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Hydrobiological investigation at Ennore backwater: emphasize to seasonal consequence.

Investigación hidrobiológica en el remanso de Ennore: énfasis en las consecuencias estacionales.

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ABSTRACT

Hydrobiology regulates the plankton diversity in a water body and is a fundamental research area in aquatic and ecological studies. The present study was carried out to assess the physicochemical parameters viz. temperature, salinity, pH, at four stations in Ennore estuary for the period of one year from January to December 2021. Atmospheric Temperature of the Ennore backwaters varied from 26 to 36°C and the mean temperature of 31.20°C. Surface water temperature in the present study was varied from 25°C to 34°C and the mean temperature of 29.45°C. Salinity was varied from 22.35 to 54.65 ppt and the mean salinity of 37.44 ppt. *p*H at Ennore back waters ranged from 7.5 to 8.5 with the mean *p*H of 8.08. Dissolved oxygen content was ranged from 0.59 to 8.2 mg/l and the mean dissolved oxygen content of 4.85 mg/l. Salinity is the predominant parameter altered in wide range. The basic reason for the salinity alteration is the continual ventilation hot water from thermal power stations with temperature raise.

Keywords: Hydrobiology, physico chemical Parameters, Ennore backwaters.

RESUMEN

La hidrobiología regula la diversidad de plancton en un cuerpo de agua y es un área de investigación fundamental en los estudios acuáticos y ecológicos. El presente estudio se llevó a cabo para evaluar los parámetros fisicoquímicos a saber. temperatura, salinidad, pH, en cuatro estaciones en el estuario de Ennore durante el período de un año de enero a diciembre de 2021. La temperatura atmosférica de los remansos de Ennore varió de 26 a 36 °C y la temperatura media de 31,20 °C. La temperatura del agua superficial en el presente estudio varió de 25°C a 34°C y la temperatura media de 29,45°C. La salinidad varió de 22,35 a 54,65 ppt y la salinidad media de

37,44 ppt. El pH en las aguas residuales de Ennore osciló entre 7,5 y 8,5 con un pH medio de 8,08. El contenido de oxígeno disuelto osciló entre 0,59 y 8,2 mg/ly el contenido medio de oxígeno disuelto fue de 4,85 mg/l. La salinidad es el parámetro predominante alterado en un amplio rango. El motivo básico de la alteración de la salinidad es la ventilación continua del agua caliente procedente de centrales térmicas con aumento de temperatura.

Palabras clave: hidrobiología, parámetros fisicoquímicos, remansos de Ennore.

INTRODUCTION

The aquatic environment is a complex system formed by interactions between the ecological structure, functions, physicochemical processes, and socioeconomic systems (Elliott et al., 2017). Among, estuarine ecosystems are highly dynamic, complex hydro biological processes under way which culturally, commercially and recreationally important. They offer multiple unique ecosystem services that maintain health of marine and coastal ecosystem and benefit of mankind (Elliott and McLusky, 2002). They support diverse and abundant communities of plants and animals which capable of living in fresh water, saline and marine ecosystems. Ennore Estuary is one among the impacted estuary showed high spatial heterogeneity, complexity and highly fragmented habitats in the freshwater– estuarine–coastal–marine continuum (Dauvin and Ruellet, 2009). 450 metric tons of Effluent Treatment Plant Sludge (ETPS), Domestic sewage of 0.9 million gallons/day and ETPS Fly ash were released in the creek. In addition, they are exposed to high degrees of anthropogenic impact (Elliott and Quintino, 2007) which leads to the “estuarine quality paradox” (Dauvin, 2007; Dauvin and Ruellet, 2009). This hot spots of vulnerability (Newton et al., 2012; Newton and Weichselgartner, 2014) need to restore by lowering human activities (Jones and Schmitz, 2009; Lotze et al., 2011) and industrialization. For that, the hydrobiology study is prerequisite. Hence, the study was undertaken to perceive the level of fluctuation of various physicochemical characteristics and their consequence by seasonal impact.

MATERIAL AND METHODS

Study site: Ennore estuary is a backwater located along the Coromandel Coast of the Bay of Bengal near Chennai, Tamilnadu. It is a peculiar geomorphological structure, formed as a brackish water lagoon which nearly 400 meter wide, extended parallel creek up to Pulicat Lake in Northeast–Southwest direction with the opening to the Bay of Bengal. The creek covers an area of 2.25 sq.km and the ecosystem spreads up to 8 sq.km. The creek area stretches its arm 3 km from the sea. The depth of the creek varies from 1 to 2 meter. Twenty three industries releases its discharges into creek water. The North Chennai Thermal Power Station and the Ennore Thermal Power Station are the important industries which release coolant water to the creek. As per the 1991 Coastal Regulation

Zone notification, the entire creek water system is designated CRZ I. Still, the treated and untreated municipal and industrial wastewaters such as raw municipal sewage,industrial trade effluents,industrial cooling waters, oil from boat repairs, fish cleaning wastes etc., are discharged to the Ennore Creek and ultimately reached to the coastal waters. The present study was carried out four sampling stations which was identified (Study area Fig.1) by GPS for sampling and assessment of hydrobiological parameters. GPS values to the respective stations are given in the table 1.

