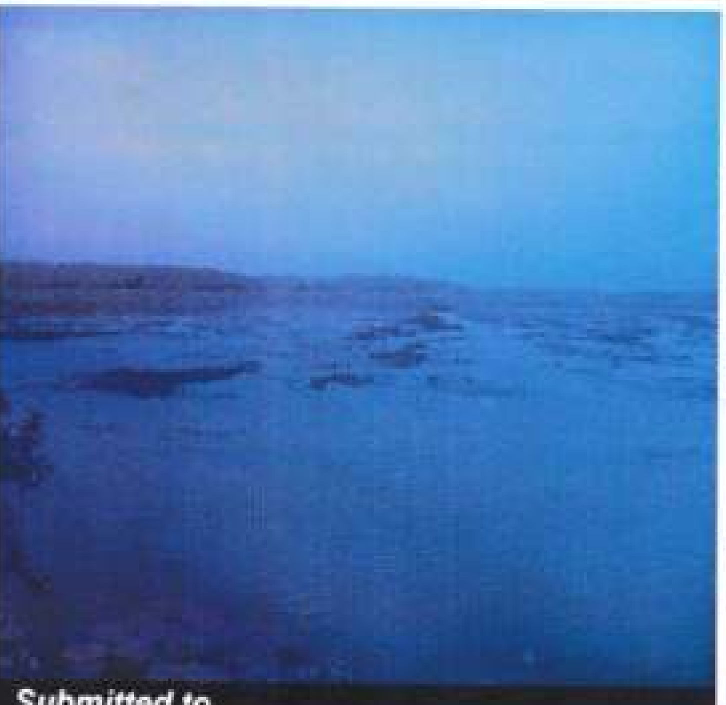
FINAL PROJECT REPORT

WETLAND BIODIVERSITY ENHANCEMENT THROUGH SUSTAINABLE UTILISATION OF WETLAND RESOURCES (FORMULATION OF A MODEL WETLAND MANAGEMENT PROGRAMME FOR THE KOLE WETLANDS)- DIVERSITY AND ABUNDANCE OF PLANKTON AND BENTHIC FAUNA OF MARANCHERY WETLAND

AUGUST 2009 TO AUGUST 2011



Submitted to
Kerala State Biodiversity Board
Thiruvananthapuram

Dept. of Marine Biology, Microbiology & Biochemistry
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Final Project Report

Wetland biodiversity enhancement through sustainable utilisation of wetland resources (Formulation of a model wetland management programme for the Kole wetlands) – Diversity and abundance of Plankton and Benthic fauna of Maranchery Wetland

August 2009 to August 2011

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Submitted to

KERALA STATE BIODIVERSITY BOARD, THIRUVANANTHAPURAM
GOVERNMENT OF KERALA

KERALA STATE BIODIVERSITY BOARD, TRIVANDRUM

FINAL PROJECT REPORT

1. Title of the project	:	***Wetland biodiversity enhancement through sustainable utilisation of wetland resources (Formulation of a model wetland management programme for the Kole wetlands) – Diversity and abundance of Plankton and Benthic fauna of Maranchery Wetland***
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3. Implementing Institution(s)	:	Dept. of Marine Biology, Microbiology and Biochemistry, School of Marine Sciences, Cochin University of Science and Technology, Cochin-16
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6. Name of the Project Fellows	:	**Amal Dev. (15. 10. 2009 to 30.07.2010)** **Vineetha. S (15.10.2009 to 30.06.2011)** **Rakhi Gopalan. K. P (06.08.2010 to 22.08. 2011)**
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i)Total fund allotted	:	**Rs. 7.36 Lakhs**
ii)Utilized first year grant	:	**Rs.3.93 Lakhs**
ii) Sanctioned second year grant (80%)	:	**Rs. 2, 74,400.00**
iii)Balance 20% funds to be released for 2010-2011 period	:	**Rs. 68,600.00**

CONTENTS

1. Objectives

i) To assess the composition, distribution, abundance and diversity of phytoplankton and zooplankton.

ii) To study the composition, distribution, abundance and diversity of macro and micro and meio benthic organisms (invertebrates) including the insect fauna.

iii) To study the water and sediment quality of the study area

iv) To assess the relationship of plankton and benthic fauna in relation to the water and sediment quality of the system.

2. Abstract of the project proposal

The Kole wetlands of Kerala are unique in the context of the diversity of fish and other faunal resources (Sujana and Sivaperuman, 2008). In this context, the Kole wetlands lying in the Veliamkode and Maranchery panchayats in the Malappuram district having an area of 500 acres is an important wetland habitat. On a survey of the area, it was seen that, the portion of the wetlands in the Maranchery Panchayat were occupied mainly by migratory waterfowl in large numbers, while that in the Veliamkode panchayat (about 206 acres) is under paddy cultivation using chemical fertilisers and pesticides. The two are separated by an earthen bund and most of it is under private ownership. Further the wetlands of the Maranchery panchayat do not give much monitory benefit to the community except the meager amount obtained through fishing.

In view of this, the Kerala State Biodiversity Board has initiated productive measures to enhance the social structure of the people by strengthening the biodiversity of the Veliamkode and Maranchery panchayats through beneficial economic uses of the wetland habitats. This is being done through scientific fish, duck, vegetable and homestead farming and management practices as well as introduction of organic farming and agriculture methods for improving livelihood condition of the communities in the area. This would require the survey of the existing biodiversity of the Maranchery wetland and also its regular monitoring for effectively managing such ecosystems for the benefit of common man.

Therefore in view of the above, assessing the abundance and diversity of plankton and benthic fauna in the Maranchery wetland is of prime importance in understanding its role in the fertility and productivity of the system for managing it for the diversified and sustainable utilization for human needs.

3. Background of the project

The Kole wetland lying on the Veliamkode and Maranchery panchayats in the Malappuram district having an area of 500 acres is an important wetland habitat (Fig.1). On a survey of the area, it was seen that, the portion of the wetlands in the Maranchery Panchayat are occupied mainly by migratory waterfowl in large numbers, while that in the Veliamkode panchayat (about 206 acres) is under paddy cultivation using chemical fertilisers and pesticides, the two are separated by an earthen bund. Measures were taken to enhance the social structure of the people by strengthening the biodiversity of the Veliamkode and Maranchery panchayats through beneficial economic uses of the wetland habitats. So, evolving the current ecosystem based comprehensive monitoring programme for the largest wetland ecosystem of south India is really important in the context of management and conservation objectives.

4. Literature Review

Wetlands are defined in various ways. Cowardin *el al.* (1979), defined wetlands as lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. This definition is widely accepted by wetland scientists of the United States and is also used in India (Mitsch and Gosselink, 1989). A broad definition of Wetlands of South and West Asia is given by The Asian wetland Bureau (1991). Maltby (1986) aptly described Wetland as water logged wealth. Another simple definition is that the wetlands are areas where for part of the year atleast, water stands naturally from 2.5cm to around 300 cm .Wetland is defined differently by individuals or agencies depending on the objective and need like Anon (1994), WWF (1987) etc. Anon (1994) defined wetland as all submerged or water saturated lands, natural or man-made. Inland or coastal, permanent or temporary, static or dynamic, vegetated or non-vegetated, which necessary have a land-water interface. Cowardin *et al* (1979) gave an idea on the classification of wetlands and deepwater habitats of the United States. Keddy (2000) classified wetlands as six basic types. He described wetland as a shallow water community as those dominated by truly aquatic plants growing in and covered by at least 25cm of water. Status of wetlands of the world were reported by Maltby and Turner(1983). According to them about 6.4% of the total land area in the world is estimated as wetland area. Biotic control of wetland hydrology, especially by wetland vegetation was studied by Gosselink *et al* (1984). Status of wetlands in India here assessed by Anon (1990) and by Garg (1998).The nationwide wetland inventory carried out by Garg (1998) reveals that there are 7.6 million ha of wetland units in the country of which 4.0 million ha are coastal wetlands and 3.6 million ha are inland wetlands.

Agencies like IUCN surveyed the extend of wetlands in India and was reported by Scott (1989). An estimate of the wetlands in India was also made by Jhingran (1991). The Ministry of Environment and Forests, Government of India (1990) has estimated that 4.1 million ha area (excluding paddy fields and mangroves) is occupied by different types of wetlands in India. India's wealth of inland wetland include both natural as well as man-made wetlands. According to Sinha and Mohanty (2002) India's land area under man-made wetlands is about 1.8 times higher than its area under natural wetlands. It is estimated that in Kerala 25.72% area of inland wetlands are man-made (Nair and Sankar, 2002). The wetland of Kerala has been studied by Abdul Aziz (1990) who made a detailed study on certain wetland ecosystems in Kerala. The environmental degradation of Vellayani fresh water wetland in Neyyatinkara taluk, the Shasthamkotta freshwater wetland in the Kunnathur taluk and Ashtamudi estuarine wetland in the Karunagappally-Kunnathur taluks of Kerala were discussed in detail. Other important contributions on wetlands of Kerala were given by SAC (1991). Nair *et el.* (1993), Nair and Sankar

(1995), Sankar *et al.* (1998) and Nair *et al.* (2001). Details of wetland area in Kerala have been provided by Nayar and Nayar (1997). Various threats faced by, wetlands of Kerala and its impact and the need for their conservation were studied by Nair (1998). A geo-morphological classification of wetlands in Kerala were also given by Nair and Sankar (2002). They considered wetlands as important habitats for fish and wildlife species, including rare and endangered birds.

Kurup (1996) made a survey of coastal wetlands of Kerala. The distribution of mangroves, a complex wetland ecosystem, in Kerala had been worked out by Basha(1991). Mohanan (1997) studied the mangrove ecosystem and estimated the mangrove area in Kerala to be about $50km^2$. A fragile ecosystem study in Near East countries is discussed by Kassas(1998). The study deals with a major natural hazard of that fragile ecosystem namely desertification. Abbasi (1997) worked on the wetlands of India, their ecology and threats to them. There are some specific reports from the Kole wetlands (Johnkutty and Venugopal, 1993; Sujana and Sivaperuman, 2008; Ahmed Ali, 1987)

The *kayals* of the Kerala coast are mostly separated from the sea by elongated sandbars and based on this they can be treated as "coastal lagoons". Since perennial rivers debouch into the sea through these water bodies, making the system compound, these can be considered as lagoonal-estuarine systems, or partially mixed estuarine systems (Biggs, 1978). The available literature mainly pertains to the ecological characteristics, seldom taking into consideration the interrelationship with the fishery. Several reports are available before the construction of the Thannermukkom barrage, on the flora and fauna, and the soil and water quality emanating from the University of Kerala, Cochin University of Science and Technology, CMFRI, National Institute of Oceanography, etc.

Most of the research on the ecology and fisheries of the Vembanad backwater in Kuttanad was conducted during the pre-impoundment phase ie, before the commissioning of the Thanneermukkom barrage. The Cochin backwaters and its incoming rivers constituting the northern wing of the Vembanad backwater was the major area of interest to the researchers. Due to this, the literature based on studies extending up to the southern tip of the lake near Allappuzha is rather few. Some of the works are highlighted here. An account of the formative history of the Vembanad backwater was studied by Rasalam and Sebastian (1976). Gopalan (1983) has presented a comprehensive account of the history of reclamation and the consequent shrinkage of the backwaters, especially the Vembanad backwaters. Similarly under the Indo-Dutch Collaborative Research Project on the Water Balance study of the Kuttanad Region, various aspects of the ecology and fisheries of Vembanad lake were investigated and reported (Anon., 2001). *Sarala Devi et al (1991) elaborated the coexistence of different benthic communities in the northern limb of Cochin backwaters. Nair et al. (1983) gave an account on the* population dynamics of amphipods in Cochin backwater area. Devassy and Gopinathan (1970), Kurian *et al* (1975), Desai *et al* (1967) and Gopalan *et al* (1987) undertook some of the investigations on the benthic fauna extending right from Cochin to Alappuzha. Sarala Devi *et al*. (1979) and Unnithan *et al* (1975) documented the effect of organic pollution due to industrial pollution on some water quality parameters in Cochin backwater. Remanai *et al.* (1980) studied the quality of sediment in Cochin backwaters in relation to pollution aspects. Investigations on the distribution and abundance of fishes of Vembanad lake extending from Cochin to Alappuzha have been done by a number of workers. Pillay (1960) made a record of the distribution of the *Hilsa ilisha* in the lake. Shetty (1965) made a comprehensive description of the fishery practice along with a listing of the commercially important fish and prawn species of the Vembanad lake. Kuttyamma (1980) assessed the distribution and abundance of prawns and prawn larvae in Cochin backwaters. Raman (1964, 1967) made the first contribution on the biology of *Macrobrachium rosenbergii* in the river stretches of the lake. Kuttyamma (1980) assessed the distribution and abundance of prawns and prawn larvae in Cochin backwaters. The fishery estimation during the post barrage phase was mainly made by Kurup and Samuel (1987). Kurup and Samuel (1987) listed 150 species of fishes belonging to 100 genera categorised under 56 families. Some preliminary Information is also available on the decline in fishery in the Vembanad wetland based on the study by Padmakumar *et al* (2002). Recently the biodiversity of the estuarine systems of the south west coast of India has been studied (Bijoy Nandan, 2008).

Studies conducted at the Centre for Water Resource Development and Management. Kozhikode, was mainly on the hydrology, salinity intrusion, core water quality parameters and abundance of zooplankton from Vembanad, Pookot backwaters and backwaters of Kozhikode (James, 2007). The Central Inland Fisheries Research Institute has undertaken some preliminary seasonal studies on the water and sediment quality, distribution of plankton, benthos and fishery of selected backwaters of Kerala (Anon, 2005). The Cochin University of Science & Technology and the Department of Aquatic Biology & Fisheries, University of Kerala has also done substantial work in these lines but most of the contributions are from the Cochin backwater, the Vembanad (before the construction of the barrage) and Veli, Kadinamkulam backwaters.

5. Field Visit and sampling

Field sampling was undertaken for 24 months in the Marancherry wetland for the collection and analysis of water, sediments, plankton, macrophytes, benthos (invertebrates) including the insect fauna. Eight stations were selected for monthly field sampling from the Maranchery wetland system. An earthen bund separated station 1 to 5 and 6 to 8. The details of the different study stations are given in Table. 1. (Fig. 1 to 9). There was seasonal variation in the land use pattern of the stations 1 to 5. From January to May 2009, the water level was significantly low on southern side of the wetland because the water was drained for paddy cultivation but with from June to December 2009 the area was inundated with water. From November to December 2009, the area was under fish farming activities. Stations 6 to 8 were inundated with water throughout the study period.

Table 1. Description of the study area

Stations	Features
1	Under seasonal paddy cultivation, deep, aquatic macrophytes present
2	Under seasonal paddy cultivation, deep, aquatic macrophytes present, adjacent to residential area
3	Under seasonal paddy cultivation, deep, comparatively less aquatic macrophytes.
4	Under seasonal paddy cultivation, deep, aquatic macrophytes present
5	Under seasonal paddy cultivation, Shallow, less aquatic macrophytes present
6	Inundated with water throughout the year, aquatic macrophytes present
7	Inundated with water throughout the year, less aquatic macrophytes, channel connecting station 1-5 and 6-8.
8	Inundated with water throughout the year, variety of aquatic macrophytes

Fig. 1. Map of Maranchery wetland showing the study stations during 2009-11

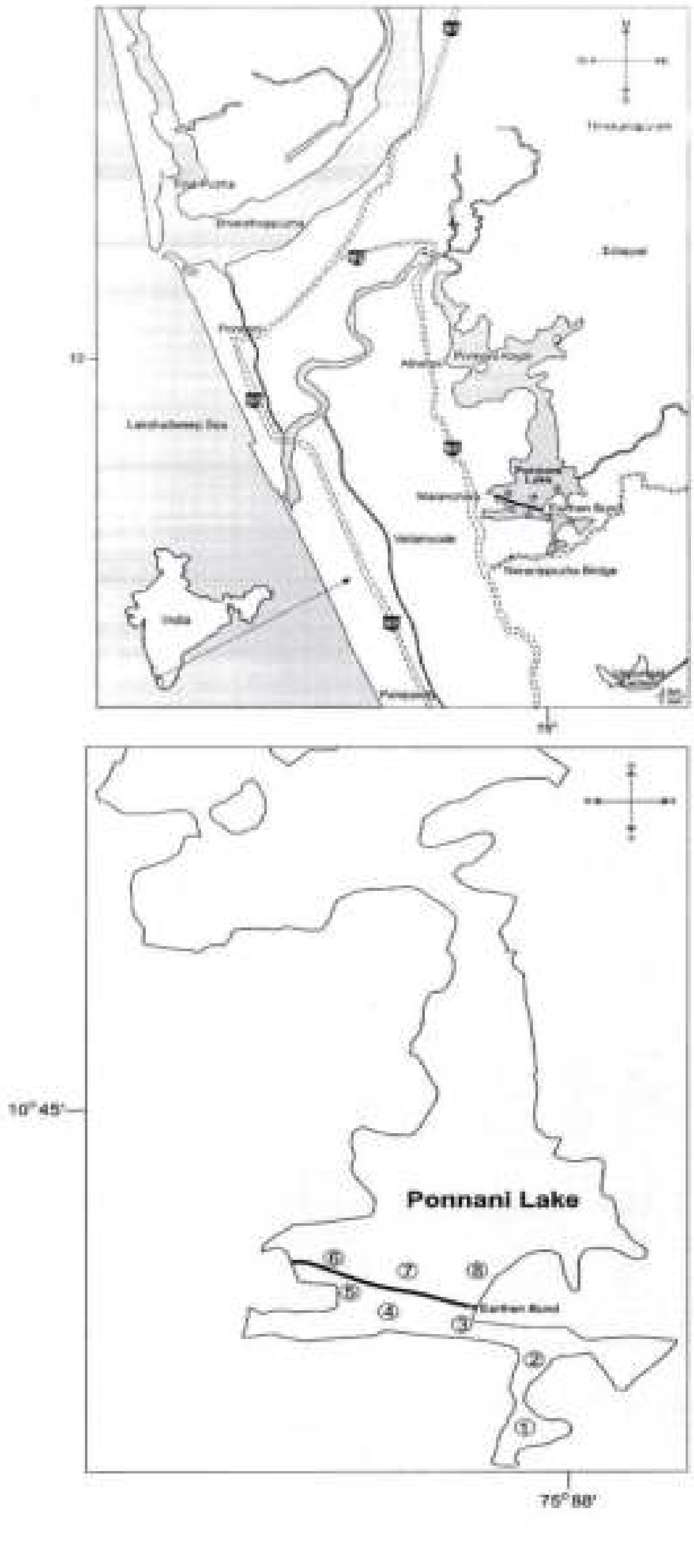

Fig. 2. Station 1 (10 ^{0} 726'N 75^{0}988'E)

July -December

March-June , January

Fig. 3. Station 2 (10 ^{0} 725'N 75^{0} 986'E)

July -December

March-June , January

Fig. 4. **Station 3 (10^0 723'N 75^0 986'E)**

July-December

March-June , January

Fig. 5. **Station 4 (10^0 723'N 75^0 983'E)**

July-December

March-June , January

Fig. 6. Station 5 (10^0 722'N 75^0 982'E)

July -December

March-June , January

Fig. 7. Station 6 (10^0 727'N 75^0 985'E)

Nov 2009 – Oct 2011

Fig. 8. **Station 7 (10^0 726'N 75^0 986'E)**

Nov 2009 – Oct 2011

Fig.9. **Station 8 (10^0 728'N 75^0 989'E)**

Nov 2009 – Oct 2011

6. Materials and Methods

Field sampling was undertaken for 24 months from November 2009 to October 2011 from 8 selected stations on a monthly basis for the collection and analysis of water, sediment, plankton and benthos including the insect fauna. The water samples were collected using a standard Niskin sampler. Temperature was determined in the field and was measured by a standard degree centigrade thermometer. pH, total dissolved solids and conductivity of water samples were measured using Systronics model 371 water analyser, based on the procedure of APHA (2005). Transparency of the water body was measured using Secchi Disc (Strickland and Parsons, 1972). Turbidity was measured using Nephelo – Turbidity meter – Systronics make no. 132 (APHA, 2005). Dissolved oxygen was estimated using the modified Winkler method and salinity by Mohr-Knudsen method (Strickland and Parsons, 1972, Grasshoff *et al,* 1983). Free carbon dioxide and total alkalinity was analyzed by the titrimetric method and that of total hardness, calcium hardness, and magnesium hardness by EDTA titrimetric method (APHA, 2005). Chloride was analyzed by argentometric method and dissolved hydrogen sulphide by cline's method (Grasshoff *et al,* 1983). Ammonia-nitrogen, nitrate-nitrogen, nitrite-nitrogen, inorganic phosphate-phosphorus, silicate-silicon were analyzed by spectrophotometer procedure based on the methods by APHA (2005). Biochemical oxygen demand (BOD) was also estimated by APHA (2005). The primary productivity (gross and net production) was estimated using the conventional light and dark bottle method (Strickland and Parsons, 1972). The chlorophyll, a, b and c were estimated by vacuum filtration – acetone extraction method by using the membrane filter assembly (APHA, 2005).

