CHARACTERISTICS OF URBAN SETTLEMENTS IMPACTING MIGRATORY BIRD SPECIES IN INDIA

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1. Introduction

On a broad level, India can be divided into six types of climate.(Figure 1) (Padmanabhamurthy, 1990) This in conjunction with the country being situated in three of the major global flyways, makes conservation of avian species highly essential. The different climates lead to rich diverse biomes where the migratory birds stop, nest, breed and progess on to their destinations. The grasslands and wetlands throughout the country make effective pitstops for landbirds and water birds alike. With massive urbanisation taking over, these ecological spaces are constantly encroached, leading to a decline in the native and migratory avian species. While there are different initiatives taken by the Indian Government such as the National Action Plan and the Perspective Plan on bird conservation, these are tentative guidelines with no legal binding on urban development. In reality, the National urban planning code (Urban and Regional Development Planning Framework of India) and the urban bye laws are devoid of biodiversity clauses. Optional frameworks such as the Indian Green Building Council guidelines mention incentivisation for preserving nocturnal habitats and native vegetation. The absence of such guidelines in the Urban development norms make native vegetation an easy prey to development and loss of habitat for birds.

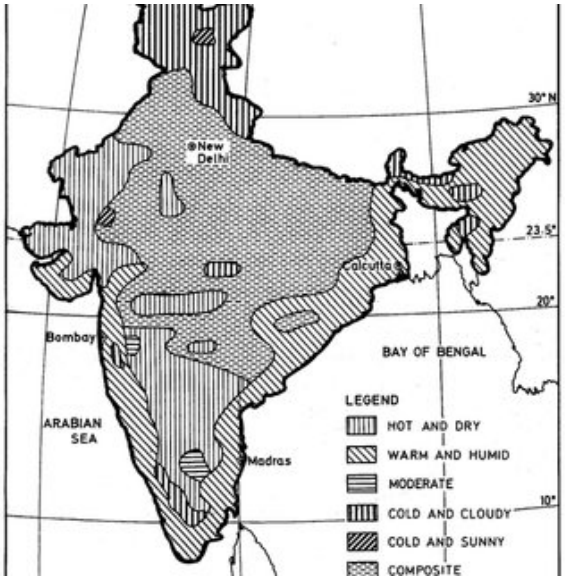

Figure 5 Climate Map of India (Padmanabhamurthy, 1990)

1.1. The Global Flyways

India falls within three of the nine global flyways- Central Asian Flyway (CAF), East Asian Australasian Flyway (EAAF) and Asian East African Flyway (AEAF). (Figure 2) (Pardikar, 2020) Out of approximately 1230 species of avifauna in India, the CAF is a stopover for approximately 370 species of migratory birds on the way to their destination, which is a combination of both landbirds using terrestrial environments such as bar-tailed godwicks and waterbirds dependant on wetlands, such as northern shovelers. (Forests, 2005) Through the flyways, the birds find the necessary nutrition and settlement in warmer countries like India until further movement towards the equator.

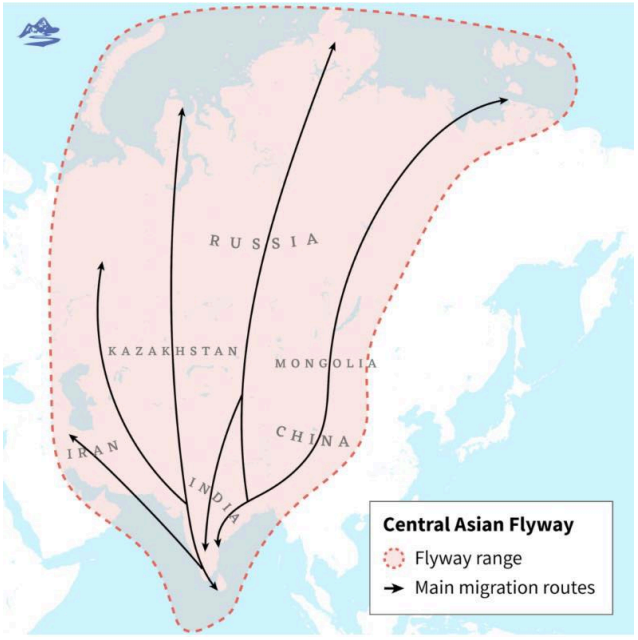

Figure 6 Central Asian Flyway (Pardikar, 2020)