Table. 1 Sampling stations and its GPS positions

Stations	Latitude	Longitude
Station 1	13° 13' 35.61"	80° 19' 14.28"
Station 2	13° 14' 14.07"	80° 18' 59.87''
Station 3	13° 15' 45.38"	80° 19' 17.73''
Station 4	13° 16' 10.3"	80° 19' 18.06"

Methodology: Water Samples were collected in four stations in Ennore creek on monthly basis for the period of one year from January to December 2021 at distinct stations. The samples were collected using clean plastic bottles and brought to the laboratory for further analysis. The following parameters were analysed (Table 2.)

Table2. List of hydrobiological parameters assessed in Ennore Back waters

S. No	Parameters
1	Temperature
2	Salinity
3	pH
4	Dissolved Oxygen

The temperature was measured through standard centigrade laboratory thermometer. The salinity was measured by salinity refractometer (made by ATAGO) by the principle of refraction. *p*H was measured by a *p*H pen (made by Eutech instruments), which was dipped in a beaker containing sample water. Dissolved oxygen was determined by Winkler's method (Winkler's, 1988).

Statistical analysis

Coefficient of correlation: coefficient of correlation (r) was performed to understand the relationship between the various parameters by showing their positive, negative correlation. It was performed using Microsoft Excel (Version 2013, USA).

Principal component analysis: PCA is a powerful pattern recognition tool that attempts to explain the variance of a large dataset of intercorrelated variables with a smaller set of independent variables (Simeonov et al. 2003). PCA technique extracts the eigenvalues and eigenvectors from the covariance matrix of original variables. PCA is designed to transform the original variables into new, uncorrelated variables (axes), called the principal components, which are linear combinations of the original variables. The new axes lie along the directions of maximum variance (Shrestha and Kazama 2007). It reduces the dimensionality of the data set by explaining the correlation amongst a large number of variables in terms of a smaller number of underlying factors, without losing much information (Vega et al. 1998). The PCA can be expressed as

$$Z_{ij} = pc_{i1}x_{1j} + pc_{i2}x_{2j} + \ldots : pc_{im}x_{mj}$$

Where z is the component score, pc is the component loading, x is the measured value of the variable, i is the component number, j is the sample number, and m is the total number of variables. PCA was analysed through PAST 3 statistics software.

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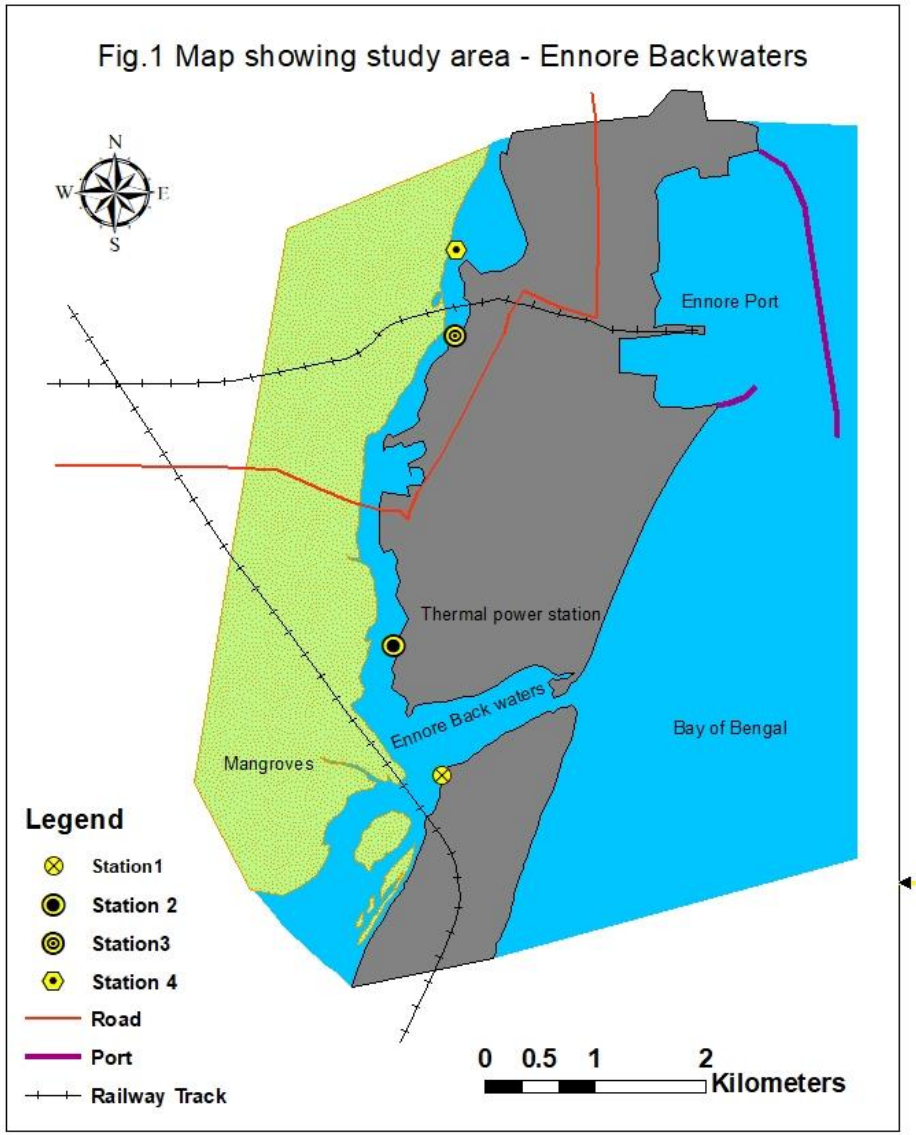

