

# Ecological status of migrants in selected study area of Navegaon National Park, Maharashtra, India

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## Abstract

Ecological survey of migrants in selected study area of Navegaon National Park from January 2010 to December 2013 reveals total 167 species. 40 species of migrants (Total No. =11814) constituted local migrants (19 sp., Count No. = 4083) winter migrants (19sp., Count No. = 7190) and 02 species of summer migrants (Count No. = 541). Out of total 40 migrant species 06 species were recorded as common , 21 as frequent , 09 as occasional and 04 as rare . Within the forest 30 species preferred water holes and lake as their habitat while remaining species preferred forest vegetation and cultivation .In context of conservation status, 38 species were recorded as least concern and 02 species as Not Threatened .Population trend of 14 species was stable ,that of 02 species was increasing while 16 species showed decreasing trend and that of 08 species was unknown due to unavailability of authentic information. Winter migrants showed the higher values of Shannon and Weaver index ( $H'$ ), Simpson Index ( $D$ ) and Evenness Index ( $J'$ ) as compare to local migrants. In winter migrants the values of indices were calculated as  $H' = 0.964509245$ ,  $D = 0.844956$  and  $J' = 0.754257$  respectively, while in local migrants' values were  $H' = 0.70646$ ,  $D = 0.629676$  and  $J' = 0.5524$  respectively. Within the forest, water holes and lake are an important habitat for a variety of migrants. Further considerable work would require to arrive at a more accurate understanding of the ecological status of migrant fauna of the area which will be helpful to propose the conservation management strategies of r habitat and decreasing trend of migrant avifauna as well in future.

**Keywords:** migrants, ecological status, habitat, management, Navegaon National Park.

## Introduction

Migration is the regular seasonal journey undertaken by the birds in response to changes in food availability, habitat or weather [1]. Long distance migrants are believed to disperse as young birds and form attachments to potential breeding sites and favorite wintering sites. Once the site attachment is made, they show site fidelity visiting the same wintering site year after year [2]. Many species aggregate in large numbers along established corridors during migration with concentrations ranging from thousands of birds to millions at some locations [3]. Migration behavior is a product of natural selection and varies widely among species and populations [4]. Quality and abundance of stopover habitat can influence the survival of migrating birds. Ideal stopover sites provide migrants with water, food, and protection from predation [5]. How migrants select stopover habitat when migrating through unfamiliar terrain is unclear [6].

Buler et al. [7] found that forest cover, distance to the migration flyway, and the abundance of invertebrates and fruit at a local scale were all important in explaining songbird densities during migration along the Gulf of Mexico. Ktitorov et al. [8] suggested that large patches of suitable habitat form the basis for the initial selection of sites by forest songbirds and may be more important than other landscape attributes.

India is of outstanding international importance for migratory birds lying on some of the Central Asian Flyway. Large number of migrants are attracted especially during winter by the extensive areas of wetlands of Indian subcontinent. These wetlands fulfill the food and habitat requirement of migrants and help to maintain biodiversity globally.

Navegaon National Park is a southern tropical dry forest enriched with varied wildlife, and is an important conservation unit in central India. The park provides an array of home sites from the top canopy to the forest floor for a number of species of vertebrates as well as invertebrates. These forests are an important habitat for a wide variety of bird species. within a single dry deciduous forest, there are many micro-habitats which are home to residential as well as migratory birds. Management of such habitats is only possible by using available information on existing habitat components and the avifauna utilizing it.

## Methodology

Navegaon National Park with total area of 133.88 sq km is situated in Gondia District of Maharashtra State, India and lies between Longitude 80° 5' E to 80° 15' E and Latitudes 20° 45'N to 21° 2'N comes under Southern Tropical Dry Deciduous Type-subgroup 5A [9] (Figure 1).

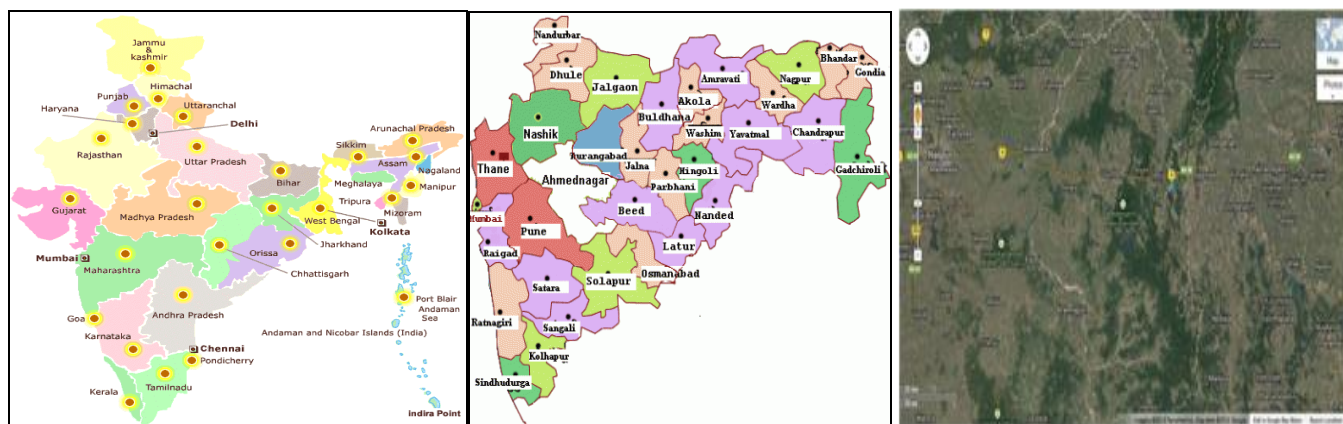


Figure 1: Location of Navegaon National Park in Maharashtra and India

Selected study area considered as representative area of the Navegaon National Park is the tourist zone of the park and is 32.398 sq km.

