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Simulation of Natural Habitat Supports Avian Existence in Urban Mysuru: Case Study of Institutionalized Water Bodies and Forests

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Abstract: Institutionalized water bodies and forest patches in the urban landscape of Mysuru city have been studied to analyse these habitats in supporting the birds' life. The major role of habitat provisioning for birds through simulation of standard natural habitat of Ranganathittu Bird sanctuary has provided an optimal condition for many species of birds to nest, roost and to feed. Large number of wetland birds and dryland birds are supported by these simulated habitats. The forests developed and protected in these habitat mainly composed of native plants, fruit trees like *Ficus* sp., natural fruit yielding shrubs. Also including some exotic plants and alien species to native habitat are also grown but these trees are not preferred by birds. Constructed islets with native plant having graded canopy is the major optimal habitat for wetland birds. The role of such habitat simulation discussed in this study.

Keywords: Institutional water bodies, Forests. Urban landscape. Habitat simulation, Graded canopy, Native plants, Ecosystem services, Avian conservation

Introduction

The impact of human activities on ecological functions and unprecedented increase in human population as well as the increased rate of consumption have resulted in the destruction of natural habitats of many animals (Zakaria and Nordin, 1998). The extension of agriculture, industry, commercial fishing, addition and removal of new species, addition of genetically modified species have removed characteristic populations in the ecosystem and have altered ecological

functions (Sala *et al.*, 2000; Wilson, 2002; MEA, 2005; IPCC, 2007). Assessing the species responsive changes to the environmental changes requires conservative planning, prioritization and making the biodiversity to adapt to the changes is need of the situation. Such things are important for conservation biologists (Caugley and Gunn, 1996; IUCN, 2004, Lavergue *et al.*, 2005). It has been estimated that the rate of extinction is between 1,000 to 10,000 times higher than

the natural process (IUCN, 2004). Habitat loss affects the taxonomical and spatial dimensions of species (Balmford and Long, 1995). Some groups like amphibians and fresh water fishes are more vulnerable than others such as birds and mammals (McKinney 1997; Owens and Bennet, 2000). But majority of the water birds suffer that prefer to feed on amphibians and fishes.

Avian species abundance and composition change in response to changes in the vegetation structure and habitat (Arellano-Valle *et al.*, 2005) because the vegetation influences microhabitat, diet and body size. The heterogeneous habitats will have greater avian diversity and species richness. The composition of diverse assemblages differ in different habitats (Loss *et al.*, 2009; Evans *et al.*, 2011). Understanding the diversity and structure of bird communities is essential to delineate the importance of regional or local landscapes for avian conservation (Kattan and Franco, 2004). Identifying bird population in different habitats is essential to know the community structure and niche relationships. Ecological role of these water bodies as optimal habitats for survival and maintaining avian diversities is significant. Three lakes within the urban limits have been taken care by different agencies and have been drastically metamorphosed into a system of bio-conservations and ecosystem services. Institutionalization of forests and water bodies has helped to modify the water bodies and adjacent forest land to simulate a natural standard habitat that provisioned optimality for many species of wetland and dryland birds in this urban landscape. Three lakes and two institutional forests have been taken care by three institutions namely University of Mysore, Karnataka Zoo Authority, Governance

of CFTRI and supported by Forest Department of Karnataka in one case, are supporting hundreds of bird species to live and reproduce.

Materials and Methods

The field study has been carried out at selected places of Mysuru from September, 2017 till mid May, 2018 fortnightly visits. Avian diversity study in selected urban areas was done choosing key areas of bird abundance. Man made and institutionalized lakes in Mysuru are selected include Karanji lake, Kukkarahalli lake and Lingambuddhi lake. For study of passerine birds, the dry land and forest area or cultivated plant area around lakes were selected. Exclusive passerine bird studies were done in institutional forests of Manasagangothri and CFTRI. For natural water body landscape, Ranganthittu bird sanctuary selected as a standard point. Different species of birds existed in relation to each of these habitats were recorded and a checklist of birds prepared. Natural habitat simulations in each of the institutional water bodies and forests were photo recorded using Nikon D7000 DSLR camera.

