Paddy field Pipit <i>Anthus rufulus</i>	R, C	M	√										√	√
			N												

M: Morawane dam vicinity; **N**: Natuwadi dam vicinity.
Common, **O**: Occasional, **R**: Rare,

* **Status**: - **R**: Resident, **RM**: Resident migrant, **M**: Migratory,

@ **Occurrence**: - **C**:

Table 2: Order wise distribution of bird species in MDV and NDV during January 2012 to December 2012 with Sorensen's Similarity Index (IS_s).

Order	Total No. of species	Species reported in		Species common to 'MDV' & 'NDV'	IS _s (%)
		MDV	NDV		
Galliformes	05	03	05	03	75%
Anseriformes	01	01	01	01	100%
Ciconiformes	15	11	13	09	75%
Gruiformes	01	01	01	01	100%
Turniciformes	01	01	01	01	100%
Columbiformes	04	04	04	04	100%
Psittaciformes	01	01	01	01	100%
Cuculiformes	03	03	03	03	100%
Strigiformes	05	05	05	05	100%
Upupiformes	01	01	01	01	100%
Coraciformes	08	07	07	06	85.71%
Bucerotiformes	02	00	02	00	-
Piciformes	04	02	04	02	66.66%
Passeriformes	53	49	46	42	88.42%
	104	89	94	79	86.33%

Table 3: Order wise Shannon-Weiner Index (H) and Simpson’s Index (D) for bird diversity in MDV and NDV.

Order	Total No. of species	MDV				NDV			
		P _i	P _i ²	H	D	P _i	P _i ²	H	D
Galliformes	05	0.6	0.36	0.4422	0.64	1	1	0	0
Anseriformes	01	01	1	0	0	1	1	0	0
Ciconiformes	15	0.7334	0.5378	0.3281	0.4622	0.8666	0.7510	0.1790	0.249
Gruiformes	01	01	0	0	0	01	1	0	0
Turniciformes	01	01	0	0	0	01	1	0	0
Columbiformes	04	01	0	0	0	01	1	0	0
Psittaciformes	01	01	0	0	0	01	1	0	0
Cuculiformes	03	01	0	0	0	01	1	0	0
Strigiformes	05	01	0	0	0	01	1	0	0
Upupiformes	01	01	0	0	0	01	1	0	0
Coraciformes	08	0.875	0.7656	0.1686	0.2344	0.875	0.7656	0.1686	0.2344
Bucerotiformes	02	0	0	0	0	1	1	0	0
Piciformes	04	0.5	0.25	0.5	0.75	1	1	0	0
Passeriformes	53	0.9245	0.8547	0.1047	0.1453	0.8679	0.7533	0.1774	0.2467

Table 4: Species wise Shannon-Weiner Index (H) and Simpson’s Index (D) in ‘MDV’ and ‘NDV’.

Sr. No.	MDV				NDV			
	P _i	P _i ²	P _i log ₂ P _i	‘H’/ ‘D’	P _i	P _i ²	P _i log ₂ P _i	‘H’/ ‘D’
1	0.03371	0.001136	-0.1649	H = -ΣP _i log ₂ P _i H=2.3851	0.05319	0.00283	-0.2251	H = -ΣP _i log ₂ P _i H= 2.641
2	0.01124	0.000126	-0.0728		0.01064	0.0001132	-0.0697	
3	0.1236	0.0153	-0.3728		0.13829	0.019124	-0.3947	
4	0.01124	0.000126	-0.0728		0.01064	0.0001132	-0.0697	
5	0.01124	0.000126	-0.0728		0.01064	0.0001132	-0.0697	
6	0.0445	0.00198	-0.1998	D = 1 - Σ P _i ² D= 1 - 0.336 D=0.6664	0.04255	0.001958	-0.1938	D = 1 - Σ P _i ² D= 1 -0.2762 D=0.7238
7	0.01124	0.000126	-0.0728		0.01064	0.0001132	-0.0697	
8	0.03371	0.001136	-0.1649		0.03191	0.001018	-0.1585	
9	0.05618	0.003156	-0.2334		0.05319	0.00283	-0.2251	
10	0.01124	0.000126	-0.0728		0.01064	0.0001132	-0.0697	
11	0.07865	0.006186	-0.2885		0.07446	0.00554429	-0.2790	
12	00	00	-		0.02128	0.0004528	-0.1182	
13	0.02247	0.000504	-0.1230		0.04255	0.001958	-0.1938	
14	0.5510	0.3036	-0.4738		0.4899	0.24	-0.5043	
		Σ P _i ² = 0.3336	ΣP _i log ₂ P _i = -2.3851			Σ P _i ² = 0.2762	ΣP _i log ₂ P _i = -2.641	

