

BIODIVERSITY REPORT DODDAKALLASANDRA LAKE



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act:onaid

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FOREWORD

Civilization, marked by urban development, has changed the way city dwellers interact with water. From rivers and water bodies, we moved to wells and canals, and then to pipes and taps, and now we consume water from plastic bottles and powerhungry water purification devices. In the last many decades urban water bodies, including the natural ponds, lakes and rivers and the traditional water structures including wells, stepwells, tanks and human made ponds and lakes have fallen into disuse, become polluted and the land they occupy was seen as waste garbage dump sites and the potential real estate development site. In recent years, the growing concern for urban environment and clean cities, has called for “restoring” urban water bodies. However restoration projects very often focus more on beautification and pay scant attention to the role that water bodies serve as “urban water commons” which include both ecological services and forming the basis of non-consumptive livelihoods.

In Bengaluru, the system of lakes created in the sixteenth century or earlier and maintained by successive rulers supplied the area with drinking water, water for irrigation and as place for fishing. However these lakes have suffered encroachment and pollution, and in many cases “restoration” processes have seen the creation of “soup bowl” lakes, that only contain water, surrounded by manicured lawns and decorative bushes and trees. To a quick glance these may look like a delightful combination of blue and green, but the appearance is deceptive, the reality is sterile. We need lakes to be filled with living waters, full of plants and photosynthetic organisms which create materials storing energy, which are fed on by a range of tiny invertebrates creating and supporting a food chain with fish, birds and other animals. Lakes filled with living waters become a hotspot for biodiversity. Biodiversity and freshwater consumption are amongst the most crucial processes that protect life on Earth. We need to see how lakes can help re-create, protect and sustain biodiversity, and favorably impact freshwater reserves.

This report speaks about the novel and important intervention with the Doddakallasandra Lake in Bengaluru by ActionAid Association in collaboration with NTT DATA. The report shares details of the attempt made towards the successful transformation of an urban lake into a biodiversity space with active participation of local residents and volunteers, underscores the importance of local action in the global solution on climate crisis. The increasing number of plant species, birds, insects and butterflies in the Doddakallasandra

Lake are encouraging outcomes of the consistent efforts by our colleagues over the past two years. The multi-sectoral collaboration involving NTT DATA, ActionAid Association, various departments of the Bruhat Bengaluru Mahanagara Palike (BBMP), the urban local government, local residents, student volunteers, and subject experts, highlight the need to democratize the governance of commons of which Doddkallasandra lake is part of.

I am grateful to NTT DATA for their collaboration and the enthusiastic participation of their volunteers. The guidance provided by experts including J. N. Prasad, Nanda Kumar Ramesh, P Srinivas, Dr. S. Subramanya, Kshithij Urs, Ulhas P Anand and N. R. Swamy, helped us stay the course. My colleagues in the Karnataka Regional Office including Kevin Noronha, Eshwarappa M. and Raghavendra B. Pachhapur led this initiative from ActionAid Association, giving me great professional esteem and personal satisfaction that our efforts in improving the biodiversity in the country have a great example in Bengaluru. As always, I look forward to comments and suggestion to help us in the mission of further transforming the Doddakallsandra Lake into a rich biodiversity space.

In solidarity,

Sandeep Chachra

Executive Director – ActionAid.

ACKNOWLEDGEMENTS

We would like to express our deepest appreciation and gratitude to all who rendered support and encouragement to complete the Biodiversity Report of Doddakallasandra Lake. Special thanks to our resource persons for thier contributions – Mr. Ulhas Anand for Tree & Butterfly Survey; Mr. J.N. Prasad & Mr. Nanda Ramesh for Bird Survey; P. Srinivas for Plants & Shrubs Survey; N. R. Swamy for Contour Mapping; Dr. Subramanya & Dr. Kshithij Urs for the guidance, throughout the process.

A word of thanks to NTT DATA without whose support it would have not been possible. Last but not the least thanks to my colleagues of ActionAid Association Eshwarappa. M & Raghavendra B. Pachhapur who have put in their efforts in achieving the goal.

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CONTRIBUTORS

J N Prasad has been a keen naturalist and birdwatcher for the last 4 decades. A postgraduate in International Marketing and also in Ecology and Environment, he has over 50 papers and notes to his credits in leading national & international publications. More recently, besides creating awareness, Prasad along with a team of Hakkigoodu network of volunteers are building and installing nest boxes for sparrows and other birds. For all this and more, he has also been recognized and awarded by the Rotary Club for outstanding service and contribution to the community.

Nanda Ramesh is an amateur bird-watcher who enjoys nature whenever given a chance. He also writes short stories, photography, volunteering, trekking, and sports in his spare time. P Srinivas, also called as Vasu, is the founder of SOIL, a trust for caring – protecting – rebuilding Soil Health. He is campaigning for a better SOIL POLICY through promoting Diversity based Ecological Farming Systems. To address nutritional food security for soil organisms – farm animals and humans, he is running a programme with small landholding farming families under Rain fed conditions in parts of Chinthamani Taluk. He is especially concerned about the state of soils in Karnataka and has developed several teaching and demonstration modules related to the issues around soil.

Dr. S. Subramanya, Retired Professor from the University of Agricultural Science in Bangalore is a reputed Ornithologist in India. He worked in BNHS under Dr. Salim Ali, on bird migration project. After his Ph.D., studying birds in agricultural ecosystems, He joined University of Agricultural Sciences. Dr. Subramanya continued his bird research in parallel, working on the Red Data Book, the “Threatened birds of Asia” at the Bird Life International, Cambridge, UK between 1997-98. He has compiled details on heronries in India and helped in their conservation. He has also conducted surveys on several enigmatic bird species in southern India, including the Yellow-throated Bulbul and Broad-tailed Grass bird. He played a key role in the establishment of the Ramadevara betta Vulture Sanctuary at Ramnagara to save the habitat of the critically endangered Indian Vulture and getting GKVK Campus declared as a Biodiversity Heritage Site. He has been working with a number of residents’ lake conservation groups in Bangalore to help preserve them as bird habitats. After his retirement in 2018, he undertook a dream project to follow the footsteps of Salim Ali to re-conduct his 1939-40 Mysore Bird Survey.

Kshithij Urs is deeply committed to social justice and a healthy planet and has worked for more than 25 years at the interface between academics, direct action, policy drafting and institution building with a particular focus on subaltern communities - the poorest of the poor in the Global south and in large scale of lakes and forests. His leadership has contributed to many game changing laws and policies conservation in strengthening the agency of the most deprived communities in India and in deepening democracy in one of the most stratified societies in the world. Some of the laws that he has contributed to, include: The Juvenile Justice Act, The Right to Information Act, The Karnataka Lake Development Law and the NREGA. He is currently an adjunct professor of public policy at the National Law School of India University and a member of the sustainable development goals committee of Government of Karnataka. He has been the country head of Greenpeace, the global campaigns coordinator at ActionAid International, the regional manager of ActionAid and the Director of APSA - The Association for Promoting Social Action. He has a PhD from National Law School of India University, a Masters in Development Studies from SOAS, London and Bachelors in Medicine from Bangalore University.

Ulhas Anand has been associated with wildlife and the environment for over 25 years, starting out as a birdwatcher and a naturalist. His primary interest has been in building awareness and sensitizing children towards the outdoors – conducting numerous nature camps, talks, walks and workshops for schools, colleges, and corporates. He has been associated with various groups including Birdwatcher's Field Club, Merlin Nature Club, WWFIndia, and WildPassion. As a moderator for over 15 years, he helped BngBirds grow into one of the largest online discussion groups on birds and wildlife in India. He is currently the cofounder at EcoEdu, an environment education startup focused on delivering high-quality environmental education through activities, games, and publications. He has done his postgraduation in Marketing from the University of Wales, UK and builds software products for a living. He currently works as the Vice President of Product Management at Tyfone Inc.