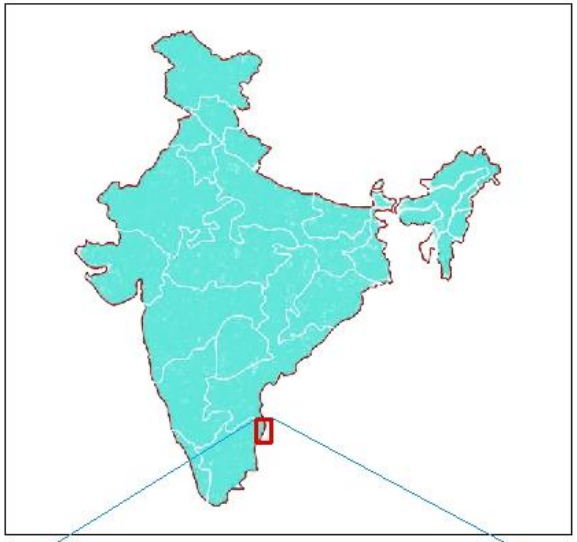

RESULT AND DISCUSSION

The hydro biological parameters were analyzed from January to December 2021 at Ennore backwaters. Atmospheric Temperature of the Ennore backwaters varied from 26 to 36°C and the mean temperature of 31.20°C (Fig. 2). Seasonally, higher temperature was observed in summer and lower was during pre-monsoon. Surface water temperature in the present study was varied from 25°C to 34°C (Fig. 3) and the mean temperature of 29.45°C. Seasonally, higher temperature was observed in summer and lower was during pre-monsoon season. Water temperature is the most important environmental factor altered by waves, wind speed, tides, sunlight and other hydrological parameters of the estuarine system which in turn considerable changes in the species composition, distribution, density, and zonation. Atmospheric and surface water temperature are positively correlated (r=0.81, Fig. 7), hence, the atmospheric temperature is greatly influence the rising and falling of surface water temperature at Ennore back waters. In the present study, high water temperature noticed in summer coincided with heat wave in summer could be attributed to high solar radiation (Kamalkanth *et al.,* 2012 and Mohammad M. Rahman *et al,* 2013; Gadhia *et al.,* 2012). This is supported by Principal component analysis, where summer season (Year 2021) with atmospheric and surface water temperature grouped into single axis (Fig. 8). Similar observations noticed at Mahanadhi estuary (Pravat Ranjan Dixit *et al.,* 2013); Kanyakumari coastal waters (John Peter Paul, 2012); Point Calimere (Srilatha, 2013) indicated that surface water temperature of Ennore creek has little elevation. This might be release of hot water from Thermal power stations. Low temperature in the pre monsoon season was contributed by precipitation, cool breeze (Damodharan *et al.,* 2010, Kamalkanth *et al.,* 2012), and fresh water inflow in the back waters caused by the Northeast monsoon which was onset during August, 2021. Similar pattern were recorded by Soundarapandian *et al.*, (2009) in Uppanar estuary; Palpandi, (2011) in Vellar estuary; Kamalkanth *et al.,* (2012) from Tranquebar; Vengadesh Perumal *et al.,* 2009 from Kaduviyar estuary, Nagapattinam. Salinity was varied from 22.35 to 54.65 ppt (Fig.4) and the mean salinity of 37.44 ppt. Higher salinity was noticed in the month of April at station 1, 2021. Lower salinity was observed in the month of February, 2021 at station 2. Seasonally, higher salinity was observed in summer and lower was during monsoon season. Low salinity is the reason of freshwater inflow from the rivers of Kosasthalaiyar and Koratallayar along with land run off during monsoon season (Sadhuram, 2005 and Pravat Ranjan Dixit, 2013). Higher salinity observed in the Ennore creek during summer could be attributed to low rainfall and ultimately reduction of fresh water flow and overwhelming mixing of seawater (Balasubramanian and Kannan, 2005; Sridhar *et al.,* 2006; Asha and Diwakar, 2007). Often, hot water released from two thermal power stations might have accelerated the evaporation, resulted higher salinity. Similar seasonal changes were investigated by Manikannan *et al*., (2011) from Great Vedaranyam mangrove swamp, Point Calimere wildlife sanctuary, Prabhahar *et al*., (2011) from Kadalur coastal waters, Damotharan *et al.,* (2010) from Point Calimere coastal waters; and Kamalkanth *et al.,* (2012) from Tranquebar, Nagapattinam coast and abstracted that Ennore creek water found to be high saline despite there is regular fluxing of tidal waters. *p*H at Ennore back waters ranged from 7.5 to 8.5 (Fig.5) with the mean *p*H of 8.08. Ennore backwater was alkaline in nature throughout the study. Higher *p*H was noticed in

