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# Fish diversity and its conservation in major wetlands of Mysore

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***Abstract:*** *The paper highlights the fish diversity in major wetlands of Mysore district, Karnataka, India and its conservation status. Forty-five species of fishes belonging to 15 families, 31 genera have been identified. Fish species belonging to genus Puntius were more common in many of these lakes. However, it was observed that the fish diversity was decreasing since last two years unprecedently, mainly due to manifold human activities. Fish diversity in the lakes is becoming rare and about seven species were identified as endangered. Out of the 45 identified fishes, six fish species were identified as threatened species. Tor khudree, also known as Deccan mahseer and seven other species were identified as vulnerable fish species. Though there were 40 species of fish endemic to this region, their number decreased with introduction of more exotic species. Conservation of endemic fishes, propagation of endangered and threatened fishes should be therefore, undertaken to preserve and protect fish diversity in the wetlands of Mysore district.*

***Key words:*** *Fish, Lakes, Diversity, Endemic, Exotic, Endangered, Threatened*
*PDF of full length paper is available online*

## Introduction

Wetlands provide subsistence and livelihood for people through irrigation and agriculture, fish culture and fishery, domestic use and water transport. These water bodies are the major life supporting systems facing ecological degradation today due to irrational human interference and unsustainable developments. The demographic pressure or the anthropogenic disturbances on our water resources and its ecosystems will irrevocably damage and destroy the rich biodiversity supported by it. Developments are necessary, but it shouldn't be at the cost of damage to the environment and should take place along the rational and sustainable lines. Environmental conservation should be at the base of all developments. It is necessary to ensure that the use of water from these habitats should be within sustainable limits without any environmental stress so that it doesn't affect either the fish biodiversity or the fish productivity.

Mysore district has undulating river like Cauvery on the northern side and its major tributary Kabini on the south-west side. Lakshmanathirtha, Shimla, Lokapavani and Surarnavathi are the other tributaries that flow through the district and it is seen that the drainage of the district is towards the east. The flow of river Cauvery and its tributaries form large number of small and large reservoirs which are the sources of water for cultivation of different crops like sugarcane, paddy, ragi and jowar. Encroachment of the lakes, pollution of air, agricultural and sewage disposal into the lakes and rapid urbanization has apparently caused undesirable change in the climate and lake structure. It was observed that more intense activities in the catchment zones have been a dominant factor causing deterioration of the lake structure and posing a threat to its biodiversity.

The lakes of Mysore are shallow with varied dimensions. No systematic study has been made to know the fish diversity in these lakes keeping in view of fish productivity. Sustainable utilization and management of fishes are lacking. Hence investigations were carried out to assess the fish diversity. Valuable contribution towards better understanding of fish production in ecologically different ponds has been done by workers like Muddanna (1971), Rajagopal *et al.* (1978), Mathew *et al.* (1979) Jayaram (1981), Jhingran (1983), Talwar *et al.* (1991), Harmer (1999) and Kumar (2001), Park and Shin (2007) and Muley *et al*. (2007).

Review of literature showed that the knowledge on the ecology of the lakes of Mysore district and the scope for better utilization of them for sustaining the fish fauna and sustainable fish production were still lacking. With this consideration, during the present study importance was given for assessing the fish diversity and its present status in these wetlands, which provide baseline information for the conservation of fishes in these wetlands.

## Materials and Methods

Mysore district, spreading over an area of 196 sq. km is situated between 13°35 and 11°36 North latitude and 75°55 and 77°20 East longitude. The soil in this region is generally red-laterite, fine-red loam and clay type. It gets rain during both the monsoons, *i.e.* South-west and north-east with an annual rainfall of about 295.0 mm. The season in the year can be distinctly divided as winter (December-February), summer (March-May) and monsoon (June-November) with extremely short spring.

The study area lies in the semiarid region of the deccan plateau at an elevation of 2,250 ft. above the sea level. The presence of many water reservoirs with suitable hydrobiological features enhances the potentials for greater inland fisheries in this region. The lakes selected for study (Fig. 1) are Doora and Kuduregundihalla lakes (Nanjangud taluk), Devibudhi and Yennehole lakes (Mysore taluk), Karigaladodda kere and Paduvakote lakes (H.D Kote taluk), Santhe kere and Karimuddanahally lakes (Hunsur taluk). These irrigation tanks were once used only for agriculture and domestic purposes but are being used today for inland fish culture.

