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RESEARCH ARTICLE

BIODIVERSITY STUDY OF LAKE SHORELINES OF BENGALURU PERI URBAN AREA AND ITS MANAGEMENT.

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Abstract

Lakes are the most productive and biologically rich endangered ecosystems and they function as an interface between land and water systems and its Biodiversity severely are threatened globally by inappropriate management measures taken for protection of Lake Shorelines. To bear out the point of the Biodiversity Study of Lake Shoreline of Bengaluru peri urban area and its management, 7 lakes namely Dorekere lake, Hosakerehalli lake and Subramanyapura lake, Margondanahalli Hosakere lake, Kommaghatta lake, Bandematta lake and Byramangala lake were selected for sampling in the peri-urban area of Vrishabhavathi river basin in Byramangala series. Biodiversity Study for the Identification of Flora and Fauna in the Shoreline of Studied lakes were carried out by following the methods of William (2006), Subramanian, (2005; 2009), Mark *et al.*, (2000), Richard *et al.*, (2002), Krushnamegh Kunte (2008), Jayaram, (1999), Rema and Indra (2009), Hutchins *et al.*, (2003); Nelson, (2006); Quentin Richard and Moore (2008), Fredrick *et al.*, (2011), Bookhout (1994), Donald and Richard (1970), Meenakshi Venkataraman (2010), Subramanian and Sivaramakrishnan (2007) and Karen Edelstein (1999). The overall recorded number of species of Flora and Fauna in the study area were recorded between 146 species to 171 species. They were found to be highest in number of species presence is due to recent rejuvenation and plantation programmes carried out in the studied lakes, the local associations and citizens have also adopted the plants for the maintenance and protection, are in the less populated zone, and are situated away from the village and near to reserve forest cover. The less no of species were found due to the lakes situated in urbanised and industrialised area.

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Introduction:-

The environmental condition of any Lake system depends upon the nature of that lakes and its exposure to various ecological factors. These fragile ecosystems must maintain the state of environmental equilibrium with the existing condition of the surroundings. Lakes are the most productive and biologically rich endangered ecosystems and they function as an interface between land and water systems. They filter sediments and nutrients from surface water and support all life forms through extensive food webs and biodiversity such as critical habitat for plants and animals

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together with bacteria, fungi, algae, plankton, mussels, snails, crustaceans, insects, fish, amphibians, reptiles, birds and mammals. These types of Lake Biodiversity severely are threatened globally by inappropriate management measures taken for protection of Lake Shorelines.

Materials And Methods:-

Description of Study Area:

To bear out the point of the Biodiversity Study of Lake Shoreline of Bengaluru peri urban area and its management, 7 lakes namely Dorekere lake, Hosakerehalli lake and Subramanyapura lake, Margondanahalli Hosakere lake, Kommaghatta lake, Bandematta lake and Byramangala lake were selected for sampling in the peri-urban area of Vrishabhavathi river basin in Byramangala series.

Table 1:-Coordinates indicating the lakes in the study area

Name of the lake	Latitude	Longitude
Margondanahalli Hosakere	12°56'07.98"N	77°26'01.43"E
Kommaghatta	12°55'49.12"N	77°27'58.69"E
Bandematta	12°55'28.25"N	77°28'51.75"E
Hosakerehalli	12°52'54.36"N	77°53'39.93"E
Dorekere	12°50'29.04"N	77°51'10.67"E
Subramanyapura	12°49'68.74"N	77°54'24.69"E
Byramangala	12°45'55.42"N	77°41'85.16"E

The following are the methods followed for the Identification of Flora and Fauna in the Shoreline of Studied lakes and tabulated in terms of presence or absence;

Trees in the 50m vicinity of water-bodies were individually counted to assessing the densities of large trees (William, 2006).

Shrubs and Herbs in the vicinity of water-bodies were quantified by using the intensive quadrant. The quadrant was in square shape, which adapted to characterise the floral community. For the herbaceous plants 1m x 1m quadrant was made (William, 2006).

Aquatic plants include floating plants, submerged and rooted plants which were quantified by using 1m x 1m quadrat wooden frame, which is used to sample floating or emergent vegetation on the water surface (William, 2006). To standardize the study, 5 quadrats were laid down in the water-body having dense aquatic vegetation.

Odonates sample was conducted for adult dragonfly and damselfly of the water-bodies from the time of 10.00 to 14.00 (midday), where the most Odonate are active by walking along the offshore where ever possible and if the water-body is large, then a portion of water-body shore was considered. As a rule, dragonflies and damselflies were identified (Subramanian, 2005; 2009) by sight for 30 minutes and occasionally the Odonates was captured by using nets when there was doubt in identification.