Water samples were collected from the study area for the analysis of phytoplankton using plankton net of size 20 µm and zooplankton by a net of mesh size 200 µm. The biomass of plankton was determined based on the displacement method and was expressed as no/m^3 (Davis, 1955, Ward and Whipple, 1959). The composition, distribution and abundance of plankton in the samples were determined and expressed as no/m^3. Relative dominance of macrophytes were studied following the procedure of APHA (2005). The macrophytes were sampled from the eight stations using quadrate of size 25cm x 25cm. The samples from each quadrate were collected in separate polythene bags. The individuals of each species present in each quadrate were separately counted for the determining species density.

The sediment samples were collected using a standard Van Veen grab of size $0.04m^2$ for analysis. Temperature was determined in field using standard degree centigrade thermometer. pH and Eh were measured using a water analyser : Systronics model no.371 based on the procedure of APHA (2005). Moisture content was determined by wet dry method, the organic carbon by Walkley-Black method, available phosphorous by Olson's method and available nitrogen by Kjeldhal method (Jackson 1973, Byju 2001). A standard Van Veen grab of size $0.04m^2$ was employed for collecting the macro benthic fauna. The samples were preserved in 4 % formalin. These preserved samples were washed through suitable sieves of mesh size 500μm for macro fauna, those that are retained in the sieve were collected and preserved in 4% formalin and stained in Rose Bengal for identification (APHA, 2005, Holme and Mc Intyre, 1971). The samples were then analysed for macro fauna by hand picking and microscopic analysis. The standard as well as published references were employed for identification of the different fauna (Holme and McIntyre,1971, Fauvel, 1953 and other published works).

7. Results and Discussion

7.1 Water and sediment quality

The monthly data obtained for the various abiotic factors are presented in Table 2- 45. Seasonal variations are shown in the Fig. 1-85.

The water depth ranged from 0.3 to 2.91 m in the wetland (Table 2). The minimum water depth recorded was 0.3m during pre monsoon and maximum water depth recorded was 3.2 m at station 7 during monsoon. The variation in the annual range was 1.04m to 2.91m during the year 2009-10 and 0.53 to 2.71 during 2010-11 period. ANOVA result of depth of the water body showed that it was significant at 1% level between seasons (F=81.14) and stations (F=12.40). The air temperature ranged from 23.1^0C to 32.4^0C (Table 3). The lowest air temperature was recorded 23.1^0C at station 2 during January 2011 and highest air temperature was recorded 32.4^0C during March 2010 in all stations. The ANOVA significance at 1% level (R^2= 0.131).The minimum mean value of dissolved CO_2 was recorded at 2.1 mg/L and highest was 17.8 mg/L.

The alkalinity ranged from 16 mg/L in station 6 and 8 during October 2010 to 160 mg/L in station 1 during January 2011 (Table.12). The lowest mean value of alkalinity was recorded at 14 mg/L in monsoon period and highest at 70 mg/L during post monsoon period. ANOVA of alkalinity was significant at 1% level between seasons during the study period. A negative correlation coefficient was observed between the alkalinity and total dissolved solids. Season wise, Duncan test showed that, it was grouped into 2 subsets, significant at 1% level. The chloride ranged from 12.0 mg/L to 229.93 mg/L (Table 13). A positive correlation coefficient significant at 1% level emerged between salinity and chloride content in the study period. The lowest chloride was recorded was 12.0 mg/L at station 3 during December 2010 and the highest chloride was recorded 229.93 mg/L at station 2 during May 2011. The maximum mean value of chloride recorded was 153.45 mg/L. The salinity ranged from 0.01 ppt to 0.88 ppt (Table 14). ANOVA of total hardness was significant at 1% level between seasons. Season wise Duncan test showed that it was grouped into 2 subsets, significant at 5% level. A positive correlation significant at 1% level (r^2= 0.998) was observed between total hardness with turbidity and TDS. The average hardness in the wetland during 2009-11 period was 90.3 mg/L, with the maximum in station 7 and 8 during May 2011 (Table 15). The calcium concentration ranged from 10.0 mg/L to 76 mg/L (Table 16). The mean value of calcium recorded was 60.5 mg/L for the wetland. The magnesium values ranged from 0 mg/L to 76.0 mg/L (Table 17). No magnesium was present at station 5 and 6 during December 2010 and the highest magnesium of recorded 76.0 mg/L was recorded in station 4 during April 2011.

The average dissolved oxygen regime in all stations during the study period showed maximum variations, ranging from 3.49 mg/L to 7.65 mg/L respectively(Table 18). The dissolved oxygen level exhibits wide variation during monsoon period while high values were observed at station 2 during post monsoon period. Duncan test showed that it was grouped into 2 subsets, significant at 1% level. The ANOVA of dissolved oxygen significance at 1% level (R^2= 0.131).The minimum mean value of dissolved CO_2 was recorded at 2.1 mg/L and highest was 17.8 mg/L.

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The nutrients represented by nitrate-nitrogen, nitrite-nitrogen, phosphate- phosphorus were low, whereas silicate- silicon values were comparatively higher in all the study stations. ANOVA showed that nitrate nitrogen and other nutrients like, nitrite, ammonia, phosphate and silicate were significant at 1% level between seasons. A negative correlation significant at 5% level (r^2= -0.163) emerged between phosphate and total dissolved solids and also between phosphates and salinity (r^2= -0.017). Among the nutrients, nitrite values were the lowest with mean of 0.02 µmol/L for the wetland, that of phosphate was 0.13 µmol/L, that of nitrate was 0.003 µmol/L and that of silicate was 15.18 µmol/L (Table.20,21,22). Duncan test showed that it was grouped into 2 subsets, significant at 5% level. A positive correlation coefficient significant at 5% level (r^2= 160) was observed between nitrate and water temperature, that with nitrate and pH significant at 1% level (r^2= 0.249) and also with alkalinity (r^2=0.502) significant at 1% level. Duncan test showed that it was grouped into 2 subsets, significant at 1% level. In addition a negative correlation significant at 1% level (r^2=-0.346) was observed between nitrate and chlorophyll 'a'. The ammonia value ranged from 0.10µmol/L to 40.0 µmol/L. The lowest ammonia of 0.10µmol/L was recorded in Station 4 and 6 during March, 2010, and 2011 periods respectively and the highest ammonia of 60.0 µmol/L was recorded in Station 8 during May 2011 (Table 24). Duncan test showed that it was grouped into 2 subsets, significant at 1% level.

The lowest sediment temperature recorded was 23 ^{0} C at Station 1 during January 2011 and highest was 31.5^0 C in May 2011 in Station 5 (Table 4). ANOVA of sediment temperature was significant at 1% level between seasons during the study period. The lowest mean value of sediment temperature recorded was 25.23^{0}C in December 2010 and highest was 30.61^{0}C in June 2011. A positive correlation significant at 1% level ((r^2=

0.265) was observed between sediment temperature and Eh. Sediment pH showed no much variation during the study period (Table 25). The lowest pH was 4.7 in Station 1 in March 2011 and highest was 8.01 in Station 8 in April 2010 and July 2011. The Eh values showed a highly reducing trend in all stations through out the study period. The oxidation reduction potential ranged from -483 in Station 4 in April 2010 to -103 in Station 1 in March 2011 (Table 26). Moisture content if soil in percentage ranged from 1.62% to 5.62%. A positive correlation significant at 1% level (r^2= 0.204) emerged between soil moisture and available nitrogen and also with available phosphorus (r^2= 0.272) significant at 1% level. In addition a negative correlation significant at 5% level (r^2= -0.141) was observed between moisture content and Eh. The lowest moisture content recorded was 1.13% at station 1 during October 2011, and the highest moisture content of 6.28% was recorded in Site 8 during September 2011 (Table 27). High moisture content may be due to high organic matter. Organic carbon in percentage ranged from 0.66% to 7.25% which is classified as high organic carbon availability class. The lowest recorded value was 0.66% in Site 7 during May 2011 and the highest of 7.25% in Site 1 during June 2011(Table 28). A positive correlation significant at 1% level (r^2= 0.237) was observed between available nitrogen and available phosphorus. Available nitrogen in percentage ranged from 0.0044 in Station 1 during May2011to 0.0364% at Station 1 during October 2011 (Table 29). Available phosphorous ranged from 0.01 ppm in Station 6 during November 2010 to 3.546 ppm in Station 8 during September 2011 (Table 30).

Table 2. Monthly variation in depth in selected stations of Maranchery wetland during 2009-11

Stations									
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Mean**
N' 09	1.5	**1.5**	1.75	1.5	0.75	2	**2**	2	1.63
D' 09	1.5	**1.5**	1.75	1.5	0.75	2	**2**	1.5	1.56
J' 10	0.21	0.34	0.25	0.33	0.51	3	2.5	2.5	1.21
F' 10	1.5	2	1.5	1.8	1.5	1.75	1.9	1.85	1.73
M' 10	0.4	0.4	0.5	0.3	0.3	2.2	2.1	2.1	1.04
A' 10	0.8	0.6	0.6	0.6	0.5	2	2.3	2.2	1.20
M' 10	3	2.9	3	2.6	2.8	2.9	3.1	3	2.91
J' 10	2.9	2.8	2.9	2.5	2.6	2.9	3.2	3.1	2.86
J' 10	2.6	2.5	2.5	2.4	2.5	2.8	3	3	2.66
A' 10	2.5	2.4	2.8	2.3	2.5	2.8	3	2.9	2.65
S' 10	2.3	2.2	2.3	2.4	2.5	2.7	2.8	2.8	2.50
O' 10	2.1	2	2.1	2.2	2.4	2.5	2.5	2.6	2.30
N' 10	0.3	0.3	0.4	0.3	0.4	2.8	2.8	2.9	1.28
D' 10	0.3	0.5	0.2	0.5	0.5	2.5	2.6	2.5	1.20
J' 11	0.2	0.3	0.3	0.5	0.5	1.3	1.5	1.5	0.76
F' 11	0.2	0.2	0.2	0.3	0.3	1	1.1	1.1	0.55
M' 11	0.2	0.2	0.2	0.3	0.3	1	1.0	1.0	0.53
A' 11	0.2	0.3	0.2	0.3	0.3	1	0.9	1.0	0.53
M' 11	1.6	1.5	1.4	1.4	1	2.2	2.3	2.3	1.71
J' 11	2.7	2.7	2.8	2.7	2.3	2.8	2.9	2.8	2.71
J' 11	2.1	2	2.1	2.2	2.4	2.5	2.6	2.9	2.35
A'11	2.1	2	2.1	2.2	2.4	2.5	2.5	2.4	2.28
S'11	2.1	2.2	2.1	2.2	2.2	2.5	2.6	2.4	2.29
O'11	2.1	2	2.1	2.2	2.4	2.5	2.6	2.4	2.29

Table 3. Monthly variation in Atmospheric Temperature (^{o}C) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	30.2	30.1	30.3	30.2	30.2	30.3	30.2	30.1	**30.2**
D' 09	30.3	31.3	31.2	31.1	30.3	31.3	31.2	31.4	**31.0**
J' 10	29.1	29.2	29.3	29.2	27.2	30.1	30.2	30.3	**29.3**
F' 10	32.3	32.2	32.2	32.3	32.4	32.1	32.2	32.3	**32.3**
M' 10	0	0	0	0	0	32.3	32.2	32.1	**32.2**
A' 10	0	0	0	0	0	30.2	30.2	30.1	**30.2**
M' 10	32.4	32.3	32.1	32	32.1	32.3	32.1	32	**32.2**
J' 10	30.3	30.5	30.5	30.5	30.4	30.4	30.6	30.6	**30.5**
J' 10	30.2	30.2	30.3	30.3	30.4	30.5	30.5	30.5	**30.4**
A' 10	30	30.1	30.1	30.1	30.2	30.2	30.3	30.3	**30.2**
S' 10	28.3	28.2	28.2	28.3	28.1	28.4	28.4	28.4	**28.3**
O' 10	29.2	29.3	29.3	28.4	28.5	28.7	28.7	28.6	**28.8**
N' 10	27.5	27.5	26.4	26.4	27.1	27.4	27.3	27.3	**27.1**
D' 10	26.3	26.5	26.5	26.4	26.4	26.3	26.3	26.4	**26.4**
J' 11	24.3	23.1	23.5	27.1	27.1	27.2	27.3	27.3	**25.9**
F' 11	28.0	27.5	27.5	26.0	26.5	28.0	29.0	29.5	**27.8**
M' 11	26.0	26.0	25.0	26.5	27.5	28.0	28.5	29.0	**27.1**
A' 11	27.0	27.2	28.2	30.0	31.0	30.1	30.1	31.0	**29.3**
M' 11	30.0	28.5	29.0	30.0	29.0	30.8	30.9	28.0	**29.5**
J' 11	29.0	29.0	28.5	29.5	29.0	28.5	29.0	29.5	**29.0**
J' 11	30.0	29.0	29.2	29.0	28.0	30.5	30.0	32.0	**29.7**
A'11	27.5	27.0	27.0	26.0	27.0	28.5	27.0	28.0	**27.3**
S'11	29.0	28.0	29.0	27.0	26.0	27.0	29.0	30.0	**28.1**
O'11	28.5	27.5	26.0	25.5	25.0	27.5	28.0	29.0	**27.1**

Table 4. Monthly variation in Water Temperature (°C) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	29.2	29.3	29.1	29.2	29.2	29.4	29.2	29.1	29.2
D' 09	29.2	29.1	29.2	29.3	29.2	29.1	29.3	29.2	29.2
J' 10	27.1	27.3	26.3	26.2	26.2	27.2	27.2	27.2	26.8
F' 10	26.4	26.1	26.2	26.3	26.2	26.3	26.2	26.1	26.2
M' 10	0	0	0	0	0	29.2	29.4	29.1	29.2
A' 10	0	0	0	0	0	28.3	28.3	28.2	28.3
M' 10	0	0	0	0	0	31.3	32.1	32	31.8
J' 10	0	0	0	0	0	30.4	30.6	30.6	30.5
J' 10	30.2	30.2	30.3	30.3	30.4	30.5	30.5	30.5	30.4
A' 10	30	30.1	30.1	30.1	30.2	30.2	30.3	30.3	30.2
S' 10	28.3	28.2	28.2	28.3	28.1	28.4	28.4	28.4	28.3
O' 10	29.2	29.3	29.3	28.4	28.5	28.7	28.7	28.6	28.8
N' 10	27.5	27.5	26.4	26.4	27.1	27.4	27.3	27.3	27.1
D' 10	26.3	26.5	26.5	26.4	26.4	26.3	26.3	26.4	26.4
J' 11	24.3	23.1	23.5	27.1	27.1	27.2	27.3	27.3	25.9
F' 11	27	27.2	28.3	31	31.5	29.5	29.5	29.5	28.2
M' 11	27	27	27	28	28	29	29.5	30	30.5
A' 11	29.5	29.8	29.9	33	32	30.1	30	30	30.5
M' 11	29	28.5	28.5	33	33	30.5	30.5	30.8	31.4
J' 11	31.0	31.5	31.0	31.0	31.0	31.0	32.0	32.5	31.4
J' 11	31.0	30.0	29.5	29.5	29.0	31.0	31.0	31.0	30.3
A'11	29.0	28.5	28.5	28.0	28.0	29.0	28.0	29.0	28.5
S'11	30.0	29.5	30.0	28.0	27.5	29.0	30.0	31.0	29.4
O'11	29.0	28.0	28.0	26.0	26.0	28.5	29.0	29.0	27.9

Table 5. Monthly variation in Sediment Temperature (°C) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	28.1	28	28.1	28.2	28.2	28.1	28.2	28.2	**28.14**
D' 09	29	29	29.1	28.9	29.1	29	29	29.1	**29.03**
J' 10	27.2	27.1	27.1	27.2	27.1	27.3	27.1	27.3	**27.18**
F' 10	28.1	28.4	28.2	28.1	28	28.1	28.1	28.3	**28.16**
M' 10	28.1	28.1	28.2	28.2	28	28.1	28.2	28.2	**28.14**
A' 10	27.5	27.8	27.9	27.8	27.8	27.9	27.9	27.9	**27.81**
M' 10	28.1	27.9	27.7	27.6	27.4	27.9	27.8	27.6	**27.75**
J' 10	27.6	27.6	27.8	27.4	27.4	27.6	27.7	27.7	**27.60**
J' 10	27.3	27.4	27.4	27.3	27.2	27.2	27.2	27.3	**27.29**
A' 10	27.3	27.2	27.3	27.2	27.3	27.3	27.2	27.2	**27.25**
S' 10	27.1	27	27	27.2	27.2	27.3	27.2	27.1	**27.14**
O' 10	28.1	28.6	28.4	28.2	28.1	28.1	28.4	28.3	**28.28**
N' 10	26.3	26.2	26.2	26.1	26	26.6	26.7	26.6	**26.34**
D' 10	25.3	25.2	25.2	25.1	25.1	25.3	25.3	25.3	**25.23**
J' 11	26.3	26.2	26.2	26.1	26	26.6	25.3	25.3	**26.00**
F' 11	25.3	25.1	25.1	25.2	25.2	26.3	26.3	26.2	**25.59**
M' 11	27	27.1	27.1	29	29.2	29.2	29.3	28.1	**28.25**
A' 11	29.1	27.8	27.9	27.8	27.8	27.9	27.9	27.9	**28.01**
M' 11	28.3	29.8	30.1	30.1	31.1	30.5	30.5	30.6	**30.13**
J' 11	31	31	28.5	31	30.9	30.5	31	31	**30.61**
J' 11	27.2	27.3	27.1	27.1	27.3	27.2	27.2	27.3	**27.21**
A'11	28.1	28.1	28	28.4	28.3	28.1	28	28.2	**28.15**
S'11	27.2	27.2	27.4	27.3	27.6	27.5	27.8	27.4	**27.43**
O'11	27.3	27.3	27.2	27.2	27.3	27.4	27.3	27.2	**27.28**