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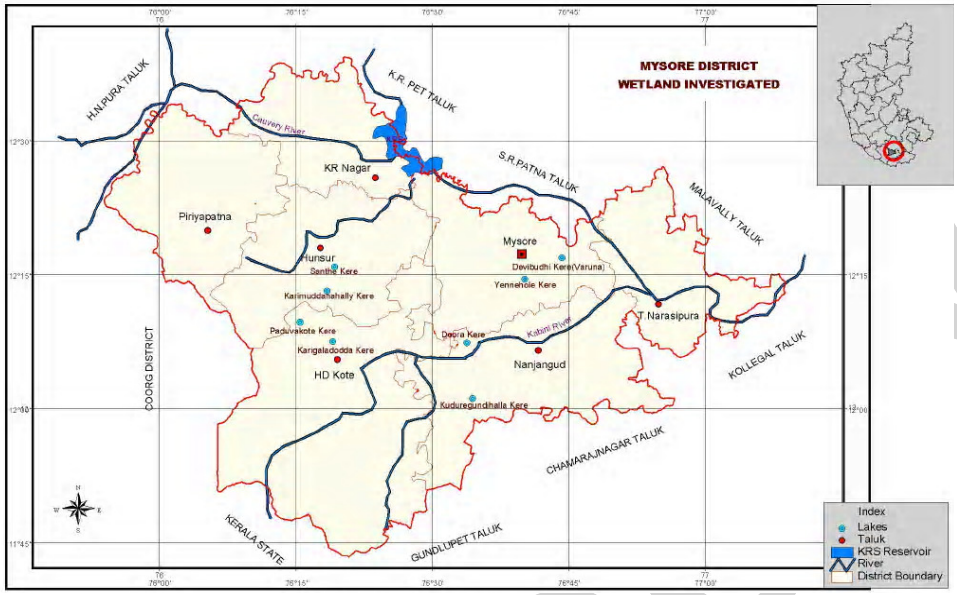


**Fig. 1:** Lakes of Mysore district selected for study

Kuduregundihalla and Karigaladodda lakes are rain filled perennial tanks (Table. 1). Santhekere lake receives supply of water from the Harangi reservoir and supports excessive growth of *Nelumbo*. Karimuddanahally lake receives water from the Lakshmanatheertha tributary of Cauvery and irrigates about 2500 acres of land in its vicinity. Paduvakote lake sometimes tend to retain less water when the annual rainfall is moderate or less. Karigaladodda lake is a perennial lake. Doora lake is a semi-dry tank continuously receives water from Cauvery river basin. Yennehole lake is one of the biggest lakes of Mysore taluk. Devibudhi tank also known as Varuna lake receives sewage occasionally. Yennehole and Devibudhi lakes are polluted to a greater extent than the rest of the lakes. The composite water samples were collected from each of these lakes during winter, summer and monsoon for a period of two years and the physico-chemical parameters were analyzed as per the methods described in APHA (1995).

In the present investigation, fish diversity among endemic and the introduced species for the purpose of fish production were separately studied. The collected fish species were identified by following the methods mentioned by Jayaram (1996) and using the manual of 'Freshwater and Marine fishes of Karnataka (SAA, 2002). Assistance of local fishermen was also taken for collection of fish, identifying the number of fishes present in each catch. Occurrences of the fishes, their distribution were recorded from each lake to understand its conservation status.

## Results and Discussion

During the investigation, 45 species of fish belonging to 15 families and 31 genera including four exotic ones were identified from the eight selected wetlands (Table 2). Of these, family Cyprinidae showed the greatest species richness (22 species), followed by Bagridae (5 species), Channidae (4 species), Notopteridae and Siluridae (2 species), while other families were represented by single species each. Among Cyprinidae, the genus *Puntius* was numerically abundant (5 species) followed by *Labeo* (3 species) and *Cirrhinus* (2 species). Genus *Channa* (4 species) of family Channidae, genus *Mystus* (3 species) and *Aorichthys* (2 species) of family Bagridae were other common genera, while all other genera were represented by a single species. Fishes belonging to genus *Puntius* were more common in the Cauvery river drainage. This genus was represented by *P. arulius arulius, P. carnaticus, P. cauveriensis, P. filamentosus* and *P. sarana.* Fishes belonging to family Channidae, popularly known as 'snake head murrels' were represented by *Channa marulius, C.orientalis, C. punctatus* and *C. striatus*.