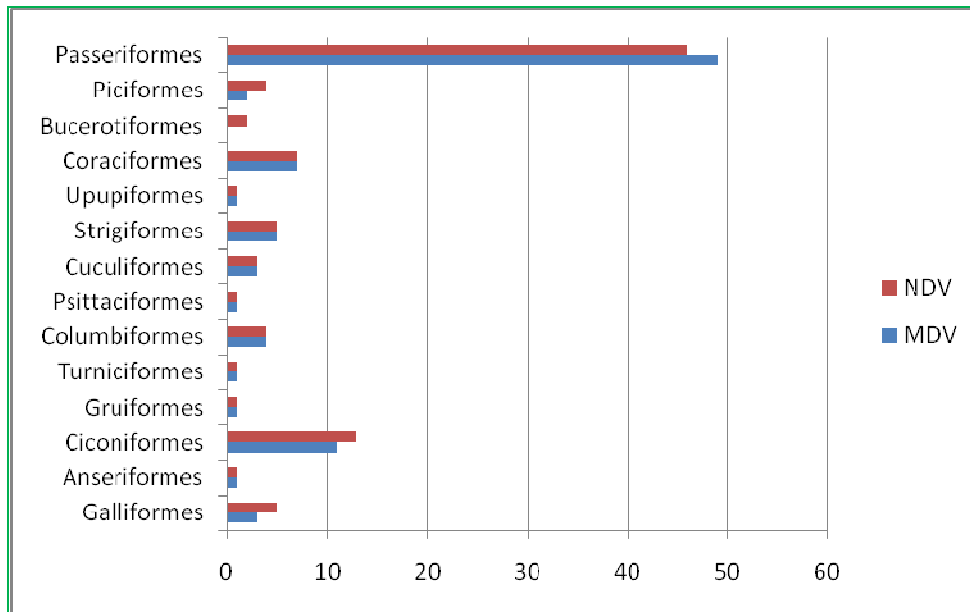


Fig. 1: Orderwise distribution of number of bird species in MDV and NDV during study period.

Order wise Shannon-Weiner Indices for bird diversity gives rather broader sense of order wise distribution of bird species along with dominant order supporting status of habitat and nature of vegetation in there. But efforts have not been taken by researchers to correlate order wise bird diversity with the habitat status. In the present investigation order wise Shannon-Weiner Indices were 0.51 for Piciformes followed by 0.4422 for Galliformes and 0.3281 for Ciconiformes; where as in the NDV they were 0.1790 for the order Ciconiformes followed by 0.1774 for Passeriformes and 0.1686 for Coraciiformes. The order wise Shannon-Weiner Indices for the bird diversity in both the study areas were well supported by Simphson's Indices by following similar trend (Table 3). The order wise Simpson's Indices (D) were 0.75 for Piciformes followed by 0.64 for Galiformes and 0.4622 for Ciconiformes in the MDV; where as it was 0.249 for Ciconiformes followed by 0.2467 for Passeriformes and 0.2344 for Coraciiformes (Table 3).