Bird sampling strategy was based on 'random stratified sampling' (Mark *et al.*, 2000). Sampling points are randomly located throughout the water-body area to obtain representative samples of the species and numbers of each species. 'Point counts' methodology was followed for essentially strip transects of zero length, in which the count is 360° arcs around a fixed sampling point. The radius of 50m was used and the birds were counted for 10 minutes. Birds that are seen flying over the census area (aerial species) are recorded separately because they cannot be included in standard density estimation. The birds were identified using Binoculars and field guide (Richard *et al.*, 2002).

Butterflies in the water-bodies were sampled by 'searching and direct observation'. The method was adopted especially for productive in fairly open habitats with sparse vegetation; direct observation is clearly the basis of recording day flying butterflies. The sampling was done for 1 hour in the water-body area and repeated for 10 times in a season on fine days (William, 2006). Butterflies were identified by use the field manual by Krushnamegh Kunte (2008).

Fishes found in the water-bodies were identified by collecting the samples by using the experimental multifilament gillnets of varying mesh size from 8 mm. Two fleets of gillnet were set one inshore and another offshore (about 100 m from shoreline). The retrieved fish specimens were sorted; structure determined and identified using external morphological characteristics and identification keys (Jayaram, 1999; Rema and Indra 2009; Hutchins *et al.*, 2003; Nelson, 2006; Quentin Richard and Moore, 2008). Collected fishes were counted on species basis and total numbers of each species caught per study site recorded in a catch composition data sheet (Fredricket *et al.*, 2011).

Mammals, which found in the water-body areas as migration form other than human were evaluated by 'Total counts' (Bookhout, 1994) and 'Holy Grail of mammal census method'.

Insects in and near the water-body was collected by using the 'Sweep net', which was swung through the vegetation to dislodge the specimens. Each sample consists of 10 sweeps considering the area from ground level to 2 meter (Janzen, 1968). Sweep net has 1.5mm mesh size with 30cm diameter and the collected species been identified by followed the manuals of Donald and Richard (1970) and Meenakshi Venkataraman (2010). Aquatic insects was carried out by taking a fixed number of sweeps, netting for a set period (typically up to 3 minutes, during which time the net may need emptying as it becomes clogged with vegetation) or continuing to samples and sort the catch for a set period (typically 30–45 min)(William, 2006). The aquatic insects were identified by following the field manual by Subramanian and Sivaramakrishnan (2007) and Karen Edelstein (1999). All the biodiversity carried out once for the research study during the years between 2012-2015. However, during regular field visits for water sampling time for water quality study, the identification of biodiversity species were documented.

Results & discussion:-

In the Peri urban area of Bengaluru, water bodies covers have attained an important ecological status as the lakes have turned into lentic-closed water habitats. These lakes form a characteristic extremely rare system and habituated different types of biodiversity.

The following are the biodiversity species were identified in the studied lakes. Herbs and Shrubs: A maximum of around 37 species of Herbs and shrubs were recorded in Byramangala lake and a minimum of 28 species in Bandematta lake (Annexure 2). Aquatic Plants: A maximum of around 13 species of aquatic plants were recorded in both Hosakerehalli lake and Dorekere lake and a minimum of 3 species in Bandematta lake (Annexure 3). Trees: A maximum of around 21 species of trees were recorded in Hosakerehalli lake and a minimum of 11 species in Margondanahalli Hosakere lake (Annexure 1). Reptiles: Around 6 species of Reptiles were recorded in Bandematta lake, Hosakerehalli lake and Dorekere lake and only 3 species were recorded in Bandematta lake (Annexure 4). Odonates: 16 species of Odonates were recorded in Kommaghatta lake and 7 species in Subramanayapura lake (Annexure 5). Birds: A maximum of around 38 species of Birds were recorded in Kommaghatta lake and a minimum of 19 species in Hosakerehalli lake (Annexure 6). Butterflies: 24 species of Butterflies were recorded in Dorekere lake and 10 species in Byramangala lake (Annexure 7). Mammals: Around 9 species of Mammals were recorded in Margondanahalli Hosakere lake and only 4 species in Hosakerehalli lake (Annexure 9). Insects: 21 species of Insects were recorded in Bandematta lake and 12 species in Kommaghatta lake (Annexure 10). Fishes: 10 species of Fishes were recorded in Kommaghatta lake and only one species in Bandematta lake (Annexure 8).