N.R. Swamy has been actively pursuing natural history studies and environmental education for over three decades. He has been involved in various census and surveys in wildlife sanctuaries and protected areas. He has been instrumental in mapping the wetlands of Bangalore region along with the bio-diversity of each wetland. He has co-authored many reports for government on issues related to conservation. Combining his profession with passion, he has visited exotic wildlife rich areas like Alaska and Ethiopia. He was part of groups like Birdwatchers Field Club of Bangalore, Merlin Nature Club, WildPassion which have been instrumental in spreading environment awareness in Bangalore. He is now associated with EcoEdu which is an environment education start-up. N.R Swamy hold as Bachelor's degree in Engineering and is a "Photogrammetry and GIS" professional. He specializes in mapping from 3 D imagery and creating GIS maps.

INTRODUCTION TO LAKES

Ecologically speaking, lakes are wetlands which are vulnerable to minute changes. They are a combination of aquatic and terrestrial environment [CES, IISc 2011]. They are extremely productive ecosystems and ideally, are a boon to urban spaces in and around which most flora and fauna of a city thrive. Assessment of lakes provides an understanding of the ecology of the lake and the surrounding neighborhood. Well maintained lakes are abuzz with birds and insects and are rich in a variety of microorganisms and plants. Regular joggers, walkers and evening strollers enjoy the lake setting and contribute to keeping the lake active.

Along with supporting the local biodiversity, these wetlands are hosts to many migratory birds. They also provide non-recreational services to the city, for example, they play a major role in preventing floods by letting excess water drain into them from various sources [CES, IISc 2012]. They allow storm water to percolate to aquifers and recharge groundwater resources [CES, IISc 2009]. The microorganisms of lakes aid in cost effective treatment of toxic pollutants or contaminated media, therefore helping in bioremediation [CES, IISc 2013]. Lakes help in managing the microclimate by keeping the surrounding locality cool.

Although these lakes provide abundant ecological services, they have been seriously ignored and majority of them face innumerable threats, mostly due to human activities. Rapid urbanization and unplanned development has resulted in decline of lake health. Various anthropogenic activities like improper sewage systems, discharge of industrial effluents, non-sustainable garbage disposal, dumping of solid construction wastes, ungoverned tourist activities and illegal mining disturbs the natural composition of lakes and ends up choking them.

Regular dumping of wastes and untreated sewage inlet increases the nutrient content of the lake which induces excessive growth of plants which are invasive, for example Eichhornia, Alternanthera, etc. have taken over many lakes in the city, even of those which have already been rejuvenated. The inflow of solid debris also reduces the depth and blocks water from percolating to aquifers.

Being aware of the services provided by lakes and appreciating their roles in an urban setting is the first step to conserving them.

DODDAKALLASANDRA LAKE

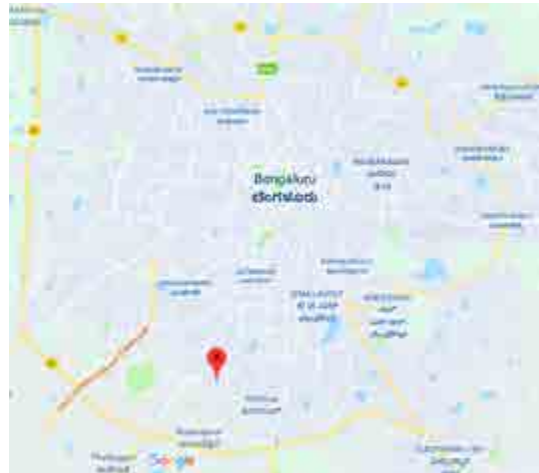


Doddakallasandra Lake is a large water body located in south Bangalore. It is surrounded by extensive development but has managed to retain a lot of its expanse with less damage and thereby holding on to a barely healthy but alive habitat unlike many other similar lakes within the city limits. Those have been either made into either 'soup bowls' with misdirected lake development making them very poor bird habitats, for example Ulsoor Lake, or polluted extensively with sewage and other toxic effluents essentially killing the lake slowly as is the case for Bellandur lake (CES, 2015, PSWB).

To ascertain the current state of the Doddakallasandra Lake as a bird friendly habitat, a bird survey was done during December of 2018. Information gleaned from the survey along with some recommendations to improve and make this lake a healthy bird habitat supporting all kinds of flora and fauna is presented in this report.

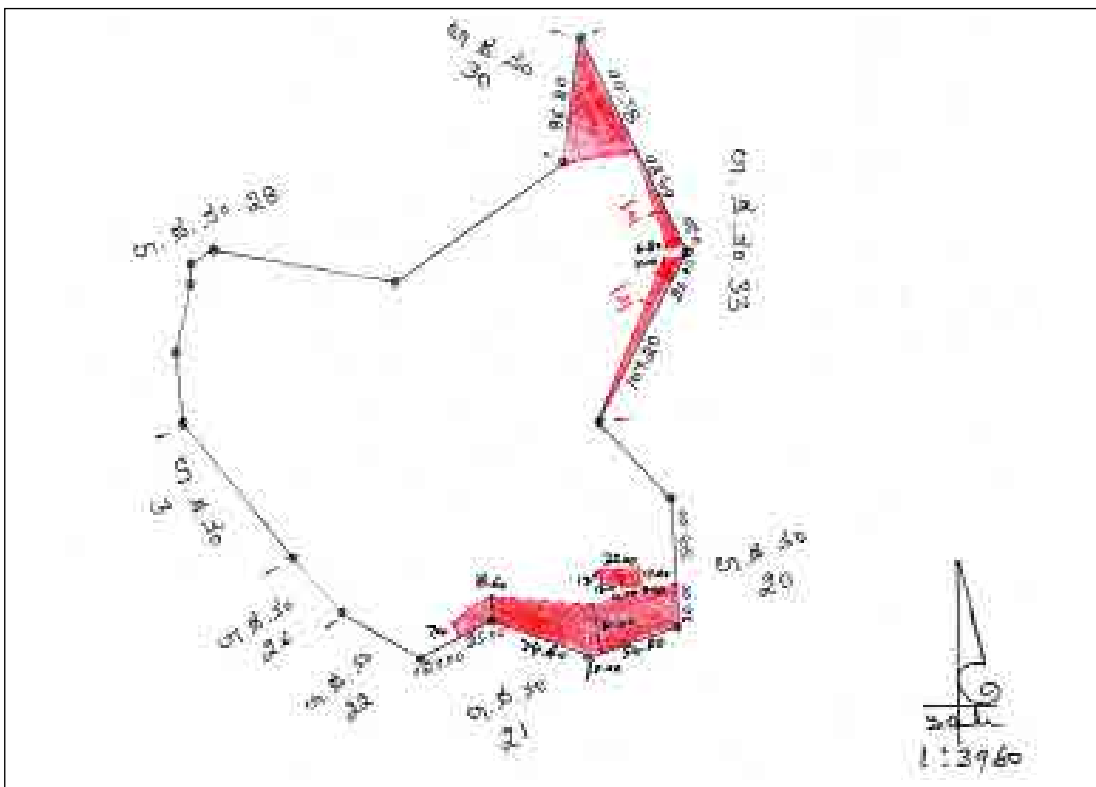
Location

Doddakallasandra lake is also called Konankunte Lake and is located off Kanakapura Road. It can be accessed by the public through a path next to Sri Kumarans Children's Home School (SKCHS) gate. This path skirts its west bank and exits the lake area towards the North onto a public road.