Karnataka state has 4.75 lakh hectares of inland waters and about 200 freshwater species recorded from the inland water, of which nearly 40 species are considered 'threatened'. Therefore urgent measures have to be taken for their conservation. According to IUCN 'Red list of threatened animals' (Baillie and Groombridge, 1996), about 20% are freshwater fishes. *Puntius parrah, P. pinnauratus, P. narayani, P. melanostigma, P. puckelli* and *P. sophore* were reported by Jayaram (1981) during their survey of river Cauvery system and its fish fauna. Above mentioned fishes were not found during the present investigation, indicating that probably they have become rare or extinct in this region. Exotic species introduced in these water bodies either with a purpose or accidentally can decimate native species and significantly alter the aquatic food webs. *Oreochromis mossambica* (Tilapia), which has inadvertently entered and dominated most of these lakes like Yennehole lake and Kuduregundihalla lakes are prolific breeders and have multiplied fast to the extent of declining the population of indigenous fish species comprising of *Puntius, Labeo, Cirrhinus, Murrels* and *Catfishes*. Other exotic fish species significantly found in all these wetlands include *Hypophthalmicthys molitrix, Cyprinus carpio, Oreochromis mossambicus* and *Ctenopharyngodon idella.* Culturing few of them was exerting excessive pressure on the endemic fishes. The biodiversity status of fishes in the lakes of

**Table - 1:** Topographical details of the selected wetlands of Mysore district

| Lakes | Distance (Km) from Mysore | Water spread area (ha) | Catchment area (Sq. Km) | Average depth (m) | Bund dimension (m) | Field irrigated ( ha) |
|---|---|---|---|---|---|---|
| Doora kere | 23 | 9.20 | 3.71 | 7 | 750 X 11 | 120 |
| Kuduregundihalla kere | 60 | 93.0 | 67.35 | 8 | 957 X 17 | 810 |
| Devibudhi kere | 12 | 66.0 | 5.49 | 7 | 1200 X 10 | 160 |
| Yennehole kere | 15 | 80.94 | 41.0 | 10 | 1000 X 5 | 1200 |
| Karigaladodda kere | 30 | 26.13 | 26.80 | 9 | 810 X 5 | 800 |
| Paduvakote kere | 42 | 2.60 | 2.54 | 8 | 450 X 4 | 741 |
| Santhe kere | 60 | 70.31 | 60.95 | 8 | 600 X 11 | 1102 |
| Karimuddnahallykere | 40 | 125.86 | 258.27 | 11 | 422 X 18.32 | 2500 |

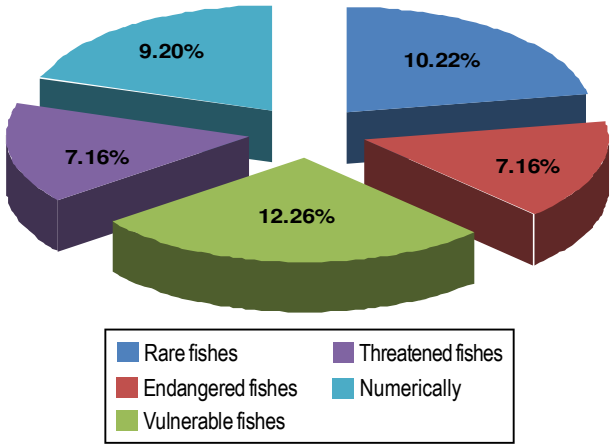


**Fig. 2:** Biodiversity status of fishes in the wetlands of Mysore district

Mysore district is represented in the Fig. 2. It is recorded from all the lakes that 15.5% of the fish species are in endangered state and 13.3% are threatened. About 24% of the fish species have become rare and 17.8% are vulnerable. This is mainly due to unchecked sewage pollution of the lakes leading to eutrophication.

