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Avian diversity in Urban Green and Urban Blue space in Bangalore India

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Abstract

Birds are the common group of organisms in any ecosystem; they are the important species that help in ecological balance and sustenance of biodiversity. They play very important rolein pollination and also act as seed dispensers, scavengers, pest and rodent control. Urbanization and landscape modification has greatly affected global avian diversity and population due to the reduction of feeding and nesting resources. However, studies have reported diverse avian fauna in many humans dominated cities. Natural or manmade urban structures can provide a heterogenous range of habitatsthat can be used for managing biodiversity.Thus, the present study was conducted to understand the avian diversity in urban green and urban blue areas, two seminatural habitats in the city. A naturallake and seminatural green area located in the urban residential area in Madiwala, Bangalore were selected to document the bird diversity from November 2020 to February 2021. Observation was conducted by surveys in the study areas at particular time. Different diversity indices were used to analyze the data. Species diversity, evenness and abundance was found by comparing the values of Simpson and Shannon indices. During the study a total of 22 species belonging to 15 families were recorded. Individual population in urban bluearea (395) was higher than urban green area (216). The species diversity was found to be grater in urban greenarea (22) than urban blue area (19). Shannon's diversity index indicated that urban green space (2.584) had higher species diversity than urban blue space (2.417). Similarly, insectivorous, nectivorous and frugivorous birds were abundant in urban green area in contrast to omnivorous and piscivorous species in the urban blue area. Our study confirmed that proper management and planning of urban green and blue areas can help in conservation of avian biodiversityin the anthropogenically altered urban habitats.

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Birds are the common group of organisms in any ecosystem. They help in the ecological balance and sustenance of biodiversity. They play a very important role in pollination and perform diverse ecological functions, as seed dispensers, scavengers, pest and rodent controllers[19,49,52]. They can be used to assess the status of ecosystem health, as they are sensitive to changes in the habitat structure and composition[34]. Therefore, they are also the bio indicators of a healthy ecosystem. Urbanization and landscape modification leading to the reduction of feeding and nesting resources[12,32] has greatly affected the global bird diversity and population decline. This decline, in turn canlead to ecological imbalance affecting plants that depend on birds for pollination and seed dispersal and also the insects and predators they feed on[18]. Urbanization is regarded as the largest ecological transformation process[25] has affected the natural habitat[8,22] leading to the environmental problems mainly the loss of biodiversity. Urban areas cover nearly 2.7% of the world surface (Center of international Earth Science Information network 2004) and have been dominated by human inhabitation (United Nations 2008). It was estimated that the total urban population by the year 2030 will be 610 million, which will account for the 40% of the total population of the country[36]. Urbanization generally leads to an environment that is favorable for humans and not for other organisms.Therefore, urbanization is considered as a major threat to global biodiversity[21,37]. Rapid urbanization and urban expansion have resulted in the great loss of natural habitat leading to the drastic decline in the avian diversity[13]. Therefore, ecofriendly landscape planning and proper management of green resources within the urban areas can play a n important role in restoringthe declining avian diversity within the cities[8,29]. Biodiversity is important as it balances the ecosystem. A tropical country such as India is considered as a mega diversity center harboring nearly1,200 to 1,300 species of avian fauna[1,20,40] accounting to 12% of the bird species of the world[2]. There are about 100 evolutionary distinct and globally endangered (EDGE) bird species around the world, of which 15 are from India (Zoological Society of London (ZSL) and Yale University 2014). 10%of India's wild flora and fauna are seen as threatened species[35]. The reason for these to be under threat is due to destruction of their habitat.One of the main causes for biodiversity loss in India is due to urbanization. Urbanization causes habitat loss and fragmentation. Some of the reasons for the biodiversity loss in India include degradation of habitat by pollution, deforestation, climate variability. In addition, changes in the environmental and climatic conditions, also have threatened many bird species as they find it difficult to adapt and this may further lead to the extinction of such species. However, studies have reported diverse avian fauna in many human dominated cities. Natural or manmade urban structures can provide a heterogenous range of habitats[15] within the cities that can be used for managing biodiversity. Especially in developing countries, urban areas support large number of wildlife including wild birds[7]. Natural or manmade green patches of vegetation and water bodies can serveas hotspots for urban biodiversity[38]. Urban green spaces comprise a range of habitats in the form of patchy native vegetation, gardens, and green yards[5,11] that can sustain biodiversity[39,50]. Similarly, urban blue spaces such as natural or manmade water sources, inland

