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# Fish fauna of Sasthamcotta Lake Ramsar Site, Kerala, India, with notes on long-term changes in fish assemblage

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**ABSTRACT**

The fish fauna of Sasthamkotta Lake Ramsar Site, the largest freshwater lake in Kerala state, India was investigated. Based on field surveys and market observations undertaken between February 2021 and August 2022, 24 fish species belonging to 17 families and 20 genera were recorded. Of these,15 species formed the basis of a local fishery. Cyprinidae and Channidae were the most speciose families (three species), followed by Aplocheilidae and Osphronemidae (two species each), while Anabantiformes (six species) and Siluriformes (four species) were the dominant orders. Of the 24 species of fish collected from Sasthamcotta, the majority (79%) were represented by those listed as 'Least Concern' on the IUCN Red List, and only three species were assessed as 'threatened'. A unique feature of the Sasthamcotta Lake is the total absence of any non-native fish species. An analysis of the long-term data (1980 to 2022) available on the fish of Sasthamcotta Lake revealed that the fish species richness showed significant fluctuation patterns varying from 17 species (in the year 2018) to 30 species (in the year 2011). The current and potential future threats to the lake, as well as suggestions for conservation and sustainable management, are also discussed.

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## 1. Introduction

Freshwater aquatic ecosystems and their associated biodiversity are in a state of global crisis (Albert *et al*., 2021). Multiple anthropogenic stressors continue to significantly impact critical habitats and their resources, resulting in the populations of freshwater-dependent species declining by 83% since the 1970s (WWF Living Planet Index, 2022) – a rate of decline that is two or three times greater than those in terrestrial and marine environments (Birnie-Gauvin *et al*., 2023). It has been more or less agreed that the world has lost a significant share of its natural wetlands, a vanishing rate that is three times faster than forests (Tickner *et al*., 2020). The extent of global wetland loss ranges between 54–57% since 1900 AD, and around 87% since 1700 AD (Davidson, 2014). Wetlands have been lost at greater levels and at a faster pace in the inland than in the coastal realm, with much of this loss happening in continental Asia (Davidson, 2014). Recent estimations are that 3.4 million km$^2$ (confidence interval 2.9–3.8) of inland wetlands have been lost since 1700 AD, primarily for conversion to croplands (Fluet-Chouinard *et al*., 2023).

The Sasthamkotta Lake (3.73 km$^2$), located in the Kollam district of Kerala State, Southern India, is an internationally recognized wetland (a Ramsar Site since 2002) and the largest freshwater lake in the region. The lake and its catchment area (9.34 km$^2$) are densely populated with more than 1700 households within a 300-400 m distance of the waterbody. It has been observed that the lake is ancient, having evolved during the Early to Middle Holocene (Nair *et al*., 2010). The lake is estimated to provide ecosystem benefits, including providing drinking water to nearly 0.5 million people living in Kollam City and its suburbs (WISA & CWRDM, 2017). Apart from its designation as a wetland of international importance, the Sasthamcotta Lake has also been recognized as a protected wetland by the Ministry of Environment, Forests and Climate Change MoEFCC, Government of India (Ramsar 1212). Despite these legislative and regulatory instruments in place, the lake, however, dries up every summer causing several socio-economic issues in the region, including scarcity of drinking water (Sreekumari *et al*., 2016). Many recent studies have also suggested that the ecological and biodiversity health, value and services of the Sasthamkotta Lake have been deteriorating and urgent remedial and rejuvenation measures need to be adopted to manage and conserve this globally important wetland (Vijith *et al*., 2013, Prijilal *et al*., 2018, Sreeraj *et al*., 2018; WISA & CWRDM, 2017; Nandana *et al*., 2024).

Very few studies have been carried out on the fish and fisheries of Sasthamcotta Lake. Thomas *et al*. (1980) carried out the first studies on the ichthyodiversity of Sathamcotta Lake. This was followed by the works of Prakasam (1991), and Joseph (1994), who computed the annual fish exploitation from the Lake in 1991-92 to be around 10 tonnes, with *Etroplus suratensis*, *Parambassis dayi* and *Macrognathus guentheri*, contributing to the major catches. Subsequently, Girijakumari (2007) and Girijakumari *et al*. (2011) recorded 26 and 30 species, respectively. The most recent study was a citizen-science based approach by the University of Kerala in 2018 that managed to record only 17 species (https://www.thehindu.com/news/national/kerala/fish-stocks-decline-at-sasthamkotta-lake/article22909753.ece). A trophic network analysis of the Sasthamkotta Lake carried out using the Ecopath with Ecosim model revealed low ecological efficiency, and high fishing demand on top predatory fishes such as eels and catfishes (Regi *et al*., 2020).

