Ecological characterization of Moyar and Cauvery river using box plot model approach

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Abstract
Freshwater systems are arguably among the most endangered ecosystems on the Earth. Human activities on water lands/streams/rivers changed the hydrologic and ecological processes. Hence sound management of aquatic resources is necessary to understand the condition of habitats, the extent of changes in habitats and the factors influencing the changes. In order to arrive a better understanding of the biological processes, the study was carried out to a total of 16 Water and Habitat characters considered for analysis using Box Plot Model approach. During the sampling, a total of 22 sites as a whole was selected and sampled with 15 in River Moyar and 7 in River Cauvery.

It has been observed that River Moyar is highly supplied with primary and secondary orders of streams and is rich in water quality and habitat structure which are unique in nature. No man-made habitat alterations with effects onto the fish community and assemblage structures have been identified. Hence by comparing the water quality and habitat characteristics of Moyar and Cauvery River system, it is concluded that the Moyar river system is rich in the water quality and habitat structure compared to the Cauvery river system.

Keywords: Moyar, Cauvery, Water quality, Habitat Structure, Substratum.

Introduction

Water is one of the most common and the precious resources on earth on which the life on the earth depends. The River Moyar which has its source in the NBR of Western Ghats flows to the east direction along the Karnataka and Tamil Nadu border, confluences with three perennial rivers Sigur, Kahanhalla and Kedrahalla which are flooded by the small streams and the ultimate headwater sheds of the NBR mountains of the Western Ghats. River Moyar is one of the largest rivers in the Nilgiris draining to the Eastern Ghats. Rivers form the lifeline of human society.

Rivers are the vital freshwater systems of strategic importance across the world, providing main water resources for domestic, industrial, agricultural and recreational purposes. Rivers also play a major role in assimilating or carrying industrial and municipal wastewater and runoff from agricultural fields. The river Cauvery is termed to be one of the sacred rivers of southern India, which plays a vital role as a source of water for the irrigation system and hydroelectric power in southern India. The river Cauvery is the lifeguard of central Tamil Nadu Agriculture. Increasing use and misuse of natural resources exert great pressure on earth's sustainability. Since the Western Ghats contain many threatened and endemic species of fishes, there is an urgent need to consider their conservation[13].

Human activities on water lands/streams/rivers changed the hydrologic and ecological processes. Water pollution and freshwater depletion are currently viewed as the top environmental problem in Asian region. In order to arrive a better understanding of the biological processes, a study was carried out to analyze physical - chemical water quality. The habitat structure parameters were studied at selected sites in River Moyar and River Cauvery.

Material and Methods

Study area: The River Moyar has its source in the Nilgiri mountain of Western Ghats, flowing west-east direction along the Tamilnadu and Karnataka State border. It is one of the largest rivers in the Nilgiris, draining to the Eastern Ghats. Three major streams that confluence with the River Basin such as Kedrahalla, Sigur and Kahanhalla are perennial. Moyar River is one of the tributaries of Bhavani Tamil Nadu, South India. The Moyar River originates from a small town called Moyer along the Masinagudy - Ooty road. This is a natural line of separation between Bandipur and the Mudumalai sanctuary to the south. Moyar River Gorge is 20 km long and also called as the Moyar Canyon. The river flows into the gorge. Theppakadu is a roaring water fall, called as Moyar falls. This river is checked by Bhavanisagar Dam at the valley near Satyamangalam along with Bhavani River. During the sampling, a total of 22 sites as a whole were selected and sampled with 15 in Moyar River system (Table 1, Fig. 1 and 2)

The river Cauvery, one of the sacred rivers of southern India, is the source of water for an extensive irrigation system and hydroelectric power. The river enters Tamil Nadu through Dharmapuri district leading to the flat plains where it meanders. It drops into the Hogenakkal Falls just before it arrives in the town of Hogenakkal in Tamil Nadu. The three minor tributaries Palar, Chennai and Thoppar enter into the Cauvery on her course, above Stanley Reservoir in Mettur, where the dam has been constructed. It has supported irrigated agriculture for centuries and served as the lifeblood of the ancient kingdoms and modern cities in the States of Karnataka and Tamil Nadu. This river is the very lifeguard of central Tamil Nadu Agriculture.

The five districts (Karur, Namakkal, Tiruchirappalli, Thanjavur and Nagapattinam) depend on the Cauvery for irrigation produce over 40% of the food crops of Tamil Nadu. In addition to the bumper cropped agriculture and dense vegetation of the Eastern Ghats, the rapid industrialization and urbanization along the river bank are the supporting pillars of the economic development of this part of the Nation. On the other hand, environmental degradation is felt intensely in this area. For a sustainable progress, it is necessary to strike a balance between the two. To manage the environmental degradation, it is mandatory to assess the quality of the chief fresh water source, river Cauvery. A total of 7 sampling sites at Hogenakkal of Cauvery River were selected and they are tabulated (Table 1, Fig. 3 and 4).

Data collection: Regular sampling of physical - chemical water quality parameters has been carried out in all the sampling stations based on APHA[3]. Field analysis of the samples was done using portable water analyzer (X tech, Nagman Instruments Electronics, India)[2,9,14]. Habitat structure of the sampling stations has been characterized[5,6,8,10,11]. Along with the habitat, the Riparian Profile which includes Riparian zone, bank vegetation has been recorded. Further, the land use, agricultural practices and the forestry operations are done by the forest department and the public has been taken into account.

