6. CONCLUSION

From the present study, it is obvious that the Greater Bangalore Metropolitan City region harbours a moderate number of aquatic bird species and more number of terrestrial bird species. The variation in seasonal occurrence and abundance of the aquatic and terrestrial bird species in the study sites of the GBMC region may be due to migration of birds, availability of food and water sources, canopy interactions, suitable habitat factors for perching birds, roosting and nesting sites and human interferences. Several species of waterbird fauna showed positive significance /affinities with the water depth and water coverage, number of islands and tree density around the lake, which were present in the Lalbagh Botanical Garden lake and thus, the number of waterbird species, diversity and richness was the highest in the above lake. In contrary, the waterbird fauna showed negative significance /affinities with the number of weed species and weed coverage, which were common in Medahalli, Thippagondanahalli and Ulsooru lakes and thus, the number of waterbird species, diversity and richness was the lowest in these lakes. Many species of terrestrial bird fauna showed positive significance /affinities with the canopy coverage and tree density, which was present in the Bannerghatta National Park and thus, the number of terrestrial bird species, diversity and richness was the highest in the above habitat. In contrary, the terrestrial bird fauna showed negative significance /affinities with the number of buildings and human population density, which were common feature of Kempegowda Bus Station and Krishnarajendra Market and hence, the number of terrestrial bird species, diversity and richness was the lowest in these landscapes. Despite the fast growth of the city, the habitat fragmentation and destruction has not affected the diversity of birds much. Therefore, the GBMC region is still suitable for aquatic and terrestrial bird species.

A number of species might have already become extinct as the result of habitat destruction during the past several years in India, and about 231 Indian species of birds are listed as endangered in the Red Data Book (http://www.eubios.info/EJ71/EJ71J.htm). Among the recorded aquatic and terrestrial bird species in the GBMC region, Pelecanus philippensis and Mycteria leucocephala are near threatened, Gyps indicus is critically endangered, Neophron percnopterus is endangered and Parus muchalis is vulnerable (BirdLife International 2009). Similarly, two birds i.e. Pavo cristatus and G. indicus are
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under Schedule-I, and *Gallus sonnerati* under Schedule-II of protected animals as per the Indian Wildlife Protection Act 1972 (Anonymous 2002). The birds are the best known indicators among vertebrate groups and unless effective conservation measures are taken, many species may disappear. Smaller animals and birds, and even vegetation constitute urban wildlife. In fact, these are indicators of the health of the urban ecosystem.

Barn Owl (*Tyto alba*), Baya (*Ploceus philippinus*), Bulbul (*Pycnonotus* spp.), House Sparrow (*Passer domesticus*), Munia (*Lonchura* spp.), and Parakeets (*Psittacula* spp.) are mainly used in the illegal trade in the GBMC region. The numerous bird seizures of the above said species were also reported in local newspapers from different parts of the GBMC region during the study period. Biologists, naturalists, ornithologists and many other scientists recognized that instead of giving stress on “Charismatic mega fauna”, there is a need to look into a more representative range of bird species, some of which have been dangerously threatened by pet trade in recent years.

To conserve aquatic birds in the GBMC region, urban lakes should be rejuvenated with two to three islands planted with suitable vegetation. Plants and trees should be maintained around the lakes for roosting and nesting. The lakes, where there are no bunds are to be formed with tree planting. The programme for formation of tree parks and regional parks should be initiated. It is recommended that Government should allocate sufficient finances to the Forest Department for implementing the programme (Gowda and Sridhara 2006). Among the 15 study lakes only Jakkuru lake is under rejuvenation process, and Hebbala lake is maintained by East India Hotels (The Oberoi group under the Public-Private-Partnership policy). The privatization of Hebbala lake has been pointed out as a threat to the bio-diversity of the lakes, particularly the birdlife as the company plans to introduce recreational activities on the shore apart from draining and drying of the lake for various operations. Kengeri lake maintained by Karnataka State Forest Department, Lalbagh Botanical Garden and Ulsooru lakes are maintained by Bangalore Lake Development Authority, Hesaraghatta and Thippagondanahalli lakes maintained by Bangalore Water Supply and Sewage Board. Whereas remaining eight lakes are not maintained properly by any authority. Operation of local fishing boats should not be permitted in the lake which is less than 50 ha (Lake 2008; 2010). In larger lakes the number of such boats should be limited to carrying capacity of the water body. Boating
activities should be avoided during avian breeding season in winter, because of arrival of migratory birds (Lake 2008; 2010). Small sized gill nets should not be allowed to catch small fishes, which are main source of food for waterbirds (Sivaperuman and Jayson 2000). Bharucha and Gogte (1990) advised the aquatic management such as desilting, eradication of excessive weeds, fishing, sewage management, protection of waterbird nest colonies, and habitat improvement. These recommendations shall be implemented to improve the quality of lakes that helps to conserve waterbird populations in the urban lakes.