Description

The lake is just above 21 acres in size (CES, 2015, PSWB). There is a small island towards the South of the lake waters providing a safe area for the water birds for nesting. Low waters can be found on the East side banks creating a swamp like habitat. There is space to circumvent the lake fully though at some places it does not have a clear path. It is bordered as shown in Fig. 2



| | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>East</p> <p>This is bounded by a public road separated from lake area by a large fence. An open drain runs along the edge. Large patches of swamp like habitat can be found here. There is quite dense settlements along the road here leading to lot of garbage thrown over the fence into lake area.</p> | <p>North</p> <p>It is bordered with many trees with no clear path to walk along the shore. An open drain and public road exists with fences in some spots separating the lake area in some spots.</p> |
| <p>Middle</p> <p>There is a small island towards the South about 20x10 square meters. It hosts many large trees and provides a safe zone for the water birds. Several active nests of Grey Herons were Cormorants and Darter spotted on them.</p> | |
| <p>West</p> <p>SKCH school and parking lot. A shrub forest patch with undergrowth exists between the school compound and lake and is about 80x40 square meters in size. The forest patch is quite large for urban landscape and enough to support birds like flycatchers, Bulbul and Warblers which prefer them. A wide walking mud path for about 40 meters with benches and large trees on one side has been recently constructed which continues towards the north-west side and exits onto a public road.</p> | <p>South</p> <p>Tree lined bund with a channel for overflow and open space at a lower level from the lake which is partially dumped with construction debris. The overflow drain, though not clean, has created an hospitable feeding area for shore birds like Egrets and Herons.</p> |

Contour Map

Contour map of Doddakalsandra tank wetland area prepared in order to identify the streams flowing into the tank and downstream. To understand other special features in the terrain of the wetland area.

Methodology

The contour was generated using the Digital Elevation Model data of Cartosat (CartoDEM ver. 3R1 with water body flattening). The original data was at 30m interval which was resampled to 10 m interval. This DEM data was supplemented with around 115 points taken with hand held mobile phones with GPS.

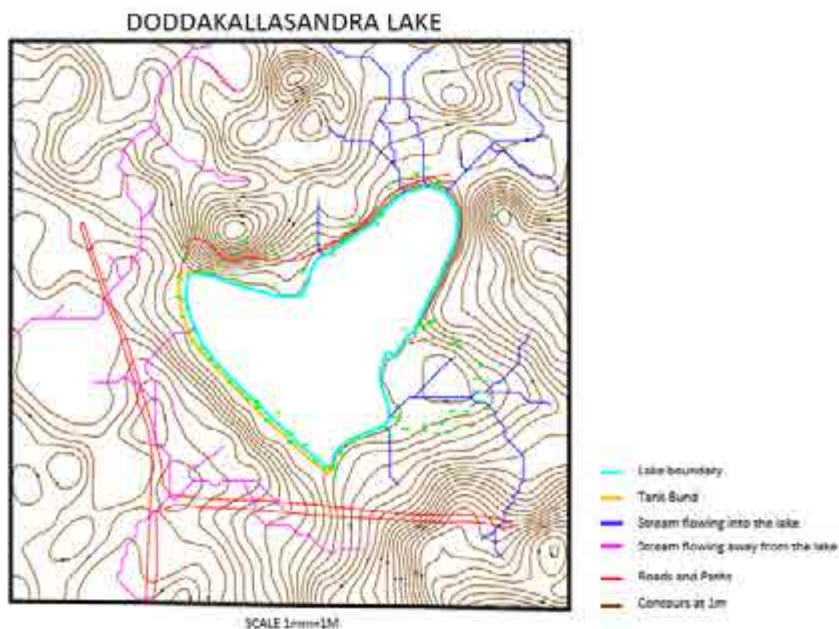
The contours were generated at 1m interval. The extent of the water area, the tank bund area and the roads were digitized from the satellite imagery downloaded from the free imagery source from DigitalGlobe.

Analysis

The final contour map is as shown below, as can be seen in the in Fig. 3. The blue lines show the streams flowing into the tank. The streams flow into the tank from the North-East and the East. As can be seen in the contour map the gradient in the East of the tank is greater than the gradient in the North-East of the tank. This clearly shows that the flow into the lake is more from the East direction than from the North-East direction.

The magenta lines show the flow of the stream flowing out of the tank. This stream flows from the South-West end of the bund and flows in the South-East direction. There is a steep gradient of 6mts from the bund. This shows that before the buildings came about, there used to be a lot of water which is used to flow out from the tank. Hence it can be deduced that lot of water used to flow continuously into the tank.

Towards the Eastern side of the water area there is a big depression of put 2m depth. This is the area as confirmed by Ground truthing and looking at the same area in Google Earth, where the water flowing into the tank from the East direction is collected. The heavy particles in the water settle down in this area and the water free from these heavy particles



flow into the main water area. Since as per the contour the depth is only 2 mts, it means that this area has been filled with the heavy particles and needs cleaning up of this area so that more water can stand here.

BIODIVERSITY SURVEY – DODDAKALLASANDRA LAKE

Biodiversity in urban areas

For thousands of years, humans have formed large communities that have grown to become cities, with the increase of non-natural materials and carbon emissions; it can be difficult for local plants and animals to thrive. Biodiversity is often used as a means of measuring how healthy a particular ecosystem is; a healthy ecosystem will be able to sustain a wide variety of life. A lack of biodiversity in an area can lead scientists studying it to notice problems like unclean water or air pollution.

The term “biodiversity” (short for “biological diversity”) has become more even important in the 21st century, and biodiversity is now used as a means of measuring the health of an urban environment. 51% of the world’s population now lives in cities, creating a huge carbon footprint. One way to offset this carbon footprint is to promote a healthy environment by encouraging its biodiversity. Although only 30% of India’s population lives in Cities now, this proportion is expected to increase to 50% in the next two decades. It is becoming increasingly important therefore, to have a good understanding of the processes that shape ecology and conservation in Indian cities. Unfortunately, we have very little information to draw on. The attention of Indian ecologists and conservation biologists has largely focused on understanding ‘natural’ ecosystems such as forests in protected areas, while cities have largely remained in the background of ecological conservation.

Biodiversity loss can have significant direct human health impacts if ecosystem services are no longer adequate to meet social needs. Indirectly, changes in ecosystem services affect livelihoods, income, local migration, and on occasion, may even cause political conflict.



Lakes provide critical habitat for an amazing array of plants and animals including bacteria, fungi, algae, plankton, mussels, snails, crustaceans, insects, fish, amphibians, reptiles, birds and mammals. Lake biodiversity globally is severely threatened. Taking cognizance ActionAid decided to take up three surveys at Doddakallasandra Lake. A bird survey, a tree census and a butterfly survey were conducted around the Doddakallasandra lake during December 2018 and October 2019. These censuses helped us understand the biodiversity of the lake, make connections and identify the inter-relations between different organisms, which in-turn will prove useful in taking proper measures to develop the lake

Tree Survey

A tree census was conducted at Doddakallasandra Lake on Sunday, December 20, 2018. This report provides an overview of the survey and the results from it. The results of the survey are listed in Appendix. 1

Methodology

The survey was conducted through a walk around the periphery of the lake, looking at each tree, and identifying it taxonomically. Number of trees for each species was also noted down. Planned only as a tree census, this survey excluded other types of vegetation like bushes, shrubs and smaller plants. It also excluded vegetation found within the lake and on the island.

Results

A total 41 species of trees were identified, with about 354 individual trees counted. Two individual trees that were without leaves, flowers or fruit have been left unidentified. The table below is laid out with the English common name first, followed by the prevalent local common name in this region, followed by the scientific name and the count of trees. The serial number in the first column can be considered for the species diversity count.

Observations

Most of the trees recorded were non-native and the result of planting efforts by the authorities. Pongam, *Millettia pinnata*, was the most common species recorded and further planting of this species should be discouraged at this location. Both Subabul, *Leucaena leucocephala*, and Yellow Nile Tulip Tree, *Markhamia lutea*, have become wild plants in the lake. The latter was observed to have hundreds of small saplings taking root near the entrance to the lake next to the school. If unchecked, this single species can over-run the entire periphery of the lake and constrict growth of other trees. The main host tree is within the school premises and the school can be requested for its removal.