the month of April at station 1, and July, station 1, 2021. Lower *p*H was observed in two months *viz*., October and December at station 2 and station 1, 2, 2021 respectively. There is no conspicuous seasonal changes in *p*H values. However, lower *p*H was noticed in monsoon season alone. Hydrogen ion concentration (pH) in the water determined by quantities of carbonate, bicarbonate and hydroxide (Trivedy and Goel, 1984). Carbon di oxide release during photosynthesis, bicarbonate degradation, temperature and decomposition of organic materials and supply of calcium carbonate by fresh water input contribute the alkaline nature (Karuppasamy and Perumal, 2000; Rajasegar, 2003; Paramasivam and Kannan, 2005 and Gadhia *et al.,* 2012) prevailing in the study area, *in situ* carbonate content play a major role for alkaline *p*H and thus have a greater ability to buffer free hydrogen ions. This was evidenced that lower *p*H was noticed during monsoon season, the monsoonal and riverine in flow might not contributed carbonate ions to determine the pH of Ennore back waters. It is supported by Principal component analysis (Fig. 8) explained that pH grouped with pre monsoon and their respective stations. Further it is supported that pH and salinity are positively correlated (r= 0.637, Fig. 7) (Srinivasan *et al.,* 2013) where dissolved salt content in the water might have more carbonate and control the pH which is in alkaline state. The elevated *p*H level in the summer and pre monsoon might be the reason on the creek water evaporation which cause high salt accumulation and that can influence the seawater penetration in deeper soil, favours more pyrite oxidation and high biological activity *i.e.,* phytoplankton production and greater photosynthetic activity (Rutner 1966; Damodharan *et al.,* 2010) and bicarbonate degeneration by the carbonic anhydrase (Ashok Prabhu *et al.,* 2008). According to Ellis, (1937), a water body with the *p*H ranging between 6.0 and 9.0 sustains good fishery. The present condition existing in the study area may act as a potential area for fishery despite accumulation of pollutants and sewages. Similar *p*H fluctuation pattern were observed in Tranquebar, Nagapattinam coast (Kamalkanth *et al.,* 2012); Great Vedaranyam swamp, Point Calimere (Manikannan *et al.,* 2011); Kadalur coastal waters, (Prabhahar *et al*., 2011). Dissolved oxygen content was ranged from 0.59 to 8.2 mg/l (Fig.6) and the mean dissolved oxygen content of 4.85 mg/l. High saturation of oxygen was observed during monsoon while lower saturation was noticed during summer season, despite least value observed at pre monsoon season. Station 1 and 4 were found to have higher dissolved oxygen content in all the seasons. The higher DO recorded during the monsoon attributed to the influx of fresh water and water current enhances solubility of oxygen when there was low temperature, and cumulative effect of higher wind velocity joined with heavy rainfall (Manikannan *et al.,* 2011). High decomposition rate, respiratory activity and high temperature might have caused lower dissolution of oxygen during summer. Higher temperature and salinity might affected dissolution of oxygen in sea water as confirmed by the report of Anitha and Sugirtha Kumar, (2013). The similar study has been reported from the Kadalur coastal zone, Tamilnadu (Prabhahar *et al.,* 2011); Tranquebar, Nagapattinam Coast (Kamalkanth *et al.,* 2012) and Agniar estuary in Adirampattinam (Sukumaran *et al.,* 2013). DO saturation concentration was higher at station 1 and station 4 might me due to surface agitation caused by water flow. Station 1 near to sea mouth, recorded higher DO might by tidal and wave effect during in and out flow of water in the Ennore creek.