The following plate details are the main examples of Flora and Fauna identified with common names.



Plate 1: Common Cattail and Alligator weed



Plate 2: Indian lotus



Plate 3: Rain tree



Plate 4: Peninsular Rock Agama



Plate 5: Ditch Jewel



Plate 6: Spot Billed duck



Plate 7: Common Emigrant



Plate 8: Cattles



Plate 9: Water Strider



Plate 10: Mrigal

The overall recorded species of Flora and Fauna in the decreasing order are as follows: Kommaghatta lake (171 species)> Dorekere lake (169 species)> Margondanahalli Hosakere lake (161 species)> Subramanayapura lake (159 species) > Byramangala lake (157 species) > Bandematta lake (148 species)> Hosakerehalli lake (146 species). It was observed that, the various decaying weeds in the lakes formed floating vegetation islands/mats which deteriorate habitat quality and also interfere with foraging activities of water birds as observed by Bhatnagar *et al.*, (2007). Further birds' nests were not found in these weeds. Mukherjee *et al.*, (2002) reported that aquatic weeds and short vegetation are not suitable for nesting. In addition to the weeds, other factors affecting the water bird populations in various lakes were due to fishing.

Kommaghatta Lake and Dorekere Lakes were found to be highest in species diversity; this is due to recent rejuvenation and plantation programmes carried out in these lakes. These two lakes are having the Islands and were recorded highest Bird species diversity. The local associations and citizens have also adopted the plants for the maintenance and protection. Next species diversity was recorded in Margondanahalli Hosakere as it is in the less populated zone; the lake is situated away from the village and near to Sulikere reserve forest. The shorelines of these lakes are also well maintained and hence, the recorded species were found maximum in these lakes. The lakes are situated in urbanised and industrialised area and the shorelines of these lakes are facing issues like encroachment, sewage entry and waste dumping. Similarly the study of Erickson (2011) revealed that, biodiversity of lakes helped in cleaning of larger water bodies by removing the nitrate pollutants. Research study of Meli *et al.*, (2014) revealed that, ecological restoration of wetlands will increase both biodiversity and provides many ecosystem services such as water quality.

Bio diversity in and around lakes and its management

The lakes in the study area are maintained by the authorities such as BDA, BBMP and Zilla Panchayath of Bengaluru Urban district. The authorities should maintain buffer zones around the lakes and at the upstream of lakes, which should be made mandatory for the conservation of biodiversity.

In all the lakes in the study area only horticultural Plantations have been planted, native species are not maintained. The existing conditions of lakes including water quality can be improved by protecting the native species in and around lakes. The regular monitoring and surveys using GIS and Remote sensing techniques will help in giving vegetation cover database of lakes.

Sustainable management of water and sanitation for all lakes ensure fresh water, help replenish ground aquifers, and purify and filter harmful waste from water such as fertilizers and pesticides, as well as heavy metals and toxins. There is a need to conserve and maintain the vegetation of the wetlands that help in absorbing these harmful toxins. Sustainable management of lakes can also be achieved through participation of local communities, nature conservation organisations and fishing associations as cooperation partners in the lake management. Policy incentives to encourage nature conservation are emerging around the world, and yet this trend remains handicapped by a lack of understanding of the economic benefits of conserving Biodiversity, therefore it is recommended that appropriate policy incentivise are to be developed and employed.

Conclusion:-

The Bengaluru periphery area experiencing accelerated growth with changes in ecosystems, land use and governance leading to impacts on freshwater ecosystems and its biodiversity. Managing of these area lakes is a challenging mission for the sustainable development of Bengaluru. Biodiversity is to be considered as a prime point of conservation by adopting the good lake shoreline management techniques or practices by the dogmatic authorities such as maintaining buffer zones around the lakes and at the upstream of lakes, the native species in and around lakes, regular monitoring and surveys using GIS and Remote sensing techniques, by adopting Sustainable management of water and sanitation encouraging the Policy incentives for conserving the lakes.