#### Water Sources:

There are several water sources in the form of natural and man-made waterholes spread over the entire Park area which have rendered the landscape an attractive and comfortable abode for the avifauna. Abundant water is available in the National Park throughout the year, even in summer, because of the presence of good number of natural and artificial waterholes and streams. As a result, the density of avifauna does not show much decline in harder times.

#### Navegaon Lake:

Navegaon Lake situated in Navegaon National Park located at  $20^{\circ} 45'$  to  $21^{\circ} 2'$  N and  $80^{\circ} 5'$  to  $80^{\circ} 15'E$  with an average depth of 40 feet has a circumference of about 17 miles and a water surface of about 5 sq miles. The shape of the tank is very irregular, running into long creeks. The lake is surrounded by hills endowed with rich flora and fauna and provide refuge to the waterfowl and waders harboring an important habitat to a variety of avifauna, lies to the South -West of the study area. A village named Rampuri is situated adjoining this lake. Here agriculture is practiced. The village and the lake lie outside the South -West boundary of the National Park giving an edge effect to the South-Western side of the Park. The study area was visited on a monthly basis for a period of 4 years from January 2010 to December 2013 by the authors accompanied by bird enthusiasts in morning hours when the avian activity is optimum.

Binoculars (Olympus 8X40) were used for collecting the data on the habitat domain of the present avifauna. Digital camera of the brand SONY model-DSC-H7 was used for photographic evidences. "Point-count" method was used for the present study. Local bird experts were interviewed regarding the habitat utilization and other details of the avifauna. Revised edition of Grimmett *et.al*, [10-11] and Salim Ali [12-13] was followed for the identification, nomenclature and information on species distribution and habitat preferred by avifauna whereas

for the global conservation status and population trend of the avifauna, IUCN Red List of Threatened Species - Version 2018-2., <http://www.iucnredlist.org> was referred [14].

#### Quantitative analysis

The data that were observed by applying Point Count method as mentioned earlier; was tabulated in the worksheets. Out of these tabulated data, following calculations were done to analyze the obtained data.

1. Total count of the migrants observed.
2. Average encounters of migrants: Total of average encounters of all migrant's species recorded in a particular year.

Total number of migrants recorded throughout the study period.

3. **Relative abundance** for different species

$$(P_i) = n/N$$

where  $n$  stands for total number of individuals of a particular raptor species, whereas  $N$  stands for total number of individuals of all raptor species.

4. **Shannon Wiener Diversity index:**

$$(H') = - [\sum P_i * \text{Log} P_i]$$

where  $H'$  is the diversity index,  $P_i$  is the relative abundance and  $\text{Log} P_i$  is the natural logarithm of the relative abundance.

5. **Simpson Index:**

$$D = 1 - [\sum n*(n-1)] / [N * (N - 1)]$$

where  $n$  is the total number of birds of a particular species and  $N$  is the total number of birds of all species.

6. **Evenness Index:**

$$J' = H' / H'_{max}$$

where  $H'$  is the Shannon Wiener diversity index and  $H_{max}$  is the natural log of the total number of species.

## Results and Discussions

Quantitative analysis of raptors in selected study area of Navegaon National Park, Maharashtra, India. was conducted in various habitats for a period of four years from January 2010 to December 2013. Throughout the study period out of total 167 species, 114 species as resident, 19 species as local migrant, 19 species as winter migrant and 2 species as summer migrant were recorded by applying Point Count Survey method (Table 1, 2). These survey methods are easy to conduct and prove useful in collecting information on habitat relationships, abundance, species diversity and the effects of environmental change and management on bird populations over a specific period [15].

Total count of all migrant species throughout the study period was recorded 11814, out of these winter migrants were 7190, local migrant = 4083 and summer migrant =541. (Table 3,4 and 5)

During the study period species were categorized on the basis of encounters with a particular species. The total number of visits to the study area was 48. Though some migratory species could be seen in the study area for more than four months, each season was considered as a four months period. So, for 4 years, 16 visits were done for each season throughout the study period. The term "Common" was used for the migrants that were spotted on 14-16 visits throughout their respective seasons. The migrants spotted 11-13 times were recorded as "Frequent". Those spotted 8-10 times as "Occasional". The species that were seen 5-7 times were categorized as "Rare". The category "Need More Study" was against the birds that were sighted less than five times during the entire study period (Table 1).

Out of total 40 migrant species 06 species were recorded as common, 21 as frequent, 09 as occasional and 04 as rare (Table 1). In context of conservation status, 38 species were recorded as least concern and 02 species as Not Threatened. Population trend of 14 species was stable, that of 02 species was increasing while 16 species showed decreasing trend and that of 08 species was

unknown due to unavailability of authentic information (Table 1).

Out of total 40 migrant species, 30 species preferred the habitat of lake. For the convenience of study Navegaon lake was categorized into Water Edge (WE), Reeds along and in the lake (RE), Floating Vegetation (FV) and Open Water (OW). The category "Open Water" was recorded against the birds found at an approximate visual distance of 20 meters from the water edge. while remaining species preferred forest vegetation and cultivation as their habitat (Table 2). In previous study of same habitat, similar trend of habitat selection was observed by Chinchkhede and Kedar in 2013 [16].