Table 6. Monthly variation in transparency in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	1.2	0.98	0.95	0.98	0.53	1	1.03	0.98	**0.95**
D' 09	1.2	0.98	0.95	0.98	0.53	1	1.03	0.98	**0.95**
J' 10	1	1	1	1	1	1.2	1.03	.98	**1.02**
F' 10	0	0	0	0	0	1	1	1	**0.37**
M' 10	0	0	0	0	0	1	1.5	1.3	**0.47**
A' 10	0	0	0	0	0	0.85	1.6	1.2	**0.45**
M' 10	0	0	0	0	0	1	1.4	1.2	**0.45**
J' 10	0	0	0	0	0	1	1.2	1.2	**0.42**
J' 10	1.1	1.2	1.3	0.65	1.6	0.95	1.1	1	**1.11**
A' 10	1.1	1.1	1.2	0.69	1.5	0.96	1.1	1.1	**1.09**
S' 10	1.3	1.2	1.3	0.72	1.5	0.88	0.96	0.97	**1.10**
O' 10	1.2	1.1	1.2	0.7	1.6	1	1	0.98	**1.09**
N' 10	1.1	1	1	0.68	1.5	1	0.99	1	**1.03**
D' 10	1	1	1.1	0.7	1.4	1	1	1	**1.02**
J' 11	0	0	0	0	0	0.65	0.7	0.81	**0.27**
F' 11	0	0	0	0	0	0.7	0.63	0.77	**0.26**
M' 11	0	0	0	0	0	0.65	0.54	0.64	**0.22**
A' 11	0	0	0	0	0	0.7	0.75	0.64	**0.26**
M' 11	0	0	0	0	0	0.86	0.65	0.71	**0.27**
J' 11	0.7	0.6	0.5	0.6	0.5	1.0	1.2	1.5	**0.82**
J' 11	1.0	1.0	1.2	0.54	0.9	0.95	1.0	1.2	**0.97**
A'11	1.1	1.0	1.2	0.6	1.0	0.95	1.1	1.2	**1.01**
S'11	0.9	1.0	1.0	0.6	1.2	1.0	1.0	1	**0.963**
O'11	1.1	1.2	1.3	0.65	1.1	0.95	1.1	1.1	**1.063**

Table 7. Monthly variation in water pH in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	6.29	6.61	6.71	6.58	6.50	6.55	6.71	6.82	6.60
D' 09	6.25	6.47	6.93	6.78	6.61	6.56	6.71	6.63	6.62
J' 10	5.96	6.01	5.77	5.74	5.67	6.18	6.28	6.33	5.99
F' 10	6.14	6.46	6.43	6.32	6.33	6.59	6.82	6.72	6.48
M' 10	0	0	0	0	0	6.3	5.8	6.3	6.13
A' 10	0	0	0	0	0	6.5	7.1	7.2	6.93
M' 10	0	0	0	0	0	6.45	7.8	6.5	6.92
J' 10	0	0	0	0	0	6.81	7.1	6.21	6.71
J' 10	6.33	6.77	6.88	7.03	6.3	6.5	6.9	7.1	6.73
A' 10	5.9	6.47	6.23	6.48	5.9	5.55	5.87	6.31	6.09
S' 10	6.5	6.4	6.59	6.02	6.03	6.11	6.02	6.04	6.21
O' 10	7.04	6.96	6.88	7.11	6.74	6.77	6.95	6.88	6.92
N' 10	6.58	6.82	6.81	6.64	6.85	6.68	6.43	6.87	6.71
D' 10	6.69	6.6	6.55	6.62	6.63	6.87	6.92	7.14	6.75
J' 11	5.98	6.65	6.83	8.95	6.41	6.74	6.94	6.36	6.86
F' 11	6.88	6.89	7.04	4.23	4.39	6.76	6.6	6.98	6.22
M' 11	5.14	6.76	5.95	5.8	6.34	6.28	6.71	6.6	6.20
A' 11	4.4	5.83	6.34	5.81	5.78	5.2	5.42	4.42	5.40
M' 11	3.63	5.14	6.2	4.45	6.28	3.15	3.74	3.96	4.57
J' 11	6.23	5.91	5.99	5.89	6.62	5.98	5.65	5.71	6.00
J' 11	6.62	6.45	6.3	6.28	6.21	6.2	6.61	6.45	6.39
A'11	6.48	6.13	5.85	5.67	5.63	5.88	6.17	6.2	6.00
S'11	6.57	6.55	6.28	6.19	6.38	6.47	6.56	6.38	6.42
O'11	6.69	6.55	6.57	6.27	5.96	6.38	6.59	6.4	6.43

Table 8. Monthly variation in Conductivity (mS) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	117	118	115	111	112	123	111	110	**114.6**
D' 09	110	93	124	98	104	93	247	107	**122.0**
J' 10	22	315	237	285	258	218	224	165	**215.5**
F' 10	211	230	211	241	244	198	346	176	**232.1**
M' 10	0	0	0	0	0	254	256	268	**259.3**
A' 10	0	0	0	0	0	433	393	398	**408.0**
M' 10	0	0	0	0	0	180	175	210	**188.3**
J' 10	0	0	0	0	0	99.8	99.7	167	**122.2**
J' 10	41	38	38.9	44.2	65.1	46.6	50.6	60.3	**48.1**
A' 10	66.3	61.5	65.9	60.9	63.5	56.7	93.6	91.2	**70.0**
S' 10	100	75.1	141	81.1	83.8	81.9	72.3	43.8	**84.9**
O' 10	88.1	75.9	53.5	62.3	54.3	48.2	66.7	58.3	**63.4**
N' 10	66.7	67.9	67	73.4	76.2	67	67.5	65.6	**68.9**
D' 10	43.4	60.3	68.3	68.5	63.9	77.1	60.9	84.8	**65.9**
J' 11	298	303	234	254	144	270	174	147	**228.0**
F' 11	43.4	60.3	68.3	68.5	63.9	77.1	60.9	84.8	**65.9**
M' 11	298	303	234	254	144	270	174	147	**228.0**
A' 11	253	504	372	398	456	227	236	240	**335.8**
M' 11	860	755	674	571	523	616	498	668	**645.6**
J' 11	756	625	520	480	490	426	367	301	**495.6**
J' 11	327	425	349	386	391	275	397	359	**363.6**
A'11	155	213	195	147	148	204	147	142	**168.9**
S'11	288	305	305	269	275	465	333	287	**315.9**
O'11	166	151	161	145	121	167	162	209	**160.3**

Table 9. Monthly variation in Total Dissolved Solids (ppm) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	5.98	6.08	5.82	5.59	5.47	5.97	5.41	5.48	**5.7**
D' 09	15.1	9.7	6.7	15.7	15.4	15.7	8	16.3	**12.8**
J' 10	11.3	16.9	12.8	15.2	13.9	11.6	12	13.6	**13.4**
F' 10	1.17	1.26	1.17	1.27	1.46	1.78	1.98	0.98	**1.4**
M' 10	0	0	0	0	0	139	140	144	**141.0**
A' 10	0	0	0	0	0	232	218	214	**221.3**
M' 10	0	0	0	0	0	84.36	95.6	61.5	**80.5**
J' 10	0	0	0	0	0	52.1	47	39	**46.0**
J' 10	78.1	74.3	80.1	77.1	118	91.8	92.4	95.5	**88.4**
A' 10	36.4	46	36.6	34.1	32.6	31.6	52.9	46.7	**39.6**
S' 10	55.7	41.9	77.3	47.5	46.4	47.4	40.3	44	**50.1**
O' 10	45.7	40.3	28.1	33.3	29.8	26.4	36.8	31.7	**34.0**
N' 10	37.7	38.3	38.7	40.9	41.4	36.7	37.2	35.5	**38.3**
D' 10	24.6	33.7	38.5	37.5	35.4	44.9	33.8	46	**36.8**
J' 11	171	188	134	162	82.9	161	98.3	83.7	**135.1**
F' 11	142	277	208	213	249	127	132	133	**185.1**
M' 11	670	412	367	289	264	333	257	357	**368.6**
A' 11	431	575	298	276	279	240	209	567	**359.4**
M' 11	286	432	490	230	223	285	332	357	**329.4**
J' 11	84.4	88.3	89.1	64.7	66.7	66.8	71.3	65.1	**74.6**
J' 11	144	185	164	174	181	125	199	174	**168.3**
A'11	83.8	83.4	89.9	67.5	120	131	75	72.6	**90.4**
S'11	145	196	176	237	165	251	157	205	**191.5**
O'11	120	129	98.7	71.4	93.9	78.9	98.2	127	**102.1**

Table 10. Monthly variation in Turbidity (NTU) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Mean**
N' 09	1.9	2.3	2.3	5.6	15	5.6	7.5	7.7	**6.0**
D' 09	4	4.6	6.1	10	13.4	3.4	6.1	5.4	**6.6**
J' 10	25	24	26	41	19	6.7	9.6	6.7	**19.8**
F' 10	7.3	8	9.6	24	10	7.6	9.6	7.9	**10.5**
M' 10	0	0	0	0	0	14	14	14	**14.0**
A' 10	0	0	0	0	0	41	35	47	**41.0**
M' 10	0	0	0	0	0	28	13	30	**23.7**
J' 10	0	0	0	0	0	16	21	20	**19.0**
J' 10	1.9	1.4	1.7	1.8	1.9	1.7	2.6	2.7	**2.0**
A' 10	1.5	1.4	1.9	1.1	2	1.8	2.4	2.1	**1.8**
S' 10	2.3	1.6	2.3	1.8	1.6	2.8	2.6	2.2	**2.2**
O' 10	4.8	3.3	1.9	1.1	2.5	0.67	1.5	1.8	**2.2**
N' 10	2.1	1.6	1.8	1.3	3.6	1.5	1.8	1.9	**2.0**
D' 10	4.8	6.8	4.5	4.2	3.9	6.6	8.3	4.8	**5.5**
J' 11	40	13	12	50	44	14	8.3	6.8	**23.5**
F' 11	27	7.3	20	10	8.3	8.1	7.3	8.5	**12.1**
M' 11	4.8	3.9	11	17	14	11	15	21	**12.2**
A' 11	2.7	22	11	12	18	11	7.9	5.7	**11.3**
M' 11	6.3	14	5.1	10	14	11	7.9	6.7	**9.4**
J' 11	2.9	2.2	3.2	3	2.8	2.8	2.9	5.9	**3.2**
J' 11	4.7	5	5.9	8.8	13	5.9	5.3	4.4	**6.6**
A'11	2.3	2.5	5.3	14	12	3.4	2	2.4	**5.5**
S'11	2.9	3.1	2.9	5.8	4.2	2.6	3.3	3.2	**3.5**
O'11	11	14	8.3	10	16	8.4	5.8	12	**10.7**

Table 11. Monthly variation in Dissolved CO_2 (mg/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	4	4	2	2	3	2	2	5	3.0
D' 09	4	6	5	5	8	8	6	7	6.1
J' 10	4	4	5	5	8	2	4	3	4.4
F' 10	7	7	7	7	7	7	7	7	7.0
M' 10	0	0	0	0	0	7	7	7	7.0
A' 10	0	0	0	0	0	19	16	7	14.0
M' 10	0	0	0	0	0	8	6	3	5.7
J' 10	0	0	0	0	0	8	7	5	6.7
J' 10	6	3	4	5	4	3	4	5	4.3
A' 10	1	2	1	1.5	7	1	2	5	2.6
S' 10	2.5	2.6	4.1	3.8	3.6	3.8	3.2	4	3.5
O' 10	5	4	3	6	7	6	4	2	4.6
N' 10	5	5	4	6	5	6	15	4	6.3
D' 10	5	4	9	10	7	4	5	2	5.8
J' 11	5	2.5	2.5	4	5	5	6	7	4.6
F' 11	2	2	2	3	4	2	1	1.5	2.2
M' 11	2	3	3	5	2	4	2	3	3.0
A' 11	1	1	2	3	3	1	2	2	1.9
M' 11	14	12	11	10	13	12	10	9	11.4
J' 11	21	20	18	15	21	16	15	21	18.4
J' 11	6	6	5	4.5	8	5	4	8	5.8
A'11	5	7	21	15	17	9	9	5	11
S'11	8.8	11	13.2	15.4	22	4.4	6.6	8.8	11.3
O'11	6.6	13.2	13.2	19.8	22	11	8.8	6.6	12.7

Table 12. Monthly variation in Alkalinity (mg/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	62	81	76	70	71	74	78	73	73.1
D' 09	72	70	73	68	72	70	76	68	71.1
J' 10	76	72	76	56	54	70	76	72	69.0
F' 10	71	69	70	73	70	68	71	69	70.1
M' 10	0	0	0	0	0	78	79	73	76.7
A' 10	0	0	0	0	0	77	76	78	77.0
M' 10	0	0	0	0	0	58	60	56	58.0
J' 10	0	0	0	0	0	71	64	48	61.0
J' 10	60	49	51	52	60	56	38	62	53.5
A' 10	22	38	40	54	32	36	52	42	39.5
S' 10	32	36	48	28	60	72	72	60	51.0
O' 10	28	20	20	24	24	16	24	16	21.5
N' 10	24	24	24	24	20	20	28	24	23.5
D' 10	52	48	24	64	44	36	40	52	45.0
J' 11	160	88	152	112	108	112	116	100	118.5
F' 11	60	40	40	16	16	24	24	32	31.5
M' 11	12	24	24	20	24	20	24	16	20.5
A' 11	18	16	20	24	20	16	16	16	18.3
M' 11	12	16	20	16	16	12	8	12	14.0
J' 11	16	12	32	12	16	16	12	20	17.0
J' 11	20	20	24	20	20	16	16	20	19.5
A'11	16	16	20	24	20	20	20	24	20.0
S'11	24	20	16	24	24	24	28	24	23.0
O'11	32	32	56	36	28	36	44	36	37.5

Table 13. Monthly variation in Chloride (mg/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	**Mean**
N' 09	35.90	26.90	17.90	14.90	13.90	17.90	22.90	20.90	**21.4**
D' 09	21.90	19.90	17.90	19.90	10.90	28.90	54.90	24.90	**24.9**
J' 10	36.90	38.90	47.90	54.90	48.90	49.90	45.90	31.90	**44.4**
F' 10	37.90	43.90	30.90	49.90	54.90	21.90	36.90	36.90	**39.2**
M' 10	0	0	0	0	0	31.00	28.00	20.00	**26.3**
A' 10	0	0	0	0	0	29.5	25.98	26.33	**27.3**
M' 10	0	0	0	0	0	20.10	35.70	28.87	**28.2**
J' 10	0	0	0	0	0	19.10	18.50	16.99	**18.2**
J' 10	0	0	0	17.99	29.99	23.99	21.99	27.99	**24.4**
A' 10	16.00	23.99	19.99	17.99	23.99	21.99	19.99	29.99	**21.7**
S' 10	27.99	21.99	23.99	23.99	19.99	21.99	19.99	23.99	**23.0**
O' 10	23.99	19.99	19.99	21.99	19.99	17.99	19.99	21.99	**20.7**
N' 10	16.00	19.99	19.99	19.99	19.99	19.99	21.99	19.99	**19.7**
D' 10	25.99	23.99	12.00	31.99	21.99	17.99	19.99	25.99	**22.5**
J' 11	71.98	59.98	55.98	61.98	33.99	19.99	45.99	51.98	**50.2**
F' 11	61.98	133.96	93.97	107.97	63.98	59.98	59.98	47.99	**78.7**
M' 11	79.98	179.94	77.98	149.95	59.98	63.98	55.98	83.97	**94.0**
A' 11	69.98	113.96	133.96	139.96	121.96	71.98	79.98	133.96	**108.2**
M' 11	151.95	229.93	103.97	191.94	129.96	119.96	135.96	163.95	**153.5**
J' 11	25.99	25.99	25.99	19.99	19.99	17.99	19.99	21.99	**22.2**
J' 11	13.99	17.99	19.99	15.99	19.99	11.99	17.99	17.99	**17.0**
A'11	17.99	9.99	9.99	11.99	11.99	9.99	15.99	5.99	**11.7**
S'11	13.99	9.99	13.99	11.99	15.99	13.99	11.99	15.94	**13.5**
O'11	13.99	15.99	13.99	13.99	11.99	13.99	15.99	13.99	**14.2**

Table 14. Monthly variation in salinity (ppt) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	0.06	0.04	0.01	0.02	0.02	0.03	0.04	0.03	**0.03**
D' 09	0.039	0.03	0.03	0.03	0.01	0.05	0.09	0.04	**0.04**
J' 10	0.06	0.07	0.08	0.09	0.08	0.09	0.08	0.05	**0.08**
F' 10	0.06	0.07	0.05	0.09	0.09	0.03	0.06	0.06	**0.06**
M' 10	0	0	0	0	0	0.65	0.58	0.63	**0.62**
A' 10	0	0	0	0	0	0.65	0.71	0.72	**0.69**
M' 10	0	0	0	0	0	0.19	0.1	0.13	**0.14**
J' 10	0	0	0	0	0	0.05	0.06	0.06	**0.06**
J' 10	0	0	0	0	0	0.13	0.1	0.07	**0.10**
A' 10	0	0	0	0	0	0.05	0.06	0.06	**0.06**
S' 10	0.08	0.05	0.06	0.09	0.15	0.12	0.11	0.14	**0.10**
O' 10	0.08	0.12	0.10	0.09	0.12	0.11	0.10	0.15	**0.11**
N' 10	0.14	0.11	0.12	0.12	0.10	0.11	0.10	0.12	**0.11**
D' 10	0.04	0.05	0.06	0.05	0.05	0.06	0.05	0.07	**0.05**
J' 11	0.88	0.29	0.19	0.26	0.12	0.23	0.14	0.12	**0.28**
F' 11	0.22	0.42	0.3	0.32	0.37	0.19	0.2	0.2	**0.28**
M' 11	0.74	0.52	0.47	0.48	0.33	0.41	0.29	0.35	**0.45**
A' 11	0.12	0.19	0.22	0.23	0.20	0.12	0.13	0.22	**0.18**
M' 11	0.56	0.59	0.6	0.71	0.55	0.48	0.71	0.52	**0.59**
J' 11	0.15	0.16	0.16	0.13	0.15	0.13	0.12	0.13	**0.14**
J' 11	0.39	0.5	0.42	0.47	0.46	0.32	0.47	0.41	**0.43**
A'11	0.14	0.21	0.39	0.2	0.37	0.34	0.22	0.2	**0.26**
S'11	0.37	0.57	0.39	0.48	0.33	0.33	0.44	0.28	**0.40**
O'11	0.22	0.16	0.2	0.16	0.17	0.24	0.22	0.17	**0.19**