Results

Ranganthittu Bird Sanctuary (RBS) as a model natural habitat of wetland birds

Ranganthittu is a natural habitat (Fig. 1) situated at a distance of 16 kms from the city of Mysuru and it is in Srinrangapattana taluk of Mandya district. This sanctuary is formed of seven small islets in the river Cauvery and this locality is the main breeding ground for various varieties of migratory and resident birds. These islets are surrounded by water round the year because of a weir constructed

across the river centuries ago but there is continuous inflow of water in the river in all seasons. The seven islets are familiarly known by the dominant or marker tree like Indian willow island (0.5 acre), Kaduhunase island (0.5 acre), Ranganthittu island (80 acres), Banyan tree island (0.6 acres), Black stone island (rock of 25 mt wide), Raintree island, Terminalia tree island (0.25 acre) and Cliff swallow island (about 6 mt long cliff). All these islets accommodate different species of birds. In addition to this, the river bank hallow form the habitat for living and reproduction of birds like kingfishers, whereas the hallow of the old trees are excellent habitat for birds like coppersmith, hoopoe, parrots, owlets etc. Each type of habitat accommodates characteristically different varieties of avian fauna.

The sanctuary lies between 12° 22' and 12° 25' N latitudes and 76° 39' and 76° 49' E longitudes. The Ranganthittu bird sanctuary is about 0.67 sq kms. Above the bank of the river small constructions have come up to encourage tourism. The river margin is formed of soft and loamy soil. The terrain is flat and in case of floods in Kaveri, the island bank is susceptible to soil erosion. The average temperature in the year ranges from 15 C to 30 C, thus the climate is moderate.

Ranganthittu bird sanctuary has two types of vegetation-- thorny scrubby jungle in the central part of the main island and broad leaved deciduous forest in the margin of the island and islets comprising of 400 species of non-flowering plants, majorly ferns.

In addition, there are many other species of animals like otters, crocodiles, large varieties of fishes which are also found in this sanctuary. This sanctuary has been noted as a

tourist hot spot where recreation and learning are co-ordinated. This centre formed a best educative centre of eco-habitat study of aves. More than two lakh people visit this sanctuary in an year as tourists, as researchers and wild photographers.

Kukkarahalli Lake

Kukkarahalli lake (Fig. 2) is situated at the central location of Mysuru city. This lake has a water spread area of 55 hectares with the maximum flood level of 755.73 metres and has catchment area of 414 hectares, foreshore area of 55 hectares with lake water capacity of 7533.3 ML. This lake area has different ecological habitats to accommodate different bird species (Table 1). It has forest area of about 30 hectares attached to the water body in the north and north-eastern part of the lake. A part of the water spread is converted into a marshy land of 10 acres in the north-west part of the lake. The south-west of the lake is lined with scrubbing forest land and extreme south-west of the lake has farm land maintained by University of Mysore, Manasagangothri campus. Manasagangothri campus is demarcated from this lake by roads and several other constructions.

The main component of wetland avian diversity support is five man-made islets amidst the water body towards the northern end of the lake. The trees grown there have wide canopy with graded growth. This type of graded natural arrangement has made it easier for birds to prefer the height of their choice of the tree canopy to build nests.

The dryland forest area is separated from the water bodies by construction of roads. These roads have made provision for regular walking space for citizens. Many people visit