Wetlands are relatively safe areas which provide the birds with abundance of food and safe place for roosting, nesting and moulting. Wetlands play major role in the landscape by providing unique habitats for a wide variety of flora and fauna [17]. Chinchkhede and Kedar [18] observed Srinagar lake as habitat domain of 59 species of birds near Navegaon National Park.

The forest is composed of 40 species of trees ,16 species of shrubs and 44 species of herbs which serves as a living repository of the flora providing ideal habitat for the resting, feeding and breeding of birds [19]. The relative abundance of avian species in an area usually is related to the availability of main life requirements i.e. food, water and shelter, as well as suitable weather conditions [20].

Species composition of birds in an area is related to the type of vegetation, availability of microhabitats and various other factors [21]. The various natural and man-made waterholes in the forest habitat of the study area have rendered the landscape an attractive and comfortable habitat niche for the migrant avifauna.

Data analysis of 40 migrant species (i.e. 19 winter migrants, 19 local migrants and 2 summer migrants) was done on the basis of valid records obtained during the observations throughout the study period.

**Table 1: Occurrence, Conservation Status and Population Trend of migrants in selected study area of Navegaon National Park, Maharashtra, India**

Sr. No.	Common name	Zoological name	Occurrence	Conservation status	Population Trend
1	Indian Peafowl	<i>Pavo cristatus</i>	C	LC	St
2	Red Junglefowl	<i>Gallus gallus</i>	F	LC	Dc
3	Grey Junglefowl	<i>Gallus sonneratii</i>	R	LC	Dc
4	Red Spurfowl	<i>Galloperdix spadicea</i>	F	LC	St
5	Painted Spurfowl	<i>Galloperdix lunulata</i>	O	LC	St
6	Jungle Bush Quail	<i>Perdica asiatica</i>	F	LC	St
7	Rain Quail	<i>Coturnix coromandelica</i>	R	LC	St
8	Yellow-footed Green Pigeon	<i>Treron phoenicoptera</i>	C	LC	Inc
9	Laughing dove	<i>Streptopelia senegalensis</i>	C	LC	St
10	Spotted Dove	<i>Streptopelia chinensis</i>	C	LC	Inc
11	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	F	LC	Inc
12	Emerald Dove	<i>Chalcophaps indica</i>	O	LC	Dc
13	Red Collared Dove	<i>Streptopelia tranquebarica</i>	F	LC	St
14	Rock Pigeon	<i>Columba livia</i>	F	LC	Dc
15	Rose-ringed parakeet	<i>Psittacula krameri</i>	C	LC	Inc
16	Asian Koel	<i>Eudynamis scolopacea</i>	F	LC	St
17	Greater Coucal	<i>Centropus sinensis</i>	O	LC	St
18	Common Hawk Cuckoo	<i>Hierococcyx varius</i>	F	LC	St
19	Sirkeer Malkoha	<i>Phaenicophaeus leschenaultii</i>	R	LC	St
20	Barn Owl	<i>Tyto alba</i>	O	LC	St
21	Collared Scops Owl	<i>Otus bakkamoena</i>	F	LC	St
22	Brown Fish Owl	<i>Ketupa zeylonensis</i>	R	LC	Dc
23	Spotted Owlet	<i>Athene brama</i>	C	LC	St
24	Indian Nightjar	<i>Caprimulgus asiaticus</i>	O	LC	St
25	House swift	<i>Apus affinis</i>	C	LC	Inc
26	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	C	LC	Inc
27	Common Kingfisher	<i>Alcedo atthis</i>	F	LC	Unk
28	Pied Kingfisher	<i>Ceryle rudis</i>	F	LC	Unk
29	Green bee-eater	<i>Merops orientalis</i>	C	LC	Inc
30	Indian Roller	<i>Coracias benghalensis</i>	C	LC	Inc
31	Common Hoopoe	<i>Upupa epops</i>	F	LC	Dc
32	Indian Grey Hornbill	<i>Ocyrceros birostris</i>	C	LC	St
33	Coppersmith Barbet	<i>Megalaima haemacephala</i>	C	LC	Inc
34	Brown-headed Barbet	<i>Megalaima zeylanica</i>	O	LC	St
35	Common Flameback	<i>Dinopium Javanese</i>	C	LC	St
36	Black-rumped Flameback	<i>Dinopium benghalense</i>	C	LC	St
37	Yellow-crowned Woodpecker	<i>Dendrocopos mahrattensis</i>	O	LC	St

Table 1: Continued...