The present study was carried out between 2021 and 2022 to generate a checklist of the fishes of Sasthamcotta Lake, and understand the changes in the fish assemblage patterns over a 40-year period (1980-2020).

## 2. Materials and Methods

Fish samples were collected through two approaches. The first involved visiting and observing catches at the main fish landing center adjoining the Sasthamcotta Lake, and the second involved sampling in the different locations of the lake. For convenience of sampling, the lake was divided into two sections (hereafter mentioned as Zone A and Zone B). Eight sampling locations each were selected in the two zones (S1 to S16) from where fish samples were collected from February 2021 until August 2022 (monthly sampling disrupted in May, June, July due to Covid-19 related lockdown and containment zones; and also, because no fishery was in place during monsoon months) (Table 1). Fish were caught using gill nets (predominant gear) (with varying mesh sizes: 28 mm, 32 mm, 36 mm, 40 mm, 45 mm, 50 mm, 65 mm, 70 mm, 90 mm and 110 mm), seine nets, cast nets, scoop nets and rod and line. Artisanal fishing traps were also used in selected sampling locations to collect benthic species that otherwise do not entangle in conventional nets. Only representative samples required for identification were collected, and the remaining fish were released back into the lake. During the study period, 55 field surveys and 104 market observations were undertaken. All fish specimens were identified using standard literature on freshwater fishes of the region (Jayaram, 2010). The taxonomy and nomenclature of species listed in this paper follow the Catalog of Fishes (Fricke *et al*., 2024). Conservation status of fish species follows the IUCN Red List of Threatened Species™ (www.iucnredlist.org).

## 3. Results and Discussion

Twenty-four species of fish belonging to 17 families and 20 genera were recorded from the Sasthamcotta Lake (Table 2) of which 15 species formed the basis of a local fishery. Cyprinidae and Channidae were the most speciose families (three species) followed by Aplocheilidae and Osphronemidae (two species each), while Anabantiformes (six species) and Siluriformes (four species) were the dominant orders. Of the 24 species of fish collected from Sasthamcotta, the majority (79%) were represented by those listed as 'Least Concern' on the IUCN Red List of Threatened Species (Fig. 1). Three species occurring in the lake are under the 'threatened' category of the IUCN Red List, which included the yellow catfish, *Horabagrus brachysoma*; Malabar Snakehead, *Channa diplogramma*; and the Day's paradise fish, *Pseudosphromenus dayi*. Two species have not yet been assessed for their Red List status.

Kerala has very few natural freshwater lakes, the largest of which is Sasthamcotta. Smaller lakes, including Vellayani (Thiruvananthapuram District) and Pookode (Wayanad District), have not been explored systematically for their fish diversity. Therefore, a comparison of the results between these systems becomes difficult. However, the fish diversity of Sasthamcotta Lake obtained in the current study (S=24) was lower than the number of fish species observed during a 'Fish Census' carried out at the Vellayani Lake (S= 42) (Bijukumar and Kiran, 2013). Though an even higher number of 69 species was recorded from the Vellayani Lake by Reenamole *International Journal of Science and Research*, 2019), the results are doubtful as the paper was published in a predatory journal.

A characteristic and unique feature of the Sasthamcotta Lake is the total absence of any non-native fish species, a situation different from every other water body of Kerala, including freshwater lakes (Vellayani) as well as brackishwater lakes, reservoirs, streams and rivers. The freshwater ecosystems of Kerala are known for the occurrence and proliferation of non-native/alien aquatic species, with at least 28 fishes recorded from different parts of the state (Raj *et al*., 2021). The reason for the absence of any alien species in Sasthamcotta Lake, including the ubiquitous *Oreochromis mossambicus, Clarias gariepinus* and *Pterygoplichthys* spp. is indeed surprising, but highly encouraging.