waterways, lakes, rivers are the hotspots for many migratory and native water birds. Therefore, this study aims to investigate and understand the bird community, bird diversity and density, in urban green and blue areas in Bangalore the fastest developing metropolitan city in India.

Study area:

Avian diversity was sampled in urban green and urban blue area within the urban areas of Bangalore. Bengaluru is the capital city of Karnataka, India. It lies in the Deccan plateau of southern Karnataka with a metropolitan population of around 11 million making it fifth most populous urban agglomeration in India with a height of over 900m (3000ft) above sea level. The urban green area (UGA) was a patch of green cover (12.9274166954947, 77.61590794540395), located in the residential area in Madiwala, Bangalore. The sampled urban green area houseddiverse flora consisting of ornamental plants, wild pavement trees and patches of horticultural plants spread across the residential buildings with approximate population of 35,155 inhabitants. The urban blue area (UBA), was a biggest lake (The Madiwala lake-12° 54' 28" North, 77° 37' 0" East) consisting of fresh water body and surround with wild and semicultivated vegetation spread across an area of 111.3 hectare.

Data collection:

Diversity of birds inUGA and UBAwas conducted during the winter season, from November 2020 to February 2021. Bird diversity was surveyed using point count method. The weekly survey was conducted between 6:00 to 10:00 AM in the mornings and 5:00 to 6:30 PM in the evenings. According to the point count method the survey consisted of several points which were at least 50-100m apart from each other.Around 15 minutes was spent at each sighting/point for observation and identification. Observations regarding feeding habit, flying pattern, size, shape of birds were made using binoculars. Birds were identified with the help of book 'The book of Indian Birds' by Salim Ali and an application 'Merlin Bird ID' by Cornell Lab. Birds were also identified by their call or songs and photographs were taken.

Data analysis:

Diversity of birds was determined using Shannon diversity index(*H'*). Species richness and abundance in each area was calculated by Simpson's diversity index. Birds were also categorized based on their feeding habits.

Birds can be a measure of ecosystem quality[43] and bird populations have been analysed to monitor long-term changes in natural and artificial ecosystems[53]. More than 20% of the known bird species have now been reported from urban areas[4]. Aronson and co-workers surveyed urban green spaces and urban blue spaces, which provide a structurally complex landscape that can support a rich bird diversity:their study recorded as many as 30 species of birds representing 18 families. In the UGA a total of 216 birds were recorded-during survey period; the birds belonged to 22 species representing 16 families (Table-1). The predominant bird speciesin UGA included, Rock Pigeon (family Columbidae), followed by Green Barbet (Megalania) and Purple Sunbird (Nectariniid),whereas the rare one's accounting for only 0.25% of the total were

Greater Coucal, Shikra, Alexandrian Parakeet, Blyth's Red Warbler and Indian Oriental White Eye (Fig. 2). Of the 22 species, 10 species viz, Alexandrian Parakeet, Blyth's Red Warbler, Indian Oriental White Eye, Ashy Drongo, Oriental Magpie Robin, Spotted Dove, Ashy Prinia, Pale Billed Flower Pecker, Common Tailor bird and Red Whiskered Bulbul (fig. 3), were documented only in the urban green space: The grouping based on feeding habits showed a heterogeneous mix of insectivores 48%; nectarivore 15%; herbivores and scavengers 13% each and omnivores 11% in the UGS(Fig. 4). The urban blue spaces on the contrary proved less diverse than the green spaces, with only 19 species, distributed among a total of 395 individual birds (Table-1). The predominant species in UBA included the Brown kite (Accipitridae) and water birds such as Cormorant (Phalacrocoracidae) and Painted Stork (Ciconiidae) (Fig. 5). The Greater Coucal (Cuculidae) was the rarest, accounting for only 0.2% of the total (fig. 6). Other water birds, namely Black-winged Slit (Recurvirostridae) and Indian Black Ibis (Threskiornithidae) were spotted only occasionally. The following 7 species were found only in the urban blue space: Cormorant, Black-winged Slit, Cattle Egret, Indian Pond Heron, Indian Black Ibis, Painted Stork, and Sandpiper (Fig. 1).