Sr. No.	Common name	Zoological name	Occurrence	Conservation status	Population Trend
38	White-naped Woodpecker	<i>Chrysocolaptes festivus</i>	R	LC	St
39	Ashy-crowned sparrow Lark	<i>Eremopterix grisea</i>	F	LC	St
40	Wire-tailed Swallow	<i>Hirundo smithii</i>	C	LC	Inc
41	Dusky Crag Martin	<i>Hirundo concolor</i>	C	LC	Inc
42	Long-tailed Shrike	<i>Lanius schach</i>	C	LC	Unk
43	Bay-backed Shrike	<i>Lanius vittatus</i>	O	LC	St
44	Eurasian Golden Oriole	<i>Oriolus oriolus</i>	C	LC	St
45	Black-hooded Oriole	<i>Oriolus xanthornus</i>	F	LC	Unk
46	Black drongo	<i>Dicrurus macrocercus</i>	C	LC	Unk
47	Greater Racket-tailed Drongo	<i>Dicrurus paradiseus</i>	C	LC	Dc
48	Common mynah	<i>Acridotheres tristis</i>	C	LC	Inc
49	Brahminy Starling	<i>Sturnus pagodarum</i>	C	LC	Unk
50	Asian Pied starling	<i>Sturnus contra</i>	C	LC	Inc
51	House Crow	<i>Corvus splendens</i>	C	LC	St
52	Large-billed Crow	<i>Corvus macrorhynchos</i>	C	LC	St
53	Rufous Treepie	<i>Dendrocitta vagabunda</i>	C	LC	St
54	Common Woodshrike	<i>Tephrodornis pondicerianus</i>	R	LC	St
55	Small Minivet	<i>Pericrocotus cinnamomeus</i>	F	LC	St
56	Common Iora	<i>Aegithina tiphia</i>	C	LC	Unk
57	Blue-winged leafbird	<i>Chloropsis cochinchinensis</i>	O	LC	Dc
58	Red-vented bulbul	<i>Pycnonotus cafer</i>	C	LC	Inc
59	White-browed Bulbul	<i>Pycnonotus luteolus</i>	F	LC	St
60	Jungle Babbler	<i>Turdoides striatus</i>	C	LC	St
61	Yellow-eyed Babbler	<i>Chrysomma sinense</i>	C	LC	St
62	Tickell's Blue Flycatcher	<i>Cyornis tickelliae</i>	O	LC	St
63	Asian Paradise Flycatcher	<i>Terpsiphone paradisi</i>	F	LC	St
64	White-browed Fantail	<i>Rhipidura aureola</i>	F	LC	St
65	Black-naped Monarch	<i>Hypothymis azurea</i>	F	LC	St
66	Ashy prinia	<i>Prinia socialis</i>	C	LC	St
67	Common Tailorbird	<i>Orthotomus sutorius</i>	C	LC	St
68	Indian Robin	<i>Saxicoloides fulvicata</i>	C	LC	St
69	Oriental Magpie Robin	<i>Copsychus saularis</i>	C	LC	St
70	White-rumped Shama	<i>Copsychus malabaricus</i>	F	LC	Dc
71	Orange headed Thrush	<i>Zoothera citrina</i>	F	LC	Dc
72	White-browed Wagtail	<i>Motacilla madaraspatensis</i>	F	LC	St
73	Paddyfield Pipit	<i>Anthus rufulus</i>	C	LC	St
74	Thick-billed Flowerpecker	<i>Dicaeum agile</i>	O	LC	St
75	Pale-billed Flowerpecker	<i>Dicaeum erythrorhynchos</i>	R	LC	St

Table 1: Continued...

Sr. No.	Common name	Zoological name	Occurrence	Conservation status	Population Trend
76	Purple Sunbird	<i>Nectarinia asiatica</i>	C	LC	St
77	Oriental White-eye	<i>Zosterops palpebrosus</i>	F	LC	Dc
78	House Sparrow	<i>Passer domesticus</i>	C	LC	Dc
79	Chestnut-shouldered Petronia	<i>Petronia xanthocollis</i>	F	LC	St
80	Indian Silver bill	<i>Lonchura malabarica</i>	C	LC	St
81	White-rumped Munia	<i>Lonchura striata</i>	F	LC	St
82	Red Munia	<i>Amandava amandava</i>	C	LC	St
83	Black-headed Munia	Lonchura Malacca	O	LC	St
84	Scaly-breasted Munia	<i>Lonchura punctulata</i>	C	LC	St
85	Baya Weaver	<i>Ploceus philippinus</i>	C	LC	St
86	Shikra	<i>Accipiter badius</i>	C	LC	St
87	Black-shouldered Kite	<i>Elanus caeruleus</i>	C	LC	St
88	Black-kite	<i>Milvus migrans govinda</i>	F	LC	Unk
89	White-eyed Buzzard	<i>Butastur teesa</i>	F	LC	St
90	Oriental Honey-Buzzard	<i>Pernis ptilorhynchus</i>	O	LC	St
91	Crested Serpent Eagle	<i>Spilornis cheela</i>	F	LC	St
92	Changeable Hawk Eagle	<i>Spizaetus cirrhatus</i>	F	LC	Dc
93	Lesser Whistling-Duck	<i>Dendrocygna javanica</i>	C	LC	Dc
94	Cotton Pygmy-goose	<i>Nettapus coromandelianus</i>	C	LC	St
95	Asian Openbill	<i>Anastomus oscitans</i>	C	LC	Unk
96	Black-headed Ibis	<i>Threskiornis melanocephalus</i>	C	NT	Dc
97	Grey Heron	<i>Ardea cinerea</i>	C	LC	Unk
98	Purple Heron	<i>Ardea purpurea</i>	C	LC	Dc
99	Indian Pond Heron	<i>Ardeola grayii</i>	C	LC	Unk
100	Little Heron	<i>Butorides striatus</i>	O	LC	Dc
101	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	O	LC	Dc
102	Little egret	<i>Egretta garzetta</i>	C	LC	Inc
103	Great Egret	<i>Casmerodius albus</i>	R	LC	Unk
104	Intermediate Egret	<i>Mesophoyx intermedia</i>	C	LC	Dc
105	Cattle Egret	<i>Bubulcus ibis</i>	C	LC	Inc
106	Little Grebe	<i>Tachybaptus ruficollis</i>	C	LC	Dc
107	Darter	<i>Anhinga melanogaster</i>	O	NT	Dc
108	Little Cormorant	<i>Phalacrocorax niger</i>	C	LC	Unk
109	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	C	LC	Unk
110	Purple Swampphen	<i>Porphyrio porphyrio</i>	C	LC	Unk
111	Common Moorhen	<i>Gallinula chloropus</i>	C	LC	Unk
112	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>	C	LC	Dc
113	Bronze-winged Jacana	<i>Metopidius indicus</i>	C	LC	Unk

Table 1: Continued...