Some of the unique and important tree species that were observed during the survey were

- » Ice Apple, *Borassus flabellifer*, which are relatively rare within the city limits and play host to the Palm Swift, *Cypsiurus balasiensis*, a bird species that is not very common within the city. The fact that this bird was also observed during the survey, strengthens the need to protect these trees at the lake and plant a few more trees close to this.
- » Multiple species of fig trees were also noted during the survey. These native trees play host to a significant number of birds and insects and should be encouraged.
- » Bengal Quince, *Aegle marmelos*, trees are also not very common in Bangalore and four individual trees were recorded during the census thanks to the two temples present within the periphery of the lake.
- » Only two Singapore Cherry, *Muntingia calabura*, were noted during the census and more trees of this species can be planted to encourage bird life.

WILD PLANTS SURVEY

Introduction

There has been tremendous interest in the study of wild plants and their effects on the biodiversity. There are certain plants and shrubs which are primary components of biodiversity. With their presence, they beautify the landscape. They are the strongest, also



mysterious and often have things to teach humans. Unfortunately, these plants are carrying a stigma throughout their lifespan as “weeds” in agricultural ecosystem. Weed means they are not wanted or expected in the land where crops are sown. There are certain myths gathered around these beautiful plants. Many consider them as just plants growing in the wrong place. They are bad guys. The virtues of these plants have not yet been discovered. They have to effectively get rid of.

But the reasons behind the emergence of these plants are really worth to note and understand. The positive aspects about these plants were found evident during an attempt made to understand the existing plants and shrubs found in a micro forest area, in the surrounding of Doddakallasandra lake. They were found as the source of food and nutrition for humans and variety of insects, birds etc.

A 5-member team made a visitation to Doddakallasandra lake and observed 43 plant species (considered as weeds) which were thriving on the lake bed. The information of these plants is based on the first hand study. The list of these plants and their uses / benefits, their contribution in improving and sustaining the lake biodiversity are given below.

Observation Of Lake Plants And Shrubs

Managing the biodiversity is key role of wild plants. Most of the wild plants observed in the lake ecosystem are native. These are growing in different forms, like plants – shrubs – creepers – grasses. These are naturally grown on their own and have become naturalized and seem to be the permanent denizens of lake region. They have established in the lake region to bring back the natural balance in the eco-system. Some of them also grown

aggressively. Interestingly, few of the wild plants were found interdependent. Many plants in the lake region, found emerged at higher densities and happily established under the shades of trees also. There are some fast spreading species. Some of them produce copious amount of seeds that are easily dispersed and readily germinate often forming compact cushions. These wild plants colonised the area and were acting as guardians of our soils. They invaded in certain places, where the soils are disturbed and it was found that these wild plants stabilised themselves as natural ‘Band-Aids’ and improve the quality of the soil. They breed faster. They have spread beyond their natural habitat taking the place of other plants also.

More than 20 species of wild plants found in Doddakallasandra lake are the source of nutritious food to humans and livestock. Some of them also have medicinal values, which can be used to cure many common ailments of humans and livestock. One wild plant

observed in the lake area cleans the polluted water. A complete list of Wild plant is listed in Appendix -2

Ecological – economical – nutritional - cultural – medicinal values of wild plants:

1. There is a diversity of flora associated with different types of insects and butterflies. In a way, they are habitats and acting as hosts too many living organisms in the lake bed area.
2. These wild plants also increase the population of bird species. The birds thrive in the region where the availability of their foods, in the form insects and plant seed food is guaranteed. And these wild plants as already said, are hosts of many diversified insects and are also germinate bird eatable seeds
3. Some of these wild plants bear fruits, which are the most glorious jellies, a delicious food for birds. These plants also provide shelter and safe nesting sites for small birds.
4. These wild plants also work for soils, defending them, and bring back the favourable conditions for soil microbes to survive and thrive. The dropping of old dry leaves of these plants cover the soil from direct sun rays and keep tolerable moisture within the soil, where soil microbes loves to establish.
5. With their deep diving root systems, these wild plants brings to the surface elements beyond the reach of most other plants
6. Pump up moisture, raising it by capillary action along with miles-long surface of their root system, breaking hard pan
7. With their unique ability, while struggling for existence, seek food and water under adverse conditions
8. They appear when certain deficiencies occur in the soil
9. Many of them are the source of nutritious food to humans as they store up minerals and nutrients that would be wasted or blown or leached away from bare soil and keep them readily available.
10. Wild plants make good eating, for humans as well as livestock over any other domestic form of greens and cooked vegetables.
11. The leaves of certain wild plants are included in making food like RASAM or GREEN CURRY.
12. Some of the plants do have fibre content, which manages constipation problem
13. The sticks of one type of wild plant – BARALU KADI – is used to make brooms.

14. ANTU GIDA is used to control heavy motion of domestic animals
15. LANTANA is used to heal wounds
16. GABBU GIDA is used as manure
17. JONDU / DODDA THUNGE plant detoxifies the polluted water.

Analysis

A study of plant life (flora) found in the Doddakallasandra lake region told a lot about the conditions of the biodiversity. The observation of wild plants led the team to observe other life forms, like Tree Diversity, Wild plants (Weeds – bushes – grasses etc.), birds, insects, butterflies, reptiles, mongoose, ants, bees, spiders, flies, white ants, centipede and millipedes, aquatic diversity (fishes and frogs), below soil diversity (presence of earthworms with their castings and other microbial diversity within soils. There are also varied soil types (with colour – structure – texture – with and without life). It is a paradise of many life forms, not only limited to plants.

These wild plants observed in the lake region say a lot about the condition of the biodiversity. Be it the soil, the insects – butterflies and all other living forms of the biodiversity.

The diversified plant species found in Doddakallasandra lake also indicated rich natural resources due to their presence. They might have thrived where the condition of biodiversity was very poor. They appeared as pioneers in the region and found opportunistic in colonising the region, which was earlier a disturbed ecosystem, where biodiversity is too poor to support other living beings.

They are making an attempt to correct the mess that humans have made on soils and on the ecosystem. In the real sense, these plants are “eco-friendly” plants.

BIRD SURVEY



Methodology

The survey was conducted through a walk around the periphery of the lake and focusing on the Island. Birds were identified by their species and noted down. It was conducted twice once during the month of December of 2018 and again during March 2019 for two consecutive days during both sessions.

Results

A total of 59 birds were noted during the survey and were updated on e-Bird website <https://ebird.org/hotspot/L4092548?yr=all&m=&rank=mrec>. The surveys were conducted by walking around the lake, both in the morning and in the evening. Of these, 11 were migratory species and two of the species have been listed as Near-threatened by the IUCN (Appendix 2. Doddakallasandra Lake being one of those lakes was found to be quite diverse in the habitat and attracting birds of many types. Full checklist of the birds observed during these visits is listed under Appendix -2

Observations

1. Diversity based on feeding preference

During our survey/census we could spot birds that were dependent on many types of food source. This reflected the diversity of the habitat in and around this lake. Some broad examples of exploitation of different food sources are listed below. Full complete list can be found in Appendix -2.

- (a) Insects: Warblers, Prinias, Mynahs, Flycatchers and Bee-eaters.
- (b) Nectar/fruits: Sunbirds, Koel, Mynahs.
- (c) Vertebrates: Coucal, Koel, Kites.
- (d) Aquatic food source: Ducks, Moorhens, Cormorants, Coots, Grebes, Egrets, Herons.