The piscivores were more common and showed greater diversity in the urban blue space, accounting for 38% of the total, followed byscavengers (32%), omnivores 17%. On the other hand, herbivores (8%) and insectivores (7%) wereless common in the urban bluespace than in the urban green space (Fig. 7). The following 12 species were common to both green and blue urban spaces in the present study: Greater Coucal, Asian Koel, Brown kite, Brahmini kite, Shikra, Rose-ringed Parakeet, House Crow, Large-billed Crow, Purple Sunbird, Common Myna, Rock Pigeon, and Green Barbet (Fig. 1).

The distribution of birds is governed mainly by the habitat and availability of food[31]. The major factors that influence changes in bird population are availability of food, sites and material for nesting, and the presence of predators and competitors[33,42]. The distribution of birds with reference to their feeding habit also showed a considerable difference between the two spaces.Piscivores (38%) and scavengers (32%) were predominant in the urban blue space (Fig. 7) whereas insectivores (48%) and nectarivores (15%) were predominant in urban green space (Fig. 4). Though, a greater number of birds were documented in UBA (395) than the UGA (216). The Shannon's diversity index indicatedgreater species diversity in urban green space (2.584) comparisonto urban blue space (2.417).

Vegetation plays a major role in the distribution of birds[6]. In the present study, the greaterabundance of birds in urban green spaces was probably due to the greater availability of nesting sites, materials and food, because the composition of vegetation is an important feature of a habitat[10,28,44]. The urban green space was dominated by the insectivores, which indicates the diversity of insects that serve as food for birds[16]. This observation is consistent with that made by Muhammad *et al*.,(2018), who reported a positive correlation between bird diversity and insect diversity in urban areas. Similarly, the urban green space also supported nectarivores andfrugivores as well omnivores, indicating the diversity of food

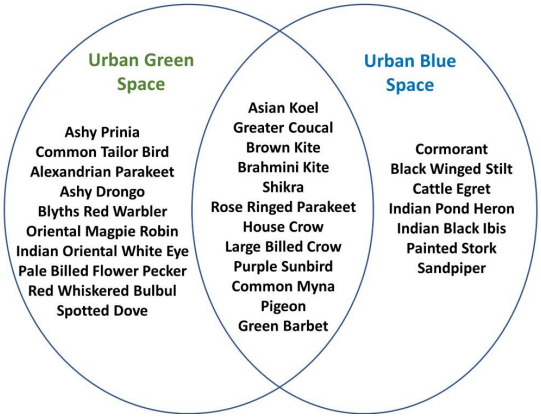
resources in heterogeneous green habitats, as was also reported by Chace and Walsh[9], who foundthat omnivores, granivores, and cavity-nesting species were predominant in urban areas.Similar studies conducted within some agro-ecosystems in Bengaluru recorded 38 species of insectivorous birds from 26 genera representing 17 families[41]. Bird diversity reported in some earlier studies conducted in urban green areas in and around Bengaluru is in line with our study: a study conducted in the campus of the Indian Institute of Science in Bengaluru also recorded a total of 35 bird species[51] and another[45] in the campus of Christ University reported 40 species, representing 27 families, over 15 months, the predominant species being Black Drongo, Eurasian Golden Oriole, and Grey Wagtail.