Migrator Avian Species in India

1.1.1. Introduction

Due to different terrain and climate throughout the country, India has both grassland and wetland environments which support the nesting, roosting and feeding habits of migratory birds. If broken into biomes, central India consists of the grasslands for the landbirds, while notable wetlands in the north western region (Rajasthan, Haryana), eastern region (Bengal, Odisha) and the Southern region (Tamil Nadu) attract the waterbirds. In the urban scenario, landcover can be further broken into grassland, wetland, agricultural land and human habitation. (Figure 3) The distribution of avifauna, according to habitat in urban settlements is as given in Figure 4. (Forests, 2005; Panda, et al., 2020)

Figure 7 Land cover distribution in India (Forests, 2005)

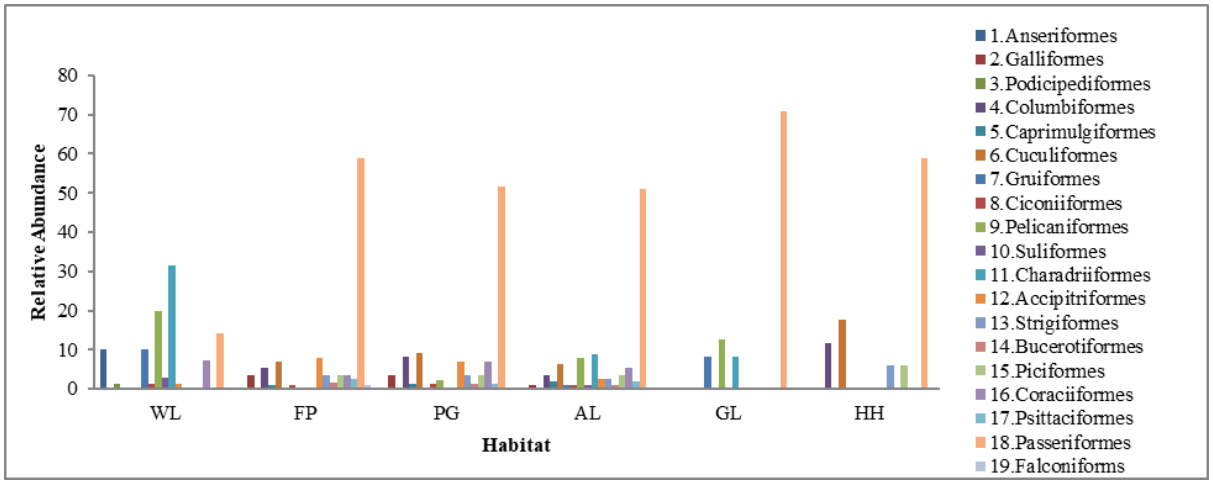

Figure 8 Relative abundances of bird species belong to different Orders across various urban habitats in Bhubaneswar, Odisha, India: Grassland (GL), Wetland (WL), Forest Patches (FP), Park and Garden (PG), Agricultural Land (AL), Human Habitation (HH) (Panda, et al., 2020)

1.2. Adaptation of local birds to human settlements

Of all local and migratory birds, the taxa most observed in urban settlements are passers viz. sparrows and rock pigeons and raptors viz. crows and hawks. The reasons for the proliferation of these species over others is abundance of food and adaptability of nesting habits to human settlement fabric. In the case of sparrows, availability of grain due to homes and shops is high in cities. Similarly, for raptors, the garbage dumps, landfills, rodents and traditional burial systems such as the Parsi cemetery provide a constant supply of food in cities. (Isaksson, 2018) Interestingly, while the number of Corvus species and hawks have been observed to increase while selective carrion eaters like vultures are on a steady decline. This may be attributed to nesting habits and human conflict as well. Vultures prefer nesting at higher altitudes, which is a challenge in urban settlements in India, known predominantly for mid-rise and low-rise settlements. The flat roofs of India are not preferable to the birds for nesting. Moreover, traditionally, vultures are perceived as ominous and unclean, leading to humans shunning them. The downside of discouraging vultures was

noticed when the number of stray dogs increased with the decline of vultures, leading to an outbreak of rabies throughout the country. Birds such as owls prefer nesting in holes, mainly trees. With the incessant felling of trees in Indian cities, owl numbers are dwindling. The mythological element is contradictory, as some cultures see the owl as holy while the others perceive them to be ominous. (Aggarwal, 2020)

Some species of birds have become comfortable in human habitat, such as rock pigeons. With high rise building societies proliferating the settlements, the plumbing shafts and decorative waterbodies are enticing the cavity nesting birds to roost and breed. (Reynolds, et al., 2019) This is leading to an opposite human-bird conflict as rock pigeons, through their feathers and droppings, are the cause of many respiratory diseases in humans. This leads to humans discouraging proximity to the birds.