Table 15. Monthly variation in Total Hardness (mg/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	18.9	25.2	23.1	23.1	25.2	37.5	21	21	**24.4**
D' 09	25.2	27.3	29.4	33.6	25.2	23.1	29.4	27.3	**27.6**
J' 10	44.1	31.5	35.7	44.1	37.8	37.8	39.9	44.1	**39.4**
F' 10	31.5	35.7	37.8	37.8	35.7	39.9	25.2	29.4	**34.1**
M' 10	0	0	0	0	0	48	48	46	**47.3**
A' 10	0	0	0	0	0	44	48	48	**46.7**
M' 10	0	0	0	0	0	62	56	40	**52.7**
J' 10	0	0	0	0	0	52	44	52	**49.3**
J' 10	48	48	56	44	52	56	36	40	**47.5**
A' 10	24	36	20	24	24	32	26	32	**27.3**
S' 10	40	36	36	28	32	40	36	32	**35.0**
O' 10	20	24	44	28	32	40	44	40	**34.0**
N' 10	28	24	20	24	24	20	20	24	**23.0**
D' 10	32	20	20	16	24	28	36	24	**25.0**
J' 11	136	64	52	76	44	64	48	56	**67.5**
F' 11	72	88	68	92	88	60	60	48	**72.0**
M' 11	56	40	48	44	32	24	32	40	**39.5**
A' 11	72	60	92	120	96	56	84	136	**89.5**
M' 11	88	96	60	92	56	92	120	120	**90.5**
J' 11	48	16	60	16	32	48	48	36	**38.0**
J' 11	56	48	44	52	64	52	60	48	**53.0**
A'11	20	24	44	32	28	32	36	40	**32.0**
S'11	44	76	60	44	64	56	64	48	**57.0**
O'11	36	64	32	44	40	40	52	52	**45.0**

Table 16. Monthly variation in Total Calcium (mg/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	18.9	25.2	23.1	23.1	25.2	37.5	21	21	24.4
D' 09	25.2	27.3	29.4	33.6	25.2	23.1	29.4	27.3	27.6
J' 10	44.1	31.5	35.7	44.1	37.8	37.8	39.9	44.1	39.4
F' 10	31.5	35.7	37.8	37.8	35.7	39.9	25.2	29.4	34.1
M' 10	0	0	0	0	0	48	48	46	47.3
A' 10	0	0	0	0	0	44	48	48	46.7
M' 10	0	0	0	0	0	62	56	40	52.7
J' 10	0	0	0	0	0	52	44	52	49.3
J' 10	48	48	56	44	52	56	36	40	47.5
A' 10	24	36	20	24	24	32	26	32	27.3
S' 10	40	36	36	28	32	40	36	32	35.0
O' 10	20	24	44	28	32	40	44	40	34.0
N' 10	28	24	20	24	24	20	20	24	23.0
D' 10	32	20	20	16	24	28	36	24	25.0
J' 11	136	64	52	76	44	64	48	56	67.5
F' 11	72	88	68	92	88	60	60	48	72.0
M' 11	56	40	48	44	32	24	32	40	39.5
A' 11	72	60	92	120	96	56	84	136	89.5
M' 11	88	96	60	92	56	92	120	120	90.5
J' 11	48	16	60	16	32	48	48	36	38.0
J' 11	56	48	44	52	64	52	60	48	53.0
A'11	20	24	44	32	28	32	36	40	32.0
S'11	44	76	60	44	64	56	64	48	57.0
O'11	36	64	32	44	40	40	52	52	45.0

Table 17. Monthly variation in Magnesium (mg/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	6.3	4.2	10.5	14.7	16.8	29.1	21	10.5	14.1
D' 09	10.5	16.8	14.7	21	16.6	10.5	14.7	12.6	14.7
J' 10	35.7	12.6	23.1	23.1	23.1	27.3	23.1	31.5	24.9
F' 10	12.6	16.8	23.1	25.2	12.6	25.2	10.5	14.7	17.6
M' 10	0	0	0	0	0	36	36	26	32.7
A' 10	0	0	0	0	0	22	24	30	25.3
M' 10	0	0	0	0	0	18	24	24	22.0
J' 10	0	0	0	0	0	12	12	20	14.7
J' 10	4	8	12	8	8	10	16	8	9.3
A' 10	6	4	4	4	4	6	10	12	6.3
S' 10	16	4	4	2	8	16	16	8	9.3
O' 10	4	4	8	4	8	16	16	8	8.5
N' 10	8	4	8	4	4	8	4	8	6.0
D' 10	8	2	4	4	4	4	12	4	5.3
J' 11	40	20	28	28	8	36	24	28	26.5
F' 11	8	40	28	56	20	16	36	12	27.0
M' 11	12	12	12	24	0	0	4	16	10.0
A' 11	8	8	48	76	48	8	40	44	35.0
M' 11	12	24	8	40	16	36	56	48	30.0
J' 11	24	8	12	4	8	24	24	8	14.0
J' 11	36	24	4	24	32	20	44	24	26.0
A'11	8	12	36	12	12	20	20	28	18.5
S'11	32	44	44	32	48	36	48	32	39.5
O'11	16	40	12	12	8	16	20	36	20.0

Table 18. Monthly variation in Dissolved Oxygen (mg/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	5.67	6.43	4.68	5.61	4.78	4.87	4.58	4.81	5.18
D' 09	6.1	6.34	6.29	5.38	5.87	4.03	6.3	4.79	5.64
J' 10	6.42	6.51	6.45	6.43	5.6	5.32	6.2	5.47	6.05
F' 10	6.22	6.43	6.2	6.14	5.69	6.11	5.94	5.86	6.07
M' 10	0	0	0	0	0	3.6	3.6	4.1	3.77
A' 10	0	0	0	0	0	3.4	3.6	3.4	3.47
M' 10	0	0	0	0	0	3.9	4.8	4.9	4.53
J' 10	0	0	0	0	0	4.8	4.1	4.5	4.47
J' 10	6.4	5.6	4.8	4	5.6	3.4	3.6	4.8	4.78
A' 10	8	4.8	5.6	6	8	6.4	7.2	8	6.75
S' 10	7.6	7.6	7.2	8	8	8	8	8	7.80
O' 10	7.6	7.2	7.25	8	7.2	5.61	4.95	8	6.98
N' 10	8	7.6	6.6	8	8	6.4	8	8	7.58
D' 10	5.2	5.2	5.6	4.4	5.2	4.8	5.6	6	5.25
J' 11	4.4	7.2	8	8	5.2	4.8	7.2	5.6	6.30
F' 11	8.8	8.4	8	5.2	6.4	10	10.2	6.4	7.93
M' 11	5.2	6.4	4.8	7.2	6.6	5.6	8	7.2	6.38
A' 11	3.2	5.6	7.2	7.2	7.2	6.4	8.8	9.6	6.90
M' 11	5.60	4.80	8.00	6.40	6.40	8.00	7.20	7.20	6.70
J' 11	7.20	7.20	4.80	5.60	4.00	8.00	8.80	7.20	6.60
J' 11	9.20	9.20	8.00	3.20	4.00	8.00	8.80	8.80	7.40
A'11	7.20	9.60	4.00	2.40	4.00	8.00	7.20	8.00	6.30
S'11	8.00	8.00	6.40	5.60	3.20	8.80	8.00	7.20	6.90
O'11	8.00	5.60	5.60	3.20	2.40	5.60	8.80	9.60	6.10

Table 19. Monthly variation in BOD (mg/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	2.6	3.4	2.6	2.2	2.6	2	2.7	2.4	**2.56**
D' 09	3.31	3.16	3.48	2.03	2.47	2.63	2.7	2.45	**2.78**
J' 10	2.46	4.87	3.5	2.6	2.47	2.27	2.62	2.87	**2.96**
F' 10	2.49	3.76	3	2.43	2.36	2.69	2.44	2.5	**2.71**
M' 10	0	0	0	0	0	3.6	3.6	4.1	**3.77**
A' 10	0	0	0	0	0	3.4	3.6	3.4	**3.47**
M' 10	0	0	0	0	0	2.4	2.5	2.7	**2.53**
J' 10	0	0	0	0	0	2.1	2.5	2.1	**2.23**
J' 10	2.1	2.3	2	2.9	3.2	2	2	2	**2.31**
A' 10	4.00	2.40	4.80	2.00	3.20	5.60	4.00	4.00	**3.75**
S' 10	3.60	2.00	3.20	6.40	4.00	2.80	2.40	1.68	**3.26**
O' 10	4.80	5.60	6.40	6.40	5.60	4.00	2.40	4.00	**4.90**
N' 10	4.80	4.00	2.00	4.80	5.60	4.00	3.28	5.60	**4.26**
D' 10	2.20	2.12	2.92	2.04	2.20	2.28	2.60	2.10	**2.31**
J' 11	2.40	1.60	3.60	4.80	2.80	3.20	2.40	2.80	**2.95**
F' 11	4.4	5.6	2.4	2	3.2	8	8	2.4	**4.50**
M' 11	3.6	2.4	2	4.8	3.4	3.6	6.4	5.2	**3.93**
A' 11	2.4	4	3.2	2.4	2.4	4.4	6.4	6.4	**3.95**
M' 11	3.20	3.20	2.40	2.40	4.00	2.40	0.80	2.40	**2.60**
J' 11	1.60	1.60	0.80	3.20	0.80	1.60	2.40	0.80	**1.60**
J' 11	3.20	3.20	4.00	2.00	0.80	0.80	4.00	1.60	**2.45**
A'11	0.80	4.80	3.20	1.60	3.20	2.40	1.60	0.80	**2.30**
S'11	3.20	1.60	3.20	2.40	2.40	3.20	2.00	1.60	**2.45**
O'11	0.80	1.60	1.60	2.00	1.40	1.60	0.80	3.20	**1.63**

Table 20. Monthly variation in Nitrate (µmol/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Mean**
N' 09	10.441	9.933	7.725	10.669	13.98	11.037	13.98	15.706	**11.684**
D' 09	9.367	10.471	9.622	12.414	13.244	9.197	10.379	13.311	**11.001**
J' 10	9.367	10.471	9.622	12.414	13.244	9.197	10.379	13.311	**11.001**
F' 10	11.829	12.876	15.451	10.007	10.283	12.441	14.792	13.622	**12.663**
M' 10	0	0	0	0	0	3.311	5.518	6.254	**5.028**
A' 10	0	0	0	0	0	6.99	7.35	8.09	**7.477**
M' 10	0	0	0	0	0	0.51	0.756	0.81	**0.692**
J' 10	0	0	0	0	0	0.2	0.24	0.21	**0.217**
J' 10	0.81	1.296	1.62	2.43	0.648	8.1	1.62	1.296	**2.228**
A' 10	1.46	2.43	1.13	2.96	4.86	0.65	1.13	0.81	**1.929**
S' 10	4.86	1.78	1.30	1.78	7.94	0.16	1.78	3.24	**2.855**
O' 10	4.86	7.78	4.54	9.07	7.94	5.99	2.92	1.78	**5.609**
N' 10	0.32	0.81	2.27	1.62	0.81	1.46	0.49	0.16	**0.992**
D' 10	0.034	0.013	0.013	0.005	0.008	0.006	0.002	0.034	**0.014**
J' 11	0.029	0.034	0.021	0.023	0.026	0.019	0.023	0.018	**0.024**
F' 11	0.008	0.018	0.003	0.010	0.003	0.003	0.008	0.013	**0.008**
M' 11	0.013	0.011	0.002	0.011	0.006	0.021	0.005	0.018	**0.011**
A' 11	0.019	0.016	0.013	0.024	0.015	0.015	0.016	0.019	**0.017**
M' 11	0.015	0.050	0.015	0.032	0.024	0.050	0.028	0.039	**0.032**
J' 11	0.018	0.024	0.016	0.031	0.010	0.018	0.008	0.089	**0.027**
J' 11	0.021	0.026	0.005	0.028	0.011	0.002	0.002	0.016	**0.014**
A'11	0.070	0.035	0.070	0.070	0.052	0.035	0.017	0.017	**0.046**
S'11	0.006	0.003	0.021	0.032	0.010	0.023	0.008	0.006	**0.014**
O'11	0.002	0.016	0.011	0.013	0.005	0.008	0.005	0.026	**0.011**

Table 21. Monthly variation in of Nitrite (µmol/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	0.041	0.02	0.062	0.021	0.144	0.041	0.103	0.041	**0.059**
D' 09	0.288	0.515	0.247	0.226	0.494	0.082	0.453	0.267	**0.322**
J' 10	0.288	0.226	0.329	0.782	0.618	0.391	0.473	0.311	**0.427**
F' 10	0.226	0.309	0.267	0.206	0.082	0.082	0.288	0.082	**0.193**
M' 10	0	0	0	0	0	0.329	0.309	0.189	**0.276**
A' 10	0	0	0	0	0	1.050	1.050	1.070	**1.057**
M' 10	0	0	0	0	0	1.080	1.210	1.300	**1.197**
J' 10	0	0	0	0	0	0.420	0.520	0.590	**0.510**
J' 10	0.905	0.800	0.853	0.766	0.800	0.365	0.539	0.957	**0.748**
A' 10	0.226	0.244	0.400	0.418	0.400	0.505	0.574	0.679	**0.431**
S' 10	0.087	0.017	0.348	0.052	0.261	0.122	0.104	0.174	**0.146**
O' 10	0.209	0.087	0.035	0.035	0.052	0.052	0.052	0.035	**0.070**
N' 10	0.087	0.070	0.139	0.157	0.209	0.261	0.713	1.009	**0.331**
D' 10	0.157	0.261	0.313	0.365	0.435	0.748	0.191	0.487	**0.370**
J' 11	0.348	0.244	0.104	0.139	0.174	0.244	0.122	0.244	**0.202**
F' 11	0.209	0.244	0.557	0.748	0.244	0.365	0.418	0.348	**0.392**
M' 11	0.522	1.088	0.261	0.157	0.331	0.313	0.261	0.452	**0.423**
A' 11	0.070	0.017	0.070	0.017	0.174	0.017	0.139	0.087	**0.074**
M' 11	0.261	0.244	0.035	0.174	0.365	0.261	0.209	0.139	**0.211**
J' 11	0.070	0.104	0.122	0.139	0.174	0.035	0.087	0.087	**0.102**
J' 11	0.122	0.104	0.226	0.244	0.365	0.139	0.017	0.087	**0.163**
A'11	0.070	0.035	0.070	0.070	0.052	0.035	0.017	0.017	**0.046**
S'11	0.017	0.017	0.139	0.104	0.139	0.070	0.070	0.122	**0.085**
O'11	0.122	0.052	0.087	0.104	0.209	0.157	0.122	0.087	**0.117**

Table 22. Monthly variation in of Phosphate (µmol/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	1.118	3.741	1.591	2.967	1.376	1.763	2.666	4.816	**2.50**
D' 09	4.988	6.493	5.246	6.453	3.397	4.042	2.709	2.58	**4.49**
J' 10	5.16	5.76	2.88	2.62	6.79	6.66	3.26	7.96	**5.14**
F' 10	4.558	5.289	3.698	6.665	10.191	8.256	5.375	12.384	**7.05**
M' 10	0	0	0	0	0	5.97	7.86	2.91	**5.58**
A' 10	0	0	0	0	0	2.96	4.98	6.02	**4.65**
M' 10	0	0	0	0	0	0.54	0.85	0.74	**0.71**
J' 10	0	0	0	0	0	0.91	0.58	0.61	**0.70**
J' 10	0.18	0.30	0.30	0.18	0.30	0.35	0.48	0.57	**0.33**
A' 10	0.30	0.24	0.30	0.30	0.35	0.13	0.07	0.18	**0.23**
S' 10	0.30	0.41	0.47	0.18	0.13	0.13	0.24	0.18	**0.25**
O' 10	0.30	0.10	0.47	0.52	0.52	0.58	0.52	0.63	**0.45**
N' 10	0.24	0.35	0.41	0.24	0.35	0.24	0.92	0.35	**0.39**
D' 10	0.97	0.52	0.52	0.97	0.75	0.63	0.92	1.25	**0.82**
J' 11	0.45	0.39	0.13	0.18	0.18	0.29	0.35	0.41	**0.30**
F' 11	3.06	1.99	1.03	0.86	0.75	4.01	3.62	2.38	**2.21**
M' 11	1.48	0.97	0.86	0.63	1.08	1.03	1.03	1.14	**1.03**
A' 11	0.41	0.97	0.75	0.41	0.69	1.42	1.08	0.86	**0.82**
M' 11	0.24	0.69	0.13	0.18	0.47	0.52	0.30	0.47	**0.37**
J' 11	0.13	0.30	0.18	0.35	0.35	0.24	0.47	0.35	**0.30**
J' 11	0.691	0.409	0.691	0.409	0.578	0.465	0.803	0.184	**0.529**
A'11	0.747	0.296	0.634	0.634	0.184	0.127	0.691	0.353	**0.458**
S'11	0.184	0.240	0.409	0.296	0.353	0.240	0.353	0.296	**0.296**
O'11	0.916	0.353	0.296	0.634	0.691	0.127	0.127	0.522	**0.458**

Table 23. Monthly variation in of Silicate (µmol/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	6.16	8.16	7.24	9.8	8.14	8.63	9.13	6.41	**7.96**
D' 09	6.79	8.71	9.79	7.45	8.89	7.44	6.93	7.29	**7.91**
J' 10	9.8	7.09	8.25	6.12	8.29	7.35	8.17	7.08	**7.77**
F' 10	7.28	6.4	7.37	9.3	6.18	9.03	8.55	9.46	**7.95**
M' 10	0	0	0	0	0	33.01	34.38	30.85	**32.75**
A' 10	0	0	0	0	0	5.08	2.7	2.22	**3.33**
M' 10	0	0	0	0	0	15.1	16.8	12.5	**14.80**
J' 10	0	0	0	0	0	18.1	19.5	22	**19.87**
J' 10	18.48	16.91	23.48	15.87	13.05	15.5	18.5	17	**17.35**
A' 10	21.80	14.30	16.91	18.70	11.31	5.71	12.99	12.67	**14.30**
S' 10	12.67	14.35	23.10	14.19	13.21	7.23	22.61	13.75	**15.14**
O' 10	7.02	11.91	16.09	11.31	4.08	8.38	6.42	3.97	**8.65**
N' 10	8.59	9.63	4.74	4.95	5.99	7.29	4.74	4.35	**6.28**
D' 10	7.34	15.71	15.11	12.78	13.65	9.79	13.21	14.57	**12.77**
J' 11	18.86	42.72	22.34	20.60	10.93	26.69	13.54	18.37	**21.76**
F' 11	20.8	7.3	18.9	3.6	2.4	10.7	9.7	3.8	**9.65**
M' 11	22.0	60.2	34.7	8.6	7.7	4.6	22.3	3.4	**20.44**
A' 11	6.1	13.5	17.2	11.2	12.3	4.4	6.6	18.4	**11.22**
M' 11	9.90	6.42	8.32	4.30	10.17	7.07	9.95	3.59	**7.47**
J' 11	10.98	8.59	4.46	11.15	21.52	9.14	5.77	8.16	**9.97**
J' 11	24.948	24.839	16.363	35.815	27.991	16.309	25.274	22.503	**24.255**
A'11	0.747	0.296	0.634	0.634	0.184	0.127	0.691	0.353	**0.458**
S'11	0.184	0.240	0.409	0.296	0.353	0.240	0.353	0.296	**0.296**
O'11	0.916	0.353	0.296	0.634	0.691	0.127	0.127	0.522	**0.458**