An analysis of the long-term data available on the fishes of Sasthamcotta Lake reveals that the fish species richness has shown significant fluctuation patterns. The fish species richness of the Lake varied from 17 species (in the year 2018) to 30 species (in the year 2011) over a four-decade period, decreasing to a further lower number of 24 in the current study (Fig. 2). The differences in the fish species richness recorded over a 40-year period is more a result of taxonomic updates including synonymy, nomenclatural

**Table 1.** List of sampling locations in the Sasthamcotta Lake

| Zone/Sampling Station | | Location |
|---|---|---|
| A | S1 | Near to Vallakadavu (Sasthamcotta) |
| | S2 | Near to filter house |
| | S3 | Near to Kuthiran Munamb |
| | S4 | Near to Brook International School |
| | S5 | Near to Adikkadu |
| | S6 | Near to Sree Mahadeva Temple |
| | S7 | Near to Vettoli Kadavu |
| | S8 | Near to DB College |
| B | S9 | Near to Bungalow |
| | S10 | Near to Taluk Hospital |
| | S11 | Near to Sasthamcotta Block Panchayat |
| | S12 | Near to Pullikuzhi Temple |
| | S13 | Near to IOC Petrol Pump (Bharanikkavu) |
| | S14 | Near to MTMM Hospital (Ookenmukku) |
| | S15 | Near to Sasthamcotta Lake View Point |
| | S16 | Near to Lake Bund |

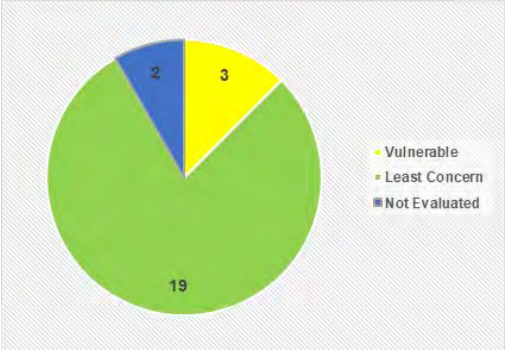


**Fig. 1.** IUCN Red List Status of fish species of Sasthamcotta Lake

**Table 2.** List of fishes of Sasthamcotta Lake and their conservation status

| Species | Common Name | Family | IUCN Red List Status |
|---|---|---|---|
| *Aplocheilus blockii* | Green Panchax | Aplocheilidae | Least Concern |
| *Aplocheilus lineatus* | Striped Panchax | Aplocheilidae | Least Concern |
| *Bhava vittata* | Green Stripe Barb | Cyprinidae | Least Concern |
| *Channa diplogramma* | Tiger Snakehead | Channidae | Vulnerable |
| *Channa pseudomarulius* | Giant Snakehead | Channidae | Not Assessed |
| *Channa striata* | Striped Snakehead | Channidae | Least Concern |
| *Dayella malabarica* | Day's Round Herring | Ehiravidae | Least Concern |
| *Dawkinsia filamentosa* | Filament Barb | Cyprinidae | Least Concern |
| *Etroplus suratensis* | Pearl Spot | Cichlidae | Least Concern |
| *Glossogobius giuris* | Tank Goby | Gobiidae | Least Concern |
| *Heteropneustes fuscus* | Stinging Catfish | Heteropneustidae | Not Assessed |
| *Horabagrus brachysoma* | Yellow Catfish | Horabagridae | Vulnerable |
| *Horadandia brittani* | Glowlight Carplet | Danionidae | Least Concern |
| *Hyporhamphus limbatus* | Congaturi Halfbeak | Hemiramphidae | Least Concern |
| *Macrognathus guentheri* | Malabar Spiny Eel | Mastacembelidae | Least Concern |
| *Mystus oculatus* | Spotted Mystus | Bagridae | Least Concern |
| *Nandus nandus* | Leaf fish | Nandidae | Least Concern |
| *Ompok malabaricus* | Malabar Butter Catfish | Siluridae | Least Concern |
| *Parambassis dayi* | Glassy Perchlet | Ambassidae | Least Concern |
| *Pseudetroplus maculatus* | Orange Chromide | Cichlidae | Least Concern |
| *Pseudosphromenus cupanus* | Spike-tailed Paradise fish | Osphronemidae | Least Concern |
| *Pseudosphromenus dayi* | Day's Paradise fish | Osphronemidae | Vulnerable |
| *Puntius mahecola* | Mahe Barb | Cyprinidae | Least Concern |
| *Xenentodon cancila* | Needle fish | Belonidae | Least Concern |