Annexure 1:-List of Tree species recorded during the study period in and around lakes

Scientific name	Common Name	Margondanahalli Hosakere	Kommaghatta	Endemat	Hosakeralli	Coreker	Subramanyapur	Byramangala
<i>Ficus religiosa</i>	Peepal Tree	+	+	+			+	+
<i>Bamboo sp.</i>	Bamboo	+	+	+			+	+
<i>Phoenix sylvestris</i>	Jack fruit tree	+	+	+			+	+
<i>Areca catechu</i>	Aracanut tree	-	-	+			-	+
<i>Pongamia pinnata</i>	Pongam	+	+	-			+	+
<i>Cocunucifera</i>	Coconut Tree	+	+	+			+	+
<i>Tamarindus indica</i>	Tamarind Tree	+	+	+			+	+
<i>Samanea saman</i>	Rain Tree	-	-	+			-	+
<i>Azadirachta indica</i>	Neem Tree	+	-	+			+	+
<i>Tectonag</i>	Te	+	+	+			+	-

<i>randis</i>	ak Wood tree							
<i>Eucalyptus sp.</i>	Eucalyptus tree	+	+	+			+	+
<i>Casuarinaequisetifolia</i>	Casuarina Tree	+	-	+			+	+
<i>Acacia auriculiformis</i>	Acacia	-	+	+			+	+
<i>Mangifera indica</i>	Mango tree	-	-	-			-	+
<i>Grevillea robusta</i>	Silver Oak	+	+	+			-	+
<i>Dalbergiasissoo</i>	Indian rosewood	-	+	+			+	+
<i>Muntingia calabura</i>	Jamaica Cherry	-	+	+			+	+
<i>Peltophorumpterocarpum</i>	Copper Pod	-	+	+			+	+
<i>Acacia nilotica</i>	Abul	-	+	+			+	+
<i>FicusBen galensis</i>	Banyan Tree	-	+	+			+	+
<i>ArtocarpusHeterophylla</i>	Jack fruit tree	-	+	+			+	+
<i>Delonixregia</i>	Golden Mohar tree	-	+	+			+	+

Annexure 2:-List of Herbs and Shrubs species recorded during the study period in and around lakes

Scientific name	Common Name	Mar gondanahalli Hosakere	K ommaghatta	and e atta	osaker e alli	ore ere	S ubramanya p ura	B yramang ala
<i>Cynodon dactylon</i>	Grass	+	+				+	+
<i>Mimosa pudica</i>	To uch Me not	+	+				+	+
<i>Borreria stricta</i>	Ta rtaval	+	+				+	+
<i>Parthenium hysterophorus</i>	Par thenium	-	+				+	-
<i>Euphorbia hirta</i>	Ca ts hair, asthma weed	+	+				-	-
<i>Ipomoea carnea</i>	Pin k morning glory	+	+				-	+
<i>Amaranthus spinosus</i>	Spi ny	+	+				+	+

	amaranth							
<i>Lantana camara</i>	Sp anish Flag	+	+				+	+
<i>Calotropis gigantea</i>	Gi gantic swallow wort	+	+				+	+
<i>Eupatorium rugosum</i>	W hite Snake root	-	-				+	+
<i>Passiflora foetida</i>	Co mmon Passion Flower	-	+				+	+
<i>Canthium sp.</i>	Co romandel Boxwood	+	+				+	+
<i>Polygonum mglabrum</i>	Co mmon Marsh Buckwheat	+	+				+	+
<i>Achyranthes aspera</i>	Pri ckly Chaff- flower	+	+				-	+
<i>Stachytarpheta indica</i>	Ind ian snakeweed	+	+				-	+
<i>Colocasia esculenta</i>	Ele phant ear	+	+				+	+
<i>Croton bonplandianum</i>	Ba n tulsi	+	+				+	+
<i>Ricinus communis</i>	Ca stor Oil Plant	+	+				+	+
<i>Ziziphus zeyhu</i>	Juj ube	+	+				+	-
<i>Gomphrena sp.</i>	Co mmon globe amaranth	-	+				+	+
<i>Cassia auriculata</i>	Ta nner's Cassia	-	-				+	+
<i>Hamelia patens</i>	Sc arlet Bush	+	-				+	+
<i>Datura sp.</i>	Th ornapple	+	+				+	+
<i>Cassia tora</i>	Fo etid cassia	+	+				+	+
<i>Solanum torum</i>	Tu rkey Berry	+	+				-	+
<i>Cortaderia sp.</i>	Fe athery grass	+	+				+	+
<i>Pavonia eylanica</i>	Le ad wort-	+	+				+	+

