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Ichthyofaunal diversity of siluriformis from Kolleru Lake, Andhra Pradesh, India

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Abstract
In Andhra Pradesh lake Kolleru has been recognized as wet land of International significance and a Ramsar site. The wet lands are very important productive ecosystem and socioeconomic values are well established. Anthropogenic pressure such as large scale encroachment of lake bed for aqua farms, high level use of fertilizers, pesticides, fish/prawn waste discharges, domestic wastes and sewage from three municipalities and discharge of industrial effluents and agriculture run-off have vitally effected and altered the ecological character. Due to continuously increasing natural and anthropogenic stresses, now days this entire species community focus a tremendous problem of survival. The results present study revealed that the occurrence of 14 species belongs to 9 genera and 6 families order siluriformis and family bargidae is dominant group followed by siluridae and ariidae. Out of 14 species percentage of various threat category as per IUCN, 64% were least concern, 22% were near threatened, and 14% were endangered. As per CAMP, 43% were not evaluated, 22% were vulnerable, 14% of both endangered and least concern, and also 7% were least concern. The biodiversity index also discussed in the season wise.

Keywords: Catfish fauna, Kolleru Lake, biodiversity

1. Introduction
Kolleru Lake is one of the National wetland and the largest fresh water lakes of our country. Wetland ecosystems are fragile but productive and vital ecosystem recognized for their role in conservation of biodiversity and are being designated as “Ramsar sites” (International recognized wetlands) which quality under the Ramsar criteria. Role of the wetlands in conserving fish diversity is widely acknowledged as these wetlands are used by the various fish species as a refuge for breeding, feeding and spawning purpose at one stage or the other in their life cycle. The foreshore area is presently under accelerated conversion into fish ponds for culture fish and prawn. The lake is presently facing ecological crisis being situated in the deltaic region between Krishna and Godavari rivers central' to highly agriculturally and industrially developed area. The industrial pollutants are mainly of organic nature and the agricultural runoff containing nutrients and pesticide residues enter the lake. In addition, the improvements to drainage to remove flood waters by deepening, widening and straightening the out-let creek, has resulted in faster drying up of the lake since 1986 after monsoon. Until 70's the lake level was maintained at more than +5 M.S.L. from July to February and with lesser water level at +3 M.S.L. during March to June [1]. The present situation of longer period of low-level and drying and influx of nutrients, has resulted in coverage of almost the entire area with water hyacinth and other floating weeds, apart from submerged and emergent weeds. This has resulted in reduction of capture fishery of about 4,000 MT. within 10 years period. Acknowledged and these wetlands are used by the various fish species as a refuge for breeding, feeding and spawning purpose of one stage or the other in their life cycle.
The lake receives water from several sources of streams Budameru, Tammileru (East, West branches) Ramilere, Gunderu and Bulusuvagu are natural and foremost in terms of water input. Minor streams of Jayanthi, Kattaleru, Ippalavagu, Telleru, Ballaleru and Nedimeru flowing through several mandals also join in Lake Kolleru. The rest of inflow drains are largely manmade and contribute lesser inputs. The Budamerru flows through the mandals of Vijayawada, Gannavaram, Gudivadda and Kaikaluru, while the rest of the streams flow through the West Godavari district. Thammileru originating from Bethupalli in Khamam district reaches Kolleru Lake after passing through Nagireddygudem reservoir in Chintalapuddi

Madal During 1960s the lake was known as the largest pelican breeding centre in the word for the grey or spotted billed Pelican, *Pelecannus philippensis*, but the colonies declined through 1970s and disappeared completely by 1974 [2].

In the November 2006, the lake was declared as a wet land of international importance by the Ramsar convention for the conservation and sustainable utilization of wet land [3, 4]. The lake fauna include the species are primarily freshwater and are residents of the lake along with species which live in coastal waters of Bay of Bengal and enter the lake during summer when the saline waters enter the lake through Upputeru channel [1]. The lake Kolleru an important coastal wetland ecosystem, is to examine different anthropogenic activities on the community structure of the water body gained importance of lake being desolated as a Ramsar site the present study assumes importance. These communications record the fish fauna of the resident fish population of the lake, in view of the changes in the lake habitat due to anthropogenic activities. The present work provides an inventory of ichthyofauna of siluriformis of Kolleru Lake in the post-restoration phase. This will serve as a baseline of the ichthyofaunal diversity siluriformis of the lake and will facilitate future fish faunal surveys, monitoring and biodiversity studies.