acts and misidentifications, rather than an actual decrease in fish species. Fix species seem to have disappeared from the Sasthamcotta Lake since the most recent systematic study by Girijakumari *et al*. (2011). These include *Anabas testudineus, Anguilla bicolor, Ophisternon bengalense, Puntius dorsalis*, and *Wallago attu.* Except for *Puntius dorsalis*, all four species are omni-carnivores, of which *W. attu* and *A. bicolor* are known to be predatory carnivores (Froese and Pauly, 2024). Previous studies have shown that most fish groups in the Lake face high exploitation pressure, especially top predatory fishes like eels and catfishes (Regi *et al*., 2020). Of the five species mentioned above, two are eels (*A. bicolor* and *O. bengalense*) and one is a catfish (*W. attu*). Interestingly, these five species were also either rarely or very rarely encountered in the Lake from 2005 to 2009 (Girijakumari *et al*., 2011), indicating that long-term pressures on the ecosystem could have resulted in local extirpation of these five species, as evidenced by their total absence during the surveys carried out as part of the current study (2021-2022).

Three species of threatened fishes including *Horabagrus brachysoma*; *Channa diplogramma* and *Pseudosphromenus dayi* were recorded from the Lake, of which *H. brachysoma* was the second-most important exploited species by the local fishers. *Channa diplogramma* on the other hand are mostly caught by hook-and-line by both local fishers as well as members of the local communities residing along the banks of the Lake. Recently, efforts have been underway to artificially stock the Sasthamcotta Lake using the fingerlings of captive-bred *H. brachysoma* as part of an initiative led by the Kerala University of Fisheries and Ocean Studies (A. Ali, Pers. Comm.).

Sasthamcotta Lake is facing several threats including regular water depletion due to climatic fluctuations, soil erosion and siltation, laterite and clay-bed mining, infestation by aquatic weeds, microbial pollution, as well as indiscriminate felling of trees, uncontrolled grazing and unscientific agricultural practices (Chackacherry and Jayakumar, 2011; Das *et al*., 2021; Nandana *et al.,* 2024). Sand and laterite mining within drainage basin and floodplains cutting off hydrological connectivity between the River Kallada channel and the lake, high levels of water abstraction which is 2.48 times the net surface water inflow into the lake, high levels of pollution including faecal coliform, conversion of natural shoreline for agriculture, and land use intensification in the surrounding areas have been considered to be the most significant threats to the system (WISA & CWRDM, 2017). In addition, interactions with local community members as well as the personal observations of the first author suggest that the increasing population of otters are becoming a major cause for concern in the area, as they seem to be predating on the fish species, resulting in lower catches for local fishers.

The current study on the fish diversity of Sasthamcotta Lake carried out after a period of 15 years (since Girijakumari *et al*., 2011 based on studies carried out from 2005 to 2009) has revealed changes to the fish species composition and assemblage structure suggesting the urgent need for effective management and conservation interventions to be developed and implemented in the Lake so as to ensure long-term sustainability of both the

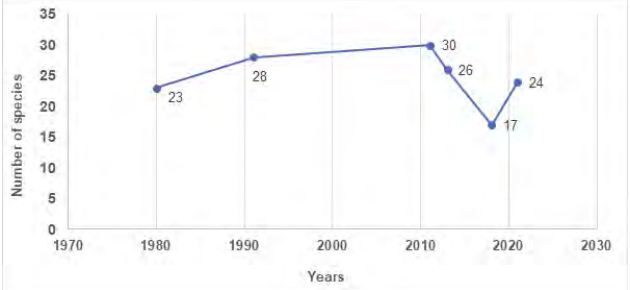


**Fig. 2.** Long-term changes in fish species richness of Sasthamcotta Lake

fish communities and the dependent human communities. Despite being a wetland of international importance, there is very little attention from both the research, awareness and policy angles focused on the Sasthamcotta Lake. The State Wetland Authority Kerala (SWAK)'s efforts to revise the management action plan for this important wetland is a potential first step in this direction. A management plan for Sasthamkotta was drafted in 2001, and approved for implementation by MoEFCC. The overall aim of the management plan is to outline a strategy and tangible actions for maintaining the full range of wetland ecosystem services and biological diversity values in Sasthamcotta (WISA & CWRDM, 2017). These include among other things, creating an institutional framework and setup for integrated management of the wetland, integrated wetland monitoring and assessment systems to inform management, and integrating Sasthamkotta in Kallada River Basin management plans (WISA & CWRDM, 2017).

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