2. Research Questions

While a variety of local birds have adapted to towns and cities, there is a necessity to assimilate migratory birds into the human settlement as well. In order to achieve this, modification and improvement is required in urban planning norms of the country to preserve pockets of avian habitat with minimal human disturbance, devise alternative ways to enhance nesting and feeding habits of birds and increase awareness among citizens towards avian preservation. Hence, this research begets the two questions:

2.1. In terms of migratory bird habitat, are there equivalent solutions in urban settlements to preserve their nesting, roosting and feeding habits?
2.2. What are the necessary modifications required in urban and design guidelines of India to conserve avifauna habitats?

3. Characteristics of migratory birds in India

Migratory birds, both land and water birds have distinct nesting, roosting and mating habits. Along with sustaining their species, they have an important role in the global ecological balance, from maintaining the insect population during monsoons to propagation of vegetation.

3.1. Habitat and taxonomic characteristics of migratory birds in India

Names	Habitat	Food	Nesting/breeding
Order: Anseriformes Ducks, Geese and swans	- Generally found in ready fresh water marshes, shallow pools, lakes with developing vegetation and submerged tree in plains. - Found in small groups and sometimes large flocks.	- Mainly Vegetarian comprising aquatic plants, arable crop. - In some instances insects, fish and frogs are also consumed.	- Breeding period is from June to October. - In and around vegetation, preferably old tree or naturally hollow trunks.
Order: Galliformes Peafowls (Peacock), Jungle Fowls, Chicken, Turkey	- They are adaptive in almost all environments except for core desert and uninterrupted ice.	- These birds are herbivorous to slightly omnivorous which feeds	- Most Galliformes are very prolific regularly exceeding

	- Very few tend to migrate over considerable distance. Others tend to stay in and around nesting place.	on ground for rootlet or other plant materials. - Young birds tend to consume insects too.	10 eggs in many species. - Galliformes young ones are very precocious and roam with their mother or both parents.
Order: Columbiformes Pigeons and Doves	- The family has adapted to most of the habitable space in the planet. - The species have also adapted to the human activities and resides mostly in the majority of cities.	- Seeds and fruits form the major component of the diet for pigeons and doves. - Ground doves and quail doves also consume a large number of prey items such as insects and worms. - Urban birds depend on human activities to obtain food, causing them to forge for spoiled food or food provided by humans.	- The nesting and breeding is peculiar in the family. The male chooses a site in view of the female. - The nests can be found along building ledges, rafters, beams, under bridges. - The nest is saucer like shape and made of stems and leaves.
Order: Accipitriformes Hawks, Eagles, Kites	-Generally found near water body, perches on trees o rocks overlooking water stream, ponds, lakes or costal sides.	- Hunt and eat large fish, also ducks, mammals and young birds.	-Eagles build their best in a branched crotch towards the top of the tree. - The bird stack and interweave sticks and branches. - Generally one to three eggs are laid during breeding.
Order: Passeriformes Crow, Sparrow, Sunbirds	- Sparrows are generally birds of open habitats, including grasslands, deserts and scrublands. - Crows can also adapt to a number of different environments as well.	-Sparrows are primarily seed eaters but increases their protein intake a lot by eating insects during breeding season. - Crows are scavengers as well as predators and will eat anything they can find.	- Different species of crows have variation in breeding but the nesting habit remains the same. The nest are generally 2ft wide and 60ft above ground. - Sparrow mainly nest in holes and cracks of man-made structure. They use different types of material for building nest.
Order: Phoenicopteriformes Flamingoes	-Highly gregarious, found in small number of groups but thousand in flock. - Prefer lagoons, water lakes, and blackish water lakes.	-Largely drink fresh water with small insects, seed of aquatic plants, larvae, and small malluses.	- Breed in colonies from July to April, nest conical mounds of mud with shallow pan

			like depression at top.