Likewise, the abundance of piscivores and omnivores in the urban blue space confirms the importance of urban wetlands in sustaining the diversity of water birds and scavenging birds that depend on fish. A similar distribution of water birds was reported by Kadam and Dhar[24] in some villages along the west coast of India. The diversity and abundance of cormorants and painted storks also confirm the contribution of urban blue spaces in sustaining waterbird populations in cities[48], as was also pointed out by Ferenc *et al*.,[17], who suggested that water bodies are important for urban bird diversity.

Shannon's diversity index for the urban green area (2.584) was higher than that for the urban blue area (2.417); Simpson's index too was higher for the urban green area (0.9082 and 0.8783) (table-1). These values also show that estimates of species diversity obtained using the two diversity indices differ greatly. The reason for the difference is that Simpson's diversity index, unlike that of Shannon, also considers relative abundance [47]. The greater number of individual birds can be one of the reasons for the greater diversity seen in urban green spaces, and the differences between the two habitats also reflect the differences in theavailability of food, the number of automobiles, and population—all of which are responsible for the variations in species diversity and evenness.

The species richness and diversity of birds in urban green and urban blue areas in Bengaluru confirms the observations on bird diversity made at several sites in different parts of India, namely the Lakkavalli range forest in the Western Ghats (Muhammad *et al*., 2018) and the semi-natural green spaces in and around the North Orissa University campus[47]. Similarly, a study[23] conducted in the Bhadra Wildlife Sanctuary, in Karnataka, also documents a similar pattern of bird diversity, which showed that the majority of bird specieswere insectivores, followed by those that feed on fruits, grains, and nectar, Purple Sunbird was one of the dominant species and species evenness was 0.58 in summer.

The present study describes the most recent status of bird diversity in semi-natural green and blue areas within a human-dominated urban area. The findings indicate that urban development must promote not only the conservation of green patches and green corridors but also the restoration and protection of available natural or artificial water bodies to ensure greater urban biodiversity in general and that of birds in particular.



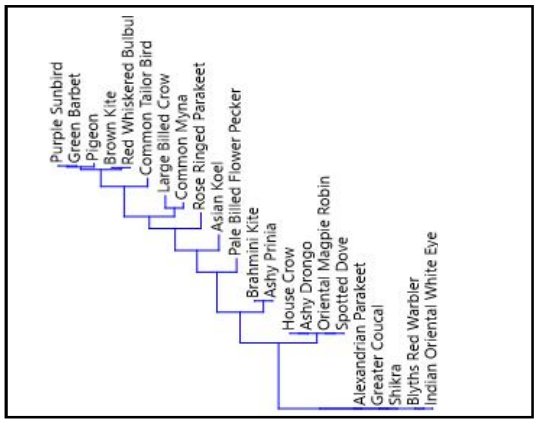
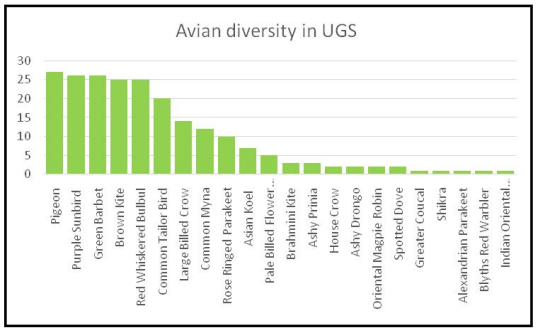


Fig 1: Diversity and distribution of avian taxa in UGS & UBS during winter at Bangalore,
Fig 2: Dendrogram showing the Cluster of bird distribution in UGS

Table 1: Diversity index in surveyed UG and UB space

Diversity indices	Urban Green Space	Urban Blue Space
Total number of Species	22	19
Individuals	216	395
Dominance_D	0.092	0.123
Simpson_1-D	0.908	0.878
Shannon_H	2.584	2.417
Evenness_e^H/S	0.602	0.590