More than 40 species of fish endemic to this region and Cauvery river basin were identified. Out of them, seven were identified as endangered fishes which were in danger of extinction and whose survival is unlikely, if the causal factors namely degradation of the habitats and over utilization of the fish resources continue to operate and happen to negatively influence them. The endangered species were *Puntius cauveriensis, P. filamentosus, Labeo konitus, L. calbasu, Aorichthys aor*, *Channa striatus* and *Gonoproktopterus curmuca.* They are mainly declining owing to the degradation of the habitats. Out of the 45 recorded fish species, 6 species were earmarked as threatened species. *Danio aequipinnatus, Puntius arulius arulius, P. carnaticus, P. sarana, Notopterus notopterus* and *Anguilla bengalensis* were the threatened fish species identified from these eight lakes. About six species of Mahseers are reported as vulnerable fish species of India of which only *Tor khudree,* also known as 'Deccan mahaseer' (Jayaram, 1981) was reported during the present study from Kudregundihalla, Devibudhi and Karimuddanahally lakes. Other than this fish, seven more species were identified as vulnerable fish species. Most vulnerable fish species identified were *Rasbora caverii, Channa marulius, C.orientalis, C.punctatus* and *Clarias batrachus*.

Significantly, 11 fish species were scarcely distributed in these wetlands and were found in less number. Those fishes which are not endangered or vulnerable, but are at the risk because of very small population include *Amblypharyngodon melettinus, Salmostoma acinaces*, *Schismatorhynchus nukta, Notopterus chitala, Mystus vittatus, Anabas testudineus, Osphronemus goramy* and *Rhinomugil corsula*. The most common ornamental fishes of these wetlands are *Danio aequipinnatus, Aplocheilus lineatus* and *Rasbora caverii.* A few migratory fishes namely; *Cirrhinus reba, Anabas testudineus, Mastacembelus armatus* and *Rhinomugil corsula* were also recorded. These migratory fishes generally migrate from one habitat to the other in the Cauvery river drainage. The number of migratory fishes are now decreasing, mainly because waterbodies within Cauvery river basin are becoming more disconnected and also due to variations in the outflow of water.

**Variation in physico-chemical factors:** Abiotic and biotic factors have an important role in supporting fish diversity and fish culture in lake ecosystems. The relationship between abiotic factors and living organisms in fish culture ponds is far from being unidirectional because fish population will dramatically affect the trophic status of other organisms and alter the water conditions in various ways. Physico-chemical parameters like pH, temperature, dissolved oxygen; ammonia-nitrogen, phosphorus and chlorides have a greater influence on survivability of the fishes. The average rang eof physico-chemical parameters of the wetlands during different seasons are shown in the Table 3. Changes in physico-chemical conditions of water can also cause mass mortalities of fish eggs and larvae apart from causing various abnormalities in the fish stocks.

Water temperature ranged between a minimum of 19-23°C during winter to maximum of 22.4 - 32°C during summer. Sharma and Gupta (1994) had reported that fish growth was better at a temperature range of 14.5 to 38.6°C. The water temperature in these lakes was found ideal for fish growth and fish productivity. pH of the water was found to be neutral, and ranged between 7.8-8.8 (winter), 8.4-9.23 (summer) and 7.0-8.9 (monsoon). Fishes have their own tolerable limits for pH fluctuation, beyond which they cannot survive (Alikunhi, 1957). Though the pH was slightly high during summer, it was good enough for normal fish growth. Dissolved oxygen concentration is another parameter used in judging the suitability of a water body to support fish community (Banerjee, 1967). Some fluctuation in dissolved oxygen was noticed during monsoon which was as a result of higher photosynthetic activity and