2. Materials and Methods

2.1 Study area: The Lake is situated between a latitudes 16° 32'and 16°51'N and Longitudes 81° 05' and 81° 20'E. with total catchment area of 4,763 Sq. Km. This lake is fed by 2 rivers, 15 irrigation channels and 15 drains from Krishna and Godavari barrage irrigation system. Thus, the lake swells up during S- W monsoon period from August to December when the level of the lake is around + 7 M.S.L., and shrinks to less than 25 Sq. Km. during May and June. There are 50 islands and 98 bordering habitations in the lake region having a total population of 2.16 lakhs. The foreshore area is under cultivation up to +5 M.S.L. The area below +5 M.S.L. is generally free from any cultivation, but this area is used for capture fishery. The reverine fishes use wetlands on their breeding grounds. The Kolleru Lake is a natural shallow coastal wetland formed between the River Krishna and Godavari in Andhra Pradesh. It has been function as a natural flood balancing reservoir between the delta of above rivers.

For the present study, data of the fish fauna of the lake have been collected during the period of January 2013- December 2015. Fish samples were collected from landing centers of Kolleru Lake with the help of fishermen using different types of nets namely gill net, cast net and drag nets. The fish samples were preserved in 5% formalin and brought to the laboratory for identification. The fish were identified with the help of the taxonomic keys [5, 6, 7].

Shannon–Weaver's species diversity index: This is proposed by Shannon and Weaver [8] as measure of information and their diversity across the different areas. Shannon –Weaver's (H) in commonly used to characterize species diversity in a community. The index account for both abundance and evenness of the species presents. The proportion of the species (Pi) is calculated and multiplied by the natural logarithm of this proportion (log Pi).

As per the formula given by Shannon and Weaver [8]:

$$H = -\sum (ni/N) \text{ Log } (ni/N) \text{ or } H = \sum pi/\log (pi)$$

Where

H= Shannon – Weaver' index of species diversity in individuals

ni=Total number of individuals.

N=Total number of individuals of all species

Pi=importance of probability for each species = ni/N

3. Results and Discussion

The results of the present study revealed that the occurrence of 14 species belongs to 9 genera and 6 families of order siluriformis. List of fishes including their family, genus species, IUCN [9], CAMP, [10] status and Froese and Pauly [11] were recorded in the present investigation was given (table 1 and fig 1&2). Biodiversity index of fishes was given (Table-2). Data revealed that during North East monsoon months 'H' value goes to 0.9764, summer season goes to 1.0229, Southwest monsoon goes to 0.9984, and post monsoon value goes to 1.0059.

The industrial effluents released in to the catchment of the lake from paper and sugar industries in Krishna and Godavari district and the municipal wastes from Vijayawada, Eluru and Gudivadda flowing in to the lake Kolleru. The other sources of pollution of agriculture runoff containing residues of several Argo-chemicals, fertilizers, and fish farm discharges containing antibiotics, drugs, chemicals, food wastes and other effluents from surrounding area. As a result, the water of the lake turned more alkaline in nature, turbid, nutrient rich, low dissolved oxygen, high BOD, changes in total dissolved solids and salinity imbalance in Lake Kolleru. Barman (12) have reported that the 10 sps of siluriformis cat fishes in the Kolleru lake. An assessment of biodiversity status for the listed species and assessment of endangered species from the siluriformis of Kolleru Lake was attempted for the present study. The biodiversity status of fishes and endangered fishes of Lake Kolleru based on IUCN criteria [9, 11] have documented the list of the species, which were assessed for biodiversity status. Mothanthy *et al*., [13] have recorded that the 22 species of order siluriformis fishes in Chilka Lake Odisha. Krishna *et al*., [11] have observed 14 species in siluriformis in Kolleru Lake. Further, various scientists reported that the cat fishes of Kolleru Lake [14, 15, 16].

Most of the natural lakes in India are undergoing major ecological changes due to urbanization, industrialization and increased anthropogenic activities. The tropic status of a lake ecosystem is mostly dependent on the ageing phenomena and the anthropogenic impact through habitat destruction. The lakes undergo rapid transition from oligotrophic to eutrophic conditions due to abiotic and biotic factors traceable to anthropogenic activities [17]. These ecological changes in the water bodies bring about noticeable changes in the community structure of the organisms inhabiting it. It formed as a basin between the gradually growing deltas of the peninsular rivers Godavari and Krishna near their tail end region of the east coast. The lake discharges its excess water into the Bay of Bengal through a 72 km long out-flowing brackish water canal called Upputeru. The catchment of the lake extends up to 6121km^2 of which 4763km^2 comprised of upland and 1358km^2 are deltaic.