	white flowered							
<i>Vitexnegundo</i>	Common Chaste Tree	+	+				+	+
<i>Dodonaeaviscosa</i>	Ho p Bush	-	-				+	-
<i>Barleria</i> <i>sp.</i>	La vender Lace	-	-				+	+
<i>Leucasaspera</i>	Common Leucas	-	+				+	+
<i>Tephrosia</i> <i>tinctoria</i>	Orange Tephrosia	+	+				+	+
<i>Tridaxprocumbens</i>	Dh aman grass	+	+				+	-
<i>Xanthium</i> <i>strumarium</i>	Common Cocklebur	+	+				+	+
<i>Evolvulus</i> <i>sp.</i>	Blue daze	-	+				+	+
<i>Indigofera</i> <i>a sp.</i>	Sil ky Indigo	-	-				+	+
<i>Hybanthusenneaspermus</i>	Sp ade flowewr	+	-				+	+
<i>Borreriahispidia</i>	Th aarthaval	+	+				-	+
<i>Abutilon</i> <i>indicum</i>	Kh angi	+	+				+	+
<i>Striga sp.</i>	As iatic witchweed	+	+				+	+
<i>Oxalis</i> <i>tetraphylla</i>	Iro n Cross	+	+				+	+
<i>Bacopam</i> <i>onnieri</i>	Br ahmi	+	+				+	+

Annexure 3:-List of Aquatic species recorded during the study period in studied lakes

Scientific name	Common Name	Margondanahalli Hosakere	Kommaghatta	Bandematla	Hosakerhalli	Korekere	Subramanyapuram	Byramangala
<i>Typha sp.</i>	Common Cattail	-	+	+			+	+
<i>Hydrillaverticillata</i>	Hydrilla	+	+	-			+	-
<i>Lemna minor</i>	Lesser Duckweed	+	+	-			+	-
<i>Nymphaea sp.</i>	Red water	+	-	-			+	-

	Lily							
<i>Chara</i> <i>sp.</i>	C hara	+	-	-			+	-
<i>Eichhorn</i> <i>iacrassipes</i>	W ater Hyacinth	-	+	+			+	+
<i>Aponoget</i> <i>onnatans</i>	Fl oating Lace Plant	+	+	-			+	-
<i>Cyperusa</i> <i>rticulatus</i>	jo inted flatsedge	+	+	-			-	-
<i>Alternant</i> <i>heraphiloxeroides</i>	A lligatorwee d	+	+	+			+	+
<i>Elodea</i> <i>sp.</i>	P ondweed	+	+	-			+	-
<i>Potamog</i> <i>etonillinoensis</i>	Ill inois pondweed	+	+	-			+	-
<i>Nelumbo</i> <i>nucifera</i>	In dian lotus	+	+	-			+	-
<i>Marsilea</i> <i>sp.</i>	W ater Clover	+	+	-			+	-

Annexure 4:-List of Reptiles species recorded during the study period in studied lakes

Scientifi c name	C ommon Name	Ma rgondanahal li Hosakere	K ommagha tta	E andemat ta	osaker e alli	oreker e	S ubramana ya p ura	B yramang ala
<i>Psammo</i> <i>philusdorsalis</i>	Pe ninsular Rock Agama	+	+	+	+	+	+	+
<i>Agama</i> <i>atra</i>	So thern Rock Agama	+	+	+	+	+	+	+
<i>Calotesv</i> <i>ersicolor</i>	C ommon Garden Lizard	+	+	+	+	+	+	+
<i>Mabuya</i> <i>carinata</i>	C ommon Skink	-	-	+	+	+	-	+
<i>Najanaja</i>	In dian Cobra	+	-	-	-	-	-	-
<i>Hoploba</i> <i>trachustigerinus</i>	In dian Bull Frog	+	+	+	+	+	+	+
<i>Bufo</i> <i>melanostictus</i>	C ommon Indian Toad	-	-	+	+	+	-	+

Note: PRESENT (+); ABSENT (-)

Annexure 5:-List of Odonates species recorded during the study period in studied lakes

Scientific name	Common Name	Margondanahalli Hosakere	Kommaghatta	Andeatta	Hosakerealli	Coreere	Subramanya pura	Biyamangala
<i>Trithemis aurora</i>	Crimson Marsh Glider	+	+				+	+
<i>Brachythemis contaminata</i>	Ditch Jewel	+	+				+	+
<i>Brachydiplax sobrina</i>	Little Blue Marsh Hawk	+	+				+	+
<i>Ictinogomphus rapax</i>	Common Clubtail	-	+				-	+
<i>Rhyothemis variegata</i>	Common picture wing	-	-				-	-
<i>Orthetrum sabina</i>	Green Marsh Hawk	+	+				-	-
<i>Diplacodes trivialis</i>	Ground Skimmer	+	-				-	+
<i>Crocothemis servilia</i>	Ruddy Marsh Skimmer	+	-				-	-
<i>Rhodothemis rufa</i>	Rufous Marsh Glider	-	+				-	-
<i>Orthetrum luzonicum</i>	Tricoloured Marsh Hawk	-	+				+	-
<i>Tramea limbatata</i>	Black marsh trotter	-	+				-	+
<i>Anax guttatus</i>	Blue tailed green darner	-	+				-	+
<i>Paragomphus slineatus</i>	Common Hooktail	+	+				-	-
<i>Trithemis pallidinervis</i>	Long legged marsh glider	+	+				-	-
<i>Pseudagrion</i>	Bl	+	-				-	-