2. Diversity based on Habitat

- (a) Forest/Shrub: The extent of forest area was quite limited but still large to support birds which preferred it. It attracted several species that are not normally found in smaller urban gardens. Small Minivet, Asian Brown flycatcher, Black-naped Flycatchers, India Paradise Flycatchers, Chestnuttailed Starlings and Rosy Starlings are the ones we spotted that would not have visited this patch normally if not for the tree foliage. Other birds observed which require this habitat and found in urban gardens were Sunbirds, Koels, Mynahs, Bee-eaters and White eyes Greenish Warbler (a migratory species), Oriental White eye, Cicerems Tits, Sun Birds and common lora frequently the top Canopies for Foraging.
- (b) Hedges/Grass: Warblers and Prinias depend on this type of vegetation. Blyth's reed warbler and Ashy Prinia were few of the species we spotted during the survey.
- (c) Shoreline/Marsh: Even though the amount of shoreline or marshy areas are limited, it still hosted many species. A solo sandpiper was spotted during both visits. Many Egrets, Herons were seen along the lake edge all around and on the island with a larger number on the eastern shore. Grey Heron was comfortable on the island and many active nests could be seen.
- (d) Aquatic: Water birds seen during our visits were Spot-billed Ducks, Coots, Moorhens and Grebes.

3. Migratory Birds

Migratory birds visit areas in and around Bangalore during the months of Oct to March. They are both tree based and aquatic. Doddakallasandra attracts both. Of the shore birds, we saw Sandpipers both times and clearly identifying it as a Green Sandpiper and Barn swallows both winter migratory species Greenish Warbler, Brown Shirke were seeing flying around. Flycatchers such as Asian Brown and Black-Naped Monarch both quite rare within city limits, other than at Lalbagh Botanical Gardens, were spotted other migrates noted. The highlight

however was the large number of Chestnut tailed Starlings and Rosy starlings that came to roost on the trees surrounding the lake during the evening visit. Our estimation was about 50 Chestnut-tailed Starlings and close to 500 Rosy Starlings.

Two of the birds Oriental Darter and Black-headed Ibis were observed at Doddakallasandra Lake which are listed as Nearly Threatened Species as per the International Union of Conservation of Nature. Darter was noted breeding on the Islands which needs to be protected from disturbances.

BUTTERFLY SURVEY



Butterflies are indicators of healthy ecosystems. Different butterflies lay their eggs on different plants; each butterfly has a particular host plant (or few host plants) on which they lay eggs for their off springs to get a wholesome nutrition. This implies that the number and the diversity of plants is also varied.

Methodology

The survey was conducted through a walk around the periphery of the lake. Different butterflies were identified with their common names and noted. Except for one species of butterfly which was identified with help. The survey excluded vegetation found within the lake and on the island. The survey was conducted in December 2018 & March 2019 to identify different species could be spotted in the lake area.

Result

The survey identified 29 different species of butterflies were found in this survey. In the path around Doddakallasandra Lake, butterflies belonging to 5 different families are found- Swallowtails, Lycaenidae, Nymphalidae, Hesperidae and Pieridae. The adult butterflies mostly consume nectar from Lantana, Firebushes, Ixora, Jasminum and other flowering plants. A detailed list can be found in Appendix -4

Observations

The larval forms of each species feed on specific plants, for example, Crimson Rose feeds on plants from birthwort family along with Common Rose. The Common Mormon, which is a swallowtail, feeds on Bengal Quince. The Common Wanderer, Plain Orange Tip and Pioneer Butterfly, all three of which belong to Pieridae feed on plants of the Capparaceae family. Citrus plants are also a host to the Lime butterfly and Zebra Blue. Plants belonging to Fabaceae, Euphorbiaceae (especially castor), Passifloraceae, Annonaceae and Asteraceae are important host plants.

Many butterflies exhibit mud-puddling like the Common Rose Butterfly and the Lime Butterfly where mostly the males extract nutrition from rocks, decaying matter or as the name suggests, mud. This phenomenon helps in the better nourishment of the eggs and results in better off springs. Identifying these phenomena, their hosts plants and the plants from which they draw nectar, helps us understand the biodiversity and take proper steps to rejuvenate it.

Legal Provisions Protecting Lakes

The lives of urban dwellers do not directly revolve around lakes, as opposed to a rural community, where they have direct associations with the local lake, which is of immense importance to the rural community as they encounter these wetlands on a daily basis and hence it carries a lot of emotional and cultural weightage. In an Indian city a cultural association with the lake is mostly during Ganesh Chaturti, where many immerse their idols in these wetlands.

Lakes are now perceived as spaces for building huge cement structures or sewage and garbage dumping. These activities continue until the monsoon where the entire city floats in foul-smelling untreated water. These events highlight the fact that lakes are being completely ignored in urban-scapes. About 98% of the lakes in Bangalore are subjected to encroachment. The topography of the land around the lakes have been altered due to unplanned urbanization, due to which, instead of rainwater, sewage and effluents fill up these water bodies. Hence, it is now the need of the hour to understand and evaluate legal protections available for the conservation of these urban tanks.

Since the 1960s, the environment support bodies of the government have been developing acts, programmes and policies to protect these water bodies. The Ministry of Environment and Forests (MOEF) in 1983 developed a National Wetland Conservation Programme for the conservation of lakes and other water bodies. In 1987, the first National Water Policy was launched but only in 2002 this policy took up the matter of conservation of wetlands. MOEF developed another program in 2001 called the National Lake Conservation Plan (NCLP). This particular programme was unique as it identified that the matters of water is more a concern of the State than the Centre, which is why the power between the state and the Centre is in the ratio 30:70. In addition to this, the MOEF directed all the states to constitute City Level Monitoring Committees (CLMS) for better attention to water and wetland related problems. [CSE 2013].

The Biodiversity Act of 2002 is “An Act to provide for conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto.” As this Act needs to be implemented at each ward of the city to protect, conserve, and for the proper usage of the lake, keeping in mind the socioeconomic issues.

Zooming into Karnataka, according to section 67 of the Karnataka Revenue Act, lakes are a property of the State. On 10th of July 2002 the Lake Development Authority (LDA) was formed which was a government funded non-profit organization which works for conservation and jurisdiction of lakes under the Bangalore Metropolitan Region Development Authority (BMRDA). The State transferred its sovereignty over lakes to the LDA, which itself was illegal. The LDA took this up by privatizing the development and management of the lakes, against continuous protests by hundreds of people. [ESG, 2011]

According to the Public Trust Doctrine, the public commons should be maintained based on the principle of intergenerational equity. Similarly, it is the Government’s obligatory function to ensure that the access to commons is open to all with reasonable restrictions on use.

Discharge of raw sewage or trade effluents directly into lakes without conforming to the Water (Prevention and Control of Pollution) Act, 1974 and the Wetland Rules, 2010, can be penalized under the Karnataka Town and Country Planning Act, 1961.

Apart from the above mentioned acts and policies, there are other acts or bills which help in the conservation, protection and rehabilitation of wetlands. One such important convention was the RAMSAR convention in Iran in 1971. A RAMSAR List was created which includes over 2000 Ramsar sites (lakes) in the world which need to be protected.

In the judgment established by Justice NK Patil, in accordance to the WP 817/2008 filed to highlight the deterioration of lake habitats, a set of recommendations and guidelines were provided in order to protect, conserve, rehabilitate and wisely utilize the lakes and watersheds that are available and will be available in the Bangalore region. A committee was formed in order to perform the above action and it recommended certain strategies such as lake areas must not be diverted for other purposes, lake areas and Raja Kaluves have to be surveyed regularly, lake preservation has to be integral to layout development of BDA and effective lake area should not be reduced by converting lake into parks. These were a few of the immediate recommendations made by the committee and they recommended action plans to authorities such as the BBMP, BDA and the LDA to implement these strategies accordingly. The Court also instructed the State Government to immediately constitute District Level Protection Committees and an Apex Committee at the State Level.