Table 4 Characteristics of migratory birds in India (Forests, 2005)

3.2. Role of migratory birds in the ecological balance

3.2.1. Pollination and seeding

The seasonal migration of birds, or flyways, is closely related to the monsoons in India and the vegetation. Due to the long distances covered by the birds, their droppings are rich in seeds which germinate in the monsoon. Also, the activity of birds during the retreating monsoons and the springtime assists pollination. (Forests, 2005)

3.2.2. Manure

Bird droppings are rich in phosphorus. Identifying this, certain indigenous tribes encourage migratory birds to visit their lands and ponds, in order to enrich the soil and decrease the number of insects which would otherwise damage the crops. (Aggarwal, 2020)

3.2.3. Ecological Balance

Migratory birds are highly essential in maintaining the food chain and ecological balance. In wetlands, it is observed that the waders eat the highest proliferating insects and amphibians, thus curbing their spread. Similarly, the algae and plankton the ducks and geese feed on ensure that the algae do not multiply and block the aeration of the wetlands. (Forests, 2005)

4. Impact of Urbanisation on migratory birds in India

4.1. Encroachment of non-Ramsar wetland habitat

India has approximately 750,000 wetlands, out if which only 49 are Ramsar wetlands. Ramsar wetlands are protected under international policies. The arbitrary guidelines in the case of the other wetlands do not provide protection, leaving the rest of the wetlands open to destruction due to urbanisation. In the case of the Najafgarh and Bisai wetlands near Delhi, urban habitat is gradually encroaching into the wetland. Parts of the land has been drained and structures built on it. Out of the two, Bisai is notified as an Important Bird Area (IBA), which brings it under urban development safeguards. Due to low to no monitoring, industrial and residential sewage is drained into the wetland, polluting the water and the organisms living in it. This in turn is affecting birds, leading to high mortality, weak shelled eggs, low progeny. Both Najafgarh and Bisai are important bioreserves as threatened species include Egyptian vulture, Sarus Crane, Steppe Eagle, Greater Spotted Eagle, Indian Spotted Eagle and Imperial Eagle. White-tailed Lapwings from Russia come to Delhi using CAF, raptors like Steppe Eagles from the steppes in Kyrgyzstan and Kazakhstan visit during winter in Delhi. (Chandramouli, 2022)

4.2. Loss of Native Tree Species

In the course of urban development, both public and private, ornamental vegetation is preferred over native tree species. Thus, the genetic imprint of the birds, which adapts them to nest in specific native vegetation, is disturbed,

discouraging the birds to nest. Moreover, the ornamental vegetation usually consists of shrubbery and palm trees, both of which are unsafe for nesting. These plants and trees lack any edible fruit, impacting the essential nourishment of the birds which enables to fly long distances towards their destination. This had led to many birds perishing on their way. Along with the phyla of the vegetation, the density and canopy of the trees, the thickness of the trunk with holes, which mature deciduous trees have, are important, especially for nesting birds like owls. With rampant cutting of these trees, the loss of habitat is affecting roosting and nesting habits, leading to a steady decline in owl population. (Isaksson, 2018)

4.3. Anthropogenic impact on migratory birds in Urban settlements

Anthropogenic activities, in this case, refers to all human activity which is positively and adversely impacting the habits of migratory birds in India. Four stress factors of urbanization which affect migratory avian species are noise, human proximity, chemical pollution and artificial light at night (ALAN). (Cabrera-Cruz, et al., 2018) While pollution, excessive use of chemical fertilizers and habitat loss are adverse impacts, the phenomenon of global warming is a unique predicament in relation to migratory birds and their nesting habits, which will be explained below.

4.3.1. Pollution

In case of urban settlements in close proximity or enveloping a migratory bird habitat, the lack of public ownership of these locations make them easy targets for dumping garbage, sewage and industrial effluents. These are consumed by the smaller organisms, in turn by the birds, which poison them, affect their metabolism and egg laying abilities. India is the highest consumer of chemical fertilizers and pesticides for agriculture globally. In agricultural land in and around urban settlements, the exorbitant use of pesticides is affecting the birds, similarly, leading to a concerning spike in the mortality of the birds. (Aggarwal, 2020)

4.3.2. Light pollution

Light plays an integral role in flyways. Some birds prefer to fly during the daytime while other birds like lapwings prefer nocturnal environments. Therefore, while the nocturnal birds use the darkness and calls to keep the flock together, other birds use the night to rest. The bright lights of the city disturb both, affecting the migration cycle. The distance travelled by the birds is affected as the lights confuse them, while other birds are stressed and fatigued due to lack of rest during the night. (Cabrera-Cruz, et al., 2018)