**Table - 2:** Fish diversity and its conservation status in major wetlands of Mysore

| Family /Species /Distribution | Conservation status/ Nutrition mode |
|---|---|
| **Cyprinidae** | |
| *Amblypharyngodon melettinus* (Valenciennes) | RR, EN |
| Attentive carplet/ Eli-yembu | Weed fish |
| Distribution : Karigala dodda kere, Doora kere, Karimuddanahally kere | |
| *Brachydanio rerio* (Hamilton-Buchanan) | NA, EN |
| Zebra danio/ Patte meenu | Weed fish |
| Distribution : All the selected lakes | |
| *Catla catla* (Hamilton-Buchanan) | CU, NA, EN |
| Catla/ Dodda gende meenu | Omnivorous fish |
| Distribution : All the selected lakes | |
| *Cirrhinus mrigala* (Hamilton-Buchanan) | CU, NA, EN |
| Mrigal /Surai meenu/ Bangari meenu | Omnivorous fish |
| Distribution : All the selected lakes | |
| *Cirrhinus reba* (Hamilton-Buchanan) | NA, MI |
| Reba/ Surai meenu/ Bathili meenu | Omnivorous fish |
| Distribution : All the selected lakes | |
| *Ctenopharyngodon idella* (Valenciennes) | CU, EX |
| Grass carp/ Hullu gende | Weed fish |
| Distribution : All the selected lakes | |
| *Cyprinus carpio* (Linnaeus) | CU, EX, NA |
| Common carp/ Samanya gende | Omnivorous fish |
| Distribution : All the selected lakes | |
| *Danio aequipinnatus* (Mc Clelland) | TR, OR |
| Giant danio/ Arshina-patte meenu | Weed fish |
| Distribution : Doora kere, Yennehole kere, Paduvakote kere, Karigala dodda kere | |
| *Gonoproktopterus curmuca* (Hamilton-Buchanan) | ED, EN |
| Medium carp/ Curmuca/ Koracha meenu | Omnivorous fish |
| Distribution : Doora kere, Karimuddanahally kere, Santhe kere, Devibudhi kere, Yennehole kere | |
| *Hypophthalmicthys molitrix* (Valenciennes) | CU, EX |
| Silver carp/ Belli gende | Omnivorous fish |
| Distribution : All the selected lakes | |
| *Labeo calbasu* (Hamilton-Buchanan) | ED, EN |
| Calbasu/ Kage meenu/ Kolasa meenu | Omnivorous fish |
| Distribution : All the selected lakes | |
| *Labeo kontius* (Jerdon) | ED, EN |
| Pig-mouth carp/ Moogi-halla meenu | Omnivorous fish |
| Distribution : Kudregundihalla kere, Yennehole kere, Santhe kere, Karimuddanahally kere, Paduvakote kere | |
| *Labeo rohita* (Hamilton-Buchanan) | CU, EN, NA |
| Rohu | Omnivorous fish |
| Distribution : All the selected lakes | |
| *Puntius arulius arulius* (Jerdon) | EN, TR |
| Long fin barb fish/ Kempu puthri meenu | Weed fish |
| Distribution : Karigaladodda kere, Doora kere, Yennehole kere, Kudregundihalla kere, Santhe kere | |
| *Puntius carnaticus* (Jerdon) | TR, EN |
| Carnatic carp/ Gende meenu | Weed fish |
| Distribution : Devibudhi kere, Kudregundihalla kere, Yennehole kere, Doora kere | |
| *Puntius cauveriensis* (Hora) | EN, ED |
| Cauvery barb fish/ Cauvery gende meenu | Weed fish |
| Distribution : Devibudhi kere, Yennehole kere, Doora kere, Paduvakote kere, Kudregundihalla kere | |
| *Puntius filamentosus* (Valenciennes) | EN, ED |
| Black spot barb fish/ Karse meenu | Weed fish |
| Distribution: Karigaladodda kere, Doora kere, Santhe kere, Devibudhi kere, Yennehole kere, Paduvakote kere | |
| *Puntius sarana* (Hamilton-Buchanan) | TR, EN |
| Olive barb fish/ Chikka gende meenu | Weed fish |
| Distribution : Santhe kere, Yennehole kere, Doora kere, Devibudhi kere | |
| *Rasbora caverii* (Jerdon) | OR, VU |
| Scissor-tail rasbora/ Saslu meenu | Weed fish |
| Distribution : Paduvakote kere, Kudregundihalla kere, Santhe kere | |
| *Salmostoma acinaces* (Valenciennes) | RR, EN |
| Silver-razor-belly minnows/ Sampaj | Omnivorous fish |
| Distribution : Kudregundihalla kere, Doora kere, Paduvakote kere | |
| *Schismatorhynchus nukta* (Sykes) | RR, EN |
| Nukta/ Mukurti meenu/ Hoo-bali meenu | Omnivorous fish |
| Distribution : Doora kere | |
| *Tor khudree* (Sykes) | VU, EN |
| Deccan mahseer/ Bili meenu/ Yellu | Omnivorous fish |
| Distribution : Kudregundihalla kere, Devibudhi kere, Karimuddanahally kere | |
| **Bagridae** | |
| *Aorichthys aor* (Hamilton-Buchanan) | ED, EN |
| Long whiskered cat fish/ Kappu suragi | Predatory fish |
| Distribution : Karimuddanahally kere, Paduvakote kere, Santhe kere, Yennehole kere | |
| *Aorichthys seenghala* (Sykes) | RR |
| Giant river cat fish/ Billi suragi | Predatory fish |
| Distribution : Kudregundihalla kere, Devibudhi kere | |
| *Mystus cavasius* (Hamilton-Buchanan) | EN, NA |
| Gangetic mystus/ Girlu meenu | Predatory fish |
| Distribution : All the selected lakes | |
| *Mystus kelitius* (Valenciennes) | RR, EN |
| Keletius mystus/ Tengali meenu | Predatory fish |
| Distribution : Paduvakote kere, Yennehole kere | |
| *Mystus vittatus* (Bloch) | RR, EN |
| Striped dwarf cat fish/ Girlu meenu | Predatory fish |
| Distribution : Karigaladodda kere, Paduvakote kere | |
| **Channidae** | |
| *Channa marulius* (Hamilton-Buchanan) | VU, EN |
| Giant snake head murrel/ Avulu meenu | Predatory fish |
| Distribution : All the selected lakes | |
| *Channa orientalis* (Schneider) | VU, EN |
| Asiatic snake head/ Hole-korava meenu | Predatory fish |
| Distribution : All the selected lakes | |
| *Channa punctatus* (Bloch) | VU, EN |
| Spotted snake head/ Bili-korava meenu | Predatory fish |
| Distribution : All the selected lakes | |
| *Channa striatus* (Bloch) | EN, ED |
| Banded snake head/ Kucchu meenu | Predatory fish |
| Distribution : All the selected lakes | |
| **Notopteridae** | |
| *Notopterus chitala* (Hamilton) | RR, EN |