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Fig. 2. Distribution of Atmosphereic Temperature in the study area

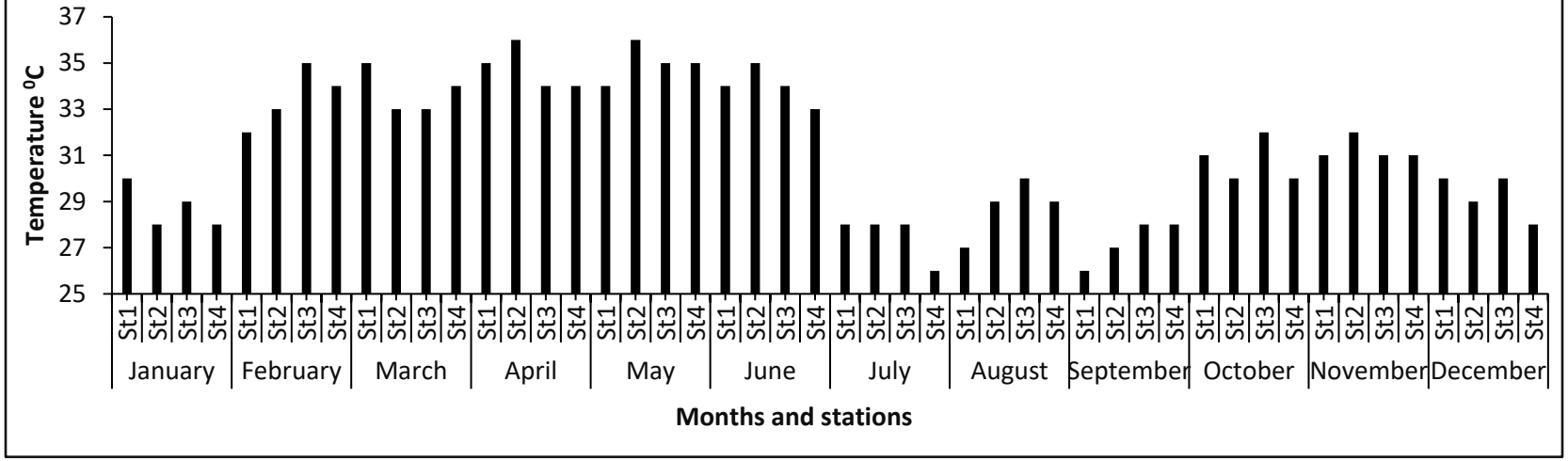
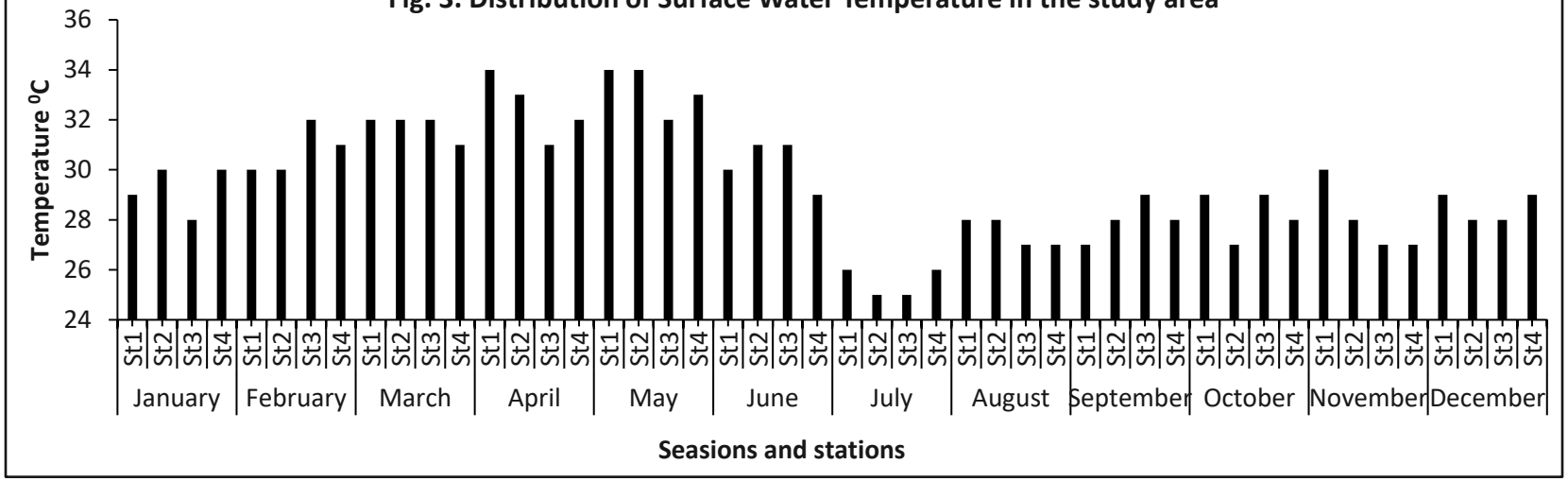