Sr. No.	Common name	Zoological name	Occurrence	Conservation status	Population Trend
114	Red-wattled Lapwing	<i>Vanellus indicus</i>	C	LC	Unk
115	Indian Pitta	<i>Pitta brachyuran</i>	F	LC	Dc
116	Ashy Drongo	<i>Dicrurus leucophaeus</i>	R	LC	Unk
117	Verditer Flycatcher	<i>Eumyias thalassina</i>	R	LC	St
118	Pied Bushchat	<i>Saxicola caprata</i>	F	LC	St
119	Blue Rock Thrush	<i>Monticola solitarius</i>	R	LC	St
120	Yellow Wagtail	<i>Motacilla flava</i>	F	LC	Dc
121	Grey Wagtail	<i>Motacilla cinerea</i>	F	LC	St
122	White Wagtail	<i>Motacilla alba</i>	F	LC	Dc
123	Citrine Wagtail	<i>Motacilla citreola</i>	O	LC	St
124	Purple-rumped Sunbird	<i>Nectarinia zeylonica</i>	F	LC	St
125	Black-breasted Weaver	<i>Ploceus benghalensis</i>	F	LC	St
126	Spot-billed Duck	<i>Anas poecilorhyncha</i>	F	LC	Dc
127	Comb Duck	<i>Sarkidiornis melanotos</i>	F	LC	Dc
128	Painted Stork	<i>Mycteria leucocephala</i>	O	NT	Dc
129	Black Ibis	<i>Pseudibis papillosa</i>	O	LC	Dc
130	Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>	O	LC	St
131	Common Coot	<i>Fulica atra</i>	C	LC	Dc
132	Black-winged Stilt	<i>Himantopus himantopus</i>	C	LC	Inc
133	River Tern	<i>Sterna aurantia</i>	O	NT	Dc
134	Blue-tailed Bee-eater	<i>Merops philippinus</i>	F	LC	St
135	Barn Swallow	<i>Hirundo rustica</i>	C	LC	Dc
136	Chestnut-tailed Starling	<i>Sturnus malabaricus</i>	F	LC	Unk
137	Eurasian Marsh Harrier	<i>Circus aeruginosus</i>	R	LC	Inc
138	Ruddy Shelduck	<i>Tadorna ferruginea</i>	F	LC	Unk
139	Northern Pintail	<i>Anas acuta</i>	C	LC	Dc
140	Garganey	<i>Anas querquedula</i>	F	LC	Dc
141	Northern Shoveler	<i>Anas clypeata</i>	F	LC	Dc
142	Common Teal	<i>Anas crecca</i>	F	LC	Unk
143	Red-crested Pochard	<i>Rhodonessa rufina</i>	C	LC	Unk
144	Common Pochard	<i>Aythya ferina</i>	F	LC	Dc
145	Tufted Duck	<i>Aythya fuligula</i>	F	LC	St
146	Gadwall	<i>Anas strepera</i>	F	LC	Unk
147	Eurasian Wigeon	<i>Anas penelope</i>	O	LC	Dc
148	Eurasian Spoonbill	<i>Platalea leucorodia</i>	O	LC	Unk
149	Wood Sandpiper	<i>Tringa glareola</i>	F	LC	St
150	Common Sandpiper	<i>Actitis hypoleucos</i>	F	LC	Dc
151	Common Greenshank	<i>Tringa nebularia</i>	O	LC	St
152	Little Ringed Plover	<i>Charadrius dubius</i>	O	LC	St
153	Pied cuckoo	<i>Clamator jacobinus</i>	F	LC	St



Table 1: Continued...

Sr. No.	Common name	Zoological name	Occurrence	Conservation status	Population Trend
154	Rosy Starling	<i>Sturnus roseus</i>	C	LC	Unk
155	Mottled Wood Owl	<i>Strix ocellata</i>	NMS	LC	St
156	Black-capped Kingfisher	<i>Halcyon pileata</i>	NMS	LC	Dc
157	Malabar Pied Hornbill	<i>Anthracoceros coronatus</i>	NMS	NT	Dc
158	Great Hornbill	<i>Buceros bicornis</i>	NMS	NT	Dc
159	Rufous Woodpecker	<i>Celeus brachyurus</i>	NMS	LC	Dc
160	Brown-capped Pygmy Woodpecker	<i>Dendrocopos nanus</i>	NMS	LC	Inc
161	Southern Grey Shrike	<i>Lanius meridionalis</i>	NMS	LC	St
162	White-bellied Drongo	<i>Dicrurus caerulescens</i>	NMS	LC	Unk
163	Short-toed Snake Eagle	<i>Circaetus gallicus</i>	NMS	LC	St
164	Common Kestrel	<i>Falco tinnunculus</i>	NMS	LC	Dc
165	Peregrine Falcon	<i>Falco peregrines</i>	NMS	LC	St
166	Lesser Adjutant	<i>Leptotilos javanicus</i>	NMS	Vulnerable	Dc
167	Brown-headed Gull	<i>Larus brunnicephalus</i>	NMS	LC	St