| | |
|---|---|
| Feather back/ Chamari meenu | Predatory fish |
| Distribution : Devibudhi kere, Kudregundihalla kere | |
| *Notopterus notopterus* (Pallas) | EN, NA, TR |
| Grey feather back/ Chappali meenu | Predatory fish |
| Distribution : All the selected lakes | |
| **Siluridae** | |
| *Ompok bimaculatus* (Bloch) | EN, NA |
| Indian butter cat fish/ Godle meenu | Predatory fish |
| Distribution : All the selected lakes | |
| *Wallago attu* (Schneider) | VU, EN |
| Freshwater shark/ Bale meenu | Predatory fish |
| Distribution : Devibudhi kere, Yennehole kere, Paduvakote kere, Karimuddanahally kere | |
| **Anabantidae** | |
| *Anabas testudineus* (Bloch) | RR, MI |
| Climbing perch/ Koru meenu | Predatory fish |
| Distribution : Devibudhi kere | |
| **Anguillidae** | |
| *Anguilla bengalensis* (Gray and Hardwicke) | TR, MI |
| Indian long fin eel/ Hari meenu | Predatory fish |
| Distribution : Devibudhi kere, Doora kere | |
| **Aplocheilidae** | |
| *Aplocheilus lineatus* (Valenciennes) | EN,OR |
| Killi fish/ Moogu-malli meenu | Weed fish |
| Distribution : Doora kere, Devibudhi kere, Santhe kere, Karigaladodda kere, Kudregundihalla kere | |
| **Clariidae** | |
| *Clarias batrachus* (Linnaeus) | VU, EN |
| Magur/ Ane meenu/ Murgodu | Predatory fish |
| Distribution : All the selected lakes | |
| **Gobiidae** | |
| *Glossogobius giuris* (Hamilton-Buchanan) | EN, NA |
| Tank goby/ Nettikannu meenu | Predatory fish |
| Distribution : All the selected lakes | |
| **Heteropneustidae** | |
| *Heteropneustes fossilis* (Bloch) | VU, EN |
| Stining cat fish/ Kappu-thode meenu | Predatory fish |
| Distribution : Devibudhi kere, Yennehole kere, Santhe kere, Karimuddanahally kere, Karigaladodda kere | |
| **Mastacembelidae** | |
| *Mastacembelus armatus* (Lacepede) | RR, MI |
| Spiny eel/ Havu-batti meenu | Predatory fish |
| Distribution : Devibudhi kere | |
| **Cichlidae** | |
| *Oreochromis mossambicus* (Peters) | EX |
| Tilapia/ Baduvara meenu | Predatory fish |
| Distribution : All the selected lakes | |
| **Osphronemidae** | |
| *Osphronemus goramy* (Lecepede) | RR, EN |
| Gorami / Gobi meenu/ Gourami | Predatory fish |
| Distribution : Paduvakote kere | |
| **Mugilidae** | |
| *Rhinomugil corsula* (Hamilton-Buchanan) | RR, MI |
| Corsula mullet/ Natti kannu meenu | Weed fish |
| Distribution : Karigaladodda kere | |