Recommendations by Justice N.K.Patil Committee

- (a) Lake area should be surveyed and not be diverted for any other purpose.
- (b) Rajakaluves and branch kaluves are to be surveyed and encroachment therein evicted.
- (c) The present norm of 30m buffer surrounding the legal boundary of lakes is a must to preserve the lakes.
- (d) Lake preservation has to be integral to layout development by the BDA and should not acquire lake area for development and allotment.
- (e) Absolute requirements like survey, removal of encroachments, fencing, watch and ward, clearing of blocked and encroachment of Raja Kaluves and drains, waste weir repairs and de-silting to be taken up on priority.
- (f) Effective lake areas should not be reduced by converting lake into parks, children play grounds, widened bunds etc. and de-silting is to be limited to minimum depth near foreshore and maximum at the bund.
- (g) Sewage entry should be stopped prior to any lake development activities taken up. Lake restoration is to be taken up based on lake series /sub-series and not in isolation.

RECOMMENDATIONS

Several lakes have been rejuvenated in Bangalore. They have well paved jogging tracks, boating facilities and aesthetic looking plants, but they are devoid an environment which supports a decent wildlife. They have been hastily developed due to pressures from the public and many authorities and focuses primarily in increasing its storage capacity. To support the local biodiversity, it is important to understand the ecology of the region. [CES, IISc 2013].

Lake

1. Fencing the Lake: It was observed during the survey that the boundary of lake, specifically towards the South South-West, where there are some marshes, is not very clear. There were multiple fences and a clear demarcation of which of these fences signifies the lake boundary, was not clear.
2. Stop sewage inflow into the lake by constructing STPs (Sewage Treatment Plants) for surrounding communities. Since construction of STP may take some time, it is strongly recommended that pipes be installed to divert the polluted water from entering the lake by skirting it and releasing into the drain downstream as soon as possible. This may require significant civil works and needs to be done in coordination with local authorities like BBMP, BWSSB, etc., so that the solution is a permanent one.
3. Clear blockages of streams: Ensure natural clean water inflow from rain and other sources by clearing blockages that may be preventing it.
4. Stop encroachment and dumping of debris on the south side of the lake. This area should be planted with trees and developed into a second healthy forest patch. The overflow from the lake flowing through it will create an excellent habitat for many birds.
5. Prevent disturbance by banning vehicular movement near the lake. It should support walking and nature related activities only. The lake should ideally be developed in such a way as to make it an educational center for wetlands and their importance. They should not become recreation boating centric places.
6. Nylon net to be installed to trap the plastic/floting debris can be filtered at inflow or outflow drains. This needs to be regularly cleaned to avoid flooding.
7. Servises of limnologist to analyze the Phyto planktors and zoo planktons to be undertaken as these Microscopic organisms form the basis of food chain.
8. Fishes and other aquatic species need to be surveyd and documented.

Appendix - 1: Tree Census

| Sl. No. | Tree (Common Name) | Tree (Scientific Name) | Number of Trees |
|---------|----------------------------------|-----------------------------------|-----------------|
| 1 | African Tulip Tree / Neer Kai | <i>Spathodea campanulata</i> | 4 |
| 2 | Pongam / Honge | <i>Millettia pinnata</i> | 76 |
| 3 | Red Date / Bere | <i>Ziziphus jujuba</i> | 2 |
| 4 | Camel Hoof Tree / Basavana Pada | <i>Phanera purpurea</i> | 2 |
| 5 | Date Palm / Yeechalu | <i>Phoenix sylvestris</i> | 20 |
| 6 | Monkeypod / Jungle Jalebi | <i>Pithecellobium dulce</i> | 2 |
| 7 | Spectacular Cassia | <i>Senna spectabilis</i> | 10 |
| 8 | Corky Coral Tree | <i>Erythrina suberosa</i> | 5 |
| 9 | Arjuna / Hole Matthi | <i>Terminalia arjuna</i> | 8 |
| 10 | Black Plum / Jamun | <i>Syzygium cumini</i> | 2 |
| 11 | Orchid Tree / Kachnar | <i>Bauhinia variegata</i> | 3 |
| 12 | Pink Trumpet Tree / Pink Ipe | <i>Handroanthus impetiginosus</i> | 4 |
| 13 | Rain Tree / Cork Ball Mara | <i>Samanea saman</i> | 11 |
| 14 | Quick stick / Gobbarada Mara | <i>Gliricidia sepium</i> | 3 |
| 15 | Ice Apple / Thaati Nungu | <i>Borassus flabellifer</i> | 3 |
| 16 | Babul Bark / Kari Jali | <i>Acacia nilotica</i> | 10 |
| 17 | Blue Gum / Nilgiri | <i>Eucalyptus tereticornis</i> | 3 |
| 18 | Cluster Fig / Atthi | <i>Ficus racemosa</i> | 5 |
| 19 | Yellow Trumpet Flower | <i>Tabebuia argentea</i> | 5 |
| 20 | Earleaf Acacia / Seeme Jali | <i>Acacia auriculiformis</i> | 28 |
| 21 | Malabar Neem / Hebbevu | <i>Melia dubia</i> | 2 |
| 22 | Big-Leaf Mahogany | <i>Swietenia macrophylla</i> | 20 |
| 23 | Yellow Nile Tulip | <i>Markhamia lutea</i> | 30 |
| 24 | Hispaniolan Rosy Trumpet Tree | <i>Tabebuia berteroi</i> | 4 |
| 25 | Coconut Tree / Thengu | <i>Cocos nucifera</i> | 18 |
| 26 | Singapore Cherry / Gasegase Mara | <i>Muntingia calabura</i> | 2 |
| 27 | Guava Tree / Seebe Hannu | <i>Psidium guajava</i> | 5 |
| 28 | Peepal Tree / Arali | <i>Ficus religiosa</i> | 6 |
| 29 | Bengal Quince / Bilva | <i>Aegle marmelos</i> | 4 |

| | | | |
|----|-----------------------------------|------------------------------|------------|
| 30 | Subabul | Leucaena leucocephala | 6 |
| 31 | Whita Bark Acacia / Bili Jali | Acacia leucophloea | 5 |
| 32 | Green Bamboo / Bidiru | Bambusa vulgaris | 7 |
| 33 | Portia Tree / Hoovarasi | Thespesia populnea | 6 |
| 34 | Mango / Maavu | Mangifera indica | 1 |
| 35 | Sandalwood / Gandhadha Mara | Santalum album | 1 |
| 36 | May Flower / Gulmohur | Delonix regia | 1 |
| 37 | Silver Oak | Grevillea robusta | 19 |
| 38 | Castor / Haralu | Ricinus communis | 1 |
| 39 | Unid Albizzia | | 5 |
| 40 | Unid trees | | 2 |
| 41 | Unid Solanum | | 2 |
| 42 | Bidi Leaf Tree / Aralukadumandara | Bauhinia racemosa | 1 |
| | | Total Number of Trees | 354 |

Appendix - 2: Survey of Plants And Shrubs Identified (Local Names)

| | |
|-----|---------------------------------|
| 1. | Anagone Soppu / Konegante Soppu |
| 2. | Baralu Kaddi Gida |
| 3. | Partheneum |
| 4. | Show Plant |
| 5. | Antu Gida |
| 6. | Lantaana |
| 7. | Beli Gida |
| 8. | Mullu Dantu Gida |
| 9. | Gowri Gida |
| 10 | Gabbu Gida |
| 11. | Amrutha Balli |
| 12. | Ogani Balli |
| 13. | Kempu Basale |
| 14. | Jondu Gida |
| 15. | Uttaraani |
| 16. | Muttidare Muni |

| | |
|-----|------------------------------------------|
| 17. | Nanju Gida |
| 18. | Dodda Thangadi |
| 19. | Hasirele Gida |
| 20. | Kaadu Badane |
| 21. | Kaadu Elachi |
| 22. | Elachi (Normal) |
| 23. | Rogar Gida |
| 24. | Inku Gida |
| 25. | Thutthi Gida |
| 26. | Kaadu Hurale |
| 27. | Gaare Kaayi (Without Thorns) |
| 28. | Gowri Gida (With Yellow Coloured Flower) |
| 29. | Haavu Kaayi Gida |
| 30. | Paper Hoo |
| 31. | Seethaa Phala |
| 32. | Huchchu Thonde |
| 33. | Haalu Kalli Gida |
| 34. | Jondu / Dodda Thunge Gida |
| 35. | Ummatthi Gida / Kari Gida |
| 36. | Banke Kaayi / Ante Kaayi |
| 37. | Kesavu / Neeru Nirmala Gida |
| 38. | Neeru Gida |
| 39. | Samudrada Huruli Gida |
| 40. | Neeru Saamraani |
| 41. | Yekke Gida |
| 42. | Bende Gida |
| 43. | Aadu Soge Gida |