**Occurrence:** C =Common , F = Frequent, O =Occasional,R = Rare  
**Conservation Status:** LC = Least Concern , NT = Near Threatened ,V = Vulnerable  
**Population Trend:** St = Stable, Inc= Increasing, Dc = Decreasing , Unk = Unknown

Table 2 : Seasonal Status and Habitat Preference selected by migrants in selected study area of Navegaon National Park, Maharashtra, India

Sr. No.	Common name	Zoological name	Seasonal Status	Habitat codes	Details of the habitat occupied.
1	Indian Pitta	<i>Pitta brachyuran</i>	LM	F	Lower branches of medium trees, foraging on ground.
2	Ashy Drongo	<i>Dicrurus leucophaeus</i>	LM	FE	Middle storey, vantage points.
3	Verditer Flycatcher	<i>Eumyias thalassina</i>	LM	F/FE	Middle and lower storey.
4	Pied Bushchat	<i>Saxicola caprata</i>	LM	Cu	Bushes, crops.
5	Blue Rock Thrush	<i>Monticola solitarius</i>	LM	Ro	Rocks at Badbada.
6	Yellow Wagtail	<i>Motacilla flava</i>	LM	WE/WH	Near Navegaon lake and waterholes.
7	Grey Wagtail	<i>Motacilla cinerea</i>	LM	WE	Near Navegaon lake.
8	White Wagtail	<i>Motacilla alba</i>	LM	WE/WH	Near Navegaon lake and waterholes.
9	Citrine Wagtail	<i>Motacilla citreola</i>	LM	WE	Near Navegaon lake.
10	Purple-rumped Sunbird	<i>Nectarinia zeylonica</i>	LM	FE	Bushes,shrubs and small trees with juicy flowers.
11	Black-breasted Weaver	<i>Ploceus benghalensis</i>	LM	Cu	Tall and thick grass in the farmland.
12	Spot-billed Duck	<i>Anas poecilorhyncha</i>	LM	OW/WE	Foraging in open water, roosting on water edge.

Table 2 : continued...

Sr. No.	Common name	Zoological name	Seasonal Status	Habitat codes	Details of the habitat occupied.
13	Comb Duck	<i>Sarkidiornis melanotos</i>	LM	OW/WE	Foraging in open water, roosting on water edge.
14	Painted Stork	<i>Mycteria leucocephala</i>	LM	WE	Foraging or roosting at water edge.
15	Black Ibis	<i>Pseudibis papillosa</i>	LM	Cu/WE	Foraging at water edge or on farmland.
16	Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>	LM	RE/WE	Roosting or foraging in the reed beds at water edge.
17	Common Coot	<i>Fulica atra</i>	LM	OW	Open water.
18	Black-winged Stilt	<i>Himantopus himantopus</i>	LM	WE	Foraging in water not far from the edge.
19	River Tern	<i>Sterna aurantia</i>	LM	OW/WE	Flying over open water, roosting at water edge.
20	Blue-tailed Bee-eater	<i>Merops philippinus</i>	WM	Cu/WE	Vantage points near water.
21	Barn Swallow	<i>Hirundo rustica</i>	WM	WE/OW	Reeds along water edge, flying over open water.
22	Chestnut-tailed Starling	<i>Sturnus malabaricus</i>	WM	FE/Cu	Middle storey, Bombax ceiba was preferred when in blossom.
23	Eurasian Marsh Harrier	<i>Circus aeruginosus</i>	WM	OW/WE/RE	Flying over open water, near the reeds at water edge.
24	Ruddy Shelduck	<i>Tadorna ferruginea</i>	WM	OW/WE	Foraging in open water, roosting on water edge.
25	Northern Pintail	<i>Anas acuta</i>	WM	OW/WE	Foraging in open water, roosting on water edge.
26	Garganey	<i>Anas querquedula</i>	WM	OW/WE	Foraging in open water, roosting on water edge among reeds.
27	Northern Shoveler	<i>Anas clypeata</i>	WM	OW/WE	Foraging in open water, roosting on water edge.
28	Common Teal	<i>Anas crecca</i>	WM	OW/WE	Foraging in open water, roosting on water edge.
29	Red-crested Pochard	<i>Rhodonessa rufina</i>	WM	OW/WE	Foraging in open water, roosting on water edge.
30	Common Pochard	<i>Aythya ferina</i>	WM	OW/WE	Foraging in open water, roosting on water edge.
31	Tufted Duck	<i>Aythya fuligula</i>	WM	OW/WE	Foraging in open water, roosting on water edge.
32	Gadwall	<i>Anas strepera</i>	WM	OW/WE	Foraging in open water, roosting on water edge.
33	Eurasian Wigeon	<i>Anas penelope</i>	WM	OW/WE	Foraging in open water, roosting on water edge.
34	Eurasian Spoonbill	<i>Platalea leucorodia</i>	WM	WE	Foraging or roosting at water edge.
35	Wood Sandpiper	<i>Tringa glareola</i>	WM	WE	Foraging along water edge.
36	Common Sandpiper	<i>Actitis hypoleucos</i>	WM	WE	Foraging along water edge.

Table 2 : continued...