RR = Rare fish, ED = Endangered fish, TR = Threatened fish, VU = Vulnerable fish, EN = Endemic fish, EX = Exotic fish, OR = Ornamental fish, CU = Cultured fish, NA = Numerically abundant fish, MI = Migratory fish

**Table - 3:** Average range of physico-chemical parameters in the wetlands

| Parameters | Season | | | Range |
|---|---|---|---|---|
| | Winter | Summer | Monsoon | |
| pH | 7.8-8.8 | 8.4-9.23 | 7.0-8.9 | 7.0-9.23 |
| Water temp (°C) | 19.0-23.0 | 28.0-30.5 | 22-32 | 19.0-32.0 |
| TDS | 159-391 | 135-1451.6 | 208-254 | 135-1451.6 |
| Total hardness | 122-325 | 34.0-354.0 | 156-245 | 34.0-356 |
| Total alkalinity | 195-325 | 120-360 | 180-305 | 120-360 |
| EC (µmhos) | 256-420 | 570-1560 | 240-371 | 240-1560 |
| DO | 3.4-10.5 | 6.0-14.4 | 0.02-7.3 | 0.02-14.4 |
| Free $CO_2$ | nil-55.0 | 12.3-48.8 | nil-39.8 | nil-55.0 |
| COD | 24.0-71.2 | 12.6-45.0 | 21.2-38.0 | 12.6-71.2 |
| BOD | 0.01-6.5 | 0.85-10.16 | 0.01-4.6 | 0.01-10.16 |
| Calcium | 28.8-67.3 | 6.8-48.7 | 0.11-46.5 | 0.11-67.3 |
| Magnesium | 13.1-61.8 | 4.22-54.19 | 46.2-90.9 | 13.1-90.9 |
| Chlorides | 40.2-102.2 | 28.8-85.4 | 18.0-87.1 | 18.0-102.2 |
| Nitrites | nil-0.16 | 0.009-0.19 | 0.02-0.2 | 0.009-0.2 |
| Nitrates | 0.01-0.18 | 0.02-0.14 | 0.1-1.03 | 0.01-1.03 |
| Ammonia nitrogen | 14.3-30.7 | 10.0-79.0 | 10.4-44.1 | 10.0-79.0 |
| Phosphates | 0.03-0.45 | 0.02-0.23 | 0.02-0.28 | 0.02-0.45 |
| Sulphates | 5.1-11.1 | 55.6-191.08 | 4.5-10.1 | 4.5-191.08 |
| Bicarbonates | 95-325 | 180-445 | 150-255 | 95-445 |

All values are in mg $l^{-1}$ except pH, electrical conductivity and water temperature. TDS = Total dissolved oxygen , EC = Electrical conductivity, DO = Dissolved oxygen, COD = Chemical oxygen demand, BOD = Biological oxygen demand

prevention of microbial decomposition which will provide a suitable environment for fish culture. The alkalinity estimated ranged between a minimum of 120 mg $l^{-1}$ and a maximum of 360 mg $l^{-1}$. The alkalinity range seen in the lakes are good enough for fish productivity. The total hardness showed an overall range of 34-354 mg $l^{-1}$, which again was within the normal limits and desirable for fish tanks. Excessive production of ammonia was noticed in Yennehole kere, Kudregundihalla kere, and Doora kere and was higher during summer (10.0-79.0 mg $l^{-1}$). Excessive buildup of ammonia in these lakes must be prevented and there should be provision for systematic monitoring of ammonia oxidizing bacteria. Otherwise, they can denitrify the entire nitrites and nitrates, causing eutrophication, abundant weed growth and many related problems.