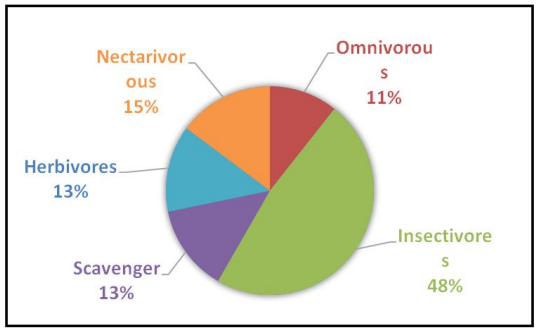


Fig 3: Rank abundance curve of bird species recorded in Urban Green Area,
Fig 4: Distribution of birds in the UGA based on the feeding habit

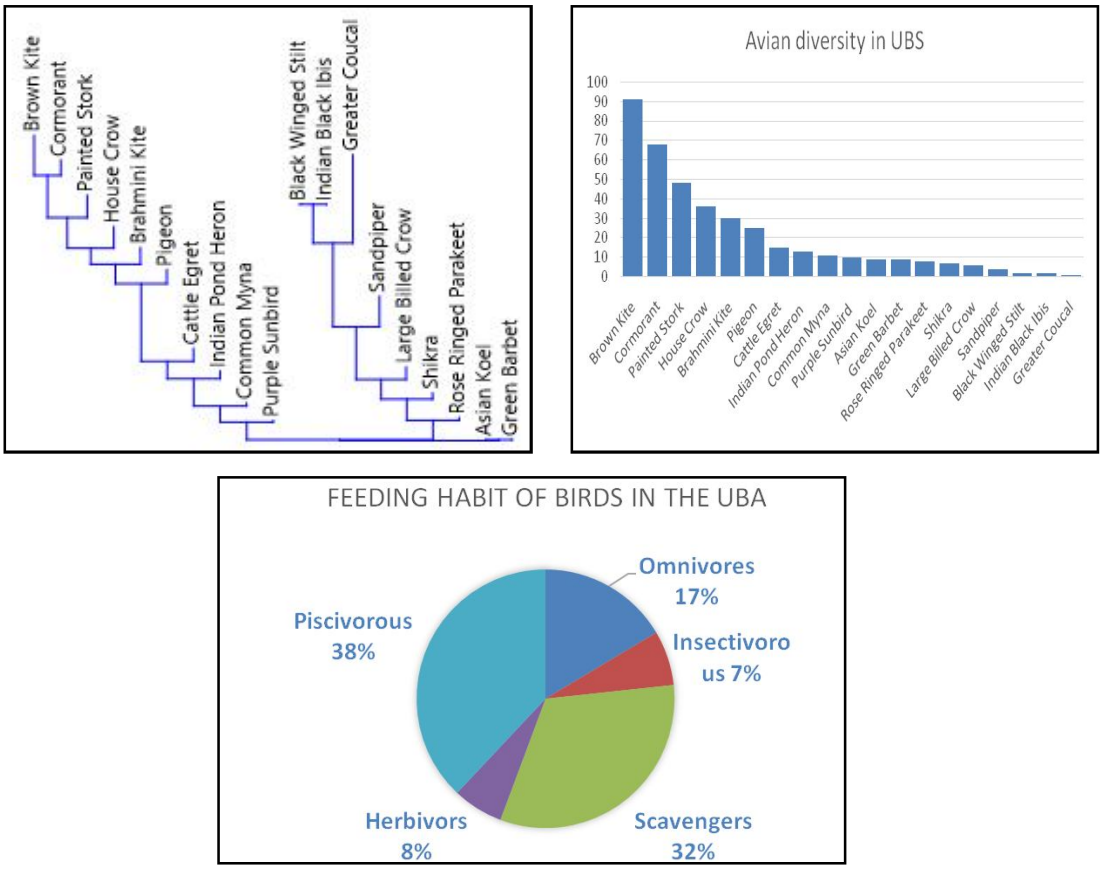


Fig 5: Dendrogram showing Avian species distribution in UBA, Fig 6: Rank abundance curve of avian species in Urban Blue Area, Fig 7: Distribution of birds in UBA based on the feeding habit