Table 24. Monthly variation in of Ammonia (μmol/L) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	0.71	2.43	2.51	2.95	0.15	0.35	1.45	0.15	1.34
D' 09	0.65	1.95	0.65	1.75	4.55	2.25	3.21	1.9	2.11
J' 10	7.91	6.42	5.8	9.75	9.01	10.05	8.65	7.85	8.18
F' 10	0.45	1.25	0.65	2.4	0.75	1.3	1.8	1.85	1.31
M' 10	0	0	0	0	0	0.1	1.65	1.45	1.07
A' 10	0	0	0	0	0	17.8	8.8	6.3	10.97
M' 10	0	0	0	0	0	1.31	1.25	4.21	2.26
J' 10	0	0	0	0	0	2.45	1.78	3	2.41
J' 10	1.15	1.90	2.70	4.90	2.35	2.55	2.20	1.05	2.35
A' 10	2.10	1.95	2.20	1.60	3.60	1.40	4.00	1.10	2.24
S' 10	2.95	2.45	4.25	3.55	1.60	15.30	2.85	3.50	4.56
O' 10	5.05	0.10	4.45	3.85	3.75	2.65	4.05	3.60	3.44
N' 10	0.85	0.65	0.35	0.35	0.15	0.10	4.15	0.50	0.89
D' 10	1.35	0.35	1.55	0.85	2.05	1.55	2.75	2.7	1.64
J' 11	39.05	13.3	7	4.05	0.95	9.55	7.3	10.5	11.46
F' 11	11.7	7.65	28.7	27.4	4.05	10.3	14.85	6.65	13.91
M' 11	0.8	36.2	31.45	1.45	0.9	7.1	17.7	1.7	12.16
A' 11	0.55	0.35	26.3	25.15	23.3	2.5	2.25	2	10.30
M' 11	40.0	39.0	35.1	32.8	38.8	3.5	62.3	65.8	39.62
J' 11	2.85	5.80	2.20	2.30	2.95	5.65	4.15	3.95	3.73
J' 11	0.950	0.600	1.050	0.050	0.900	2.100	1.450	0.500	0.950
A'11	0.300	0.850	0.850	0.450	1.950	0.500	0.250	1.150	0.788
S'11	0.250	0.100	0.250	0.650	0.300	0.200	0.050	1.100	0.363
O'11	0.400	0.650	0.900	4.450	0.650	0.200	0.550	1.150	1.119

Table 25. Monthly variation in of sediment pH in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	6.21	6.32	5.92	5.92	6.01	6.17	6.25	6.21	6.13
D' 09	5.19	5.87	5.06	5.5	5.87	6.29	6.24	6.24	5.78
J' 10	6.15	5.92	6.55	6.36	6.08	6.53	6.42	6.62	6.33
F' 10	6.19	6.48	6.73	6.52	6.29	6.33	6.6	6.42	6.45
M' 10	6.45	6.57	6.46	6.35	6.01	6.17	6.25	8.01	6.53
A' 10	6.98	6.92	6.92	7.06	7	7.13	6.65	8.01	7.08
M' 10	4.87	6.52	6.43	6.52	6.52	6.49	6.47	6.5	6.29
J' 10	6.56	6.83	6.73	6.39	6.29	6.33	6.6	6.42	6.52
J' 10	6.33	6.77	6.88	7.03	6.3	6.26	6.26	6.39	6.53
A' 10	7	6.63	6.61	6.65	7.1	6.32	6.21	7.5	6.75
S' 10	6.7	6.49	6.87	7.37	6.27	6.83	5.99	6.86	6.67
O' 10	6.62	6.34	7.37	6.7	7.37	6.27	6.87	6.49	6.75
N' 10	6.7	6.83	6.34	7.37	6.7	7.37	6.87	6.49	6.83
D' 10	6.7	6.3	6.83	6.37	6.61	6.54	5.99	6.77	6.51
J' 11	6.85	6.34	6.09	7.03	5.57	6.61	6.38	6.75	6.45
F' 11	6.93	6.37	6.83	6.84	6.77	6.83	6.87	6.77	6.78
M' 11	5.99	4.7	7.12	6.94	7.23	7.15	7.16	7.17	6.68
A' 11	6.77	6.06	6.05	6.38	6.59	6.54	6.32	6.16	6.36
M' 11	6.13	6.47	6.55	6.64	6.65	6.34	5.94	6.48	6.40
J' 11	6.21	6.68	6.62	6.73	6.43	6.34	6.45	6.51	6.50
J' 11	5.87	6.52	6.43	6.52	6.52	6.49	6.47	6.5	6.42
A'11	6.56	6.83	6.73	6.39	6.39	6.33	6.6	6.42	6.53
S'11	6.56	6.83	6.73	6.39	6.29	6.33	6.6	6.42	6.52
O'11	7	6.63	6.61	6.65	6.16	6.39	6.58	6.62	6.58

Table 26. Monthly variation in of Eh in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	-293	-107	-254	-210	-206	-241	-233	-218	-220.25
D' 09	-397	-259	-201	-225	-200	-213	-247	-198	-242.50
J' 10	-323	-176	-243	-300	-221	-223	-198	-185	-233.63
F' 10	-220	-200	-244	-254	-196	-195	-239	-177	-215.63
M' 10	-186	-344	-345	-425	-439	-409	-380	-401	-366.13
A' 10	-314	-425	-429	-461	-483	-479	-474	-466	-441.38
M' 10	-443	-198	-231	-132	-254	-250	-201	-215	-240.50
J' 10	-211	-226	-312	-313	-324	-321	-310	-287	-288.00
J' 10	-301	-318	-298	-387	-387	-362	-326	-362	-342.63
A' 10	-358	-285	-318	-335	-321	-310	-345	-320	-324.00
S' 10	-312	-287	-324	-288	-297	-341	-360	-334	-317.88
O' 10	-310	-298	-387	-387	-362	-326	-362	-298	-341.25
N' 10	-245	-285	-243	-277	-265	-255	-255	-269	-261.75
D' 10	-318	-312	-275	-239	-259	-309	-328	-286	-290.75
J' 11	-225	-413	-373	-380	-363	-325	-355	-348	-347.75
F' 11	-275	-318	-312	-326	-328	-239	-309	-259	-295.75
M' 11	-103	-285	-200	-246	-272	-265	-286	-238	-236.88
A' 11	-201	-203	-212	-208	-169	-206	-202	-200	-200.13
M' 11	-285	-252	-225	-333	-230	-229	-214	-219	-248.38
J' 11	-196	-162	-185	-217	-143	-213	-204	-228	-193.50
J' 11	-235	-220	-312	-287	-318	-335	-321	-310	-292.25
A'11	-297	-241	-210	-251	-324	-188	-197	-241	-243.63
S'11	-262	-326	-264	-298	-310	-298	-187	-207	-269.00
O'11	-265	-255	-255	-269	-245	-285	-243	-277	-261.75

Table 27. Monthly variation in of moisture content in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	4.79	4.25	4.02	3.58	3.99	3.73	4.28	4.53	4.15
D' 09	4.03	4.32	4.28	3.68	3.69	3.95	4.32	4.01	4.04
J' 10	3.85	3.68	3.76	4.14	4.75	3.75	4.57	3.58	4.01
F' 10	4.82	3.96	3.66	4.14	4.19	3.65	3.88	4.2	4.06
M' 10	3.2	3.26	2.79	3.33	3.38	3.38	3.53	4.61	3.44
A' 10	3.83	3.83	3.29	3.54	3.17	3.31	4.08	4.11	3.65
M' 10	3.62	3.71	3.58	4.03	3.99	3.73	4.28	4.01	3.87
J' 10	4.82	4.01	5.7	4.14	4.75	3.75	4.57	4.2	4.49
J' 10	4.85	4.05	5.7	4.14	4.75	3.75	4.57	4.2	4.50
A' 10	3.17	3.74	5.7	4.14	3.69	3.95	4.32	3.58	4.04
S' 10	4.79	4.25	4.02	3.58	3.99	3.73	4.28	4.01	4.08
O' 10	3.92	4.32	4.28	3.68	3.69	3.95	4.32	3.58	3.97
N' 10	2.96	3.74	2.25	2.63	2.24	2.35	3.69	3.7	2.95
D' 10	3.85	2.68	2.76	3.14	3.75	2.75	3.57	2.69	3.15
J' 11	1.82	3.01	3.13	1.76	1.68	2.26	2.58	2.78	2.38
F' 11	1.7	3	3.25	1.75	1.99	2.3	2.52	2.68	2.40
M' 11	1.94	2.92	2.33	2.4	3.3	2.3	2.52	2.68	2.55
A' 11	2.98	2.08	2.79	1.62	2.23	3.26	2.53	2.64	2.52
M' 11	1.93	2.03	2.53	1.92	2.01	2.48	1.68	1.94	2.07
J' 11	2.28	2.96	2.45	2.48	2.25	3.27	2.45	2.32	2.56
J' 11	3.99	3.73	4.28	4.01	4.79	4.25	4.02	3.58	4.08
A'11	3.69	3.95	4.32	3.58	3.92	4.32	4.28	3.68	3.97
S'11	2.24	2.35	3.69	3.7	2.96	3.74	2.25	2.63	2.95
O'11	3.85	2.68	2.76	3.14	3.75	2.75	3.57	2.69	3.15

Table 27. Monthly variation in of moisture content in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	4.79	4.25	4.02	3.58	3.99	3.73	4.28	4.53	4.15
D' 09	4.03	4.32	4.28	3.68	3.69	3.95	4.32	4.01	4.04
J' 10	3.85	3.68	3.76	4.14	4.75	3.75	4.57	3.58	4.01
F' 10	4.82	3.96	3.66	4.14	4.19	3.65	3.88	4.2	4.06
M' 10	3.2	3.26	2.79	3.33	3.38	3.38	3.53	4.61	3.44
A' 10	3.83	3.83	3.29	3.54	3.17	3.31	4.08	4.11	3.65
M' 10	3.62	3.71	3.58	4.03	3.99	3.73	4.28	4.01	3.87
J' 10	4.82	4.01	5.7	4.14	4.75	3.75	4.57	4.2	4.49
J' 10	4.85	4.05	5.7	4.14	4.75	3.75	4.57	4.2	4.50
A' 10	3.17	3.74	5.7	4.14	3.69	3.95	4.32	3.58	4.04
S' 10	4.79	4.25	4.02	3.58	3.99	3.73	4.28	4.01	4.08
O' 10	3.92	4.32	4.28	3.68	3.69	3.95	4.32	3.58	3.97
N' 10	2.96	3.74	2.25	2.63	2.24	2.35	3.69	3.7	2.95
D' 10	3.85	2.68	2.76	3.14	3.75	2.75	3.57	2.69	3.15
J' 11	1.82	3.01	3.13	1.76	1.68	2.26	2.58	2.78	2.38
F' 11	1.7	3	3.25	1.75	1.99	2.3	2.52	2.68	2.40
M' 11	1.94	2.92	2.33	2.4	3.3	2.3	2.52	2.68	2.55
A' 11	2.98	2.08	2.79	1.62	2.23	3.26	2.53	2.64	2.52
M' 11	1.93	2.03	2.53	1.92	2.01	2.48	1.68	1.94	2.07
J' 11	2.28	2.96	2.45	2.48	2.25	3.27	2.45	2.32	2.56
J' 11	3.99	3.73	4.28	4.01	4.79	4.25	4.02	3.58	4.08
A'11	3.69	3.95	4.32	3.58	3.92	4.32	4.28	3.68	3.97
S'11	2.24	2.35	3.69	3.7	2.96	3.74	2.25	2.63	2.95
O'11	3.85	2.68	2.76	3.14	3.75	2.75	3.57	2.69	3.15

Table 28. Monthly variation in of organic carbon in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	4.21	4.66	3.98	3.55	5.89	2.73	3.98	2.67	**3.96**
D' 09	3.86	4.58	3.71	4.81	3.9	6.67	4.29	4.1	**4.49**
J' 10	3.2	3.79	4.35	3.97	4.61	5.1	4	4.16	**4.15**
F' 10	1.95	4.05	3.67	2.85	3.78	4.01	4.06	7.84	**4.03**
M' 10	3.2	3.2	5.01	6.1	4.68	4.82	2.73	7.41	**4.64**
A' 10	5.46	3.51	2.82	4.26	1.8	2.91	5.97	5.97	**4.09**
M' 10	3.88	3.45	3.7	3.98	3.23	1.91	4.41	4.79	**3.67**
J' 10	2.9	1.8	1.07	3.44	1.53	1.36	4.33	2.86	**2.41**
J' 10	2.11	0.97	3.15	3.59	0.87	2.87	1.69	2.56	**2.23**
A' 10	4.33	3.12	3.82	4.78	4.79	3.87	3.3	3.86	**3.98**
S' 10	3.75	3.98	3.68	4.39	4.73	3.11	4.88	3.86	**4.05**
O' 10	4.99	4.95	5.01	3.26	3.32	4.56	3.06	2.79	**3.99**
N' 10	3.56	3.25	3.02	4.03	4.12	3.67	2.97	3.31	**3.49**
D' 10	4.18	3.64	5.03	4.75	3.33	4.09	5.11	4.67	**4.35**
J' 11	5.01	3.78	4.65	6.7	5.54	3.54	6.03	4.47	**4.97**
F' 11	4.95	3.98	5.46	1.4	6.32	5.34	6.75	4.89	**4.89**
M' 11	4.37	4.71	3.66	4.02	2.64	5	4.99	4.21	**4.20**
A' 11	3.86	5.18	5.8	2.73	6.08	6.54	6.98	5.51	**5.34**
M' 11	3.315	3.237	3.66	3.24	3.24	2.145	0.663	2.8	**2.79**
J' 11	7.25	3.12	3.24	3.04	7.18	7.16	3.9	6.24	**5.14**
J' 11	4.68	2.73	3.05	5.85	3.51	4.79	3.7	3.6	**3.99**
A'11	3.17	2.97	2.84	3.14	4.09	3.85	2.97	3.52	**3.32**
S'11	2.44	3	3.37	3.15	3.42	5.18	2.22	2.36	**3.14**
O'11	4.32	3.25	1.87	3.34	3.26	2.79	2.47	3.14	**3.06**

Table 29. Monthly variation in of available nitrogen in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	0.01848	0.01792	0.01963	0.02968	0.01872	0.01792	0.02842	0.018546	**0.0212**
D' 09	0.018642	0.02128	0.02128	0.01792	0.02328	0.01848	0.0256	0.023	**0.0212**
J' 10	0.01624	0.002	0.021987	0.02912	0.0224	0.01693	0.00668	0.02012	**0.0169**
F' 10	0.01232	0.0056	0.01854	0.01624	0.01849	0.02512	0.0196	0.025	**0.0176**
M' 10	0.02128	0.02348	0.019621	0.02172	0.02296	0.02543	0.02128	0.019456	**0.0219**
A' 10	0.02147	0.024516	0.0252	0.02688	0.02576	0.01792	0.02632	0.02296	**0.0239**
M' 10	0.0044	0.0224	0.01352	0.02128	0.01904	0.00896	0.00154	0.00121	**0.0115**
J' 10	0.02013	0.0288	0.01344	0.01458	0.01496	0.0056	0.0056	0.01446	**0.0147**
J' 10	0.0252	0.02307	0.02464	0.02352	0.019	0.02314	0.023	0.023079	**0.0231**
A' 10	0.01316	0.01623	0.019456	0.01736	0.01124	0.01542	0.0112	0.0139	**0.0147**
S' 10	0.02121	0.028	0.02128	0.03402	0.028	0.02314	0.01512	0.025011	**0.0245**
O' 10	0.0196	0.0196	0.0221	0.018471	0.01624	0.019241	0.02321	0.02464	**0.0204**
N' 10	0.0213	0.0054	0.0112	0.0111	0.0064	0.01793	0.01104	0.008014	**0.0115**
D' 10	0.019	0.021349	0.01848	0.019456	0.02856	0.01848	0.03352	0.02688	**0.0232**
J' 11	0.00616	0.0168	0.013641	0.02296	0.013542	0.013546	0.01512	0.00672	**0.0136**
F' 11	0.01624	0.02013	0.02016	0.01344	0.02184	0.01568	0.00336	0.015843	**0.0158**
M' 11	0.01456	0.01792	0.0112	0.0156	0.01288	0.02214	0.00896	0.01736	**0.0151**
A' 11	0.01456	0.02456	0.014764	0.01008	0.01456	0.0112	0.01008	0.01486	**0.0143**
M' 11	0.01136	0.01464	0.020123	0.008631	0.001548	0.014753	0.01103	0.01643	**0.0123**
J' 11	0.024412	0.02134	0.01694	0.02365	0.005433	0.024765	0.01466	0.021463	**0.0191**
J' 11	0.021342	0.013642	0.019823	0.021467	0.022364	0.01264	0.016874	0.021262	**0.0187**
A'11	0.036421	0.032146	0.03304	0.0476	0.0084	0.035113	0.05208	0.03752	**0.0353**
S'11	0.02184	0.03248	0.028113	0.02072	0.04368	0.029743	0.025746	0.02744	**0.0287**
O'11	0.010504	0.00683	0.02325	0.02736	0.014693	0.018246	0.01942	0.011693	**0.0165**

Table 30. Monthly variation in of available phosphorus in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	0.219	0.846	1.536	0.289	1.564	0.01	0.647	0.513	**0.703**
D' 09	1.121	0.877	0.768	0.651	1.259	1.3	1.107	0.677	**0.970**
J' 10	1.053	0.641	1.142	0.574	0.634	1.512	1.114	0.843	**0.939**
F' 10	0.417	0.511	0.747	0.657	0.745	0.974	0.15	0.414	**0.577**
M' 10	0.264	0.314	0.141	0.347	0.552	0.476	0.411	0.316	**0.353**
A' 10	0.316	0.311	0.332	0.454	0.413	0.51	0.224	0.425	**0.373**
M' 10	0.378	0.417	0.679	0.12	3.325	0.289	0.247	0.355	**0.726**
J' 10	1.864	0.984	1.648	1.254	1.284	0.998	2.963	2.1	**1.637**
J' 10	1.987	0.984	1.648	2.729	2.684	2.815	1.963	3.476	**2.286**
A' 10	0.941	0.764	1.852	1.687	2.612	1.983	2.331	1.647	**1.727**
S' 10	0.871	0.933	0.687	0.511	1.441	1.006	0.984	1.121	**0.944**
O' 10	0.54	0.954	0.846	0.417	0.254	0.988	0.761	0.206	**0.621**
N' 10	0.031	0.147	0.847	0.62	0.743	0.743	0.651	1.287	**0.634**
D' 10	2.164	1.237	0.251	0.364	0.469	1.475	2.549	0.927	**1.180**
J' 11	0.321	0.372	0.124	0.21	0.397	0.487	0.022	0.954	**0.361**
F' 11	0.145	0.324	0.146	0.471	0.478	0.384	0.158	0.164	**0.284**
M' 11	0.312	0.512	0.256	0.312	0.169	0.247	0.149	0.558	**0.314**
A' 11	0.497	0.641	0.238	0.33	0.197	0.546	0.473	0.046	**0.371**
M' 11	0.547	0.455	0.1	0.344	0.447	0.398	0.33	0.489	**0.389**
J' 11	2.694	1.652	1.47	0.987	1.853	1.21	1.244	1.688	**1.600**
J' 11	0.878	0.784	0.312	1.649	0.68	0.984	1.255	1.124	**0.958**
A'11	1.546	2.947	1.982	1.495	1.828	0.948	1.265	2.091	**1.763**
S'11	2.978	1.642	0.623	0.946	1.694	2.664	1.784	3.546	**1.985**
O'11	1.345	0.964	1.654	0.561	0.547	0.62	0.845	0.845	**0.923**

Table 31. Result of ANOVA of the water and sediment quality parameters in Maranchery wetland during 2009-2011

Depth

Source	df	Mean square	F
Intercept	1	670.283	1.641E3
Season	2	33.148	81.140**
station	7	5.066	12.401**
Season * station	14	0.439	1.074
Error	168	0.409	
Total	**192**		