4.3.3. Sound pollution

In many studies, it has been observed that birds living in a city are more stressed than birds living in habitats undisturbed by human activity. One important factor for this is sounds in the city. Low decibel sounds like peak hour traffic impacts the mating calls of birds, leading to a reduction in mating activity, in turn, progeny. High decibel sounds disturb birds, leading them to keep flying instead of roosting and nesting. Hence, the small migratory songbirds like wagtails are declining in population, or else, are turning nocturnal when their mating calls will be heard more clearly. (Menon, 2021)

4.3.4. Built environment

In traditional Indian houses, there were vernacular elements which would encourage nesting habits. The low to mid rise houses with high ceilings, roof shingles and lofts provided undisturbed roosting spots for local and migratory birds. Moreover, with traditional practices such as scattering grain in front of the house would ensure food for the birds as well. In present times, the extroverted houses have given way to introverted high rise buildings, with glass facades, flat roofs and introverted doorways. The roosting and nesting spots for birds are gradually disappearing. Moreover, with birds like the rock pigeon being perceived as pests, people put spikes on the exposed architectural elements, leaving no space for birds in the settlements. (Kale, et al., 2012)

4.3.5. Global Warming

Detrimental effects of global warming and desertification are shrinking of wetlands, decreasing vegetation and increasing storms and forest fires. At the same time, rising temperatures globally has led to birds reducing the distance covered during seasonal migration. This in turn, has encouraged birds to adapt to nearer areas, other vegetation and reliance on lesser food and fat conserves. Food preferences of water birds has been observed to change, adapting to food easily available. (Tryjanowski, et al., 2013)

5. Economic Potential of Migratory birds in India

For ages, nature has played an important role in the rituals, beliefs and festivals of India. Every season calls for different festivals in every part of the country. For many festivals, certain birds are said to be the heralds of the season. The monsoon is depicted by the local pheasant and national bird of India, the peacock. In the north eastern state of Nagaland, the Great Indian Hornbill is said to be the harbinger of good tidings. In a festival named after the bird, awareness of other migratory birds of the region, such as the Amur Falcon has been raised.

5.1. Eco Tourism

In states like Nagaland, grand festivals are held in the name of the Great Indian Hornbill, whom the local tribes revere and consciously protect, to increase its dwindling numbers (due to habitat loss and hunting). In other states, urban wetlands and protected sanctuaries bring heavy footfall during the retreating monsoons and springtime by avid birdwatchers.

5.2. Income generation

Indigenous knowledge helps farmers in parts of the country to appreciate migratory birds for their role in the food chain and use it to their advantage. In the case of Garapadu and Uppalapadu lakes in Andhra Pradesh, migratory birds from Siberia and Australia such as the white ibis, painted stork and open billed stork were observed to flock at Garapadu lake initially. This caused a hindrance to local business interests who depended on the lake for commercial fishery, and the birds were poached or driven away by loud sounds. The birds gradually settled in the nearby Uppalapadu wetland area where the citizens welcomed them. Encouraged by the citizens' interest, the local forest department helped create a healthy habitat for the birds, which increased their population, approximately 20,000 birds in peak season. Gradually, this led to eco-tourism in the area for bird watchers and opened up allied employment opportunities – such as lake management, commercial

ventures for tourists etc. The bird droppings collected from the lake could be converted to manure for local agriculture. (Prasad, et al., 2012)

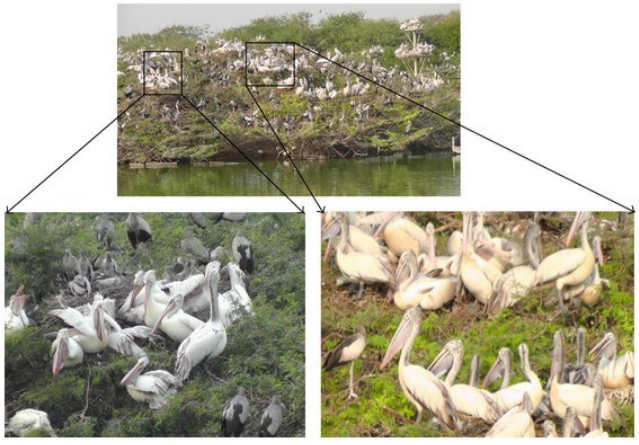

Figure 9 Avian Species at Uppalapadu Lake (Prasad, et al., 2012)