References :

1. Alfred J.R.B., A. Kumar, P.C. Tak and J.P. Sati (2001), *190:* 1-227.
2. Ali S., and S. D. Ripley (1987) Compact handbook of the birds of India and Pakistan. AGRIS; 715-721.
3. Altaf M., A. Javid, A.M. Khan, M.S.H. Khan, M. Umair and Z. Ali (2018) *Journal of Asia pacific biodiversity*, *11:* 229-236.
4. Aronson M.F.J., La Sorte F.A., Nilon C.H., Katti M., Goddard M.A., Lepczyk C.A., Warren P.S., Williams NSG, Cilliers S, Clarkson B, Dobbs C, Dolan R, Hedblom M, Klotz S, Kooijmans JL, K€uhn I, MacGregor-Fors I, McDonnell M, M€ortberg U, Pys˘ek P, Siebert S, Sushinsky J, Werner P, Winter M. Proceedings of The Royal Society B 2014; 281 (1780).
5. Aronson M.F.J., C.A. Lepczyk, K.L. Evans, M.A. Goddard, S.B. Lerman, J. Maclvor, C. Nilon, and T. Vargo (2017) *Frontiers in ecology and the environment*, *15:*189-

196.
6. Beninde J., M. Veith, and A. Hochkirch (2015) Ecology Letters, *18:* 581–592.
7. Bolwig S., D. Pomeroy, H. Tushabe, and D. Mushabe (2006) *Danish Journal of Geography, 106:* 115–130.
8. Canedoli C., R. Manenti and E.P. Schioppa (2018) *Urban ecosystems*, *21:* 779-793.
9. Chace J.F. and J.J. Walsh (2006) *Landscape and urban planning*, *74:* 46-69.
10. Chapman K.A., and P.B. Reich (2007) *Biological conservation*, *135:* 527-541.
11. Cilliers S., J. Cilliers, R. Lubbe, and S. Siebert (2013) *Urban ecosystem, 16:* 681-702.
12. Clergeau P., J.L. Savard, G. Mennechez, and G. Falardeau (1998) *The Condor-Ornithological Applications*, *100:* 413-425.
13. Coppedge B.R., D.M. Engle, R.E. Masters, and M.S. Gregory (2001) *Ecological applications*, *11:* 47-59.
14. Davis K. (1965) *Scientific American*, *213:* 41-53.
15. DeGraaf R.M., A.D. Geis, and P. Healy (1991) *Landscape and urban planning, 21:* 181-188.
16. Donnelly R., and J.M. Marzluff (2004) *Conservation Biology*, *18:* 733–745.
17. Ferenc M., O. Sedla´c˘ek, and R. Fuchs (2014) *Urban Ecosyst, 17:* 625–640.
18. Ford E.D., and H. Ishii (2001) *Oikos synthesizing ecology*, *93:* 153-160.
19. Gatesire T., D. Nsabimana, A. Nyiramana, J.L. Seburanga, and MO. Mirville (2014) *The Scientific World Journal*.
20. Grewal B., B. Harvey, and O. A. Pfister (2002) Photographic Guide to the Birds of India. Timeless books, Perplus Editions (HK) limited. Singapore.
21. Grim N.B., S.H. Faeth, N.E. Gloubiewski, C.L. Redman, J. Wu, X. Bai, and J.M. Briggs (2008) *Science*, *319:* 756-760.
22. Guneralp B. and K.C. Seto (2013) *Environmental research letters*, *8*(1):
23. Harisha M.N., and B.B. Hosetti (2007) *Ecopint- An international journal of ecology, 16:* 21-27.
24. Kadam S. and A.S. Dhar (2017) *International research journal of biological sciences*, *6:* 15-18.
25. Kareiva P., S. Watts, R. McDonald, and T. Boucher (2007) *Science, 316:* 1866-1869.
26. Karl L.E., E.N. Stuart and J.G. Kevin (2009) Ibis International journal of avian science, *151:* 19–39.
27. Kingsley D., and H.H. Golden (1954) *Economic development and cultural change, 3:* 6-26.
28. Lee P. Y., J. Rotenberry (2005) *Journal of biogeography, 32:* 1139-1150.
29. Lepczyk C.A., S.A. La Sorte, F.J. Aronson, M.A. Goddard, I.M. Fors, C.H. Nilon, and P.S. Warren (2017) *Ecology and conservation of birds in urban environments* 13-33.
30. Lepczyk C.A., A.G. Mertig, and J. Liu (2004a) *Environmental Management*; *33:* 110–125.
31. Lepczyk C.A., C.H. Flather, V.C. Radeloff, A.M. Pidgeon, R.B. Hammer, and J. Liu (2008) *Conservation biology*, *22 :* 405-416.
32. Marini M.A., and F.I. Garcia (2005) *Conservation Biology*, *19:* 665-671.
33. Margules C.R., and R.L. Pressey (2000) *Nature*, *405:* 243-253.
34. Mistry J., A. Berardi, and M. Simpson (2008) *Biodiversity and Conservation*, *17:* 2383–2409.
35. Mittermeier R.A., N. Myers, C.G.