By providing a variety of food sources, suitable habitat with specific vegetation for nesting/roosting in and around the lakes and landscapes, it is possible to increase local population of birds. Establishment of parks and gardens helps maximize bird diversity and abundance in urban and suburban areas. By careful selection of specific vegetation for food sources, nesting and roosting, and restoration of habitats, a diverse assemblage of birds could be sustained even in the city surroundings. As water depth and trophic structure are the important habitat characteristics that influence the abundance and diversity of aquatic birds in lakes, the proper and regular maintenance of lakes would further increase the aquatic bird population.

High anthropogenic activities should be avoided at isolated landscapes of the GBMC region. The threatened species should be monitored regularly as reported by Balakrishnan and Thomas (2004). An establishment of indigenous plants and trees in an urban area can also facilitate increased bird diversity and abundance as reported earlier (Subramanya and Radhamani 1993; Palita et al. 2011). If the number of indigenous plants and trees are increased, then surely the “Wealth of flying jewels - birds” will be back in various lakes and landscapes of the GBMC region. Also, the potential of nesting, fruiting, and roosting plants and trees should be planted in more numbers. Periodic survey to evaluate the status of birds, demography, and its breeding relationship has to be taken up for conservation of birds. The control of fires, grazing and planting the plants and trees in the urban landscapes with greenery may be the best step to enhance or maintain the diversity of bird fauna. Awareness levels of the public should be raised regarding the importance of lakes and surrounding areas for migratory and resident avifauna. Non-governmental organizations and the forest department need to conduct public awareness programme regarding the importance of biodiversity in general and avian fauna in
particular. The students should be the focus of such campaigns. In general, the present study provides basic information on which appropriate management strategies could be evolved for conservation of birds of the major lakes and landscapes in the GBMC region.

The various types of birds and their population will increase in direct proportion to that of increase in the number of plants and trees of urban environments. Birds such as Babblers, Barbets, Cuckoos, Doves, Flowerpeckers, Flycatchers, Kingfishers, Parrots, Partridges, Pheasants, Sunbirds, Starlings, Swallows, Tits and Wagtails, etc., are colorful and their presence among the leaves are a delight to the weary citizens. Cities need more gardens, parks and green spaces for maintaining the aesthetic value of both birds and human beings. A city having diverse type of vegetation would naturally enhance the quality of life of the metropolitans. Even today GBMC region is also known as the Garden City of India because of its many beautiful parks, lakes, gardens and natural vegetations; and is famous for its beautiful streets lined with large canopied flowering trees.

The data of the present work will supply the much needed information for the understanding of birds and their ecological problems in many of the fast growing Indian cities. The results of this study hopes to form a basis for other workers to investigate in more detail the local avian fauna for regional biodiversity assessments especially in urban habitats. The information could be useful to local authorities concerned with the planning and implementation of biodiversity conservation measures in an urban ecosystem. Further, based on the investigations and earlier published information, the following areas such as biology, behaviour, migration, suitable habitat with specific vegetations for nesting/roosting in and around the lakes and landscapes, and influence of microclimate with relation to habitat factors and anthropogenic disturbances should be investigated for better conservation of avian fauna in the GBMC region.

An inventory and census of birds and plants/trees has to be maintained and has to be periodically updated for further activities such as planning of planting of seedlings, location of planting sites, management needs of the existing trees, their protection, and even for removal of diseased, dead and hazardous trees in the cities. It also gives the current status of both floral and avifaunal wealth. Further, it also provides us knowledge of both the present population of birds and the scope for further planning to increase the green cover wherever possible.