Appendix - 3: List of Birds Recorded During the Bird Survey*

| Bird Species | Status |
|---------------------------------------------------------------|--------|
| 1. Ashy Prinia (<i>Prinia socialis</i>) | R |
| 2. Asian Brown Flycatcher (<i>Muscicapa dauurica</i>) | M |
| 3. Asian Koel (<i>Eudynamys scolopaceus</i>) | R |
| 4. Barn Swallow (<i>Hirundo rustica</i>) | M |
| 5. Black Kite (<i>Milvus migrans</i>) | R |
| 6. Black-crowned Night-Heron (<i>Nycticorax nycticorax</i>) | R |
| 7. Black-headed Ibis (<i>Threskiornis melanocephalus</i>) | R |
| 8. Black-naped Monarch (<i>Hypothymis azurea</i>) | R |
| 9. Blyth's Reed Warbler (<i>Acrocephalus dumetorum</i>) | M |
| 10. Brahminy Kite (<i>Haliastur indus</i>) | R |
| 11. Cattle Egret (<i>Bubulcus ibis</i>) | R |
| 12. Chestnut-tailed Starling (<i>Sturnia malabarica</i>) | M |
| 13. Cinereous Tit (<i>Parus cinereus</i>) | R |
| 14. Common Myna (<i>Acridotheres tristis</i>) | R |
| 15. Coppersmith Barbet (<i>Psilopogon haemacephalus</i>) | R |
| 16. Eurasian Coot (<i>Fulica atra</i>) | R |
| 17. Eurasian Moorhen (<i>Gallinula chloropus</i>) | R |
| 18. Grey Heron (<i>Ardea cinerea</i>) | R |
| 19. Grey Wagtail (<i>Motacilla cinerea</i>) | M |
| 20. Grey-headed Swamphen (<i>Porphyrio poliocephalus</i>) | R |
| 21. Great Cormorant (<i>Phalacrocorax carbo</i>) | R |
| 22. Greater Coucal (Southern) (<i>Centropus sinensis</i>) | R |
| 23. Green Bee-eater (<i>Merops orientalis</i>) | R |
| 24. Green Sandpiper (<i>Tringa ochropus</i>) | M |
| 25. House Crow (<i>Corvus splendens</i>) | R |
| 26. Indian Golden Oriole (<i>Oriolus kundoo</i>) | M |
| 27. Indian Pond-Heron (<i>Ardeola grayii</i>) | R |
| 28. Indian Spot-billed Duck (<i>Anas poecilorhyncha</i>) | R |
| 29. Jungle Myna (<i>Acridotheres fuscus</i>) | R |

| | |
|-----------------------------------------------------------------|---|
| 30. Large-billed Crow (<i>Corvus macrorhynchos</i>) | R |
| 31. Little Cormorant (<i>Microcarbo niger</i>) | R |
| 32. Little Egret (<i>Egretta garzetta</i>) | R |
| 33. Little Grebe (<i>Tachybaptus ruficollis</i>) | R |
| 34. Oriental White-eye (<i>Zosterops palpebrosus</i>) | R |
| 35. Pale-billed Flowerpecker (<i>Dicaeum erythrorhynchos</i>) | R |
| 36. Purple Sunbird (<i>Cinnyris asiaticus</i>) | R |
| 37. Purple-rumped Sunbird (<i>Leptocoma zeylonica</i>) | R |
| 38. Red-vented Bulbul (<i>Pycnonotus cafer</i>) | R |
| 39. Red-whiskered Bulbul (<i>Pycnonotus jocosus</i>) | R |
| 40. Rock Pigeon (Feral Pigeon) (<i>Columba livia</i>) | R |
| 41. Rose-ringed Parakeet (<i>Psittacula krameri</i>) | R |
| 42. Rosy Starling (<i>Pastor roseus</i>) | M |
| 43. Small Minivet (<i>Pericrocotus cinnamomeus</i>) | R |
| 44. Spotted Dove (<i>Streptopelia chinensis</i>) | R |
| 45. Tickell's Blue Flycatcher (<i>Cyornis tickelliae</i>) | R |
| 46. White-breasted Waterhen (<i>Amaurornis phoenicurus</i>) | R |
| 47. White-cheeked Barbet (<i>Psilopogon viridis</i>) | R |
| 48. White-throated Kingfisher (<i>Halcyon smyrnensis</i>) | R |
| 49. Garganey (<i>Anas querquedula</i>) | M |
| 50. Black-Winged Stilt (<i>Himantopus mexicanus</i>) | R |
| 51. Oriental Darter (<i>Anhinga melanogaster</i>) | R |
| 52. Indian Cormoran Indian shag (<i>Phalacrocorax</i>) | R |
| 53. The Shikra (<i>Accipiter badius</i>) | R |
| 54. Red-Rumped Swallow (<i>Cecropis durica</i>) | R |
| 55. White-Browed Bulbul (<i>pycnonotusluteolus</i>) | R |
| 56. Greenish Warbler (<i>Phylloscopus trochiloides</i>) | M |
| 57. Common Tailorbird (<i>Orthotomus sutorious</i>) | R |
| 58. White-browed Wagtail (<i>Motacilla maderaspatensis</i>) | R |
| 59. Common Moorhen (<i>Gallinula chloropus</i>) | R |
| 60. Oriental Magpie-Robin (<i>Copsychus saularis</i>) | R |

| | |
|----------------------------------------------------------------|---|
| 61. Coppersmith Barbet (<i>Psilopogon haemacephalms</i>) | R |
| 62. Indian Fowl Pea (<i>Pavo cristatus</i>) | R |
| 63. Black-Rumped flame back (<i>Dinopium benghalense</i>) | R |
| 64. Indian Paradise Flycatcher (<i>Terpsiphone paradisi</i>) | R |
| 65. Brown Shrike (<i>Lanius cristatus</i>) | M |
| 66. Loten's Sunbird (<i>Cinnyris lotenius</i>) | R |
| 67. Scaly Breasted Munia (<i>Lonchura punctulata</i>) | R |
| 68. Red-wattled Lapwing (<i>Red-wattled</i>) | R |
| 69. Red-Rumped Swallow (<i>Cecropis daurica</i>) | R |
| 70. Indian White Eye (<i>Zosterops palpebrosus</i>) | R |
| 71. Oriental Magpie-Robin (<i>Copsychus saularis</i>) | R |