There are several acres of crop fields around these lakes and during heavy rainfall siltation was found to be a common problem in almost all lakes of Mysore district. High siltation causes an adverse effect on fish production (Jhingran, 1983). More siltation will adversely affect the bottom fauna and causes respiratory problems in fishes even if sufficient dissolved oxygen is present. Around some lakes like Kudregundihalla kere and Paduvakote kere, there are more unprotected foreshore areas and these lakes were found to be mostly silted. During the present investigation, it was found that there were vast catchment areas around these lakes, and importance should be given for afforestation programmes to avoid excessive silting of these lakes and overcome all related problems.

Fish mass mortality was earlier reported from Yennehole kere of Mysore taluk in 2001, when more than twenty lakh fish perished in just 36 hr. The main reason attributed for the

catastrophic incident was the discharge of untreated sewage into this lake from two other highly polluted lakes at close vicinity. Mixed Cyanobacterial bloom of *Raphidiopsis mediterranea* and *Arthrospira plantensis* caused sudden depletion of oxygen content, thereby killing large number of the fishes (Lingannaiah and Hosman, 2002). Akehurst (1931) is of the opinion that every member of the phytoplankton produces an autotoxin which limits the growth of its own population. Hughes *et al*. (1958) indicated the presence to toxic substances in water blooms that kill aquatic life. Some toxic substance produced during the bloom may have been responsible for fish kill (Weibe, 1930). Discharge of untreated sewage can cause depletion of oxygen content and an increase in the BOD values, thereby threatening the existence of aquatic life. Under such circumstances, the use of nitrifiers (*Nitrosomonas, Nitrosococcus*) could be more suitable to control dissolved organic matter, suspended organic wastes (Lingannaiah and Hosmani, 2002). Sewage polluted waters especially that of Yennehole kere were supporting increased number of predatory tilapia fishes alongwith cyanobacterial blooms.

*In-situ* conservation of endemic, endangered fish species is necessary to protect fish diversity. It has been suggested by the authors that every taluk should have a fish seed producing centre and fish rehabilitation centre nearer to the lakes. Here cultivable fingerlings can be produced and the threatened fish species could be pooled out and grown to suitable size for the propagation so that they may be restored to their optimum population level. As a rehabilitation measure, young ones of the endangered fish species should be collected from the lakes and reared in these centres and thus can be propagated.

The health of the environment decides the diversity and productivity of the systems. Therefore, for sustaining the diversity of fish, and for sustainable management of the fish culture, it is important to know the factors controlling the quality of the lake systems. Certain changes in physico-chemical parameters, drainage of pesticides and fertilizers from the surrounding crop fields, heavy siltation during heavy rainfall, high density of fingerling stocking of selected culture fishes, poor management of fish culture and fish diseases were found to exert undesirable impacts on fish diversity and productivity. Rational management methods by creating public awareness has to be followed for sustaining fish diversity and for sustainable fish production in these lakes for preventing any further rural economic loss. A periodic survey and monitoring of these water bodies is essential to check the water quality and prevent any disturbances to these wetland ecosystems. The documentation of fish species distribution in various habitats will assist in resource allocation between different user communities who depend on fishing as a livelihood strategy. This baseline information allows for informed decision-making by both resource managers and users and will cater to more equitable and sustainable use of fish resources. This approach captures the key tenets of the ecosystem approach, defined by IUCN as 'a strategy for management of land, water and living resources that promotes conservation and sustainable use in an equitable way' (Smith and Maltby, 2003). Awareness programmes among the locals regarding the importance of preserving the water resources and judicious exploitation of fish resources will immensely help in sustaining these valuable aquatic resources.

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