6. Present biodiversity norms in India

Wildlife biodiversity norms in India presently focus on eco sensitive regions demarcated by international agreements such as Ramsar wetlands and national delineations such as Important Bird Areas (IBAs) or wildlife sanctuaries. With historical focus on threatened animals such as the tiger and the elephant, authorities are gradually directing their attention towards the importance of local and migratory birds and their role in maintaining ecosystems. With this, enhancement on migratory avian conservation has been captured in the following initiatives:

- Wetland Protection rules, 2017
- Visionary Perspective Plan (2020-2030) for the conservation of avian diversity, their ecosystems, habitats and landscapes in the country" –Ministry of Environment, Forest and Climate Change
- National Wildlife Action Plan – 2017 to 2031
- India's National Action Plan for Conservation of Migratory Birds and their Habitats along the Central Asian Flyway (2018-2023)

A major concern observed in these initiatives is the lack of notification or identification of bio reserves within urban settlements. The ambiguity raised by this encourages wetland pollution, draining, grassland encroachment and bird poaching. In the case of a black necked stork rescued in Bisai wetland in the NCR urban settlement, it was released back into Sultanpur National Park instead, due to Sultanpur being a documented and protected eco reserve as compared to Bisai. (Pardikar, 2020)

6.1. Overview of national urban planning norms in India

Urban and Regional Development Plans Formulation and Implementation Guidelines 2015 – While the document gives a complete breakdown of city planning, with optimum land use demarcation, amenities and health, there is no clause for urban biodiversity. All environmental and wildlife articles are dealt with in a separate volume Vol.IIA, which identifies bio reserves away from the urban settlement or agglomeration. This leaves the fate of grasslands and wetlands to the course and interpretation of development. While land use is earmarked for parks and green zones, in practice, the parks are first to be eradicated in case of public projects such as road widening, no requirement of preserving native vegetation is mentioned and ornamental low height shrubbery is planted under a beautification interpretation.

6.2. Overview of State level urban planning norms in India

State level planning norms focus on land development, infrastructure allotment and amenities planning. While the plans aim for a high quality of life, there is a myopic understanding as biodiversity is unacknowledged in the documents. In the case of UDCPR 2020, a document enumerating the urban planning and development norms of urban settlements in the state of Maharashtra, there are clear demarcations for land use in order to safeguard the green and agricultural zones from encroachment. But, in the same document, there are multiple caveats which aid people who wish to convert green zones into residential and/or commercial zones.

6.3. Green building norms in India

Since the last decade, sustainability through green buildings are gradually gaining momentum in the country, under organisational ratings such as IGBC, GRIHA and LEED. While certain clauses and incentives are tabulated in order to preserve biodiversity, the lack of a legal binding or enforcement of these guidelines make them optional and often sacrificed in the name of budgetary concerns and unnecessary responsibility with very less financial incentive. For example, in IGBC rating, under the title of site selection, 50 percent of native vegetation is to be preserved in order to win a point. Additionally, downward illuminating LED fixtures are essential for external lighting, in order to decrease ALAN at night, as well as all water bodies are to be preserved on the site to win another point. Another alternative which could be explored is making these points mandatory for rating award, instead of incentivisation.

6.4. Urban avian conservation efforts in India

Active conservation efforts have been taken by birdwatchers and the local authorities in many towns and cities of India. Through awareness campaigns in educational institutions and bird-watching camps, the younger generation is gradually being sensitized regarding local and migratory avifauna species. Through this, a severe lack of information in seasonal bird-watching data and trends is gradually being improved. With developments in technology, tracking birds through bird ringing as well as remote working and collaboration apps have amplified the efforts. These efforts are encouraged by the local forest and development authorities who use the data effectively to gain funds to maintain the bio reserves and increase the seasonal bird population. In the case of the Uppalapadu lake, the residents took up the responsibility of educating themselves and the students in the locality regarding the importance of the migratory bird species - spot-billed pelican, painted stork and night heron. The original lake, Garapadu, which the birds visited was designated as a commercial fishery. As the birds ate the fish and hampered local livelihoods, they were driven away. Through the efforts of the residents, ornithologists and the local forest department, not only was Uppalapadu lake notified as a protected area, but additions such as installation of artificial trees and native vegetation (prosopis julifera) encouraged more birds to flock and breed here. Through this initiative, an increase in the breeding population of the pelican was observed (400 individuals in October 2007 to 1,500 in February 2008), as compared to other wetlands in

the country. The tourism generated by the seasonal birds encouraged local awareness and safeguarding of the habitat. (Prasad, et al., 2012)