Atmospheric temperature

Source	df	Mean square	F
Intercept	1	145508.163	3.489E3
Season	2	278.368	6.675**
station	7	69.281	1.661
Season * station	14	45.518	1.091
Error	168	41.702	
Total	**192**		

Water temperature

Source	df	Mean square	F
Intercept	1	127823.521	1.797E3
Season	2	602.035	8.462**
station	7	188.713	2.653*
Season * station	14	66.880	0.940
Error	168	71.144	
Total	**192**		

pH

Source	df	Mean square	F
Intercept	1	6127.425	1.851E3
Season	2	69.167	20.893**
station	7	8.107	2.449*
Season * station	14	3.431	1.037
Error	168	3.310	
Total	**192**		

Conductivity

Source	df	Mean square	F
Intercept	1	6629344.053	225.399
Season	2	164354.154	5.588**
station	7	6229.692	0.212
Season * station	14	5024.424	0.171
Error	168	29411.612	
Total	**192**		

TDS

Source	df	Mean square	F
Intercept	1	2097216.803	163.588
Season	2	276159.667	21.541**
station	7	4245.338	0.331
Season * station	14	3487.938	0.272
Error	168	12820.082	
Total	**192**		

***5%significance **1% Significance**

Turbidity

Source	df	Mean square	F
Intercept	1	12412.634	164.540
Season	2	810.620	10.745**
station	7	62.149	0.824
Season * station	14	122.342	1.622
Error	168	75.439	
Total	**192**		

Salinity

Source	df	Mean square	F
Intercept	1	6.475	179.411
Season	2	0.368	10.199**
station	7	0.015	0.402
Season * station	14	0.018	0.502
Error	168	0.036	
Total	**192**		

Chloride

Source	df	Mean square	F
Intercept	1	242552.374	190.793
Season	2	37574.704	29.557**
station	7	600.778	0.473
Season * station	14	534.848	0.421
Error	168	1271.283	
Total	**192**		

Alkalinity

Source	df	Mean square	F
Intercept	1	294141.797	397.072
Season	2	16054.234	21.672**
station	7	908.225	1.226
Season * station	14	402.038	0.543
Error	168	740.778	
Total	**192**		

Total Hardness

Source	df	Mean square	F
Intercept	1	316671.908	468.541
Season	2	2455.165	3.633*
station	7	531.745	0.787
Season * station	14	289.256	0.428
Error	168	675.868	
Total	**192**		

Ca. Hardness

Source	df	Mean square	F
Intercept	1	111592.653	361.631
Season	2	1134.604	3.677*
station	7	103.365	0.335
Season * station	14	135.817	0.440
Error	168	308.582	
Total	**192**		

***5%significance   **1% Significance**

Mg. Hardness

Source	**df**	**Mean square**	**F**
Intercept	1	52758.225	277.213
Season	2	233.129	1.225
station	7	387.229	2.035
Season * station	14	174.356	0.916
Error	168	190.316	
Total	**192**		

CO_2

Source	**df**	**Mean square**	**F**
Intercept	1	7028.890	230.135
Season	2	166.901	5.465**
station	7	21.108	0.691
Season * station	14	20.889	0.684
Error	168	30.542	
Total	**192**		

Nitrite

Source	**df**	**Mean square**	**F**
Intercept	1	12.200	162.265
Season	2	0.038	0.502
station	7	0.126	1.679
Season * station	14	0.054	0.713
Error	168	0.075	
Total	**192**		

Nitrate

Source	**df**	**Mean square**	**F**
Intercept	1	1417.383	75.878
Season	2	286.982	15.363**
station	7	3.772	0.202
Season * station	14	4.673	0.250
Error	168	18.680	
Total	**192**		

Ammonia

Source	**df**	**Mean square**	**F**
Intercept	1	5527.130	54.722
Season	2	1237.907	12.256**
station	7	20.477	0.203
Season * station	14	44.282	0.438
Error	168	101.004	
Total	**192**		

Silicate

Source	**df**	**Mean square**	**F**
Intercept	1	26457.945	339.699
Season	2	434.335	5.577**
station	7	91.721	1.178
Season * station	14	38.917	0.500
Error	168	77.886	
Total	**192**		

***5%significance **1% Significance**

Phosphate

Source	df	Mean square	F
Intercept	1	358.654	89.097
Season	2	51.578	12.813**
station	7	3.689	0.916
Season * station	14	3.067	0.762
Error	168	4.025	
Total	**192**		

Sediment temperature

Source	df	Mean square	F
Intercept	1	146948.734	9.007E4
Season	2	11.575	7.095**
station	7	0.234	0.143
Season * station	14	0.143	0.087
Error	168	1.631	
Total	**192**		

***5%significance   **1% Significance**

Table 32. Season wise Duncan test of water and sediment parameters in the selected stations of Maranchery wetland during 2009-11

pH

Seasons	N	Subsets		
		1	2	3
2	64	4.5447		
3	64		5.7944	
1	64			6.6086
Sig.		1.00	1.00	1.00

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 3.310.

Conductivity

season	N	Subset	
		1	2
1	64	1.2983E2	
3	64		1.9909E2
2	64		2.2853E2
Sig.		1.00	0.333

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 29411.612.

TDS

Seasons	N	Subsets		
		1	2	3
1	64	47.2906		
3	64		90.0063	
2	64			1.7624E2
Sig.		1.00	1.00	1.00

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error) = 12820.082.

Turbidity

season	N	Subset	
		1	2
3	64	3.9797	
1	64		9.5245
2	64		10.6172
Sig.		1.00	0.478

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 75.439.

Salinity

season	N	Subset	
		1	2
1	64	0.1119	
3	64	0.1761	
2	64		0.2630
Sig.		0.057	1.00
Means for groups in homogeneous subsets are displayed. Based on observed means. The error term is Mean Square(Error)= 0.036			

Chloride

season	N	Subset	
		1	2
3	63	16.6670	
1	64	27.2683	
2	64		63.0252
Sig.		0.095	1.000
Means for groups in homogeneous subsets are displayed. Based on observed means. The error term is Mean Square(Error)= 1271.283			

Alkalinity

season	N	Subset	
		1	2
2	64	29.2188	
3	64	30.7969	
1	64		57.4062
Sig.		0.743	1.000
Means for groups in homogeneous subsets are displayed. Based on observed means. The error term is Mean Square(Error)= 740.778			

Total Hardness

season	N	Subset	
		1	2
1	64	35.7266	
3	64	38.5313	38.5318
2	64		47.5781
Sig.		0.543	0.051
Means for groups in homogeneous subsets are displayed. Based on observed means. The error term is Mean Square(Error)= 675.868			

Ca. Hardness

season	N	Subset	
		1	2
1	64	20.9141	
3	64	22.5313	
2	64		28.8797
Sig.		0.603	1.000
Means for groups in homogeneous subsets are displayed. Based on observed means. The error term is Mean Square(Error)= 308.582			

Mg. Hardness

season	N	Subset
		1
1	64	15.0000
3	64	16.0312
2	64	18.6984
Sig.		0.155
Means for groups in homogeneous subsets are displayed.Based on observed means. The error term is Mean Square(Error)= 190.316		

Salinity

season	N	Subset	
		1	2
1	64	0.1119	
3	64	0.1761	
2	64		0.2630
Sig.		0.057	1.00

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 0.036

Chloride

season	N	Subset	
		1	2
3	63	16.6670	
1	64	27.2683	
2	64		63.0252
Sig.		0.095	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 1271.283

Alkalinity

season	N	Subset	
		1	2
2	64	29.2188	
3	64	30.7969	
1	64		57.4062
Sig.		0.743	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 740.778

Total Hardness

season	N	Subset	
		1	2
1	64	35.7266	
3	64	38.5313	38.5318
2	64		47.5781
Sig.		0.543	0.051

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 675.868

Ca. Hardness

season	N	Subset	
		1	2
1	64	20.9141	
3	64	22.5313	
2	64		28.8797
Sig.		0.603	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 308.582

Mg. Hardness

season	N	Subset
		1
1	64	15.0000
3	64	16.0312
2	64	18.6984
Sig.		0.155

Means for groups in homogeneous subsets are displayed.Based on observed means.
The error term is Mean Square(Error)= 190.316

Salinity

season	N	Subset	
		1	2
1	64	0.1119	
3	64	0.1761	
2	64		0.2630
Sig.		0.057	1.00

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 0.036

Chloride

season	N	Subset	
		1	2
3	63	16.6670	
1	64	27.2683	
2	64		63.0252
Sig.		0.095	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 1271.283

Alkalinity

season	N	Subset	
		1	2
2	64	29.2188	
3	64	30.7969	
1	64		57.4062
Sig.		0.743	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 740.778

Total Hardness

season	N	Subset	
		1	2
1	64	35.7266	
3	64	38.5313	38.5318
2	64		47.5781
Sig.		0.543	0.051

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 675.868

Ca. Hardness

season	N	Subset	
		1	2
1	64	20.9141	
3	64	22.5313	
2	64		28.8797
Sig.		0.603	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 308.582

Mg. Hardness

season	N	Subset
		1
1	64	15.0000
3	64	16.0312
2	64	18.6984
Sig.		0.155

Means for groups in homogeneous subsets are displayed.Based on observed means.
The error term is Mean Square(Error)= 190.316

Dissolved Co_2

season	N	Subset	
		1	2
2	64	4.4297	
1	64	6.0625	6.0625
3	64		7.6594
Sig.		0.097	0.104

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 30.542

Dissolved O_2

Season	N	Subset	
		1	2
2	64	4.7983	
3	64		6.0250
1	64		6.1334
Sig.		1.000	0.798

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 5.707

Biochemical Oxygen Demand

Season	N	Subset	
		1	2
3	64	2.3703	
2	64	2.6688	2.6688
1	64		3.0453
Sig.		0.276	0.170

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 2.384

Nitrite

Season	N	Subset
		1
1	64	0.2372
3	64	0.2389
2	64	0.2801
Sig.		0.409

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 0.075

Nitrate

Season	N	Subset	
		1	2
3	64	0.8991	
2	64	2.2099	
1	64		5.0421
Sig.		0.088	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 18.680

Ammonia

Season	N	Subset	
		1	2
3	64	1.9856	
1	64	3.7727	
2	64		10.3378
Sig.		0.316	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 101.004

Silicate

Season	N	Subset	
		1	2
2	64	9.4739	
1	64	11.1571	
3	64		14.5857
Sig.		0.282	1.000

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 77.886

Phosphate

Season	N	Subset	
		1	2
3	64	0.3329	
1	64		1.8180
2	64		1.9493
Sig.		1.000	0.712

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 4.025

7.2 Primary Productivity

The gross primary productivity showed an average of 5.15 gC/m^3/day for the ecosystem whereas the net productivity was 3.50 gC/m^3/day (Table 33). ANOVA of gross primary productivity was significant at 1% level between seasons during the study period. A positive correlation significant at 1% level (r^2=0.480) was observed between gross and net primary productivity. Duncan test showed that, it was grouped into 3 subsets, significant at 5% level. The lowest gross primary productivity recorded was 0.98 gC/m^3/day at Station 1 during September 2010 and the highest gross primary productivity recorded was 6.43 gC/m^3/day at Station 6 during March 2010. The net primary productivity ranged from 0.65 gC/m^3/day to 4.29 gC/m^3/day (Table 34). The lowest net primary productivity recorded was 0.65 gC/m^3/day in Station 3 in September 2010 and the highest net primary productivity was 3.64 gC/m^3/day in Station 7 during March 2010. Duncan test showed that it was grouped into 1 subsets, significant at 5% level. The chlorophyll 'a' ranged from 0.29 mg/m^3 in Station 3 to 25.22 mg/m^3 in Station 7 (Table 35). ANOVA of chlorophyll 'a' and chlorophyll 'c' were significant at 5% level between seasons. Duncan test showed that it was grouped into 2 subsets, significant at 5% level. ANOVA of chlorophyll 'b' showed 1% level significance between seasons (F=5.48). Duncan test showed that it was grouped into 2 subsets, significant at 5% level. The lowest chlorophyll 'a' recorded was 0.29 mg/m^3 in Station 3 during December 2009 and the highest chlorophyll 'a' was 25.22 mg/m^3 at Station 7 in April 2011 (Table 35). A positive correlation, significant at 1% level (r^2=0.380) emerged between chlorophyll 'a' and dissolved oxygen and also with silicate (r^2=0.317). The mean value of chlorophyll 'b' recorded was 3.22 mg/m^3. The chlorophyll 'c' ranged from 0.003 mg/m^3 to 11.6 mg/m^3 (Table 36). Duncan test showed that it was grouped into 2 subsets, significant at 5% level. The lowest chlorophyll 'c' recorded was 0.003 mg/m^3 at station 7 during December 2009 and the highest was 11.6 mg/m^3 in station 6 during May 2011(Table 37).

Table 33. Monthly variation in of Gross Primary Productivity (gC/m^3/day) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	2.36	1.50	4.07	3.00	2.36	2.79	3.43	1.29	2.60
D' 09	0.69	1.29	1.57	1.82	2.32	1.63	2.64	1.82	1.72
J' 10	3.52	1.24	0.94	1.42	1.67	1.14	1.65	1.61	1.65
F' 10	1.22	1.33	5.53	3.62	5.62	2.79	4.63	2.79	3.44
M' 10	0	0	0	0	0	6.43	5.36	3.64	5.15
A' 10	0	0	0	0	0	4.07	4.50	4.07	4.22
M' 10	0	0	0	0	0	1.98	2.986	3.98	2.98
J' 10	0	0	0	0	0	2.15	1.399	1.23	1.59
J' 10	2.33	4.45	3.63	4.92	2.33	4.23	2.44	4.80	3.64
A' 10	2.45	3.78	1.22	3.12	2.54	4.18	4.21	4.65	3.27
S' 10	0.98	1.45	3.22	4.45	3.11	2.88	3.99	4.68	3.09
O' 10	2.36	1.50	4.07	3.00	2.36	2.79	3.43	1.29	2.60
N' 10	0.69	1.29	1.57	1.82	2.32	1.63	2.64	1.82	1.72
D' 10	3.52	1.24	0.94	1.42	1.67	1.14	1.65	1.61	1.65
J' 11	1.22	1.33	3.53	3.62	4.62	2.79	4.63	2.79	3.07
F' 11	4.8	3	4.8	3.6	3	1.2	2.4	3.6	3.30
M' 11	1.8	2.4	3	1.2	4.6	4.8	1.8	2.4	2.75
A' 11	3.6	1.2	3.2	1.2	2.4	2.4	3.6	4.8	2.80
M' 11	1.20	3.60	0.72	3.60	3.60	1.20	3.60	1.20	2.34
J' 11	1.6	1.2	1.8	3.6	2	1.2	1.2	2.4	1.88

J' 11	2.4	2.4	2.0	2.4	4.8	2.8	1.2	2.4	**2.55**
A'11	2.4	1.2	2.6	1.2	2.4	1.2	1.2	1.0	**1.65**
S'11	4.8	3.6	1.2	1.2	1.0	2.4	1.2	2.4	**2.23**
O'11	1.2	1.2	1.2	1.2	1.2	1.2	2.4	2.4	**1.50**

Table 34. Monthly variation in of Net Primary Productivity ($gC/m^3/day$) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Mean**
N' 09	1.72	0.64	2.79	2.14	1.29	1.07	2.79	0.86	**1.66**
D' 09	0.47	1.01	1.14	1.61	1.97	1.37	0.45	0.62	**1.08**
J' 10	1.03	0.60	0.88	0.64	0.81	0.75	1.37	1.05	**0.89**
F' 10	0.84	0.79	0.90	0.90	1.24	1.01	1.33	0.94	**0.99**
M' 10	0	0	0	0	0	4.29	3.64	2.57	**3.50**
A' 10	0	0	0	0	0	1.93	1.07	2.79	**1.93**
M' 10	0	0	0	0	0	1.1	1.22	0.935	**1.09**
J' 10	0	0	0	0	0	0.91	0.655	0.879	**0.81**
J' 10	1.91	1.07	1.33	0.76	0.51	0.81	0.86	1.21	**1.06**
A' 10	1.56	0.96	0.86	1.01	2.15	0.94	0.85	0.75	**1.13**
S' 10	0.91	0.23	0.65	1.97	1.77	2.93	1.09	2.11	**1.46**
O' 10	1.72	0.64	2.79	2.14	1.29	1.07	2.79	0.86	**1.66**
N' 10	0.47	1.01	1.14	1.61	1.97	1.37	0.45	0.62	**1.08**
D' 10	1.03	0.60	0.88	0.64	0.81	0.75	1.37	1.05	**0.89**
J' 11	0.84	0.79	0.90	0.90	1.24	1.01	1.33	0.94	**0.99**
F' 11	3.6	2.4	2.8	2.8	2.4	0.8	1.6	3	**2.43**
M' 11	1.2	1	2.4	2.5	3.5	3.6	1.2	1.2	**2.08**
A' 11	2.4	1	1.2	0.8	2	2	1.2	2.4	**1.63**
M' 11	0.84	0.48	2.4	2.4	2.4	3.6	1.2	1.2	**1.82**
J' 11	1	1.2	0.84	0.88	0.65	2.6	1.4	1.2	**1.22**
J' 11	1.6	1.2	1.2	1.2	2.6	2.5	1.6	1.2	**1.64**
A'11	3.6	2.4	2.8	2.8	2.4	0.8	1.6	3.0	**2.43**
S'11	1.2	1.0	2.4	2.5	3.5	3.6	1.2	1.2	**2.08**
O'11	2.4	1.0	1.2	0.8	2.0	2.0	1.2	2.4	**1.63**

Table 35. Monthly variation in of Chlorophyll 'a' (mg/m^3) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	0.549	0.465	0.932	1.408	0.946	0.465	0.545	0.274	**0.70**
D' 09	0.175	0.863	0.290	0.929	0.302	0.169	0.765	0.140	**0.45**
J' 10	2.095	3.753	4.185	0.236	0.946	0.717	1.324	0.289	**1.69**
F' 10	0.579	0.865	0.899	1.202	1.813	0.952	0.552	0.528	**0.92**
M' 10	0	0	0	0	0	4.333	5.535	2.880	**4.25**
A' 10	0	0	0	0	0	8.193	9.909	9.268	**9.12**
M' 10	0	0	0	0	0	4.579	3.986	4.670	**4.41**
J' 10	0	0	0	0	0	7.450	3.130	5.870	**5.48**
J' 10	3.990	2.649	5.290	3.621	2.852	2.792	3.631	1.421	**3.28**
A' 10	13.867	7.820	9.599	13.831	1.718	2.030	0.943	1.741	**6.44**
S' 10	10.781	6.288	11.280	9.621	5.609	6.935	6.018	14.071	**8.83**
O' 10	5.187	3.765	1.189	2.870	3.397	6.190	2.579	2.967	**3.52**
N' 10	4.411	3.732	3.384	4.854	2.569	4.518	9.752	4.141	**4.67**
D' 10	7.765	7.028	3.804	4.958	5.229	6.521	5.869	8.763	**6.24**
J' 11	1.831	12.869	8.182	13.399	15.038	17.138	12.031	2.953	**10.43**
F' 11	7.025	14.152	11.007	10.477	11.796	10.833	13.911	14.913	**11.76**
M' 11	8.417	3.361	7.502	3.302	14.804	9.870	13.797	15.452	**9.56**
A' 11	4.821	14.764	16.161	18.919	16.282	14.502	11.571	25.223	**15.28**
M' 11	10.597	19.837	4.649	10.025	9.533	11.560	10.447	3.692	**10.04**
J' 11	7.496	3.632	4.622	3.869	2.481	8.622	9.508	18.715	**7.37**
J' 11	4.53	4.75	10.76	63.29	38.97	1.36	2.44	0.68	**15.85**
A'11	1.40	6.76	11.84	10.57	11.54	1.37	6.98	4.55	**6.88**
S'11	4.72	4.99	11.96	15.56	9.38	7.44	4.28	4.72	**7.88**
O'11	10.66	7.51	14.65	12.23	5.47	7.06	11.52	6.04	**9.39**