In order to get a better understanding of the biological processes, this study was carried out with a total of 16 Water and Habitat characters considered for analysis using Box Plot Model Approach [pH, Conductivity (mS), TDS (ppm), Resistivity (KΩ), DO (mg/L), Salinity (ppt), Water temperature (°C), Altitude (m), Forest type, Stream order, Stream width (m), Stream depth(m), Mean velocity(m/sec), In-stream cover (%), Turbidity, Riparian cover (%)]. During the sampling, a total of 22 sites as a whole was selected and sampled with 15 in River Moyar and 7 in River Cauvery.

Results and Discussion

Physical - Chemical Parameters: The maximum value of pH of the water samples was recorded as 9.6 at Kadapilliyarthittu of Cauvery river system and a minimum value of pH was recorded as 7.2 at Kallampalayam of Moyar river system. In general, pH was within the limits of standard value. For drinking water, a pH range of 6.0-8.5 is recommended[1] (Table 2, Fig. 5).

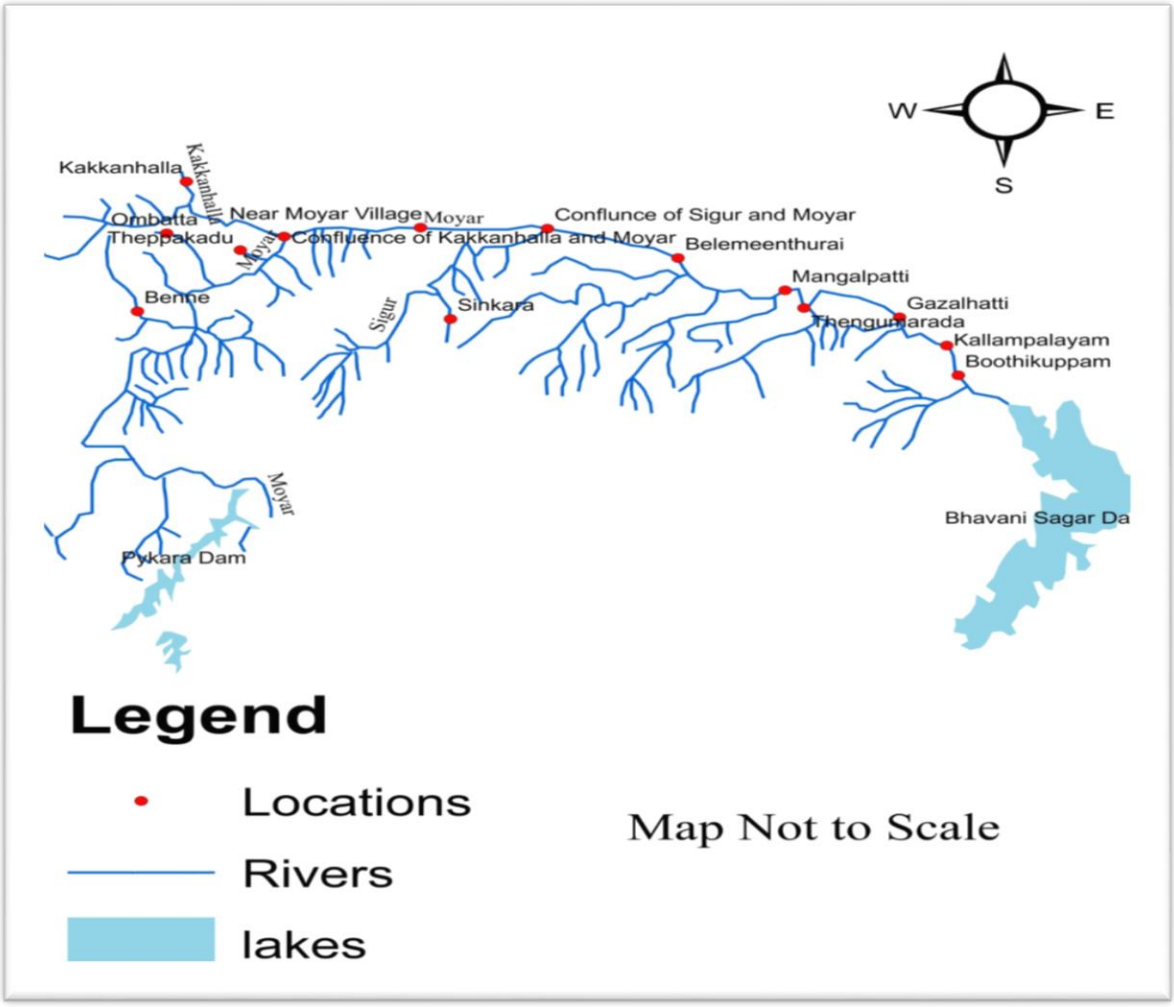
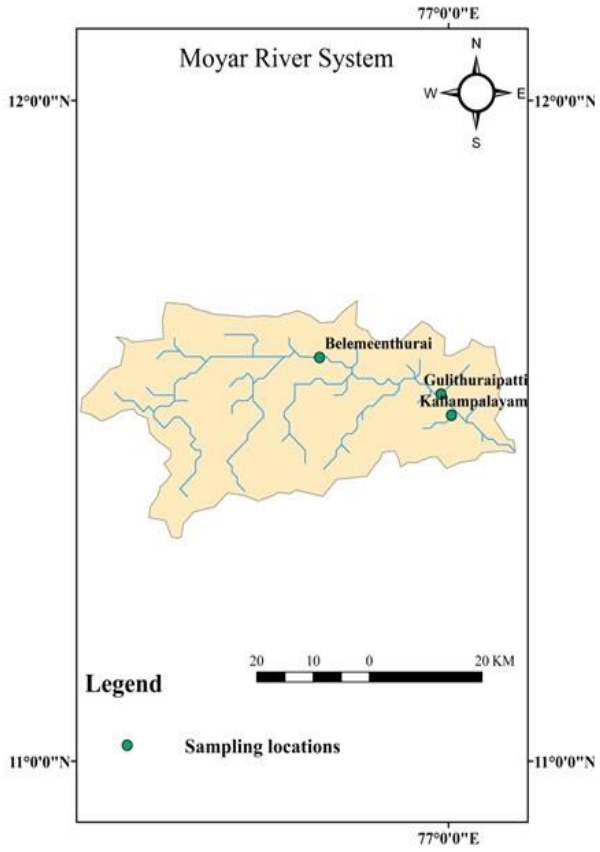