Table 1. List of birds

CFTRI	Kukkarahalli Lake and Manasagangotri Campus	Karanaji Lake	Lingamubdhi Lake
Ashy Prinia	Asian Openbill	Asian Openbill	Ashy drongo
Asian Koel	Black Drongo	Black headed ibis	Ashy Prinia
Asian Paradise-flycatcher	Black headed ibis	Black-crowned night heron	Asian Koel
Black headed ibis	Blue-rock Pigeon	Brahminy Kite	Bar headed goose
Blue-rock Pigeon	Brown-headed Barbet	Cattle egret	Black Drongo
Brahminy Kite	Cattle egret	Common coot	Black-headed munia
Cattle egret	Common coot	Common Moorhen	Blue-rock Pigeon
Common Hoopoe	Common Cuckoo	Common Myna	Brahminy Kite
Common Myna	Common Hoopoe	Eurasian spoonbill	Cattle egret
Common Tailorbird	Common Moorhen	Glossy ibis	Common coot
Coppersmith Barbet	Common Myna	Great cormorant	Common Moorhen
Fantail	Common quail	Grey heron	Common Sandpiper
Flame-backed Woodpecker	Common Sandpiper	House crow	Great cormorant
Glossy ibis	Flame-backed Woodpecker	Indian Pond Heron	Greater Coucal
Graceful Prinia	Great cormorant	Jungle crow	Green Bee-eater
Great Tit	Great Tit	Jungle Myna	Grey heron
Greater Coucal	Green Bee-eater	Large egret	House crow
Green Bee-eater	House crow	Little Cormorant	House Sparrow
Grey Francolin	House Sparrow	Little Egret	Indian Grey Hornbill
House crow	Indian Grey Hornbill	Northern shoveler	Indian Pond Heron
House Sparrow	Indian Pond Heron	Oriental Darter	Indian Roller
House Swift	Jungle crow	Painted stork	Indian Silverbill
Indian Grey Hornbill	Jungle Myna	Purple heron	Jungle crow
Indian Peafowl	Little Cormorant	Purple Swamphen	Large egret
Indian Pond Heron	Little Egret	Red Wattled Lapwing	Little Cormorant
Indian Robin	Mourning dove	Small-blue kingfisher	Little Egret
Indian Roller	Oriental Darter	Spot billed-duck	Mourning dove
Indian Silver bill	Painted stork	Spot-billed pelican	Northern shoveler
Indian Spotted Eagle	Pheasant tailed jacana	White-throated Kingfisher	Painted stork
Jungle Babbler	Purple sunbird		Purple heron
Jungle crow	Purple Swamphen		Red-vented Bulbul
Jungle Myna	Red Wattled Lapwing		Red-whiskered Bulbul
Large Grey Babbler	River tern		Rose-ringed Parakeet
Little Cormorant	Rose-ringed Parakeet		Small-blue kingfisher
Oriental Magpie Robin	Sparrow hawk		Sparrow hawk
Paddy Field Pipit	Spot billed-duck		Spot billed-duck
Pied Bushchat	Spot-billed pelican		Spot-billed pelican
Plain Flowerpecker	Spotted Dove		White-throated Kingfisher
Purple-rumped Sunbird	White-cheeked Barbet		
Red Wattled Lapwing	White-throated Kingfisher		
Red-rumped Swallow			
Red-vented Bulbul			
Red-whiskered Bulbul			
Rose-ringed Parakeet			
Shikra			
Spotted Dove			
White Browed Wagtail			
White-cheeked Barbet			
Yellow-Throated Bulbul			



Fig. 1. Natural habitat: Islets of Ranganthittu



Fig. 2. Simulated habitat: Islets at Karanji Lake



Fig. 3. Simulated habitat: Islets at Kukkarahalli Lake

this tank to watch birds, to study ecological diversity and to get recreation. This is favourite place of bird watchers and wild life photographers. Also the area has been used as ecological laboratory by Mysore University students.

Karanji Lake

Karanji lake (Fig. 3) is one of the pristine lakes existing in the heart of Mysuru city. This lake was constructed by Maharajas of Mysuru to provide drinking water to Zoo animals in the Zoo maintained by the Royal Governance earlier, later shifted to zoo authorities who are looking after the zoological gardens at present. The total area of Karanji lake is 36.4 hectares. The forest area measure is about 14 hectares. This lake has a marshy area of about 0.0675 sq kms and dry area of 0.280 sq. kms and has catchment area of 745 hectares. The geographical location of this lake is 12° 18' N latitude and 76° 40' 30" E longitude. The lake water capacity is 629.2 ML and highest flood level is 744.14 m. The lake is surrounded by tall trees with wide canopy and on the edge huge bamboo bushes can be seen along with the trees. The lake at its forefront is surrounded by Nature Park, a butterfly park and a walk through bird cage supposed to be the largest in India.

This lake after its rejuvenation and debris clearance holds good quality water that has become heaven for migratory birds as well as residential wetland birds (Table 1). The spread of water can be divided into three zones-- open water, marsh and weed covered shallow region and lotus plant covered region. In clear water region five small man-made islets exist, but these islets are larger than those found in Kukkarahally lake. In these islets a few types of trees are *Ficus* sp.,

Tamarind sp., *Acacia* sp., Rain tree and other species. A few bird species live in and reproduce in these islets.

On the offshore wood area many species of passerine birds exist. Large birds like peacocks exist here. This wood space also provides habitats like pouches in the dead wood for the burrow living birds like parrots and hoopoes. Many varieties of insects could be seen all around this lake. Zoological Authority of Mysuru introduced small fishes into this lake once or twice a year to provide food supplement for aquatic birds.

Additionally this lake is site of rendering many ecological services. The authorities have made this a major tourist attraction by introducing boating, provided education services through Butterfly Park and aviary but the entry is restricted and has to be obtained through paying charges.

In Karanji lake, a new habitat is established by painted storks in two islets. The new avian corridor establishment has taken place very late this year. The birds began to build the nest in the month of March and went upto the end of April. The nesting material is collected from the dried bed of the same lake. Earlier these birds did not build nests in this lake area but regularly visited for feeding.