Sr. No.	Common name	Zoological name	Seasonal Status	Habitat codes	Details of the habitat occupied.
37	Common Greenshank	Tringa nebularia	WM	WE	Foraging along water edge.
38	Little Ringed Plover	Charadrius dubius	WM	WE	Foraging along water edge.
39	Pied cuckoo	Clamator jacobinus	SM	FE/Cu	Middle & lower storey.
40	Rosy Starling	Sturnus roseus	SM	Cu/FE	Bombax ceiba.

Habitat occupied: F = Forest , FE = Forest Edge, Cu = Cultivation, Ro = Rocks (at Badbada) , WH = Water holes , RE = Reeds along & in the reservoir , OW = Open Water , WE = Water edge .

Table 3 : Relative abundance of Local Migrants in selected study area of Navegaon National Park, Maharashtra, India

Sr. No.	Name of species	Zoological Name	Total number of birds of a species (n)	Relative Abundance of winter migrants (p <sub>i</sub> ) p <sub>i</sub> =n/N	Ln p <sub>i</sub>	p <sub>i</sub> Ln p <sub>i</sub>
1	Indian Pitta	<i>Pitta brachyuran</i>	33	0.0080822	-2.09246544	-0.01691192
2	Ashy Drongo	<i>Dicrurus leucophaeus</i>	19	0.004653	-2.33222578	-0.01085288
3	Verditer Flycatcher	<i>Eumyias thalassina</i>	11	0.002694	-2.56958669	-0.00692272
4	Pied Bushchat	<i>Saxicola caprata</i>	57	0.01396	-1.85510452	-0.02589786
5	Blue Rock Thrush	<i>Monticola solitarius</i>	12	0.002939	-2.53179813	-0.00744099
6	Yellow Wagtail	<i>Motacilla flava</i>	38	0.009307	-2.03119578	-0.0189041
7	Grey Wagtail	<i>Motacilla cinerea</i>	33	0.008082	-2.09246544	-0.01691192
8	White Wagtail	<i>Motacilla alba</i>	11	0.002694	-2.56958669	-0.00692272
9	Citrine Wagtail	<i>Motacilla citreola</i>	9	*0.002204	-2.65673687	** -0.00585614
10	Purple-rumped Sunbird	<i>Nectarinia zeylonica</i>	46	0.011266	-1.94822155	-0.0219491
11	Black-breasted Weaver	<i>Ploceus benghalensis</i>	109	0.026696	-1.57355288	-0.04200766
12	Spot-billed Duck	<i>Anas poecilorhyncha</i>	344	0.084252	-1.07442094	-0.09052187
13	Comb Duck	<i>Sarkidiornis melanotos</i>	180	0.044085	-1.35570687	-0.05976665
14	Painted Stork	<i>Mycteria leucocephala</i>	125	0.030615	-1.51406937	-0.04635285
15	Black Ibis	<i>Pseudibis papillosa</i>	20	0.004898	-2.30994938	-0.01131496
16	Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>	36	0.008817	-2.05467688	-0.01811618
17	Common Coot	<i>Fulica atra</i>	2411	**0.590497	-0.22878217	*-0.13509523
18	Black-winged Stilt	<i>Himantopus himantopus</i>	300	0.073475	-1.13385813	-0.08331066
19	River Tern	<i>Sterna aurantia</i>	289	0.070781	-1.15008154	-0.08140425
	s= 19		N = 4083			H' = -0.70646066

\* = smallest value ; \*\* = highest value

**Table 4 : Relative abundance of Winter Migrants in selected study area of Navegaon National Park, Maharashtra, India**

Sr. No.	Name of the species	Zoological Name	Total number of birds of a species ( n )	Relative Abundance of winter migrants ( p <sub>i</sub> )	Log p <sub>i</sub>	p <sub>i</sub> *Logp <sub>i</sub>
1	Blue-tailed Bee-eater	<i>Merops philippinus</i>	356	0.049513	-1.30528	-0.064628552
2	Barn Swallow	<i>Hirundo rustica</i>	1640	0.228095	-0.64189	-0.146410496
3	Chestnut-tailed Starling	<i>Sturnus malabaricus</i>	136	0.018915	-1.72319	-0.032594414
4	Eurasian Marsh Harrier	<i>Circus aeruginosus</i>	21	0.002921	-2.53451	-0.007402601
5	Ruddy Shelduck	<i>Tadorna ferruginea</i>	306	0.042559	-1.37101	-0.058348857
6	Northern Pintail	<i>Anas acuta</i>	1035	0.14395	-0.84179	-0.121175402
7	Garganey	<i>Anas querquedula</i>	372	0.051739	-1.28619	-0.066545365
8	Northern Shoveler	<i>Anas clypeata</i>	184	0.025591	-1.59191	-0.040738753
9	Common Teal	<i>Anas crecca</i>	166	0.023088	-1.63662	-0.037785682
10	Red-crested Pochard	<i>Rhodonessa rufina</i>	1890	**0.262865	-0.58027	*-0.15253196
11	Common Pochard	<i>Aythya ferina</i>	228	0.031711	-1.49879	-0.047527822
12	Tufted Duck	<i>Aythya fuligula</i>	300	0.041725	-1.37961	-0.057563601
13	Gadwall	<i>Anas strepera</i>	282	0.039221	-1.40648	-0.055163741
14	Eurasian Wigeon	<i>Anas penelope</i>	39	0.005424	-2.26566	-0.012289417
15	Eurasian Spoonbill	<i>Platalea leucorodia</i>	11	*0.00153	-2.81534	** -0.00430719
16	Wood Sandpiper	<i>Tringa glareola</i>	34	0.004729	-2.32525	-0.010995619
17	Common Sandpiper	<i>Actitis hypoleucos</i>	156	0.021697	-1.6636	-0.036094891
18	Common Greenshank	<i>Tringa nebularia</i>	15	0.002086	-2.68064	-0.005592429
19	Little Ringed Plover	<i>Charadrius dubius</i>	19	0.002643	-2.57798	-0.006812452
	<b>s = 19</b>		<b>N= 7190</b>			<b>H' = -.964509245</b>
* = smallest value ; ** = highest value						