Figure 1: Sampling stations at Moyar River System



Sampling stations of Moyar River System

A scenic view of River Moyar

Belemeenthurai

Figure 2: A map showing the study sites of Moyar River System

Table 1
Sampling locations at Moyar and Cauvery River System

S.N.	River System	Sampling Location	Latitude	Longitude
1	Moyar	Boothikuppam	11º34′E	77º06′N
2		Kallampalayam	11º33′E	77º05′N
3		Gazalhatti	11º33′E	77º01′N
4		Thengumarada	11º34′E	76º55′N
5		Mangalapatti	11º35′E	76º51′N
6		Belimeenthurai	11º36′E	76º47′N
7		Chammanar	11º23′E	76º53′N
8		Conf.of Sigur and Moyar	11º45′E	76º46′N
9		Kakkanhalla	11º37′E	76º34′N
10		Near Moyar village	11º37′E	76º41′N
11		Ombatta	11º34′E	76º32′N
12		Confluence of kakkanhalla and Moyar	11º37′E	76º37′N
13		Theppakadu	11º35′E	76º35′N
14		Sinkara	11º32′E	76º37′N
15		Benne	11º37′E	76º27′N
16	Cauvery	Kadapilliyarthittu	12° 07'E	77° 46'N
17		Belikoondu	12° 11'E	77° 43'N
18		Nadathittu	12° 08'E	77° 44'N
19		Sinnaru	12° 06'E	77° 46'N
20		Kootaru manal medu	12° 06'E	77° 46'N
21		Arivalapani sandhukattu	12° 07'E	77° 46'N
22		Thonanthikla	12° 07'E	77° 46'N