Table 36. Monthly variation in of Chlorophyll 'b' (mg/m^3) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	0.238	0.305	0.316	0.328	0.148	0.180	0.734	0.019	0.28
D' 09	0.042	0.288	0.052	0.193	0.060	0.018	0.012	0.049	0.09
J' 10	0.172	0.125	0.174	0.148	0.148	0.159	0.013	0.085	0.13
F' 10	0.148	0.508	0.779	0.958	3.055	0.174	0.072	0.201	0.74
M' 10	0	0	0	0	0	3.008	4.571	0.94	2.84
A' 10	0	0	0	0	0	0.039	0.044	0.305	0.13
M' 10	0	0	0	0	0	1.298	0.981	1.627	1.30
J' 10	0	0	0	0	0	2.135	1.243	0.985	1.45
J' 10	0.974	0.875	0.759	0.764	0.392	0.277	0.134	0.654	0.60
A' 10	1.207	2.082	3.109	1.108	0.943	1.179	0.738	0.355	1.34
S' 10	4.694	1.267	4.969	2.369	1.225	1.729	1.743	3.557	2.69
O' 10	1.282	1.933	1.309	1.527	0.952	1.351	0.668	0.986	1.25
N' 10	0.802	1.843	2.202	1.598	1.131	0.559	0.953	0.326	1.18
D' 10	2.921	0.467	0.779	0.656	0.234	1.052	0.430	1.488	1.00
J' 11	0.134	1.424	0.345	2.155	0.185	0.425	2.916	0.111	0.96
F' 11	0.361	1.923	0.832	2.470	4.323	3.419	2.185	0.759	2.03
M' 11	0.183	0.575	0.250	0.529	1.180	0.889	0.695	0.328	0.58
A' 11	0.231	2.497	0.484	0.873	2.055	0.919	2.537	1.022	1.33
M' 11	2.409	9.312	0.857	2.681	0.940	0.928	3.624	4.978	3.22
J' 11	2.054	0.153	1.814	0.044	0.381	0.442	0.848	2.540	1.03
J' 11	6.60	7.34	0.48	0.96	0.88	0.08	1.77	0.04	2.27
A'11	3.38	1.00	4.37	1.93	3.58	2.96	4.04	0.14	2.68
S'11	0.82	0.29	1.54	2.17	2.48	1.04	0.61	0.77	1.21
O'11	0.78	0.41	2.34	1.23	0.18	0.21	1.55	1.14	0.98

Table 37. Monthly variation in of Chlorophyll 'c' (mg/m^3) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	0.251	0.353	0.733	0.512	0.065	0.268	1.674	0.778	0.58
D' 09	0.016	0.390	0.011	0.265	0.049	0.014	0.003	0.021	0.10
J' 10	0.208	0.217	0.037	0.497	0.065	0.063	0.078	0.110	0.16
F' 10	0.229	0.680	0.894	1.151	6.042	0.335	0.795	0.318	1.31
M' 10	0	0	0	0	0	3.712	5.733	1.160	3.54
A' 10	0	0	0	0	0	0.625	1.159	0.722	0.84
M' 10	0	0	0	0	0	0.421	1.210	1.763	1.13
J' 10	0	0	0	0	0	0.231	0.960	2.430	1.21
J' 10	0	0	0	0	0	0.142	0.762	1.150	0.68
A' 10	0.454	0.474	0.363	0.511	0.295	0.092	0.940	0.674	0.48
S' 10	1.497	0.335	1.197	0.732	0.097	0.421	0.707	2.619	0.95
O' 10	3.410	3.611	0.035	1.133	1.366	0.264	1.500	0.207	1.44
N' 10	1.091	1.329	1.635	1.309	3.836	0.230	1.112	0.719	1.41
D' 10	3.100	0.877	1.311	0.992	0.129	1.283	2.668	1.812	1.52
J' 11	0.410	2.412	0.558	4.237	0.792	0.830	3.615	0.429	1.66
F' 11	1.858	0.651	0.500	1.434	0.443	0.924	0.446	0.518	0.85
M' 11	1.015	1.529	0.811	1.615	0.409	0.967	0.579	0.925	0.98
A' 11	0.971	2.693	0.321	2.464	2.610	3.013	0.796	2.404	1.91
M' 11	2.044	0.268	1.614	0.945	0.984	8.486	11.632	2.548	3.56
J' 11	2.996	0.667	2.531	0.634	0.005	1.320	0.883	2.476	1.44
J' 11	1.63	0.74	0.53	1.26	1.04	0.48	1.50	0.24	0.93
A'11	0.08	0.76	0.71	0.60	0.51	0.24	3.95	0.38	0.90
S'11	0.53	0.65	1.72	1.74	0.77	1.00	0.75	1.03	1.02
O'11	0.07	0.66	0.56	0.13	0.39	0.44	0.03	1.48	0.47

Table 38. Result of ANOVA of the primary productivity in Maranchery wetland during 2009-2011

GPP

Source	df	Mean square	F
Intercept	1	996.247	502.465
Season	2	2.236	1.128
station	7	3.871	1.952
Season * station	14	2.117	1.068
Error	168	1.983	
Total	**192**		

NPP

Source	df	Mean square	F
Intercept	1	353.748	417.893
Season	2	0.711	0.839
station	7	1.744	2.060
Season * station	14	0.640	0.756
Error	168	0.847	
Total	**192**		

Chlorophyll ' a'

Source	df	Mean square	F
Intercept	1	7492.040	152.508
Season	2	129.031	2.627*
station	7	30.893	0.629
Season * station	14	52.003	1.059
Error	168	49.126	
Total	**192**		

Chlorophyll 'b'

Source	df	Mean square	F
Intercept	1	256.590	132.621
Season	2	10.617	5.487**
station	7	0.765	0.395
Season * station	14	2.099	1.085
Error	168	1.935	
Total	**192**		

Chlorophyll 'c'

Source	df	Mean square	F
Intercept	1	198.950	104.099
Season	2	4.997	2.614*
station	7	2.973	1.556
Season * station	14	2.156	1.128
Error	168	1.911	
Total	**192**		

***5%significance **1% Significance**

Table 39. Season wise Duncan test of primary productivity in the selected stations of Maranchery wetland during 2009-11

GPP

Season	N	Subset		
		1	2	3
2	24	1.6750		
1	24	1.8808	1.8808	
3	24	2.1171	2.1171	2.1171
4	24	2.1421	2.1421	2.1421
5	24	2.3300	2.3300	2.3300
6	24	2.5425	2.5425	2.5425
8	24		2.6946	2.6946
7	24			2.8410
Sig.		0.062	0.081	0.123

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 1.983

NPP

Season	N	Subset
		1
1	64	1.2358
3	64	1.4142
2	64	1.4221
Sig.		0.284

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 0.847

Chlorophyll 'a'

Season	N	Subset	
		1	2
1	64	4.6373	
2	64	6.7804	6.7804
3	64		7.3224
Sig.		0.086	0.662

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 49.126

Chlorophyll 'b'

Season	N	Subset	
		1	2
1	64	0.7342	
2	64	1.1868	1.1868
3	64		1.5471
Sig.		0.067	0.145

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 1.935

Chlorophyll 'c'

Season	N	Subset	
		1	2
3	64	0.8032	
1	64	0.9168	0.9168
2	64		1.3338
Sig.		0.643	0.090

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 1.911

7.3 Biotic Production

The phytoplankton biomass ranged from 1 ml/m^3 in Station 8 in June 2010 to 28 ml/m^3 in Station 4 and 5 during July 2011, whereas the average for the wetland was 14.3 ml/m^3 (Table 40). The ANOVA of phytoplankton biomass showed that the variation between seasons were significant at 1% level (F=5.73). The phytoplankton biomass was higher during the post monsoon period. The dominant phytoplankton group in Maranchery wetland was Chlorophyceae in all three seasons during the study. Other phytoplankton groups mainly observed were Cyanophyceae, Bacillariophyceae, and Euglenophyceae. Numerical abundance of phytoplankton was maximum in pre monsoon and minimum during the monsoon. Variation in different groups of phytoplankton are shown in Fig. 82-96. ANOVA of phytoplankton biomass was significant at 1% level between seasons. Duncan test showed that it was grouped into 2 subsets, significant at 1% level. On comparing with the study 8 different stations, it was observed that there was no marked deviation obtained in different groups of plankton. However, among the groups of phytoplankton, Chlorophyceae and Euglenopyceae exhibited highest and lowest percentage of abundance. During the pre-monsoon period Chlorophyceae (24000 No./m^3), Bacillariophyceae (12000 No./m^3), Cyanophyceae(15000No./m^3) showed higher numerical abundance compared to Euglenophyceae(11500 No./m^3).

Chlorophyceae: Eight genera were observed in Maranchery wetland. The genera encountered in the wetland were in the following order of dominance. *Volvox > Oedogonium>Spirogyra>Pediastrum>Arthrodesmus>Staurastrum>Ulothrix>Scenedes mus.*

Cyanophyceae: Three genera were observed in this wetland. Different genera encountered in the wetland were in the following order of dominance. *Nostoc > Oscilliatoria > Microcystis*

Bacillariophyceae: Two genera were observed in this wetland. *Navicula > Diatoma*

Euglenophyta: Two genera were observed in this wetland. *Euglena > Phacus*

The zooplankton biomass ranged from 1 ml/m^3 Station 2 to 35 ml/m^3 (Table: 41). ANOVA of Zooplankton biomass was significant at 1% level between seasons during the study period. Duncan test showed that it was grouped into 2 subsets, significant at 1%

level. A positive correlation significant at 1% level emerged between zooplankton biomass and phosphate (r^2=0.231). A distinct seasonal response was observed by phytoplankton and zooplankton population. During the pre-monsoon the wetland shows maximum numerical abundance (12000no./m^3) and minimum in monsoon period. Among three different groups copepods and rotifers shows maximum numerical abundance in pre monsoon period (12000no./m^3 and 2000 no./m^3 respectively). Percentage wise abundance of different group of zoo plankton in 8 different stations were depicted in Fig. 69-77. Copepods and copepods nauplii formed an important component in all the 8 Stations. Among 8 different stations St. 4 showed maximum percentage abundance of Copepods (92%). Although 5 family of rotifers were recorded during the premonsoon period. Branchionus species represented the maximum incidence among the rotifers in the present study. In this system 23% of zoo plankton contributed by cladocerans during the monsoon period compare to other groups.

Copepoda: Only four genera observed. *Mesocyclops > Microcyclops > Paracyclops > Heliodiaptomus*

Rotifera: Seven genera were observed in Maranchery wetland. *Branchionus > Platyias > Filinia > Lecanae > Polyarthra > Testudinella > Trichocerca*

Cladocera: Seven genera were observed in Maranchery wetland. Different genera encountered in the wetland were in the following order of dominance. Among different genera Daphnia and Moina were commonly observed. *Daphnia > Ceriodaphnia > Diaphanosoma > Moina > Bosmina > Chydorus > Alona*

The dominant aquatic macrophytes identified were *Limnophylla* (submerged water plant) (15%) *Lymnanthymum*(15%), Nymphyea sps (15%), followed by *Hydrilla* (10%), *Utricularia* (10%) typha (7%) *Eichornia crraseipus* (5%), *Ludweigea* (3%), and *Ipomea* (2%). (Table. 36).

Numerical abundance of macrobenthos was low in comparison to other wetlands which can be due to the alternate wet and dry phases. Numerical abundance of macrobenthos was maximum in September 2010 (965 no:/m^2) and minimum was in June 2011 (12 no:/m^2). While numerical abundance of macrobenthos was maximum in monsoon (296 no:/m^2) and minimum was in pre monsoon (81 no:/m^2) (fig 45,46). Numerical abundance showed a considerable variation between seasons (fig 46).

The benthic macrofauna was mainly composed of oligochaetes, polychaetes, nematodes, chironomid larvae, insect larvae, insects, crustaceans mollusks, hirudinae and Pisces. Olighochaetes and chironomids were the major group (Fig 47). During post monsoon oligochaetes (60%), was the dominant group followed by chironomids (27%), insect larvae (5%), insects (2%), polychaetes, Hirudinae, molluscs nematodes, Pisces and crustaceans (1%) (fig 48). During monsoon, the dominant group was oligochaetes (62%) followed by chironomids (26%), nematodes (6%), polychaetes (3%), insect larvae (2%) and insects (1%) (fig 49). While in pre monsoon, the dominant group was chironomids (47%) oligochaetes (38%), insect larvae and nematodes (3%), polychaetes (2%) and, nematodes (3%), insects (2%) and crustaceans, Hirudinae and molluscs (1%) (fig 50).

Table 40. Monthly variation in of Phytoplankton Biomass (ml/m^3) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	7	8	5	10	10	4	3	4	6.4
D' 09	3	4	2	4	10	5	2	3	4.1
J' 10	6	7	6	10	10	2	4	1	5.8
F' 10	10	6	18	20	20	4	3	1	10.3
M' 10	0	0	0	0	0	3	3	2	2.7
A' 10	0	0	0	0	0	4	4	2	3.3
M' 10	0	0	0	0	0	6	6	5	5.7
J' 10	0	0	0	0	0	6	7	4	5.7
J' 10	3	14	12	4	10	5	2	3	6.6
A' 10	4	6	10	8	6	5	3	4	5.8
S' 10	7	8	5	10	10	4	3	4	6.4
O' 10	7	6	12	10	7	4	3	4	6.6
N' 10	3	4	2	4	10	5	2	3	4.1
D' 10	8	10	4	4	4	5	6	7	6.0
J' 11	1	3	6	7	10	4	2	5	4.8
F' 11	14	10	19	10	10	12	12	17	13.0
M' 11	18	14	14	16	14	14	12	12	14.3
A' 11	10	12	12	14	13	10	14	12	12.1
M' 11	5	8	10	10	11	6	10	8	8.5
J' 11	7	7	10	8	6	4	8	10	7.5
J' 11	14	26	18	28	28.0	16.0	26.0	26.0	22.8
A'11	18	20	16	20	26.0	14.0	12.0	22.0	18.5
S'11	20	18	18	20	14.0	14.0	18.0	12.0	16.8
O'11	16	14	20	18	16.0	20.0	22.0	18.0	18.0

Table 41. Monthly variation in of Zooplankton Biomass (ml/m^3) in selected stations of Maranchery wetland during 2009-11

	Stations								
Month	1	2	3	4	5	6	7	8	Mean
N' 09	5	4	6	10	7	4	3	2	5.1
D' 09	5	4	4	9	6	20	4	3	6.9
J' 10	4	5	5	12	20	2	2	1	6.4
F' 10	12	4	12	35	31	4	8	4	13.8
M' 10	0	0	0	0	0	3	2	3	2.7
A' 10	0	0	0	0	0	5	4	6	5.0
M' 10	0	0	0	0	0	8	6	2	5.3
J' 10	0	0	0	0	0	5	8	4	5.7
J' 10	5	4	6	2	6	7	5	3	4.8
A' 10	6	4	3	4	8	10	7	5	5.9
S' 10	10	11	12	5	8	7	10	4	8.4
O' 10	10	8	6	5	10	6	5	5	6.9
N' 10	6	4	5	12	7	5	3	1	5.4
D' 10	4	5	3	9	8	12	4	8	6.6
J' 11	5	4	5	10	12	2	6	1	5.6
F' 11	15	20	20	14	20	20	15	15	17.4
M' 11	14	19	16	15	14	15	18	18	16.1
A' 11	13	10	16	14	14	17	14	10	13.5
M' 11	12	10	14	10	12	10	12	8	11.0
J' 11	14	8	12	8	10	12	7	5	9.5
J' 11	1.6	1.2	1.2	1.2	2.6	2.5	1.6	1.2	1.6
A'11	3.6	2.4	2.8	2.8	2.4	0.8	1.6	3.0	2.4
S'11	1.2	1	2.4	2.5	3.5	3.6	1.2	1.2	2.1
O'11	2.4	1	1.2	0.8	2.0	2.0	1.2	2.4	1.6

Table 42. Seasonal variation in zooplankton population in in selected stations of Maranchery wetland during 2009-11

Genus/Seasons	Premonsoon	monsoon	Postmonsoon
ROTIFERA			
FAMILY Brachionidae			
Brachionus sps	-	+	-
Platyias sps	-	+	-
FAMILY Filinidae			
Filinia sps	+	-	-
FAMILY Lecanidae			
Lecanae sps	+	+	-
FAMILY Synchaetidae			
Polyarthra sps	+	+	+
FAMILY Testudinellidae			
Testudinella sps	+	-	-
FAMILY Trichocercidae			
Trichocerca sps	-	+	-
CLADOCERA			
FAMILY Bosminidae			
Bosmina sps	+	-	+
FAMILY Chydoridae			
Chydorus sps	+	+	+
Alona sps	+	-	+
FAMILY Daphniidae			
Ceriodaphnia sps	+	-	+
Daphnia sps	+	-	+
FAMILY Moinidae			

Moina sps	-	-	+
FAMILY Sididae			
Daphanosoma sps	+	-	-
COPEPODA			
Order Cyclopoida			
FAMILY Cyclopidae			
Mesocyclops sps	+	+	+
Microcyclops sps	+	+	+
Paracyclops sps	+	+	+
Order Calanoida			
FAMILY Daiptomidae			
Heliodiaptomus sps	+	+	+
OSTRACODA			
Stenocypris sps	+	-	+
Nauplii	+	+	+
NEMATODA	+	-	-
Insect Larvae	+	+	-

Table 43. Result of ANOVA of the biotic production in Maranchery wetland during 2009-2011

Zooplankton Biomass

Source	**df**	**Mean square**	**F**
Intercept	1	8309.488	261.078
Season	2	446.817	14.039**
station	7	35.849	1.126
Season * station	14	13.338	0.419
Error	168	31.828	
Total	**192**		

Phytoplankton Biomass

Source	**df**	**Mean square**	**F**
Intercept	1	13957.130	308.948
Season	2	258.911	5.731**
station	7	27.928	0.618
Season * station	14	7.209	0.160
Error	168	45.176	
Total	**192**		

***5%significance **1% Significance**

Table 44. Season wise Duncan test of biotic production in the selected stations of Maranchery wetland during 2009-11

Zooplankton Biomass

Season	**N**	**Subset**	
		1	**2**
3	**64**	**4.5953**	
1	**64**	**5.5625**	
2	**64**		**9.5781**
Sig.		**0.334**	**1.000**

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 31.828

Phytoplankton Biomass

Season	**N**	**Subset**	
		1	**2**
3	**64**	**6.9688**	
1	**64**	**7.8125**	
2	**64**		**10.769**
Sig.		**0.479**	**1.000**

Means for groups in homogeneous subsets are displayed.
Based on observed means.
The error term is Mean Square(Error)= 45.176

8. Salient Findings

The productivity of an aquatic ecosystem depends mainly on the prevailing environmental parameters and its interactions with one another. The various parameters of physical and chemical nature are results of geoclimatic conditions of the region. The overall physical and chemical nature of an aquatic system indicates its total ecological status and further enables an assessment of its utility for purpose like fish farming and aqua culture.