**Table 5 : Relative abundance of Summer Migrants in selected study area of Navegaon National Park Maharashtra , India**

Sr. No.	Name of species	Zoological Name	Total number of birds of a species ( n )	Relative Abundance of winter migrants ( p <sub>i</sub> ) p <sub>i</sub> =n/N ; N= 541
1	Pied cuckoo	<i>Clamator jacobinus</i>	46	0.0850277
2	Rosy Starling	<i>Sturnus roseus</i>	495	0.91497

**Table 6 : Relative abundance and Different Indices of Migrants in selected study area of Navegaon National Park, Maharashtra, India**

Sr.No.	Name of the index	Notation	Winter migrants	Local migrants	Summer Migrants
1.	Shannon and Weaver index	H'	0.964509245	0.70646	--
2.	Evenness Index	J'	0.754257	0.5524	--
3.	Simpson Index D	D	0.844956	0.629676	--
4	Relative Abundance	P <sub>i</sub>	Pied cuckoo - 0.0850277 Rosy Starling - 0.91497		

After the analysis of the compiled data, For the local migrants, the lowest value of relative abundance was calculated for Citrine Wagtail (0.002204) while the Common Coot showed the highest value (0.590497) (Table 3). The lowest value of relative abundance for winter migrants was that for the Eurasian Spoonbill (0.00153) while the Red-crested Pochard with its huge congregations showed the highest value (0.262865) (Table 4).

In case of Summer Migrants relative abundance of Pied cuckoo and Rosy Starling was calculated as 0.0850277 and 0.91497 respectively Since only two species were recorded as Summer migrant, only relative abundance was taken into consideration as the data were insufficient to attempt separate analysis (Table 5)

In context of Shannon Wiener index, among local migrants, Common Coot came out with the lowest value (0.13509523) and the Citrine Wagtail showed the highest value (0.00585614) (Table 3). Among winter migrants Eurasian Spoonbill showed highest value (0.00430719) while lowest value was that of Red-crested Pochard (0.15253196) (Table 4).

The dominance of these species could be contributed by high encounter rates and the presence of favorable habitats. The availability of food makes some birds with a feeding guild of a highly abundant food to dominate the area [22].

The value of Shannon Wiener index falls between 0.70646 and 0.964509245 and it rarely is greater than 4 to 4.5. A value near 4.6 would indicate that the numbers of individuals are evenly distributed between all the species [23].

Table 6 revealed that winter migrants showed the higher values of Shannon and Weaver index ( $H'$ ), Simpson Index ( $D$ ) and Evenness Index ( $J'$ ) as compare to local migrants. In winter migrants the values of indices were calculated as  $H' = 0.964509245$ ,  $D = 0.844956$  and  $J' = 0.754257$  respectively, while in local migrants values were  $H' = 0.70646$ ,  $D = 0.629676$  and  $J' = 0.5524$  respectively.

The simplest measure of diversity is to count the number of species; the result is termed the species richness [24]. To obtain a quantitative estimate of biological variability that can be used to compare biological entities, composed of discrete components, in space or in time is the basic idea of a diversity index [25].

Shannon diversity is a widely used index for comparing diversity between various habitats. It is an information statistic index, which means it assumes that individuals are randomly sampled from an independent large population and all the species are represented in the sample. [26]. Shannon Wiener Index is a measure of diversity that combines species richness and their relative abundances and it is calculated in order to know the species diversity in different habitat based on the abundance of the species [27]. It is the basic and fundamental indicator of species diversity and richness. In Shannon Wiener calculation, higher the value obtained, higher is the [28]. The value of Simpson Index ranges between 0 and 1. Here, 1 represents infinite diversity and 0 represents no diversity [23]. After calculations, the value for winter migrants it is 0.844956, whereas for local migrants it came out as 0.629676.

Low value of Shannon Wiener Index showed that the numbers of individuals are not evenly distributed between all the species. Also, the lower value obtained shows the lower diversity of the avian species in the study area. Henderson *et al.* [29] compared bird abundance between set-aside (an arable land rested from normal intensive operations) and nearby crops or grassland.

Takele and Afework [30] conducted a preliminary study on species composition, relative abundance and distribution of bird species in Choke Mountains, East Gojjam, Ethiopia.

Bibi and Ali [31] measured the diversity indices of avian communities at Taunsa Barrage Wildlife Sanctuary in Pakistan. They studied the Shannon Wiener and Simpson Index, Species evenness, Census index and

species richness and concluded that there was a major decline in 14 avian species in the area.

Within the forest water holes and lake is an important habitat for a variety of migrants. Management of such habitats is only possible by using available information on existing habitat components and the avifauna utilizing it. Further considerable work would require to arrive at a more accurate understanding of the ecological status of migrant fauna of the area which will be helpful to propose the conservation management strategies of habitat and migrant avifauna as well in future.

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