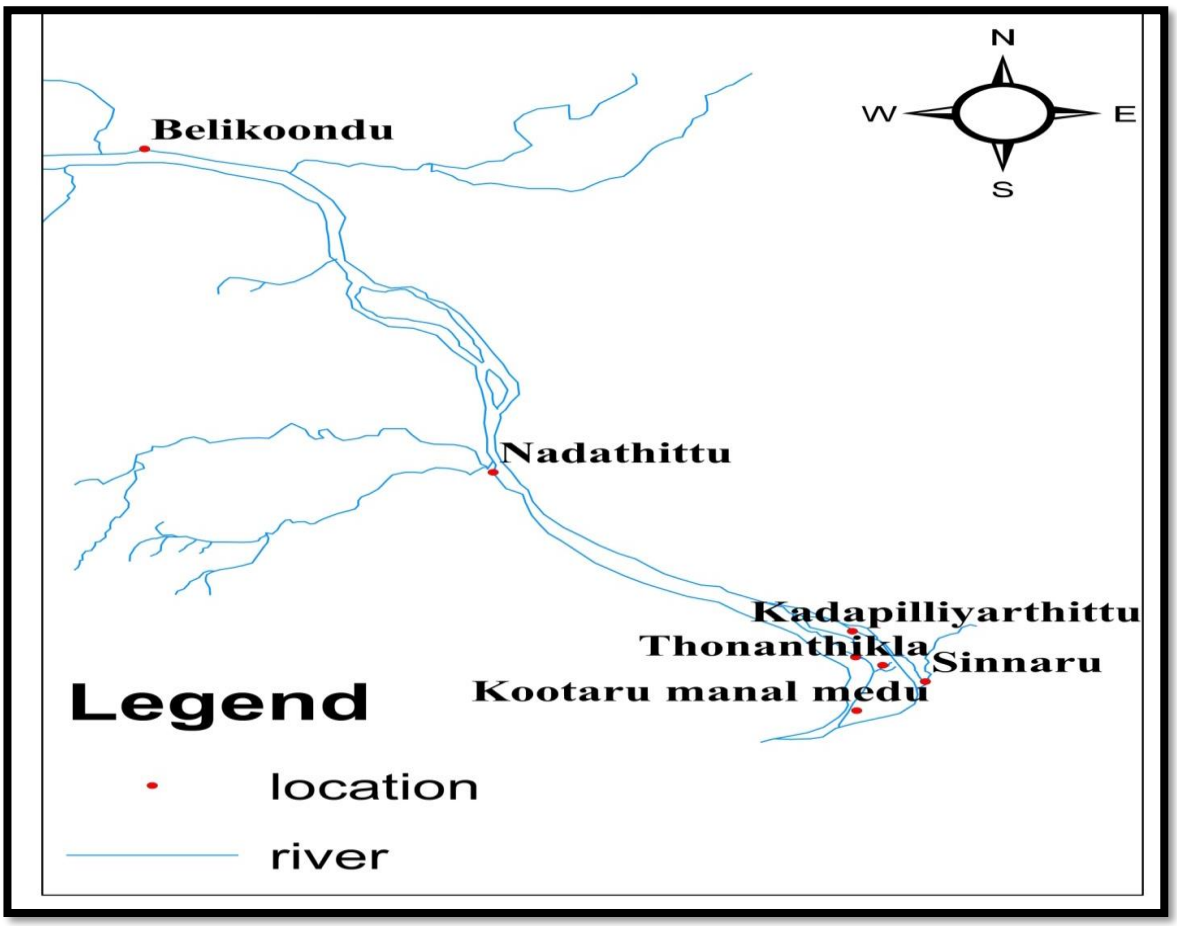
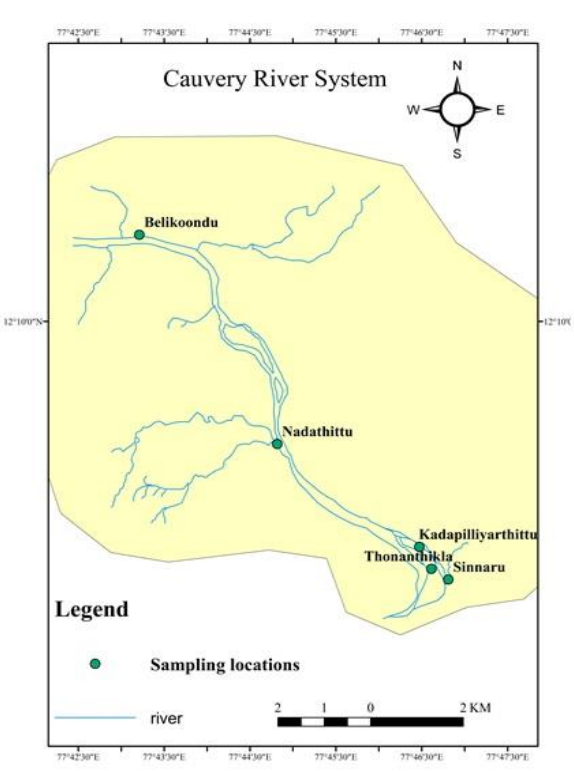