<i>microcephalum</i>	ue Grass Darlet							
<i>Ceriagrion coromandelianum</i>	Co romandel Marsh Dart	-	-				+	+
<i>Ischnura aurora</i>	Go lden dartlet	+	+				+	-
<i>Agriocnemis pygmaea</i>	Pi gmy Dartlet	-	+				-	-
<i>Lestes praemorsus</i>	Sa pphire-eyed Spreadwing	+	+				-	-
<i>Ischnurasene galensis</i>	Se negal Golden Dartlet	-	+				-	+
<i>Disparoneura aquadrimaculata</i>	Bl ack-winged Bamboo Tail	-	+				-	+
<i>Lestes elatus</i>	E merald spread wing	-	-				+	-
<i>Trithemis aurora</i>	Cr imson Marsh Glider	+	+				+	+

Note: PRESENT (+); ABSENT (-)

Annexure 6:-List of Birds species recorded during the study period in studied lakes

Scientific Name	Common Name	Margondanahalli Hosakere	Kommaghatta	Bandematta	Hosakerehalli	Dorekere	Subramanayapura	Byramangala
<i>Anas pectoratorrhynchos</i>	Spot Billed Duck	+	+					-
<i>Vanellus indicus</i>	Red wattled lapwing	-	+					-
<i>Hydrophasianus chirurgus</i>	Pheasant tailed Jacana	-	+					+
<i>Himantopus himantopus</i>	Black Winged Stilt	-	+					+
<i>Egretta garzetta</i>	Little Egret	+	+					-
<i>Streptopelia chinensis</i>	Spotted dove	-	+					-
<i>Alcedo atthis</i>	Common Kingfisher	+	+					+
<i>Ceryle alcyon</i>	Pied kingfisher	+	+					+
<i>Halcyon smyrnensis</i>	White throated king fisher	+	+					+
<i>Merops orientalis</i>	Green Bee eater	+	+					-

<i>Eudyna mysscolopacea</i>	Asian Koel	+	+					+
<i>Milvus migrans</i>	Black Kite	+	+					+
<i>Haliastur rindus</i>	Brahminy kite	+	+					-
<i>Accipiter badius</i>	Shikra	-	+					+
<i>Fulica atra</i>	Common coot	+	+					+
<i>Porphyrio porphyrio</i>	Purple Swampphen	+	+					+
<i>Prinias cialis</i>	Ashy Prinia	+	+					-
<i>Prinia ornata</i>	Plain prinia	+	+					+
<i>Cisticola ajuncidis</i>	ZittingCisticola	-	-					+
<i>Corvus splendens</i>	Common crow	+	+					+
<i>Dicrurus macrocercus</i>	Black Drongo	+	+					+
<i>Hirundo rustica</i>	Barn Swallow	+	+					+
<i>Anthus rufulus</i>	Paddyfield Pipit	-	-					+
<i>Motacilla amaderaspatensis</i>	White browed wagtail	+	+					+
<i>Copsychus saularis</i>	Oriental Magpie Robin	-	+					+
<i>Saxicola caprata</i>	Pied Bushchat	+	-					+
<i>Nectarinia zeylonica</i>	Purple Rumped Sun Bird	-	+					+
<i>Passer domesticus</i>	House sparrow	-	-					+
<i>Ploceus philippinus</i>	Baya Weaver	-	-					+
<i>Pycnonotus cafer</i>	Red vented bulbul	-	+					-
<i>Pycnonotus jocosus</i>	Red whiskered bulbul	+	+					+
<i>Acridothera tristis</i>	Myna	-	-					+
<i>Anhinga melanogaster</i>	Darter	+	+					-
<i>Nycticorax nycticorax</i>	Black Crowned Night Heron	+	-					+
<i>Bubulcus ibis</i>	Cattle Egret	+	+					+
<i>Ardeotis nerea</i>	Grey Heron	+	+					+
<i>Ardeola</i>	Indian	+	+					-