Lingambuddhi Lake

This man-made lake was built by Krishnaraja Wodeyar III in memory of his wife Lingajammanni. The main purpose was to provide water for the irrigation as the urbanization extended beyond this limit. The purpose is now non-existent and replaced by a different format. The lake is spread over 52 hectares, having 1507.7 ML lake capacity to hold water, has a water catchment area of 2,189 hectares. The highest flood level of this

lake is 727.09 m. Now this lake is preserved and developed by Department of minor irrigation as well as Zoo authority of Karnataka.

Six islands are formed within the lake provide shelter for wide variety of aquatic birds. Mainly Cormorants of all the three types, ibs and egrets build nests here. Other wetland birds do not build nest but visit the lake for feeding hence this lake acts as a food resource for such birds while many types of passerine birds are residing in this place. The environs here encourage passerine birds nesting and reproductions.

On the open area of northern side of water body, the herbal park has been developed that includes small and large bushes, herbs, large trees that encourage the avian life in this water body. Marsh in reality is non-existing but as the water level recedes, small patches of water ridges convert into temporary marshy area that supports many type of water birds, often very small atoll like land patches are formed with the depletion in the water level.

CFTRI (Central Food Technological Research Institute)

The whole campus of this institute and its small reserve forest, maintained plantations, gardens and lawns since 1948, when the Royal mansion Chaluvamba palace along with 150 acres of land handed over to the Central Government to start Food Technology and Research Institute. The geographical location of latitude and longitude of third area is in line with the Kukkarahally lake as well as Manasagangothri campus. The campus encompasses many varieties of trees, herbs, shrubs, grasses, birds, mammals, many types of insects and other invertebrates. About five

species of old trees have been preserved as heritage trees that include species like *Albizia*, *Caesalpinia* and *Ficus*. There are about 1,500 tall green trees maintained in the campus. There are many varieties of herbs, medicinal plants grown along with these trees. The north-west part of the campus has a naturally grown forest. The forest has many types of trees of tall and medium height, large number of bushes, a few thorny plants. Uniquely about six toddy palms are grown. The forest has a small water hole. Many fallen decaying trees found scattered on the floor of the forest. The canopy is tall and acts as a resting/roosting site for different types of birds. On the southeast range of the institute a few acres of fruit garden is maintained. This garden provides food for many birds as well as accommodates a large number of insects. About 25 species of grasshoppers have been reported from this campus. Many varieties of ants and beetles are present in this campus. Unique though not extraordinary Brahminy kite build nest in this forest edges that reflect habitat compatibility.

Manasagangothri

Campus Manasagangothri extends from Kukkarahalli tank located at its East. The western boundary is limited by the two educational institutes. In the north-east and south-east region of the campus there are wide patches of maintained and naturally grown forests. The campus is rich in its flora and fauna, comprised of many fruit yielding trees and old trees supporting burrow living birds.

Discussion

Ranganthittu bird sanctuary as a standard model for simulation of natural habitat of birds

Ranganathittu bird sanctuary is one of the large heronaries found around Mysuru. The heronary is located amidst the river Kaveri surrounded by backwater of the weir. This heronary consists of seven small islets, rich in vegetation, soil fertility and not easily accessible. The seven islets have been named as Neeranji island (Indian willow island), Rain Tree island, Terminalia island, Kaduhunase island, Black rock island, Ranganatittu island and Cliff swallow island or administrative and management purpose. The width of these islets range between 25 sq mts for Black stone island to 80 acres of Ranganathittu main islet. All remaining islets are within the range of 1 to 2 acres. On these islets more than 19 types of trees with wide canopy and graded canopy are present. The thick extended branches, tistles of these trees help the birds build their nests. About 20 varieties of wetland birds were found nesting on these islets. Whereas at major islet of 80 acres the situation is different. This has large tall trees at margins and scrubby vegetation simulating desert like condition at its centre. Just away from the margins marshy localities are found. Tall canopy of these islets is found which are not suitable for bird nesting though it had wide branches. Hence, medium height of trees is majorly preferred by birds, even in this the graded occupancy of tree habitat is seen.

The major concerns in simulation of this Ranganathittu bird sanctuary model are—(i) the islets constructed in the middle of the water body should be of small size not exceeding one acre (ii) the plantation of trees preferable should be of medium height canopy but not tall (iii) the canopy should have wide stretched branches with tistles but should not be of drooping type (iv) perennial water coverage should be of concern and (v) the

trees in the constructed islets should not be accessed by the land dwelling predators.

Under natural conditions of this habitat type, Ranganathittu bird sanctuary is successful in nurturing avian diversity since centuries. Hence, this plan has been simulated in institutionalised urban lakes of Mysuru.