Figure 3: Sampling stations at Cauvery River System



Sampling stations of Cauvery River System

A scenic view of Hogenekkal

Nadathittu

Figure 4: A map showing the study sites of Cauvery River System

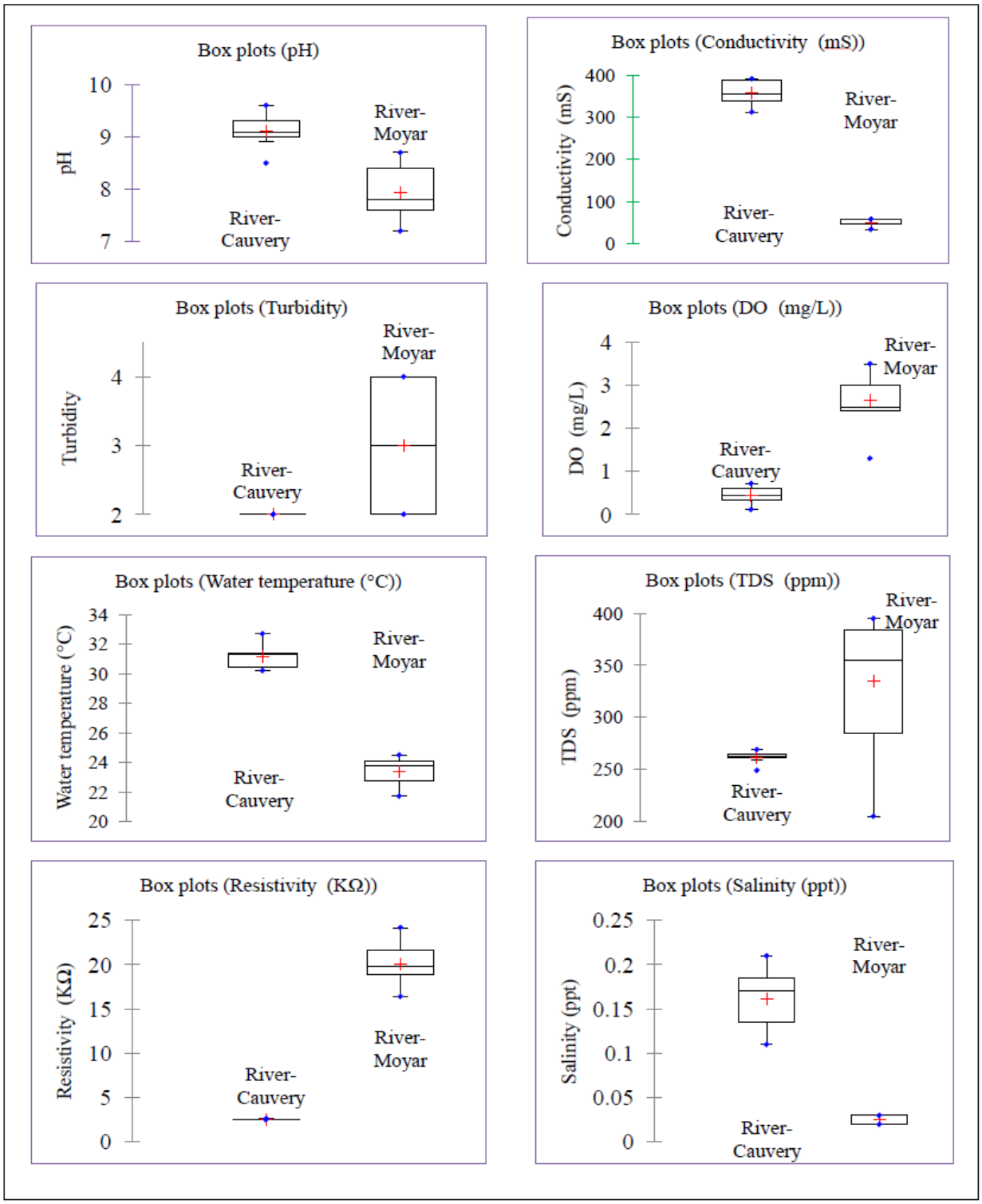


Figure 5: Box Plot Model for Water Quality Parameters

The maximum value of conductivity was recorded as 391mS at @ Kadapilliyarthittu of Cauvery river system and a minimum value of conductivity was recorded as 33.5mS at Kallampalayam of Moyar river system (Table 2, Fig. 5). The maximum value of turbidity was recorded in Moyar than that of Cauvery river system. It is due to the perennial flow of the streams from the headwaters of the Moyar river which makes the stream to wash the mud all through their flow making themselves turbid (Table 2, Fig. 5).

The maximum value of dissolved oxygen was recorded as 3.5 mg/l at @ Benne of Moyar river system and a minimum value of dissolved oxygen was recorded as 0.11 mg/l at Sinnaru of Cauvery river system. The dissolved oxygen is termed as the barometer of the ecological health of Freshwater Ecosystem, in such case, the river Moyar is fulfilled with maximum limit (Table 2, Fig. 5).The average value of dissolved oxygen (DO) in river water ranged from 4.2mg/l to 3.5mg/L which is acceptable when compared to

the tolerance limit of 3mg/L or higher as prescribed by the ISI: 2296-(1982) for inland surface water subject to pollution.

The lowest DO recorded at sampling sites is due to organic-rich domestic waste into the river thrown by the tourists in the river system[7]. The maximum water temperature (32.7ºC) was obtained at Nadathittu of Cauvery and the minimum water temperature (21.7ºC) was obtained at Ombatta in Moyar. The variation in water temperature may be due to different timing of collection. Temperature controls behavioral characteristics of organisms, the solubility of gases and salts in water. No other factor has so much influence on temperature as stated by Welch[15]. Moreover, it has a profound effect on dissolved oxygen content in the water body. These low and high-temperature differences could be due to the vegetation around the river banks[12] (Table 2, Fig. 5).

Salinity can also be measured in freshwater. Compared to seawater or brackish water, freshwater has much lower levels of "salt ions" such as Na^+ and Cl^-; in fact, these ions are often lower in concentration than hard-water ions such as calcium (Ca^{2+}) and bicarbonate (HCO_3^-). The low value of salinity was noted at Kakkanhalla 0.02 ppt and a high level of salinity was noted at Sinnaru as 0.03 ppt (Table 2, Fig. 5). A minimum value of 2.52 KΩ was measured at Sinnaru and a maximum of 24.2 KΩ was measured at Thengumarada. The hardness of water is not a pollution parameter but indicates water quality (Table 2, Fig. 5).

Habitat Structure Characteristics: Among the sampling sites, Sinnaru (225) has low altitude and Sinkara (970), Ombatta (980) and Benne (1020) have high altitude (Table 2, Fig. 6). The altitude also plays a key role in the quality of water where the high altitude streams, the river is rich in nutrients with fertile habitat for fish survival[4].