<i>grayii</i>	Pond heron							
<i>Mesophoxintermedia</i>	Intermediate egret	+	+					+
<i>Ardeapurplea</i>	Purple Heron	+	+					+
<i>Pelecanusphilippensis</i>	Spot Billed Pelicans	+	-					+
<i>Phalacrocoraxcarbo</i>	Great Cormorant	+	+					+
<i>Phalacrocoraxniger</i>	Little cormorant	+	+					+
<i>Pseudibispapillosa</i>	Black Headed Ibis	+	-					+
<i>Megalaimazeylanica</i>	Brown headed barbet	+	+					+
<i>Megalaimahamacephala</i>	Copper smith barbet	-	+					+
<i>Tachybatusruficollis</i>	Little Grebe	+	+					+

Note: PRESENT (+); ABSENT (-)

Annexure 7:-List of Butterflies species recorded during the study period in studied lakes

Scientific Name	Common Name	Margondana Halli Hosakere	Kommaghatta	Handematta	Hosakerehalli	Korekere	Subramanayapura	Byramangala
<i>Castaliusrosimon</i>	Common Pierrot	+	+	+	+		+	-
<i>Freyeriachrylus</i>	Rassjewel	+	+	+	+		+	-
<i>Jamidesceleno</i>	Common Cerulean	+	+	+	+		-	-
<i>Lampidesboeticus</i>	Sea Blue	-	+	+	-		-	-
<i>Leptotesplinius</i>	Sea Blue	+	+	+	-		+	+
<i>Pseudozizeerimaha</i>	Male Grass Blue	-	+	-	-		+	-
<i>Ariadne merione</i>	Common castor	-	+	+	+		+	-
<i>Danauschrysippus</i>	Indian Tiger	+	+	-	-		-	+
<i>Elymnias hypermenestra</i>	Common Palmfly	-	-	+	-		+	+

<i>Euplo ae core</i>	ommon Indian Crow	+	+	+	+		+	-
<i>Hypoli mnasbolina</i>	reat Eggfly	-	-	+	-		-	-
<i>Junoni aalmana</i>	eacock pansy	+	+	+	-		+	+
<i>Junoni ahierta</i>	ellow Pansy	+	+	+	+		+	+
<i>Junoni aiphita</i>	hocolat e pansy	+	+	+	+		+	+
<i>Mycal esisperseus</i>	ommon Bushbr own	-	+	+	-		+	-
<i>Tirum alalimniace</i>	lue tiger	+	+	-	-		-	+
<i>Pachli opta hector</i>	rimson Rose	-	+	+	+		-	+
<i>Graph iumagamemnon</i>	ailed Jay	-	-	-	+		+	-
<i>Graph iumdoson</i>	ommon Jay	+	-	-	+		+	-
<i>Pachli optaaristolochi ae</i>	ommon Rose	+	+	-	-		+	+
<i>Papili opolytes</i>	ommon Mormo n	+	-	+	+		-	-
<i>Coloti setrida</i>	mall Orange Tip	+	-	-	-		+	-
<i>Anaph aeisaurola</i>	ioneer	+	-	+	+		+	-
<i>Catops iliapomona</i>	ommon Emigra nt	+	+	+	+		-	+
<i>Catops iliapyranthe</i>	ottled Emigra nt	+	+	+	+		-	-
<i>Eurem ahecabe</i>	ommon	+	+	+	+		+	-

	Grass Yellow							
<i>Leptos ianina</i>	syche	+	+	-	+		-	-

Note: PRESENT (+); ABSENT (-)

Annexure 8:-List of Fish species recorded during the study period in studied lakes

Scientific Name	Common Name	Margondanahalli Hosakere	Kommaghatta	Bandematta	Hosakerehalli	Dorekere	Subramanayapura	Byramangala
<i>Catlacatla</i>	Indian carp	+	+	-	+	-	+	+
<i>Labeorohita</i>	Rohitorrohu	+	+	-	-	+	-	-
<i>Cirrhinus mrigala</i>	Mrigal	+	+	-	-	+	-	+
<i>Cyprinus carpio</i>	Common carp	+	+	-	-	+	+	-
<i>Hypophthalmichthys molitrix</i>	Silver carp	+	+	-	-	+	-	-
<i>Amblypharyngodon mola</i>	Molacarpenter	+	+	-	+	+	-	-
<i>Etroplus suratensis</i>	Pearl Spot	+	+	-	-	-	-	-
<i>Channa marulius</i>	Murrels	+	+	-	-	+	-	+
<i>Oreochromis mossambicus</i>	Tilapia	+	+	+	+	+	+	+
<i>Heteropneustes fossilis</i>	Catfishes	-	+	-	+	-	-	+
<i>Channa punctatus</i>	Spotted snake head (Korava)	+	-	-	-	+	+	+
<i>Clarias farias</i>	African catfish (Marve Fish)	-	-	-	+	-	-	+