Mittermeier, G.P. Robles (1999) Hotspots: Earth's biologically richest and most endangered terrestrial ecoregions, *431 :* 10.

36. Mohan, Rakesh. (2012) Long Term Urban Transport Policy. Centre for Policy Research, Urban Workshop.
37. Morantae-Filho J.C., and D. Faria (2017) Tropical conservation science, *10:* 1-12.
38. Patvarthan A., S. Nalavade, Saharsabuddhe and G. Utkarsh (2000) Urban wildlife from nero's fiddle to noah's arch – A report published by RANWA Pune.
39. Pickett S.T.A., M.L. Cadenasso, J.M. Grove, C.H. Nilon, R.V. Pouyat, W.C. Zipperer, and R. Costanza (2001) *Annual review of ecology and systematic*, *32:* 127-157.
40. Pfister O. (2004) Birds & mammals of Ladakh. Oxford University Press, New Delhi, India.
41. Rajashekara S., and M.G. Venkatesha (2014) *Journal of entomology and zoology studies, 2:* 142-155.
42. Ramesh K., and P. McGowan (2009) *Journal of threatened taxa*, *1:* 106-108.
43. Rude K., and K.C. Pitchford (1984) Endangered species, *1:*(9).
44. Salah O., and E. Idris (2013) *Egyptian academic journal of biological sciences, 5:* 1-10.
45. Sagar H.S., and P.U. Antony (2015) *Zoology for future education and research* 103-110.
46. Sen A., and J. Ghosh (1993) Trends in Rural Employment and Poverty Employment Linkage, ILO-ARTEP Working Paper.
47. Sethy J., D. Samal, S. Sethi, B. Baral, S. Jena, A. Payra, G.N. Das, and BHK. Sahu (2015) *International journal of innovative research in science, engineering and technology, 4:* 300-311.
48. Shwartz A., S. Shirley, and S. Kark (2008) *Landscape And Urban Planning., 84:* 219–229.
49. T. Stevenson and J. Fanshawe, (2002) Field Guide to the Birds of East Africa: Kenya, Tanzania, Uganda, Rwanda, Burundi, T & AD Poyser, London, UK.
50. Tratalos J., R.A. Fuller, P.H. Warren, R.G. Davies, K.J. Gaston (2007) *Landscape and urban planning, 83:* 308-317.
51. Varma S. (2007) *Mapana journal of sciences, 6:* 36-46.
52. Wenny D.G., T.L. Devault, M.D. Johnson, D. Kelly, C.H. Sekercioglu, D.F. Tomback and C.J. Whelan (2011) *The Auk, 128:* 1-14.
53. Wiens J.J. (2001) *Trends in ecology and its evolution, 16:* 517-523.