Fig. 3. Distribution of Surface Water Temperature in the study area



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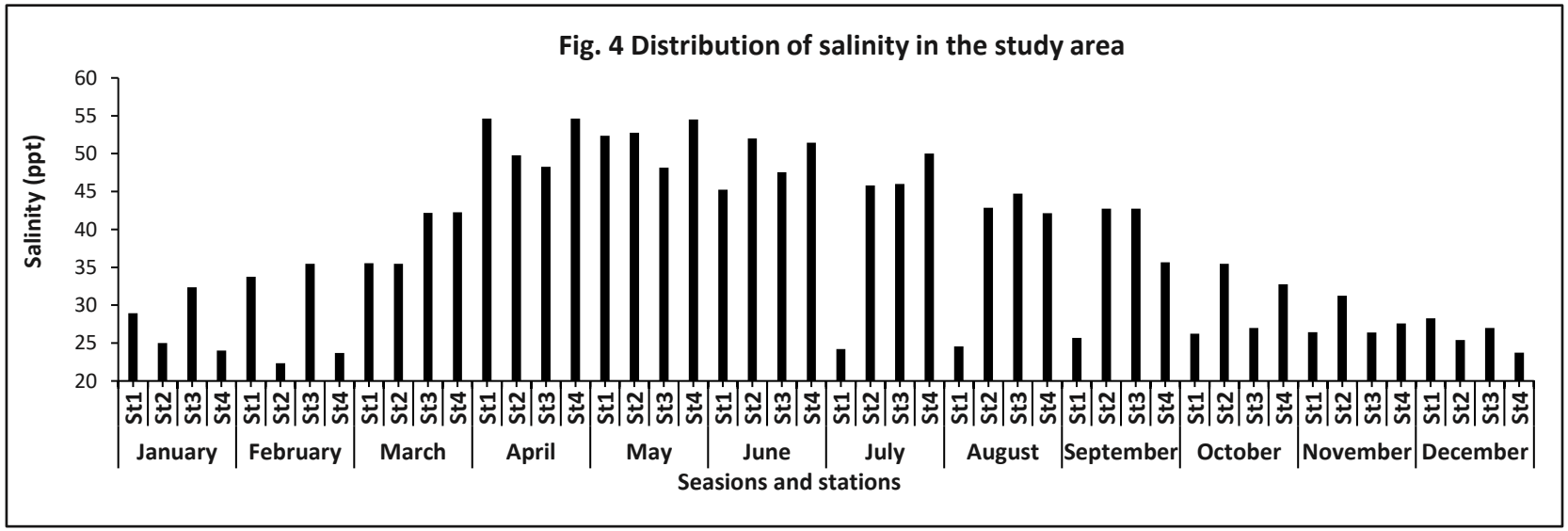