The above findings clearly indicated that order Piciformes is dominant in MDV where as order Ciconiformes is dominant in the NDV. In the MDV dominant order Piciformes includes two families such as Megalaimidae and Picidae. Brown Headed Barbet, White-chicked Barbet, Copper-smith Barbet and Lesser Golden-back are the common bird species of the families that prefer woody forest habitat, which is the characteristic feature of MDV

lying in the heart of the Western Ghats. In the NDV Waders and Cormorants from families Ardiidae, Scolopacidae, Phalacrocoracidae, Charadriidae and Laridae are very common hence the Birds of prey, belonging to family Accipitredae, like Brahmany Kite, Crested Serpent Eagle, and Crested Hawk Eagle and others have occupied the habitat. This might be due to comparatively more open water area, less dense vegetation and rather away from the Western Ghats.

The species wise Shannon-Weiner Index in MDV was 2.3851 and that for NDV was 2.641 where as the Simpson's Index for species diversity in MDV was 0.6664 and that for NDV was 0.7238 (Table 4). Jayson and Mathew (2000) reported Shannon-Weiner Index for Salient valley (3.30) and Mukkali (3.45) along with Simpson's Index 0.07 and 0.06, respectively. According to Sharat *et. al.*, (2011) the Shannon-Weiner diversity index is higher in non human habitat (H=3.098) than human habitat (H= 2.823). Utpal *et. al.*, (2012) also calculated Shannon-Weiner diversity index 3.86, 2.84 and 3.64 from GNP, BTR and RBWC, respectively. Their results of Shannon-Weiner diversity index well synchronized with the Simpson's index, 0.97, 0.88 and 0.96 for GNP, BTR and RBWC, respectively. Shannon-Weiner index for bird diversity changes from season to season. Ekhande *et. al.*, (2012) reported rather higher values of Shannon-Weiner index (3.5) during winter as compared to monsoon (2.4) for the birds at the Yashwant Lake. Our results are further supported by

the work of Rajan *et. al.*, (2013), wherein they reported $H=3.86$ at mixed deciduous forest and $H=3.17$ at cultivated area. They further reported greater Simpson's index (0.067) for cultivated area and lowest (0.027) for mixed deciduous forest. Monthly variations in the Shannon-Weiner diversity index have been reported by Hailenmariam *et. al.*, (2013). According to them there was more species diversity ($H=2.89$) in December and less ($H=0.5$) in November in the selected Church forests in Ethiopia.

Conclusion:

The Shannon-Weiner Index and the Simpson's diversity index for the bird diversity at NDV were greater than MDV, indicating that the NDV is comparatively better than the MDV, where habitat improvement and management is required. The variation in species diversity at two study areas may be due to difference in availability of food to the birds, nesting sites, changes in climatic conditions and consequent emigration and immigration.

References:

- 1) Ali, S. and Repley, S. D. (1987): A compact Handbook of the Birds of India and Pakistan, Secons Edition. Oxford University Press, Delhi, 737 pp.
- 2) Ali, Salim and Ripley, S. D. (1996): A Pictorial Guide to the Birds of the Indian Subcontinent, BNHS, Oxford University Press, Mumbai.
- 3) Ali, Salim (1997): The Book of Indian Birds, BNHS, Oxford University Press, Mumbai.
- 4) Arey N. C. (2010): Manual of environmental analysis. Ane Books Pvt. Ltd. New Delhi.
- 5) Arun, M. Chilke (2012): Avian diversity in and around Bamanwada Lake of Rajura, District Chandrapur (Maharashtra), *Annals of Biological Research*, 3 (4): 2014-2018.
- 6) Charavarthy, A. K. and Sridhar, S. (1995): Bird diversity and conservation. Ornithology Society of India, Bangalore.
- 7) Colwell, R. K. and Coddington, J. A. (1994): Estimating terrestrial biodiversity by extrapolation. – *Phil. Trans. R. Soc. B*, (345): 101-118.
- 8) Ekhande, A. P., Patil, J. V. and Padate, G. S. (2012): Study of birds of Yashawant lake with respect to densities, species richness and Shannon-Weiner indices and its correlation with lake dynamics. *European Journal of Zoological Research*, 1 (1): 6-15.
- 9) Furness, R. W. and Greenwood J. J. D. (1993): Bird as Monitor of Environmental Change. Chapman and Hall, London.
- 10) Ghosal D. N. (1995): Avifauna of conservation areas, No. 7, Fauna of Kanha Tiger Reserve. Zoological Survey of India (ZSI), pp. 63-91.
- 11) Grewal, B., Harvey, B. and Pfister, O. (2002): A Photographic Guide to the Birds of India, Periplus Edition, (HK) Ltd.
- 12) Grimmett, R., Inskipp, C. and Inskipp, T. (1999): Pocket guide to the Birds of the Indian Subcontinent (1st Ed.), Oxford University Press, New Dehli.
- 13) Grimmett, R., Inskipp, C. and Inskipp, T. (2011): Birds of the Indian Subcontinent (2nd Ed.), Oxford University Press, London (UK).
- 14) Hailenmariam, Areayn, Meheretu Yonas and Tsegazeabe Hadush Haileeselasie (2013): Community composition and abundance of residential birds in selected forests, Tigray Region, Northern Ethiopia. *Scientific Research and Essays*, 8 (22) pp. 1038-1047.
- 15) Jayson, E. A. and D. N. Mathew (2000): Diversity and species-abundance distribution of birds in the Tropical forests of Silent Valley, Kerala. *Journal, Bombay Natural History Society*, 97 (3): 390-399.
- 16) Lande, R. (1996): Statistics and partitioning of species diversity and similarity among multiple communities. – *Oikos*, 76: 5-13.
- 17) Magurran, A. E. (2004): Measuring biological diversity. – Blackwell.
- 18) Manjunath and Joshi Bhaskar (2012): Avifaunal diversity in Gulbarga region, North Karnatak. *Recent Research in Science and Technology*, 4(7): 27-34.
- 19) Manjunath, P., Subbarao P. and Bhat H. (2005): Water bird diversity at the tank of North Bangalore. *In: Proc. Of the national seminar on bird ecology and conservation* (Eds: A. Vergese, S. Sridhar, A. K. Chakravarthy, H. R. Bhat, K. P. Karanth). Bangalore, Nov. 12-13. Pp. 97-99.
- 20) Newton P. N., S. Brudin and J. Guy (1986): The birds of Kanha Tiger Reserve, M. P., India, *J. Bom. Nat. Hist. Society*, 83 (3) 977-998.
- 21) Rajan, S., D.N. Kour, F. Ahmad and D. N. Sahi (2013): Species diversity, relative abundance and habitat use of the bird communities of Tehsil Chenani, District Udhampur, Jammu and Kashmir, India. *Indian J.L.Sci.* 2 (2): 81-90.
- 22) Raje, G. B., H. T. Babar, S. S. Waghmode and Sachin Palkar (2013): Bird diversity in Chiplun Town (M.S.), *Current Trends in Life Science*, 81-92; Lambert Academic Publishing GmbH and Co.KG. Germany.
- 23) Roy, U. S., A. Pal, P. Banerjee and S. K. Mukhopdhyay (2011): Comparison of avifaunal diversity in and around Neora Valley National Park,

West Bengal, India. *Journal of Threatened Taxa*. 3 (10): 2136-2142.

- 24) Schwartz, C. W. and Schwartz E. R. (1951): An ecological reconnaissance of the pheasants of Hawaii. *Auk*. 68: 281-314.
- 25) Sharat, K. P., A. V. Pongshe and U. Dhar (2011): Habitat enrichment and its impact on avian diversity: A study at GBPIHED, Kosi-Katermal, Uttarakhand, India. *Current Science*, 100 (11): 1681-1689.
- 26) Utpal, S. Roy., P. Banerjee and S. K. Mukhopadhyay (2012): Study of avifaunal diversity from three different regions of North Bengal, India, *Asian Journal of conservation Biology*. 1 (2): Pp. 120-129.
- 27) WWW. Wikipedia. Org
- 28) Zakaria, M. and M. N. Rajpar (2013): Density and diversity of water birds and Terrestrial birds in Man-made Marsh, Malaysia. *Sains Malaysiana*. 42 (10): 1483-1492.