Figure 10 Artificial trees at Uppalapadu Lake (Prasad, et al., 2012)

An urban initiative by Yashodhara Foundation, Nagpur focused on the nesting habits of local and migratory passer and warbler species. As these birds are cavity nesters, the organization created artificial nests with provision for food and water. In 2016, the organization distributed and installed 1600 bird houses to interested residents, which encouraged an increase in the bird population that season. (Vijaykumar, 2016)

7. Observations

7.1. Legal interpretation of urban biodiversity

In India, the urban land use types are broadly classified as residential, commercial, transportation, institutional, industrial, amenities, green zones and wasteland. Green zones are interpreted as parks and recreation, instead of forests. To protect wetlands and grasslands which are migratory bird habitats, a specific delineation of the same needs to be inserted into the local planning norms. In order to reduce anthropogenic disturbances like activity, light and sound, native tree cover needs to be planned and planted to encourage the birds to visit. All effluents and pollutants should be diverted away from the reserves and legal action taken against wrongdoers. Terms such as micro-bio-reserves can be proposed to encourage bird watchers and tourist footfall in these areas. Management of these reserves will help generate local employment, cultural pride and a sense of empathy for the birds. Recently, the National Green Tribunal, recognising the importance of birds in our ecosystem, has asked all states to populate the national bird register to record the seasonal trends of avifauna. This will help to identify reserves throughout the country, especially in disputed land in cities, where land is a scarce resource. A similar successful story can be observed in Singapore and Kuala Lumpur where pockets of native vegetation, terrain and water bodies have been preserved. Apart from acting as refuge for migratory birds, these areas provide respite to people from the din of the city. Visitors are made aware

of the birds presence and certain strict rules such as no bright lights, loud noises, speech or parties are enforced. At night, soft indirect artificial lighting is provided.

7.2. Native tree species

In terms of nesting habits, native tree species need to be identified and propagated in close proximity of micro-bio-reserves and along roadways. As observed in the case of heronries, there is a preference for large canopy trees such as rain trees *amanea saman*, copper pod *Peltophorum terocarpum*, banyan tree *Ficus bengalensis*, mango tree *Mangifera indica* and jackfruit *Artocarpus heterophyllus*. These trees are also preferred by smaller raptors as the girth of the trunk has cavities for nests and boughs for nests. The dense canopy acts as light and sound barriers for healthy fledgling growth as well. (Roshnath & Sinu, 2017)

7.3. Avifauna awareness initiatives

In order to identify migratory bird species and their characteristics, record their seasonal behaviour and safeguard their habitat, a level of awareness and empathy is necessary. Collaborations between interested residents, NGOs, local development and forest authorities and law enforcement agencies can help create citizen charters to preserve identified bird habitats locally. Students can be sensitized at school towards bird conservation. Local population can be provided employment in maintaining the micro-bio-reserves. These actions will lead to more migratory bird habitats to be notified as IBAs and become tourism nodes in the city.

7.4. Adaptation of birds to human habitation

Globally, many birds are adapting to human habitation in urban areas. The birds seen in an urban settlement can be broadly divided into generalists and specialists. Through annual trends, generalist species are on the rise while specialist populations are on the decline. For generalists such as the common house sparrow, common crow, parrots and pigeons, the interpretation of human house nooks and cavities as potential nesting zones, abundance of food for omnivorous species and change in mating behaviours has led to an improvement in their numbers. Species like the cuckoo bird and red vented bulbul have shifted their mating call to night-time or dawn when low decibel noises like traffic and high decibel noises like horns and sirens are minimum. Generalists have also been observed to use artificial artefacts for nesting such as lint, cigarette butts and wire. While elements such as plastic rings and cigarette butts are dangerous for birds, due to choking hazards and toxic elements, the adaptability of the birds is encouraging to conservationists to look for or create alternative habitats. (Menon, 2021)For specialists such as herons, vultures and pelicans, reliance on specific trees for nesting and specific fish and habitat has discouraged their roosting behaviour, in turn, their propagation. An interesting phenomenon seen globally is also the impact of global warming. In the case of the Siberian crane, in order to preserve a healthy body temperature, it would need to fly from Siberia, via India, towards the Southern tropics. With rising temperatures, the temperate zones are more favourable for the birds to stop at, leading to lesser dependence on habitat, food and adverse weather, thus increasing their lifespan and progeny.