Fig. 4 Distribution of salinity in the study area

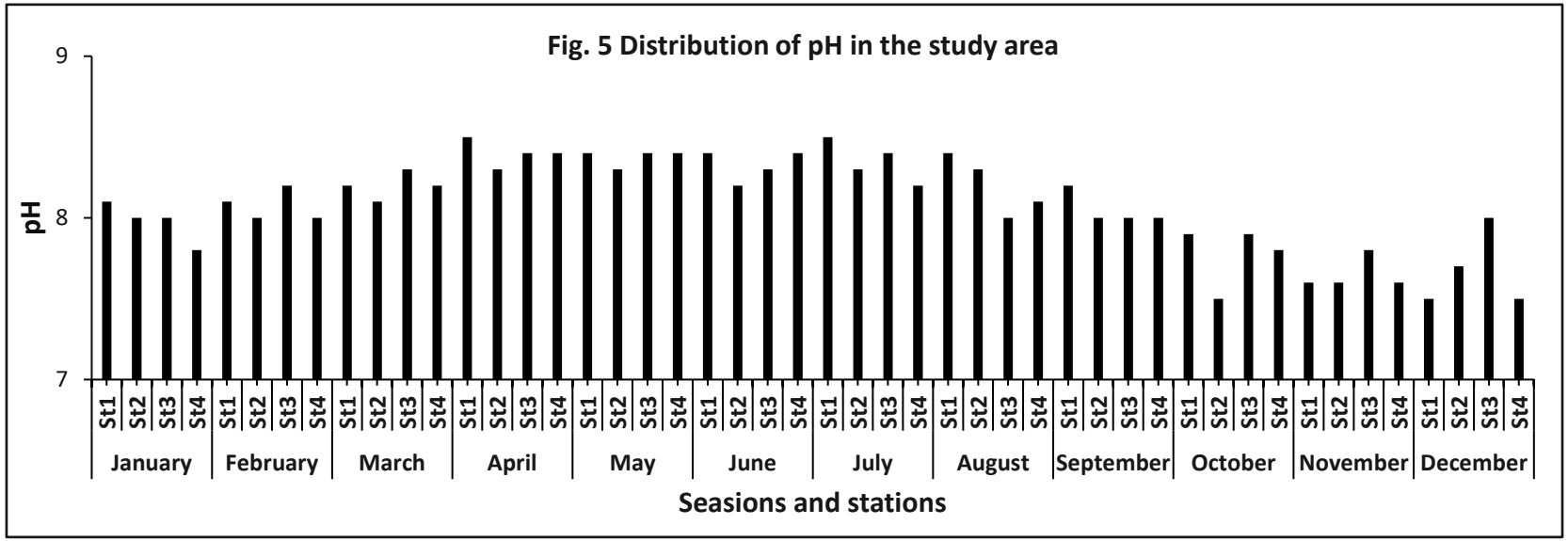

Fig. 5 Distribution of pH in the study area

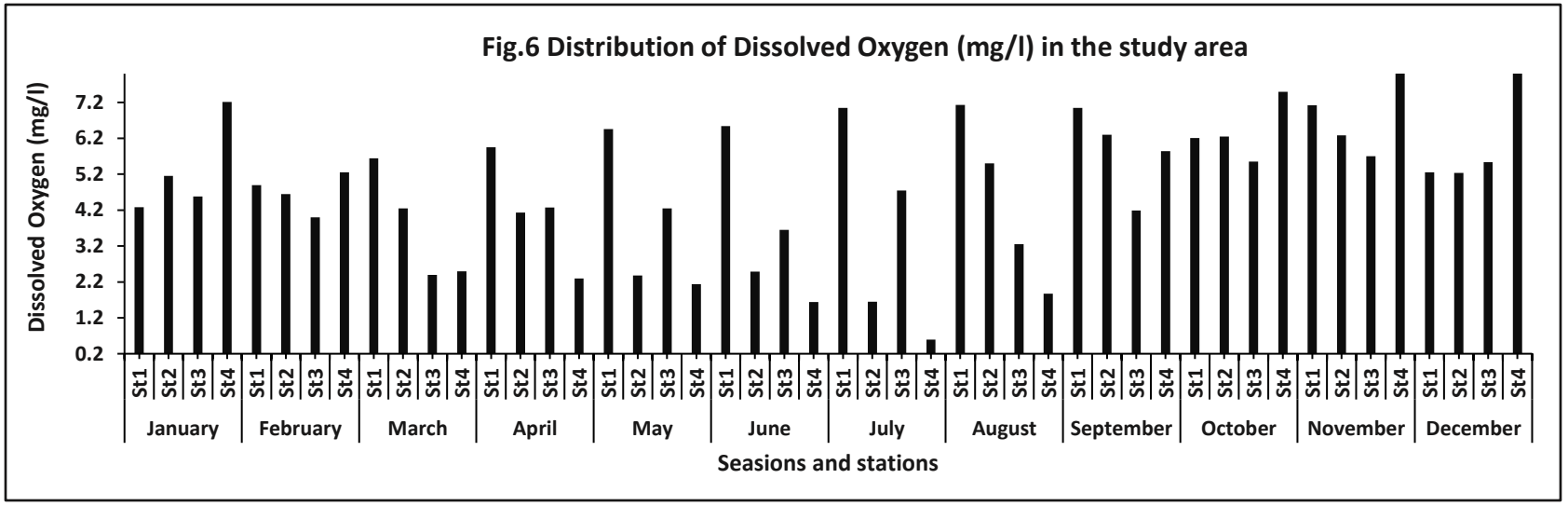

Fig 7. Correlation coefficient matrix between hydrobiological parameters at Ennore backwaters