Table 2
Water Quality Parameters

River	Study site	pH	Conductivity (mS)	TDS (ppm)	Resistivity (KΩ)	DO (mg/L)	Salinity (ppt)	Water temperature (°C)	Altitude (m)	Forest type	Stream order	Stream width(m)	Stream depth(m)	Mean velocity (m/sec)	In stream cover (%)	Turbidity	Riparian cover(%)
Moyar	Boothikuppam	8.4	57.4	380	22	3.5	0.03	23.8	280	2	4	10	6	4	60	4	60
	Kalampalayam	7.2	33.5	205	16.4	2.4	0.03	21.7	300	2	4	13	8	5	60	4	60
	Gzalhatti	7.5	45.2	285	19.4	2.5	0.02	24.1	340	2	4	22	1.5	5	60	4	80
	Thengumarada	8.5	57.8	385	24.2	3.5	0.03	23.8	380	3	4	18	1.2	4	60	4	80
	Mangalapatti	7.8	45.2	285	18.9	2.5	0.02	24.1	420	3	4	19	1.75	4	60	4	80
	Belimeenthurai	7.6	45.9	280	16.8	2.4	0.03	21.7	520	3	4	21	5	4	60	4	80
	Chammanar	8.3	57.1	383	21.2	3.5	0.03	23.8	880	4	3	7	1.2	4	40	2	80
	Confluence of Kakkanhalla and Moyar	7.8	45.4	380	19.8	2.4	0.03	21.7	700	3	4	13	1.1	3	50	3	80
	Kakkanhalla	7.6	45.2	275	19.4	2.5	0.02	24.1	900	3	3	8	0.8	2	50	2	60
	Near Moyar Village	8.7	55.2	385	21.9	2.5	0.02	24.1	860	3	4	8	1	3	50	4	80
	Ombatta	7.6	45.3	350	18.8	2.4	0.03	21.7	980	1	2	5	1.2	2	50	2	60
	Confluence of Kakkanhalla and Moyar	7.3	33.9	285	16.6	2.5	0.02	24.1	850	3	4	9	1.4	3	50	2	80
	Theppakadu	8.4	55.2	392	19.9	2.5	0.02	24.1	940	3	4	17	2	3	50	2	80
	Sinkara	7.8	49.2	355	21.4	1.3	0.03	24.5	970	3	3	3	0.4	3	50	2	80
	Benne	8.5	57.8	395	24.2	3.5	0.03	23.8	1020	4	2	3.5	0.8	2	50	2	80
Cauvery	Kadapilliyarthittu	9.6	391	263	2.58	0.72	0.18	30.5	310	3	3	75	1.5	1	5	2	60
	Belikoondu	9.1	355	265	2.59	0.33	0.11	31.3	267	3	3	80	7	3	4	2	60
	Nadathittu	9.4	389	263	2.63	0.63	0.17	32.7	262	3	3	70	6	3	5	2	60
	Sinnaru	9.2	385	259	2.52	0.11	0.21	30.2	225	3	3	55	0.5	3	4	2	60
	Kootaru manal medu	9.1	355	265	2.59	0.33	0.11	31.3	303	3	3	70	2	3	2	2	60
	Arivalapani sandhukattu	8.5	321	269	2.55	0.43	0.16	31.5	338	3	3	30	1.5	3	2	2	60
	Thonanthikla	8.9	312	249	2.65	0.55	0.19	30.4	341	3	3	25	1	5	1	2	60