Excessive nutrient addition, especially from Anthropogenic sources lead to explosive weed growth. The exploitation of the aquatic floating weeds particularly *Eichrinia crassipes* (water hyacinth) affects fish and other aquatic life [18]. The high vegetative capacity and rapid growth of *Echhrris crassipes* endow it with high vegetative development and

productive rates. These characteristic, along an extreme tolerance have given this macrophyte efficient mechanism for reproduction and dispersion, rendering it able to form dense stands within a few months in a large variety of habitats such as rivers, lakes, and reservoirs. This could be the result of shelter of predators and competitions popular explosions of these plants because an increase in appropriate sites for the development intermediate hosts like snail, which are vectors of several diseases. Krishna *et al*., (2013) have reported that the impede drains shuts out sunlight to phytoplankton and submerged hydrophytes and offers breeding ground for certain victor insects. The floating weeds are also noun to cause deplitation of dissolved oxygen by way of their decay and aidsilition by trapping suspended solids and dust. Further variations water level, water pressure on land and increasing land scale modifications have added to deterioration of the lake [19]. Srinivas Rao and Rama Rao, [20] have reported that lake contaminated of uncontrolled pesticides in agriculture and aquaculture activities. Polycyclic hydrocarbons are also reported from sediment of Lake Kolleru [21]. Overall presently the lake seems to be under serious threat of excessive loading of silt and nutrients, uncontrolled use of fertilizers and pesticides, fish/prawn pond discharges, domestic wastes and the sewage from human activities and the municipalities and low flesh-out process. This accelerated inputs has directly effect on fish faunal diversity of Kolleru Lake. Krishna *et al*., [(1)] have reported that only 64 species fishes belongs to 27 Families and 13 Orders and IUCN Conservation status was observed in the Kolleru Lake and endangered goes to 1.5%, Vulnerable 1.5%, Near threatened 4.6%, Least concern 67.18%, Data deficient 4.6% and Not evaluated 20.31%.

Release of the industrial and aquaculture effluents have been effect the fish diversity in lake specially earlay stages [1]. Due to this pollution leads to the increased mortality of the developmental stages of food organisams [22]. Rao and Lakshmi [23] have noticed the mortality of the pelagic early larval stages of *Anabas s*ps in the lake due to the release of pollutants. *Tilapia mossambica* which entered in the lake from the aquaculture ponds has established in the lake and is contributing about 2% to the lake landing. The freshwater native fishes of Kolleru Lake are currently facing an alarming decline in fish diversity and production as a result, a sizeable portion of freshwater fishes have been threatened. The lake is being subjected to considerable stresses, the adverse effects of which are being manifested in the decline of native fish populations. Another problem is the introduction of invasive alien species, the Tilapia *Oreochromis mossambicus* for commercial purposes, which has replaced many native fish species. Due to the habitat degradation, the changes in the fish and fishery of the lakes were also reported by Sharma and Jayaraju [24], Luther Das *et al*; [25]. In recent years in certain marginal ponds the banned exotic African cat fish *Clarias gariepinus* is cultivated and it is highly predacious feeding habit in entry into the lake accidentally fill the prove to be challenge in the protecting the lake populations and the important aspects for attention of ecology in the other fishes. Lakshmi *et al*., [16] have reported that the fishery consist mostly air breathing fishes which are depleted due to the anthropogenic pressures and has undergone tremendous ecological changes.

The Pollution in Kolleru is increasing day by day in the form of industrial waste, domestic garbage, solid waste, sewage disposal, pesticides and insecticides used in agriculture and aquaculture fields. All these waste carry non-biodegradable component, which results in the decreased oxygen percentage and cause mass mortality of fishes, which is another serious threat to the fish fauna of the lake. The law is not strictly followed in wetland areas, which result in the destruction of fish and their habitat. There is no check on daily catch, size of fish and mesh size of nets, by which even the juvenile fishes get killed which adversely effect the population of this area. The most important cause of destruction of fishes of Kolleru is unawareness among masses. Villagers don't understand the importance of conservation and they do fishing in unplanned manner. The most effective way to conserve the fish fauna of Kolleru Lake is to educate the masses at different level i.e. village, block, school, College etc. by organizing seminars, video show, distributing poster, sticker with slogan for conservation, and excursion. During breeding season, fishery should be banned so that fishes can breed freely and the brooder fish can be protected. After conducting a careful fish census in a particular area, with detailed study of biology, ecology, behavior, the ecstatic of threatened and rare fishes must be determined. After survey, the fish collection data should be recorded in the form of a document e.g. faunal inventory of fishes of any area which serves as baseline information to know the ichthyofauna of that area. Ultimately by compiling the information a list of fishes (endangered, threatened, and others) can be included in the red data book, which is an indicator and guiding line for helping, protecting and restoring, reestablishing the vanishing fish species in this area.