Note: PRESENT (+); ABSENT (-)

Annexure 9:-List of Mammals species recorded during the study period in studied lakes

Scientific Name	Common Name	Margondanahalli Hosakere	Kommaghatta	Bandematta	Hosakerehalli	Dorekere	Subramanayapura	Byramangala
<i>Bos indicus</i>	Cow	+	+	+	-		+	+
<i>Bubalus bubalis</i>	Buffalo	+	+	+	-		+	-
<i>Ovis montanus</i>	Sheep	+	+	+	-		-	+
<i>Capreolus capreolus</i>	Gorbat	+	+	+	-		+	+
<i>Herpestes javanicus</i>	Mongoose	+	-	+	-		+	-
<i>Bandicota bengalensis</i>	Bandicoot Rat	+	+	+	+		+	+
<i>Felis tigris</i>	S	+	+	+	+		+	+

<i>mbuluspalmarum</i>	quirrel							
<i>Canis familiaris</i>	Dog	+	+	+	+		+	+
<i>Pteropus giganteus</i>	Indian Flying fox	+	+	-	+		-	+

Note: PRESENT (+); ABSENT (-)

Annexure 10:-List of insect species recorded during the study period in studied lakes

Name	Common	Name of the lake/Species	Margondana halli Hosakere	Kommaghatta	Kandematta	Hosakerehalli	Dorekere	Subramanyapura	Byramangala
Spurthroated grass hopper		<i>Cryptacanththeristatarica</i>	+	-					+
Short horned grass hopper		<i>Cistoecrca sp.</i>	-	-					+
		<i>AcridaEuxaltata</i>	+	-					-
		<i>Acridacinerea</i>	-	+					-
Tree Cricket		<i>Phaneroptera sp.</i>	-	+					+
Praying mantis		<i>Mantis religiosa</i>	+	-					+
Domino cackroach		<i>Thereopetiveriana</i>	-	-					+
Termite		<i>Odonatermes sp.</i>	+	+					-
Indian walking Insect		<i>Carausius morosus</i>	+	+					+
Cicada		<i>Platypleura sp.</i>	-	-					+
Leaf Hopper		<i>Eurybrachystomentosa</i>	+	-					-
Water Strider		<i>Gerris sp.</i>	+	+					-
Seed bug		<i>Spilostethus pandurus</i>	-	-					+
Jewel bug		<i>Chrisodoris stolli</i>	+	-					-
Stink bug		<i>Ethensia acuminata</i>	-	-					-
Hydrometra		<i>Hydrometristagnorum</i>	-	-					-
Ranatra		<i>Nepacincerea</i>	-	-					+
Mesovelia		<i>Mesoveliainmulasanti</i>	-	-					-
Gold cross tiger beetle		<i>Cincide laaurofasciata</i>	-	-					+
Bess beetle		<i>Bascilia nusstoliczkae</i>	-	-					+
Elephant Dung beetle		<i>Sisyphus sp.</i>	+	-					-

Shining leaf chafers	<i>Trigono phorousdelisserit i</i>	+	-					-
Jewel beetle	<i>Eurythy rea sp.</i>	+	-					-
Blister beetle	<i>Mylabri spustulata</i>	-	-					-
Mango tree borer	<i>Botocer arufomaculata</i>	-	-					+
water hyacinth weevil	<i>Neochet inaeichhorinae</i>	+	+					+
Darkling beetle	<i>Tenebri o sp.</i>	-	-					+
Bee fly	<i>Argyam eobaaperta</i>	-	-					+
Blow fly	<i>Chryso maya sp.</i>	+	+					-
Flesh fly	<i>Sarcoph agalineaticollis</i>	+	+					+
Vespid wasp	<i>Polistes herbraeus</i>	+	+					-
Spechid Wasp	<i>Sphex sp.</i>	+	+					-
Black Crazy ant	<i>Paratra chinalongicornis</i>	+	+					+
Weaver ant	<i>Oecoph yllasmaragdina</i>	+	+					+
Oriental Honey bee	<i>Apiscer ana</i>	+	-					+
Indian rock bee	<i>Apisdor ceta</i>	-	-					-
Carpenta r bee	<i>Xylocop a sp.</i>	+	-					-
Macrone matini	<i>Macron ema Sp.</i>	-	-					-

Note: PRESENT (+); ABSENT (-)

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