* R= Resident, M= Migrant

Appendix - 4: Butterfly Survey

| Sl. No. | Common Name – Scientific Name |
|---------|---------------------------------------------------------|
| 1 | Crimson Rose Butterfly – <i>Pachliopta hector</i> |
| 2 | Lime Blue Crimson Row Butterfly – <i>Chilades lajus</i> |
| 3 | Common Jezebel – <i>Delias eucharis</i> |
| 4 | Six Lime Blue - <i>Nacaduba berenice</i> |
| 5 | Common Gull – <i>Cepora Nerissa</i> |
| 6 | Common Grass Yellow – <i>Eurema hecabe</i> |
| 7 | Plain Tiger – <i>Danaus chrysippus</i> |
| 8 | Lemon Pansy – <i>Junonia lemonias</i> |
| 9 | Common Emigrant – <i>Catopsilia pomona</i> |
| 10 | Common Wanderer – <i>Pareronia valeria</i> |
| 11 | Plain Orange Strip – <i>Colotis aurora</i> |
| 12 | Pioneer Butterfly – <i>Belenois aurota</i> |
| 13 | Tailed Jay – <i>Graphium agamemnon</i> |
| 14 | Common Cerulean - <i>Jamides celeno</i> |
| 15 | Forget Me Not – <i>Catochrysops strabo</i> |
| 16 | Stripe Tiger – <i>Danaus genutia</i> |
| 17 | Common Castor – <i>Danaus genutia</i> |
| 18 | Common Baron – <i>Euthalia aconthea</i> |

| | |
|----|------------------------------------------------------|
| 19 | Common Mormon – <i>Papilio polytes</i> |
| 20 | Common Lime – <i>Papilio demoleus</i> |
| 21 | Blue Mormon – <i>Papilio polynemstor</i> |
| 22 | Double Branded Black Crow – <i>Euploea sylvester</i> |
| 23 | Dark Cerulean – <i>Jamides bochus</i> |
| 24 | Common Banded Awl – <i>Hasora chromus</i> |
| 25 | Pea Blue - <i>Lampides boeticus</i> |
| 26 | Blue Tiger – <i>Tirumala septentrionis</i> |
| 27 | Tawny Coster – <i>Acraea terpsicore</i> |
| 28 | Tiny Grass Blue – <i>Zizula hylax</i> |
| 29 | Zebra Blue – <i>Leptotes plinius</i> |
| 30 | Mottled Emigrant – <i>Catopsilia pyranthe</i> |
| 31 | Dark Grass Blue – <i>Zizeeria karsandra</i> |
| 32 | Yellow Pansy - <i>Junonia hierta</i> |
| 33 | Crimson Tip - <i>Colotis danae</i> |
| 34 | White Orange Tip - <i>Ixias marianne</i> |
| 35 | Common four Ring - <i>Ypthima huebneri</i> |
| 36 | Common Jay - <i>Graphium doson</i> |
| 37 | Common Crow - <i>Euploea core</i> |

Appendix - 5: Recommended Flora to Support Birds

| Common Name | Scientific Name | Comments |
|------------------------------------|--------------------------------|----------------------|
| Ficus (Aathi hannu) | <i>Ficus recemosa</i> | Fruit yielding |
| Paper mulberry | <i>Broussonetia papyrifera</i> | Fruit yielding |
| Jamun (Sanna Nerale Mara) | <i>Syzygium cumini</i> | Fruit yielding |
| Bottle Brush | <i>Callistemon lanceolatus</i> | Nectar yielding |
| Jacaranda | <i>Jacaranda mimosifolia</i> | Nectar yielding |
| Tubular Hibiscus (Kolave Dasavala) | <i>Malvaviscus arboreus</i> | Nectar yielding bush |
| Orange Trumpet Flower | <i>Tecoma smithii</i> | Nectar yielding bush |

Appendix - 6: Bird and Butterfly Attracting Plants

Butterfly attracting bushes

| Sl. No | Common Name | Scientific Name | Method of Planting |
|--------|--------------------------------------|---------------------------|-----------------------------------------------------------------|
| 1. | Ivory Wood (Beppale/ Kodmurki) | Wrightia tinctoria | Single trees in corners |
| 2. | Star Cluster | Pentas lanceolata | In lawn corners or 15-20 bushes along borders on opposite sides |
| 3. | Indian Caper (Kathiramullu) | Capparis sepiaria | Thorny bush: 2-3 bushes between corners |
| 4. | Aristolochia | Aristolochia bracteolata | |
| 5. | Cherry Pie | Heliotropium arborescens | As low hedge as lawn borders |
| 6. | Pink snakeweed | Starchytarphata mutabilis | 20 plants as a dense patch between two corners |
| 7. | Ornamental Lantana | Lantana Camera | Small patches of 5-6 plants |

Fruit yielding bushes/ trees

| Sl. No. | Common Name | Scientific Name | Method of Planting |
|---------|-------------------------------------------------------|------------------------|-------------------------------------------------------------------------|
| 1. | Neem (Bhevu) | Azadirachta indica | Single and both together |
| 2. | Peepul (Aarali Mara) | Ficus religiosa | Single and both together |
| 3. | Ficus (Aathi hannu) | Ficus recemosa | Single |
| 4. | Singapore Cherry / Jamaican Cherry (Gasagase Mara) | Muntingia calabura | Row Planting or 4-5 trees in a dense cluster or behind every park bench |
| 5. | Banyan (Goni Mara) | Ficus benghalensis | Single in a open area and in a corner |
| 6. | Mulberry (Hippu Nerale) | Morus alba | A cluster of 4-5 plants in unused area |
| 7. | Jamun (Sanna Nerale Mara) | Syzygium cumini | Single in a open area and in a corner |
| 8. | Bastard's Sandle (Devadaru/ Jivadali) | Erythroxylum monogynum | 4 Single bushes in a corner |
| 9. | Indian Snow Berry (Bilehuli Gida) | Securinega leucopyrus | 2-3 bushes well away from visitor area |

Nectar yielding bushes

| Sl. No. | Common Name | Scientific Name | Method of Planting |
|---------|-------------------------------------|---------------------------|-----------------------------------------------------|
| 1. | Erythrina | Erythrina crista-galli | 15-20 bushes in a row along the lawn border |
| 2. | Tubular Hibiscus (Kolave Dasavala) | Malvaviscus arboreus | 10-15 bushes as a dense hedge |
| 3. | East Indian Screw Tree (Karurigida) | Helecteres isora | 4-5 bushes singly in park borders |
| 4. | Powder-puff | Calliandra haematocephala | 15-20 bushes in a row along the lawn or park border |
| 5. | Orange Trumpet Flower | Tecoma smithii | 2-3 bushes in park corners |
| 6. | Scarlet Bush | Hamelia patens | Scattered bushes in lawn corners |
| 7. | Cup and Saucer Bush | Holmskioldea sanguinea | 15-20 round bushes in a row along the lawn border |
| 8. | Fire-Flame Bush | Woodfordia fruticosa | |
| 9. | Pink Snakeweed | Stachytarpheta mutabilis | 20 plants as a dense patch between two corners |
| 10. | Queen's Wreath | Petrea volubilis | Scattered bushes along park borders |

Nectar yielding trees

| Sl. No. | Common Name | Scientific Name | Method of Planting |
|---------|-------------------------------------------------|---------------------------|----------------------------------------------------------|
| 1. | Red Silk Cotton (Buruga) | Bombax ceiba | Single in a open area and in a corner |
| 2. | Flame of the forest (Muthuga) | Butea monosperma | 3-4 trees in a cluster |
| 3. | Indian Coral Tree (Harivana) | Erythrina indica/verigata | 4-5 trees in a cluster |
| 4. | Erythrina (Mullu muruku) | Erythrina suberosa | Single trees in park corners |
| 5. | Eryrhina (Keechige) | Erythrina stricta | 4 Single trees in park corners |
| 6. | Bottle Brush | Callistemon lanceolatus | 5-6 trees in a row along park border on opposite sides |
| 7. | Indian Cork Tree (Birate mara/ Aakasha Mallige) | Millingtonia hortensis | 4-5 trees singly in corners or borders on opposite sides |

| | | | |
|-----|--------------------------------|-------------------------|-----------------------------------------------|
| 8. | Badminton ball Tree | Parkia biglandulosa | Single tree in a open area and in a corner |
| 9. | Jacaranda | Jacaranda mimosifolia | 4-5 scattered trees along borders |
| 10. | Red Tulip Tree | Spathodea campanulata | Single trees in corners or in between corners |
| 11. | White Silk Cotton (Kaduburuga) | Cochlospermum gossypium | Single tree in a corner |
| 12. | Scarlet-Sterculia | Firmiana colorata | Single tree in a corner |

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