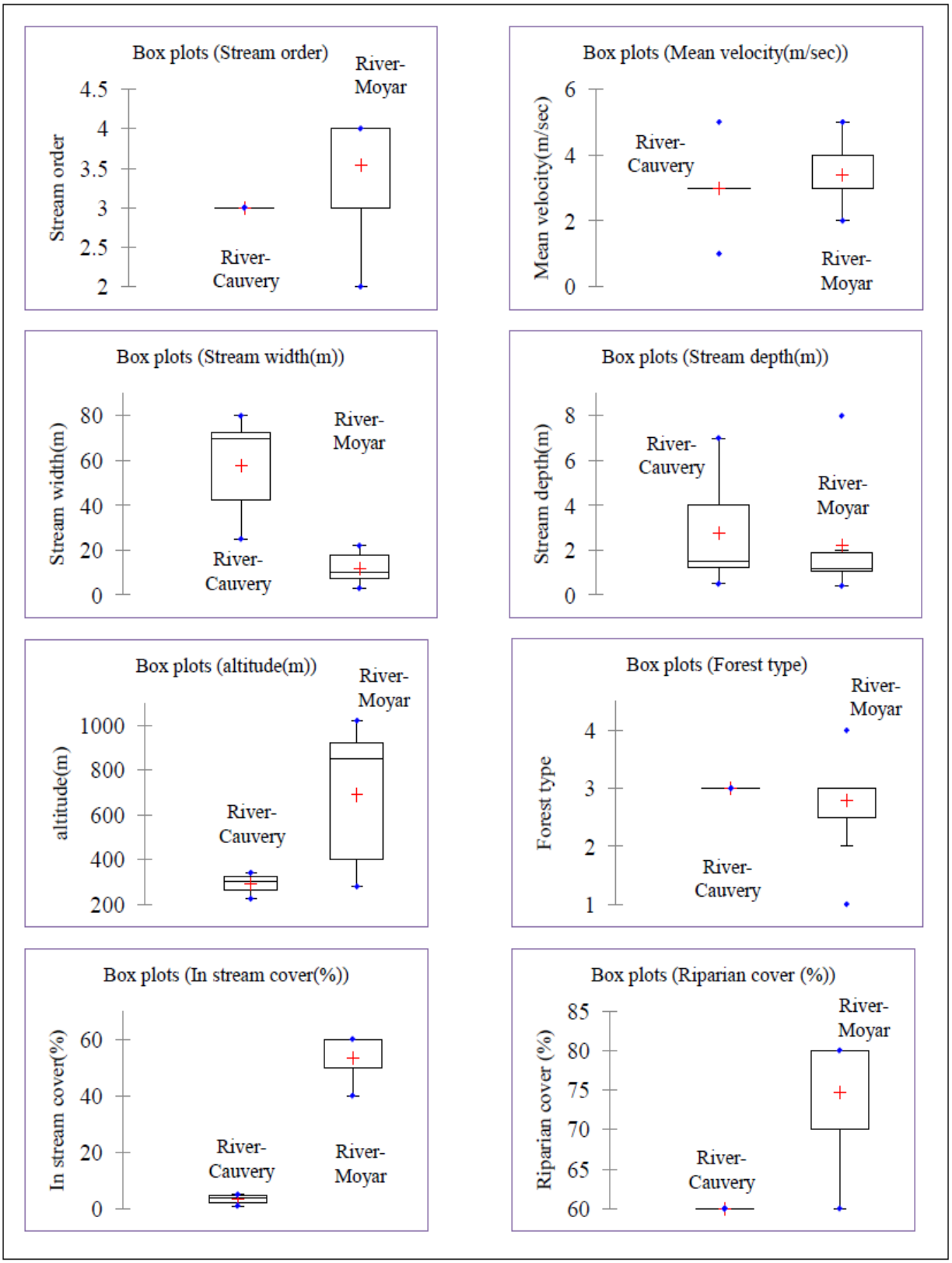


Figure 6: Box Plot Model for Habitat Structure Parameters

Stream width was recorded high at Belikoondu(80m) and Sankara(3m) has been recorded with low-level stream width (Table 2, Fig. 6). Stream depth was recorded high at Kallampalayam (8m) and Sankara(0.4m) has been recorded with low-level stream width (Table 2, Fig. 6).

Mean velocity (m/s) is a measure to find out the water flow or speed. Codes for water velocity are as follows: 1. Less the 0.05 Very slow, 2. Slow (0.05- 0.2), 3. Moderate (0.2-0.5), 4. Fast (0.5-1.0) and 5. Very fast (>1). These coding values are taken into count, Kallampalyam, Gazalhatti and

Thonanthikla have been recorded with high water velocity. Kadapilliyarthittu has been recorded with low water velocity (Table 2, Fig. 6).

Turbidity is the measure of visibility of water. Codes for turbidity are as follows: 1. Clearwater bottom visible, 2. Bottom may not be visible but not clear, 3. 25% visible and 4. Not visible. High turbidity was recorded at Boothikuppam, Kalampalayam, Thengumarada, Mangalpatti and Belimeenthurai. Low turbidity value was recorded in most of the sampling sites of River Cauvery (Table 2, Fig. 6). Our Indian forests are blessed with a vast range of forest types and at present, we have recorded four forest types viz… Bamboo, Thorn forest, Dry deciduous and Semi-evergreen forests. Considering all our sampling sites, it is observed that most of them are rich in dry deciduous and semi-evergreen forests with 60% - 80% Riparian cover (Table 2, Fig. 6).

Conclusion

The River Moyar is highly supplied with primary and secondary orders of streams. Moyar river system is rich in the water quality and habitat structure, a unique nature of its own. No man-made habitat alterations with effects onto the fish community were observed and assemblage structure has been identified. The habitat assessment of the study area says that there are four habitat types (pool, riffle, run and glide) with six substratum type (Fine Sand, Mud, debris, Silt, Bedrocks, Gravel, Pebbles, Cobbles and Boulders). The shore line is also sandy border rigid with rocks and sandy border rigid. This makes up a good habitat for the aquatic organisms. Moreover, the substratum and the vegetation create a good food resource for the fish.

By comparing the water quality in terms of physical and chemical characteristics and habitat characteristics of Moyar and Cauvery River system, we conclude that the Moyar river system is rich in the water quality and habitat structure comparing to the Cauvery river system. The River Cauvery is less supplied with primary and secondary orders of streams and more over the location is termed to be a tourist spot. The river habitat is utilized by the humans for introducing the particular type of fish community for their usage as a source of protein food. Hence it is mandatory to make conservation measures to protect River Moyar.