	Atmos. Temp	*Surface temp*	*pH*	*salinity*	*DO*
Atmos. Temp	1				
Surface temp	0.81809503	1			
pH	0.33100793	0.337349053	1		
salinity	0.45436828	0.393198179	0.63762	1	
DO	-0.28298341	-0.166379102	-0.45587	-0.63734	1

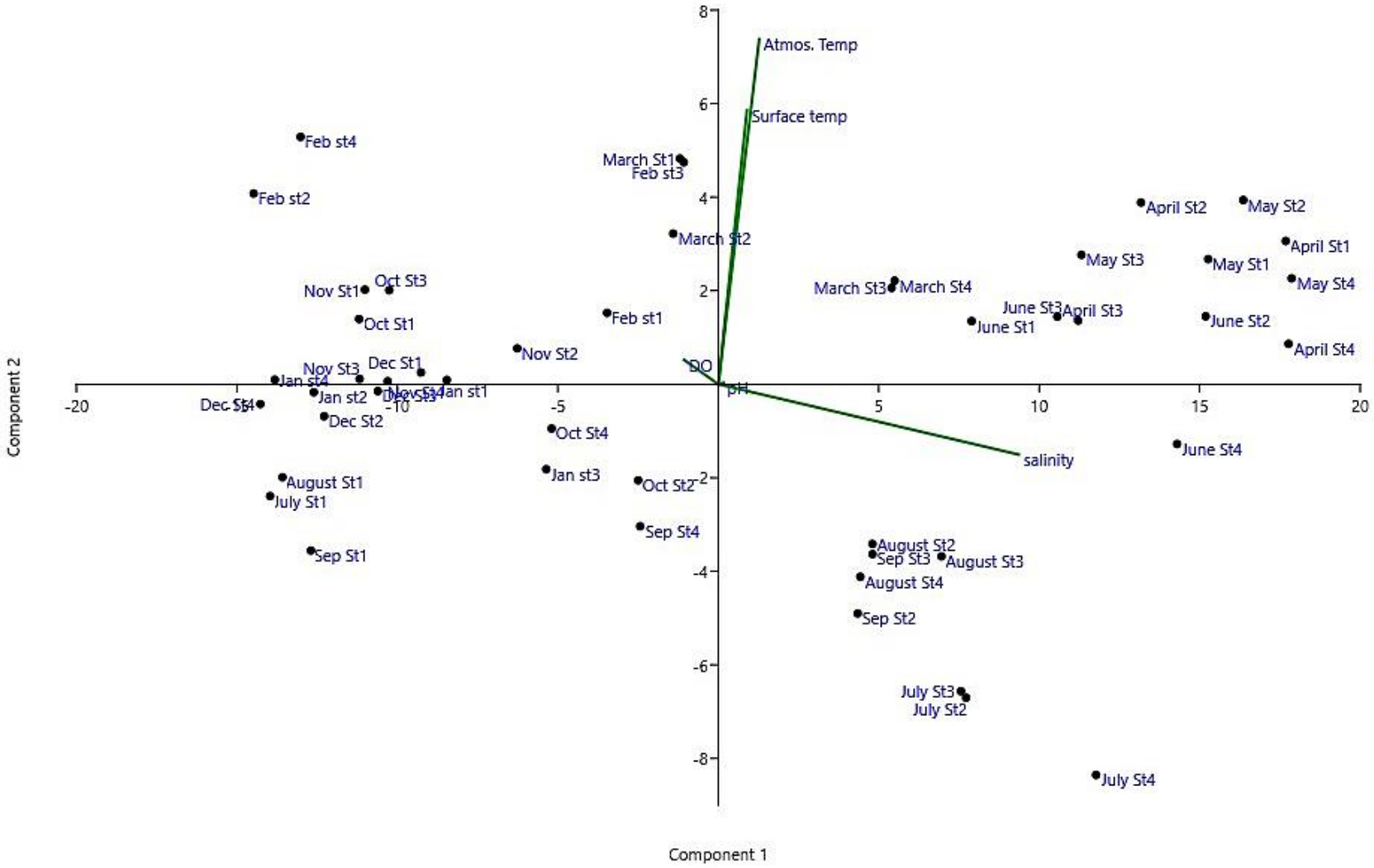

Fig 8. Principal component analysis between stations, seasons and physicochemical parameters

As conclusion, Ennore estuary is peculiar geomorphological structure, formed as a brackish water lagoon. Salinity is the predominant parameter fluctuated in wide range, influences other hydrobiological parameters and ultimate impact on distribution of faunal and floral component. The basic reason for the salinity alteration is the continual ventilation hot water from thermal power stations with temperature raise.

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