Table 1: Fish faunal diversity, IUCN, and CAMP status

S. No.	Order	Family	Species	IUCN	CAMP
1	Siluriformes	Bagridae	*Mystus gulio*	LC	NE
			M. vittatus	LC	VU
			M. cavasius	LC	LRnt
			M. bleekeri	LC	VU
		Siluridae	*Ompok bimaculatus*	NT	EN
			Ompok pabda	NT	EN
			Wallago attu	NT	LRnt
		Pangasidae	*Pangasius pangasius*	LC	NE
		Clariidae	*Clarias batrachus*	LC	NE
			C. gariepinus	NE	NE
		Heteropneustidae	*Heteropneustes fossilis*	LC	NU
		Ariidae	*Arius arius*	LC	LC
			Nemapteryx caelatus	EN	NE
			Plicofollis dussumieri	LC	NE

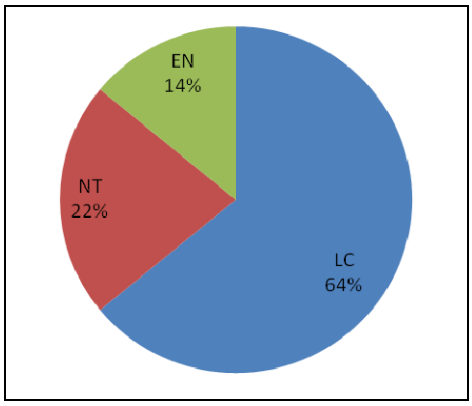

Fig 1: Species (%) under various threat categories as per IUCN

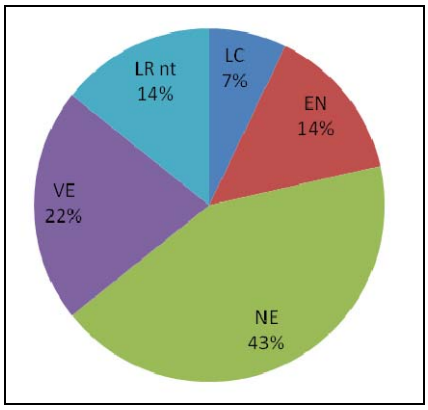

Fig 2: Species (%) under various threat categories as per CAMP

EN-Endangered VU-Vulnerable NT-Near Threatened
LC-Least Concern NE-Not Evaluated LRnt-Lower risk near

Table 2: Biodiversity index of Ichthyofauna of Siluriformis from Kolleru Lake

S. No.	Name of the Species	NE	SR	SW	PM
1	*Mystus gulio*	-0.0643	-0.0824	-0.0765	-0.0669
2	*M. vittatus*	-0.0654	-0.0865	-0.0562	-0.0734
3	*M. cavasius*	-0.0767	-0.0772	-0.0591	-0.0660
4	*M. bleekeri*	-0.0717	-0.0834	-0.0682	-0.0768
5	*Ompok bimaculatus*	-0.0628	-0.0375	-0.0670	-0.0793
6	*Ompok pabda*	-0.0626	-0.0465	-0.0707	-0.0692
7	*Wallago attu*	-0.0659	-0.0778	-0.0613	-0.0709
8	*Pangasius pangasius*	-0.0736	-0.0682	-0.0619	-0.0692
9	*Clarias batrachus*	-0.0765	-0.0759	-0.0721	-0.0747
10	*C. gariepinus*	-0.0638	-0.0643	-0.0787	-0.0713
11	*Heteropneustes fossilis*	-0.0676	-0.0748	-0.0854	-0.0738
12	*Arius arius*	-0.0754	-0.0742	-0.0829	-0.0654
13	*Nemapteryx caelatus*	-0.0745	-0.0876	-0.0826	-0.0721
14	*Plicofollis dussumieri*	-0.0756	-0.0876	-0.0758	-0.0767
Total		-0.9764	-1.0239	-0.9984	-1.0057
$H = -\sum(ni/N) \log ni/N$		0.9764	1.0239	0.9984	1.0057

Abbreviations: NE: North East monsoon; SR: Summer; SW: South West monsoon; PM: Post monsoon.

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