Figure 7: Fishes Recorded Form River Moyar

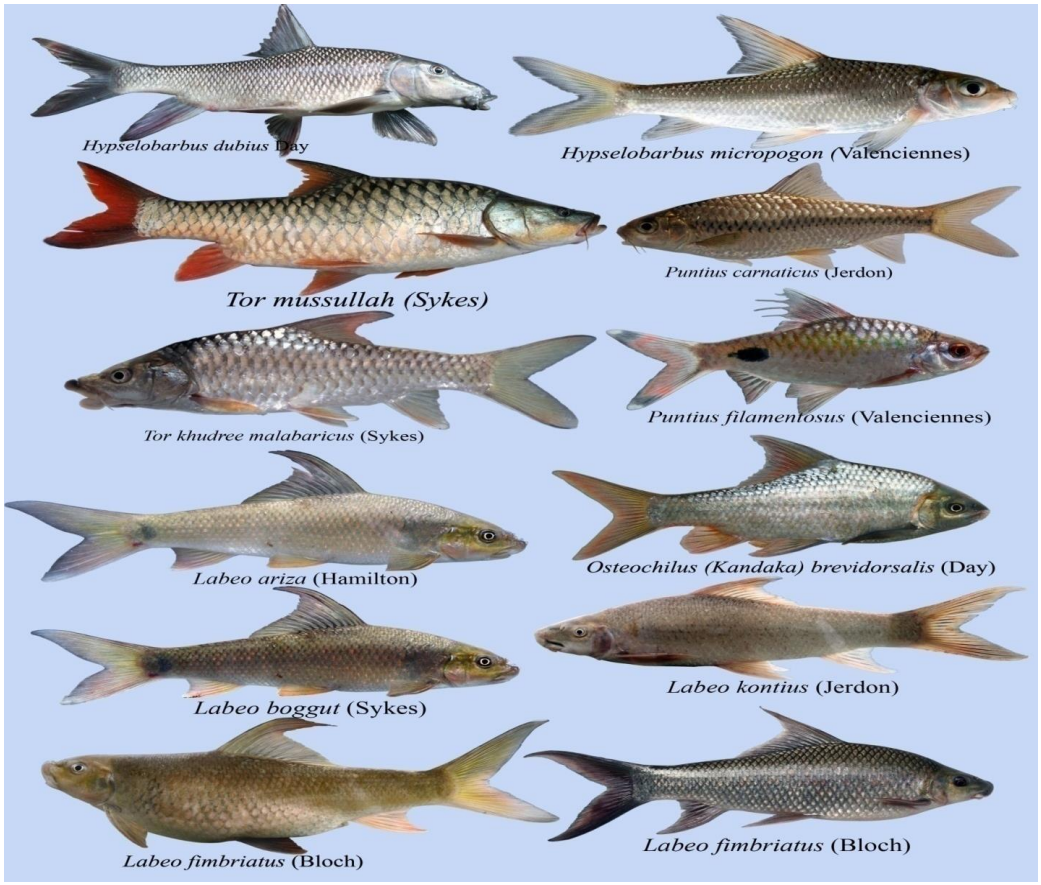


Figure 8: Fishes Recorded Form River Moyar

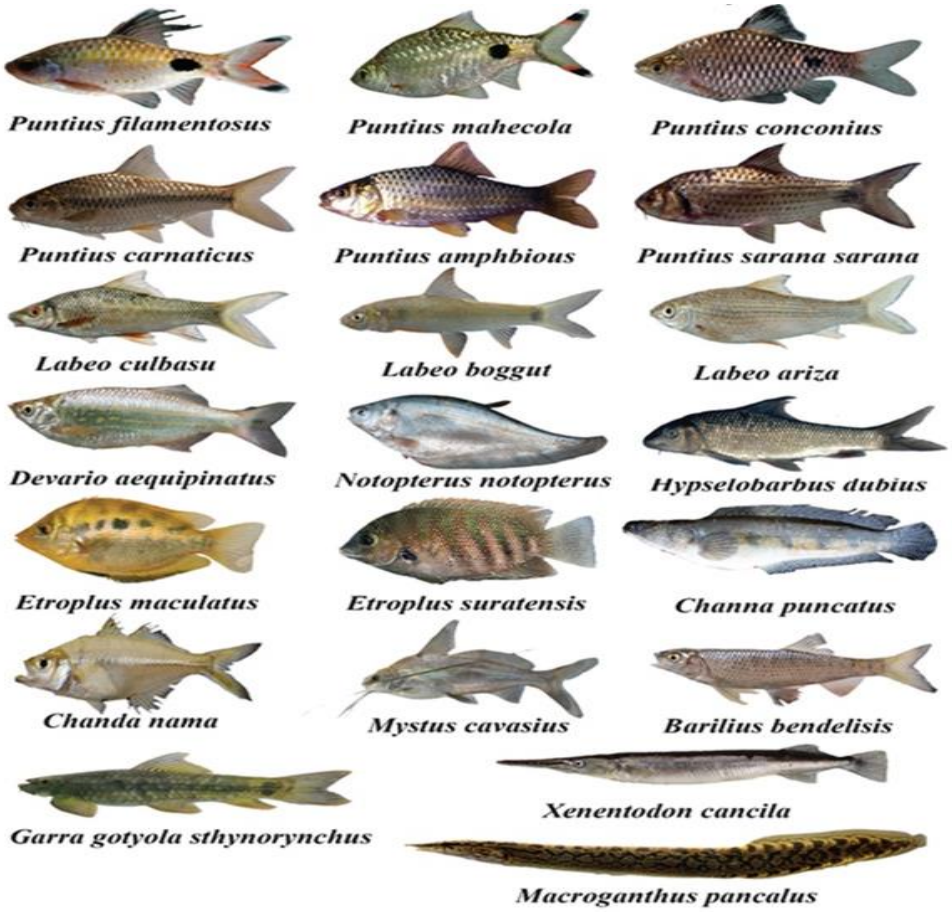


Figure 9: Fishes Recorded Form River Cauvery

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