7.5. Artificial avifauna conservation measures in urban settlements

While generalists are adapting to urban anthropogenic settlements as surrogate habitats, the decline in specialist species is concerning, which requires preservation of their natural habitat and exploration of artificial habitat. In the case of Uppalapadu lake, the construction of artificial trees encouraged the birds to roost and nest there. Similar initiatives have been taken in Nagpur and Bidar, where artificial nests and feeders are placed at regular intervals for birds. (Vijaykumar, 2016)Playing recorded bird sounds close to the feeders reduce the stress in the birds and make them comfortable to eat in human proximity. Additional initiatives in reducing ALAN by using downward illumination at night and planting trees with dense canopies along transportation corridors will bring the light and noise pollution down, encouraging migratory birds to gradually acclimatise to human environments.

7.6. Traditional knowledge

Many tribes in India consider revere local and migratory fauna as guardian deities and holy creatures, therefore protecting them, their habitat and progeny. Similar to the case of the hornbill in Arunachal Pradesh, the Greater Adjutant Stork is a migratory bird which visits Sensowa and Khutikotiya villages in Assam. (Vijaykumar, 2016)As the bird only prefers the silk cotton tree for nesting, rampant deforestation brought its numbers down to 1800. With awareness drives among the tribes, a reminder of the cultural importance of the bird and compensation for their efforts, the tribals consider the bird their identity and protect the trees where they nest. In the case of the hornbill, bird lovers from Pune, a city in West India, created a donation drive to remunerate the people who conserve hornbill habitat, thus giving them a livelihood and encouraging them to reverse deforestation, thereby protecting the hornbill habitat.

8. Framework proposal for avifauna preservation

Document	Present Status	Proposed Amendment
URDPFI	No special provision for bio-reserves within urban settlements	Addition of separate clause for micro-bio-reserves. Identification of reserves to be based on a weighted overlay method with heavy weightage given to migratory bird population, wetland rea, grassland area, number of nests and fledglings. No amenities or services to be allowed within the zone and the feeder system of the wetland to be free of industrial and chemical pollutants.
URDPFI	Buffer area around bioreserves missing	While land is a premium resource in urban settlements, a minimum buffer based on survey data to be proposed around the micro-bio-reserve. The native vegetation species for food and nesting to be within the inner ring of the buffer to limit the bird movement outwards.
Urban Construction Bye Laws	No compulsory clause for vegetation within property boundary	Native vegetation species, preferably fruit-bearing, which will not damage the built structure,

		should be made mandatory at every site. Necessary front setbacks, based on region and vegetation species to be clearly tabulated.
Urban Construction Bye Laws	No mention of external lighting norms	Clause to be inserted that all external illumination to be downward, so as to bring down the ALAN.
Urban Construction Bye Laws	Architectural elements to enhance avian nesting behaviour absent	For every urban settlement, a preliminary study can be carried out with avian experts, traditional wisdom givers and bird lovers to identify architectural elements such as roof shingles or ornamental cavities and water requirements such that human and bird can coexist without conflict. Certain elements can be made mandatory
Green Building norms	Downward lighting norms are an incentive	To be made mandatory. Clause for the same to be inserted in urban planning and local construction guidelines.
	Preserving native vegetation and waterbodies are partially incentivized	To be made mandatory.

Table 5 Framework Proposal for avifauna preservation

9. Conclusion

Urbanisation in India is occurring at a very fast pace. It is estimated that –percent of the country's population will be living in cities. This, coupled with high levels of poverty and general apathy is leading to large tracts of green zones and water bodies being encroached upon by vested parties and squatters. While the National Action Plan and the National Bird Register will aid in observing the trends in migratory bird population, actual conservation requires to be enforced at the local level. Apart from awareness and ornithologist intervention, legal provisions have to be maintained with minimum ambiguity and maximum culpability to establish the necessity of avifauna preservation. Moreover, significant architectural elements could be proposed in the local construction bye laws to weave avifauna habitat within the urban settlement fabric and increase the adaptability of seasonal birds to the urban scenario. The proposed legal framework has been devised to help bridge the gap between provision and implementation of local and national urban planning norms followed in India towards avifauna conservation. A holistic quality of life is achievable when the nature and development are allowed to coexist and avifauna is an integral element to this ecology. Preservation of avifauna should be a matter of identity, pride and above all, respecting nature which sustains all life.

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