Simulated landscape in the institutional lakes and forest area of Mysuru

Three existing lakes and surrounding forest patches of Kukkarahally lake, Karanji lake, Lingambuddhi lake, one institutional forest at CFTRI, natural and maintained forest patches at Manasagangothri adjacent to Kukkarahally lake, cultivated forest at Lingambuddhi lake and managed tree groves at Karanji are all basically simulation of natural condition to attract wetland as well as passerine birds. Four institutes are looking after these areas are -- University of Mysuru, Zoo Authority of Karnataka, Governance of CFTRI with the support of Karnataka Forest Department. Similar institutional forest system existed in India in many forms to conserve nature and to support the existence of life forms (Kumar, 2008; Tiwari *et al.*, 2013). Sustainable development and biodiversity conservation go hand in hand in agro-forestry too (Krithi *et al.*, 2016). The institutional lakes and forests in Mysuru promotes both sustainability and conservation. In addition, these are emerging as centres of learning, recreation and scientific research. Above all, these act as lung spaces for human population. Fish farming and harvest are also regularly practised in one of the three institutional water bodies.

Institutional lakes and forests at Mysuru stand as models for avian conservation and to the major extent supports human interaction

with nature without affecting the existence of biota around.

Kukkarahally lake at present is under the supervision of University of Mysuru and has been drastically modified from its earlier state. The five islets constructed simulating the natural habitat plan at Ranganthittu Bird Sanctuary. Native trees were profusely grown to attract birds. About 12 species of wide branching trees with graded canopy are grown. The islets are surrounded by perennial water bound. Nearer to these islets marshy area is also formed with receding water. The forest on the northern, north-eastern, north-western to these islets are composed of abundant local and alien plant species that provide food to many species of birds. The open water depth ranges from 5-15 ft and provide ample food in the form of fishes for aquatic birds.

The other two lakes Karanji lake and Lingambuddhi lakes too have been designed to attract birds by constructing artificial islets in the 1/3 proximity of the water body simulating the natural conditions at Ranganthittu Bird Sanctuary. Karanji lake modified from the pre-existing state in the year 2003 and has been maintained as a perennial water reservoir. Three of the five artificial islets have trees suitable for wetland bird nesting but other two islets are dominated by subabul plants those are not ideal for nest building by wetland birds, but a few small passerine birds create nest there. These islets just away from the periphery of each, include marshy condition that supports more than six types of marsh dependent birds. The surrounding plantations with broad leave trees harbour many varieties of passerine birds as revealed by this study. Even the environs have supported whole nest living

birds like parakeets and owls. This tree coverage nurtures large land living birds like peacocks and partridges.

Whereas at Lingambuddhi lake scenario is different. Five islets have been constructed, large plants are grown there but at present only Cormorants, Ibis and Egrets build the nests. This lake is not yet converted as a perennial water body. This lake at present serves as feeding ground for many wetland birds. The Karnataka forest Department looking after this lake has planted large number of bushy plants along with tall trees that has supported existence of passerine bird species.

All the three lakes serve many ecological services such as lung space, bird watching, ecological studies and research. Above all these are optimal models of avian conservation in urban area.

New corridors for painted storks

Till February 2018, the painted storks were not nesting at Karanji lake. In the mid-February of this year, which was too late period of nesting, the painted storks arrived to nest about 50 pairs and painted storks have constructed nest in between 15 February to 10 March 2018. Prior to this painted stork visited this lake for feeding. The nests were there at Kukkarahally lake although it was not a nesting place for painted storks till 1992. Establishment of new corridors is indicative of congenial environment for painted storks in the urban landscape of Mysuru.

As far the Pelicans are concerned the colonies were established at RBS only after the year 2006 (Anitha, 2010). Before that there were no pelicans at RBS (Kannan and Mankandan, 2005). This new corridor

establishment by large wetland birds indicates strong message that urban landscape of Mysuru is fit for avian life and biodiversity conservation. In addition to these, we have recorded existence of more species near the avian habitats at RBS, CFTRI, Kukkarahally lake and Karanji lake.

Conclusion

Natural habitat simulation has provided optimal conditions for birds to live and reproduce in Urban Landscape. Perennial water bodies and a forest coverage composed of native plants is more encouraging existence of the birds because these two criteria serve not only as nesting habitat but also as food reservoir. Conservation plans of following such optimal simulations seem to be more helpful in maintaining the avian diversity. Institutionalized water bodies and forests are helpful in conservation of habitat and avifauna.

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