8.1 Water quality

Physico-chemical characteristics not only reflect the quality of an aquatic ecosystem but also its biological diversity (Ghavzan *et al.*, 2006; Tas *et al.*, 2007). In fact such abiotic features deliberate on the health status and productivity of an ecological system. The land use pattern in the Maranchery wetland was different during the three seasons. During 2010 and 2011, during pre monsoon period, Stations 1 to 5 were under rice cultivation, or kept fallow which allowed the formation of a grassland, supporting grazing animals. During monsoon the area was inundated with water, supporting aquatic macrophytes and native fishes. However during post monsoon 2009, the area was inundated with water also under fish cultivation. *Labeo rohita*, *Catla catla*, and *Ctenophryngdon idella*.were the introduced fishes.

Temperature of water depends on the water depth besides solar radiation, climate and topography. It may be mentioned that no other single factor has so much profound direct or indirect influence on physico-chemical, biological, metabolic and physiological behavior of aquatic ecosystem than temperature (Welch, 1982). It also reflects on the dynamics of living organisms (Chandler, 1942). The mean water temperature of the entire period of study ranged from 26.4 to 31.4 (Fig.13). Compared to other stations Station 4, showed higher variation in pre monsoon period. The water temperature has was found to increase correspondingly with the increasing atmospheric temperature (Fig.11). Similar observations were made in previous studies by Jayaraman *et al*, 2003 for the Karamana river. From (Fig.16) the highest transparency recorded was 1.6m in Station 5 in monsoon season. From March to June and January (station 1 to 5) transparency was equal to depth(Fig.16). Wide variations were showed in transparency in both seasons (Fig. 17). The pH values showed no wide variation in all the seasons (Fig.19). The variation in the study zones exhibited a neutral trend with regard to the pH (av: 6.93). In 2010-2011 period the average pH Similar observations were made from Thrissur Kole wetlands (Tessey and Sreekumar, 2008). The present observations are in complete conformity with the findings of Verma & Shukla (1969, 1970) and Zuber & Sharma (2007). The mean conductivity was found to fluctuate between 48.1 to 645µS (Fig.20). Conductivity was high in pre monsoon season and low in monsoon season (Fig. 21). Similar trend was observed in total dissolved solids(Fig.22). The conductivity of the water was assumed to be due to two most dominant ions viz., bicarbonates and calcium. The fluctuations in the values of conductivity observed during the present study could be due to variations in the rate of decomposition of organic matter, variations in the water level and evapo-transpiration. The present observation gets reinforcement from the views placed on record by Jameel (1998), Ganesh (2006) & Zuber (2007). The total dissolved solids comprise mainly of inorganic salts and small amount of organic matter. Similar finding with regards to seasonal variation of TDS have been reported by Shastree *et al* (1991) in Ravindra Sarovar (Gaya).

The turbidity is an expression of light scattering and light absorbing property of water and is caused by the presence of suspended matter, such as clay, silt, colloidal organic particles, planktons, etc. Turbidity is the most critical factor regulating the growth of chlorophyll bearing organisms (Kaushik and Saksena, 1990). High turbidity was observed during premonsoon period (Fig.25). high value of turbidity observed in Station 5 during premonsoon period. Comparatively high values of turbidity might be due to the muddy sediment bottom. According to Kaliamoorthy (1973), in shallow waters with muddy bottom, high turbidity may be caused by wind stirring up the bottom sediments.

Moyle (1946) noticed that most of the water bodies having a total alkalinity greater than 200mg/L were highly productive. In Maranchery kole wetland the maximum alkalinity observed was 160mg/L therefore the water body can be considered as a productive ecosystem (Fig.30). Compared to other stations, Station 2 showed higher variation in post monsoon period (Fig. 31). Chlorides in water are generally due to the salts of sodium, potassium and calcium. Higher chloride value was observed in pre monsoon (Fig.29). Compared to two seasons, there was a totally different trend were shown in 2009-10 and 2010-11 period(Fig. 29). Studies reported that, increased chlorides in summer season could be due to high evaporation rate because of high ambient temperature (Kaushik *et al*, 1991). Similar reasons have been found by (Zuber, 2007) to be the responsible factors for the fluctuating chloride concentration in Lake Mansar. Dubey (2003) reported that, the chloride contents normally increases as the mineral contents increases. Salinity was very low during the study and the maximum salinity observed was 0.9 ppt in Station 4 (Fig. 26). In Season wise variation, there is no wide variation observed in 2010-11 period compared to 2009-10 (Fig. 27). Therefore the water body can be considered as a freshwater ecosystem.

Total hardness is mainly contributed by bicarbonates. In present study mean value of hardness recorded as 24.4 to 90.5 mg/L and maximum value was observed during pre monsoon period in Station 4 (Fig.33). Chary Parashal *et al* (2008) reported that the hardness of water is not a pollution parameter but it indicates water quality. Sawyer (1960) classified waters on the basis of hardness in to three categories (i) soft with hardness from 0.0 to 75mg/L, (ii) moderately hard with hardness from 75mg/L to 150mg/L and (iii) hard with hardness from 150mg/L to 300mg/L. So considering the above statement the Maranchery wetland could be soft in nature. The maximum calcium recorded was 80.5 mg/L in various sampling stations (Fig.34).Compared to other stations, Station 2 showed higher concentration in premonsoon period (Fig. 35). Similar observation was made by Gurumayum *et al* (2000). The content of calcium is one of the variables in freshwater on which faunal differences can be based as calcium served as micro nutrients to most of the organisms and is required in small quantity for phytoplanktons growth. The range of magnesium in different sampling sites was found to be 5.3 to 35.0 mg/L (Fig. 36).Compared to different seasons, study showed that higher seasonal variation in 8 selected stations (Fig.37). According to Wetzel (1975), magnesium is required by the flora to build its chlorophyll and in enzymatic transformation.

Dissolved carbon dioxide was present throughout the study period (Fig.38). Compared to other stations, Station 5 showed higher concentration in monsoon period (Fig.39). Similar observation was also made by Sreenivasan (1972). The presence of CO_2 in the surface water is mostly governed by its utilization by macrophytes and algae during photosynthesis and also through its diffusion from air (Sreenivasan, 1974). Increasing trend in dissolved carbon dioxide was also noticed in the two year study period. Alkalinity of water is its capacity to neutralize acid and is characterized by the presence of hydroxyl ions capable of combining with hydrogen ions in solution.

Nitrogen in water occurs as bound forms like nitrate, nitrite, ammonia, urea, and amino acids. The nitrogen is important in aquatic ecosystem, because of its role in the synthesis, maintenance of proteins and productivity of water. The lowest nitrate value recorded was 0.008 µmol/L and nitrite was 0 .074 µmol/L (Fig. 40). In season wise comparison, post monsoon period showed higher concentration of nitrate (Fig. 41). The nitrate value was very low than nitrite nitrogen in the present study. Similar results were observed in Cochin backwaters which revealed that, during most of the years nitrite value were lower than those of nitrate (Meera and Bijoy Nandan, 2010). Banergee *et al* (1990) mentioned that pond water containing more than 1.0 ppm nitrate- nitrogen is considered to be good for optimum production of fishes. Pailwan *et al*, 2008 have stated that, when intense macrophyte growth is taking place the nitrate concentration are very low. Compared to other stations, station 4 showed higher variation of nitrite in premonsoon period (Fig. 43) The ammonia ranged from 0.89 µmol/L to 39.62 µmol/L (Fig.44). 2010-11 period concentration of ammonia showed same trend in 8 selected sampling sites (Fig. 45). The denitrification taking place as a part of the nitrogen cycle leads to a steady decline in nitrate nitrogen accompanied by a progressive increase in ammonia (Mechala, 1974). Phosphorus, necessary for the fertility, is generally recognized as a key nutrient in the productivity of water. Hutchinson (1957) demonstrated that phosphorus is one of the major nutrients responsible for biological productivity. The main supply of phosphorus in natural waters comes from the weathering of rocks, leaching of soil from the catchment area by rain, cattle dung and agricultural activity in adjacent areas (Jhingran, 1982). The mean value of phosphate ranged from 0.23µmol/L to 7.05µmol/L (Fig.48). Compared to seasons, monsoon period showed higher concentration of phosphate in Station 6 (Fig. 49). In the present study, phosphate content exhibited highest level in late summer period. Prasad, (1990) reported that during summer season phosphate content was highest and was related to high wind speed, decrease in water level, high evaporation rate and increased decomposition due to increase in temperature. Silica occurs in fresh water as undefined dissolved silicic acid, as colloidal suspended solids and as a silica oxide. It is essential for the growth of diatoms. In the present study, silicate has shown high value (32.75µmol/L) during pre monsoon as compared to post monsoon period 6.28 µmol/L(Fig.47).

A variety of gases are found dissolved in natural waters. The dissolved oxygen level ranges from 3.4 to 10.2 mg/L in the study area (Fig. 50). There is no wide variation observed seasonally in 8 selected sampling stations (Fig. 51) The dissolved oxygen concentration was higher as compared to similar studies from Valanthakadu backwaters (Meera and Bijoy Nandan, 2010). The BIS standard for dissolved oxygen in inland waters is 3mg/L. The dissolved oxygen in the present study area remained within the permissible limits. The maximum mean value of BOD observed was 7.90 mg/L (Fig.52). compared to other stations, Station 4 showed higher concentration in premonsoon preoid (Fig. 53). Variation in the value of BOD appears to be a function of change in the degree of dilution, quantity of organic matter, and activities of micro organisms carrying decomposition of carbonaceous and nitrogenous matter (Wetzel, 1983). Oke (1999) reported that aquatic plants impede water movement and vertical circulation of dissolved oxygen, leading to the lower dissolved oxygen content of the wetland agreeing with the present study.

Fig. 10. Monthly variation in atmospheric temperature at Maranchery wetland during 2009-2011

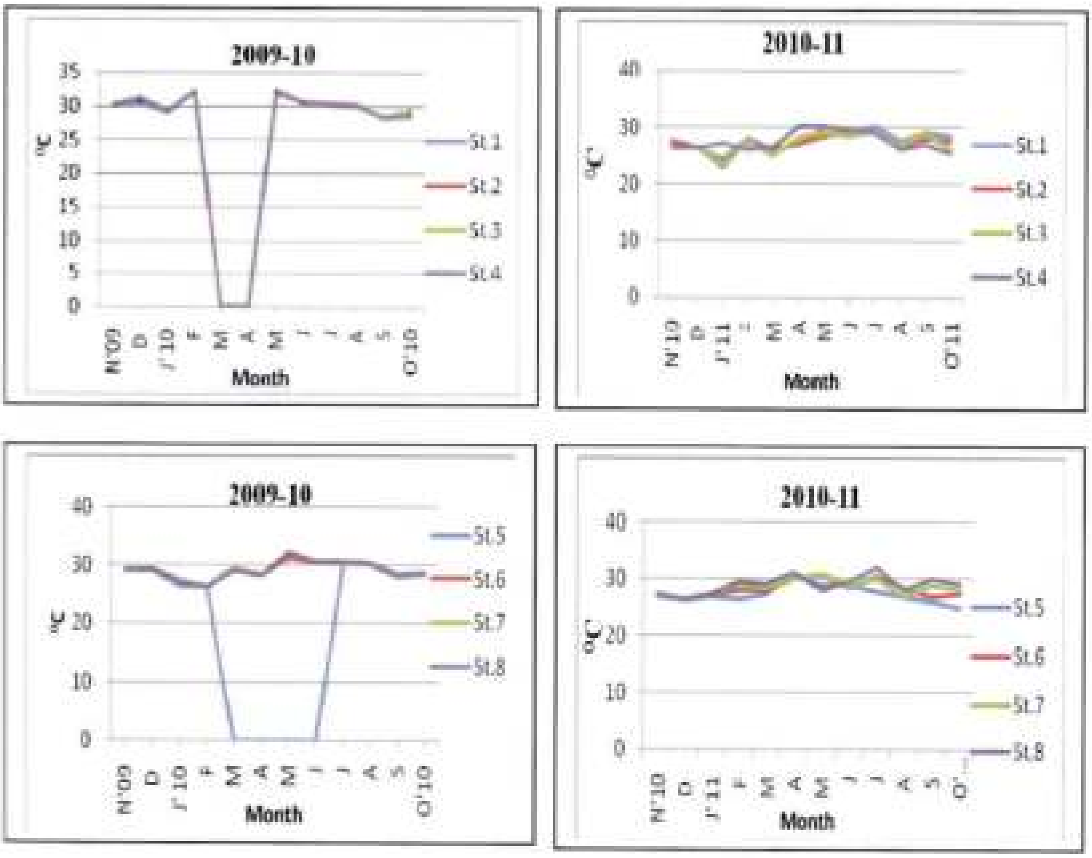


Fig.11. Seasonal variation in atmospheric temperature at Maranchery wetland during 2009-2011

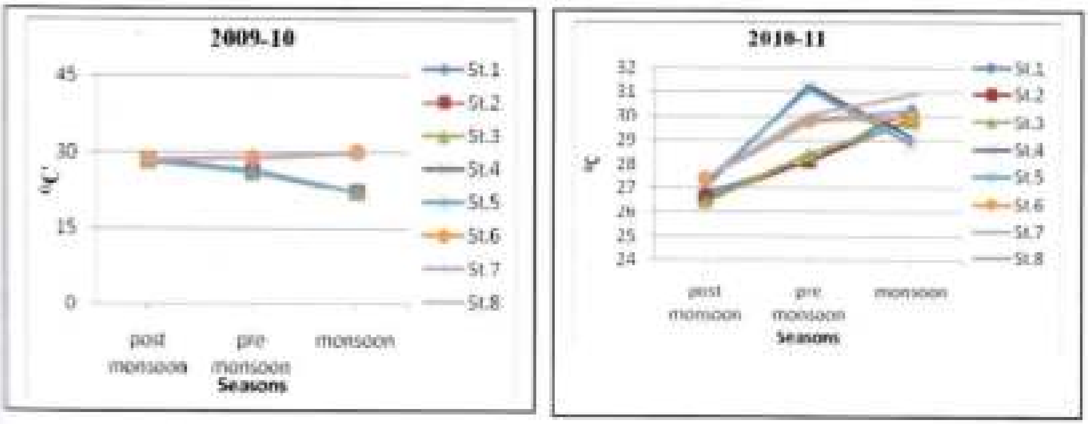


Fig. 12. Monthly variations in water temperature at Maranchery wetland during 2009-2011

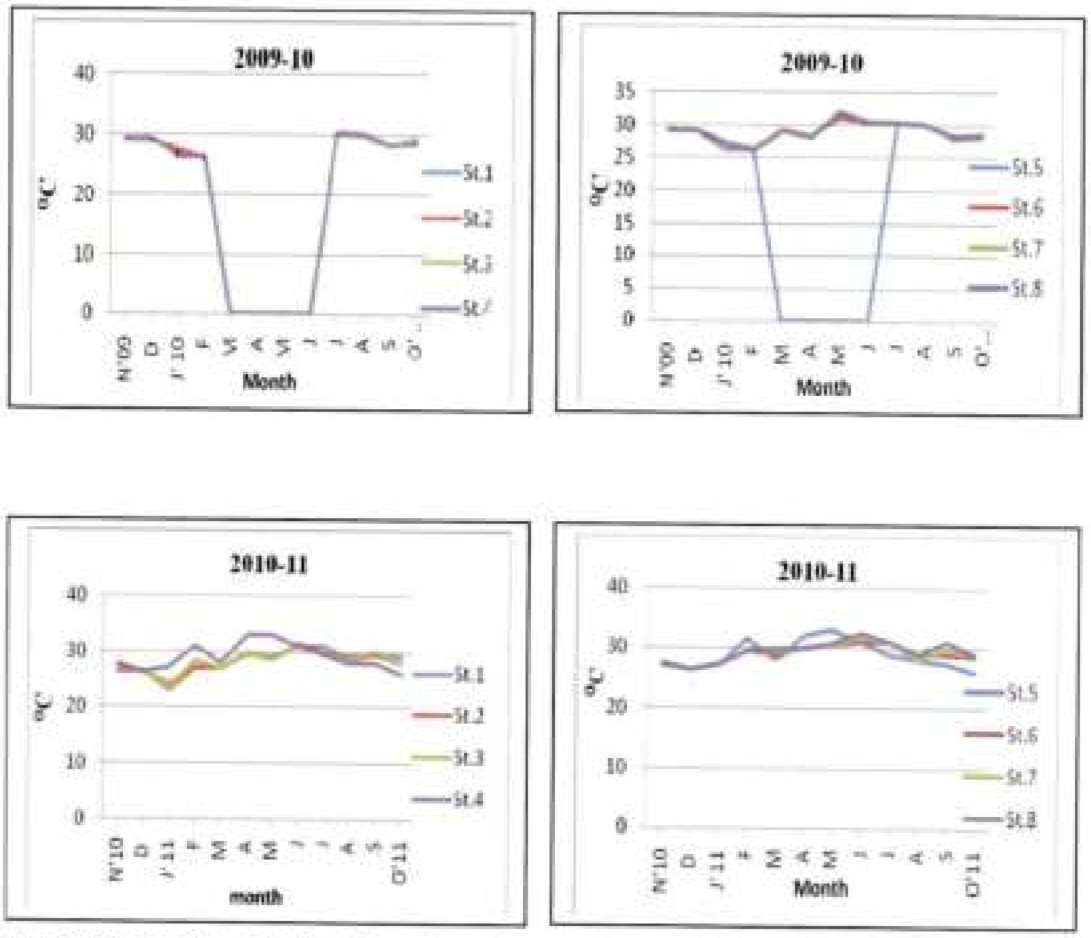


Fig.13. Seasonal variation in water temperature at Maranchery wetland during 2009-2011

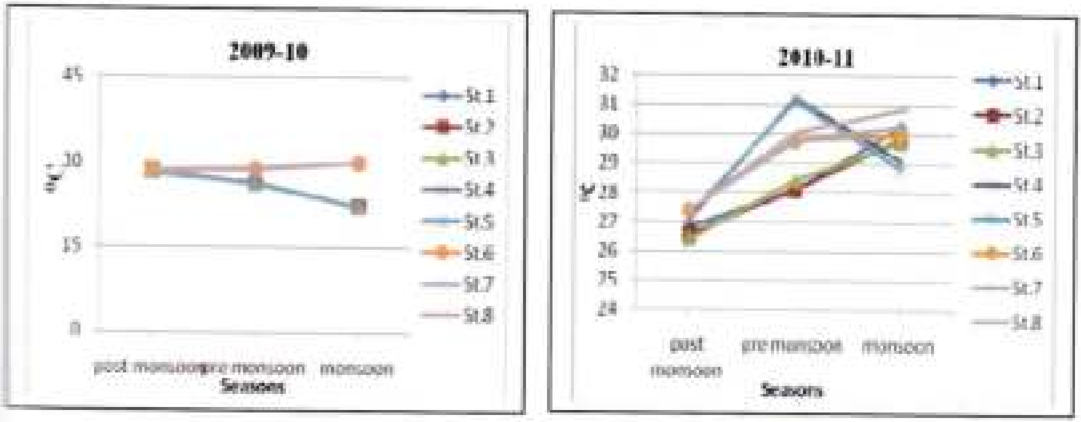


Fig. 14. Monthly variations in depth at Maranchery wetland during 2009-2011

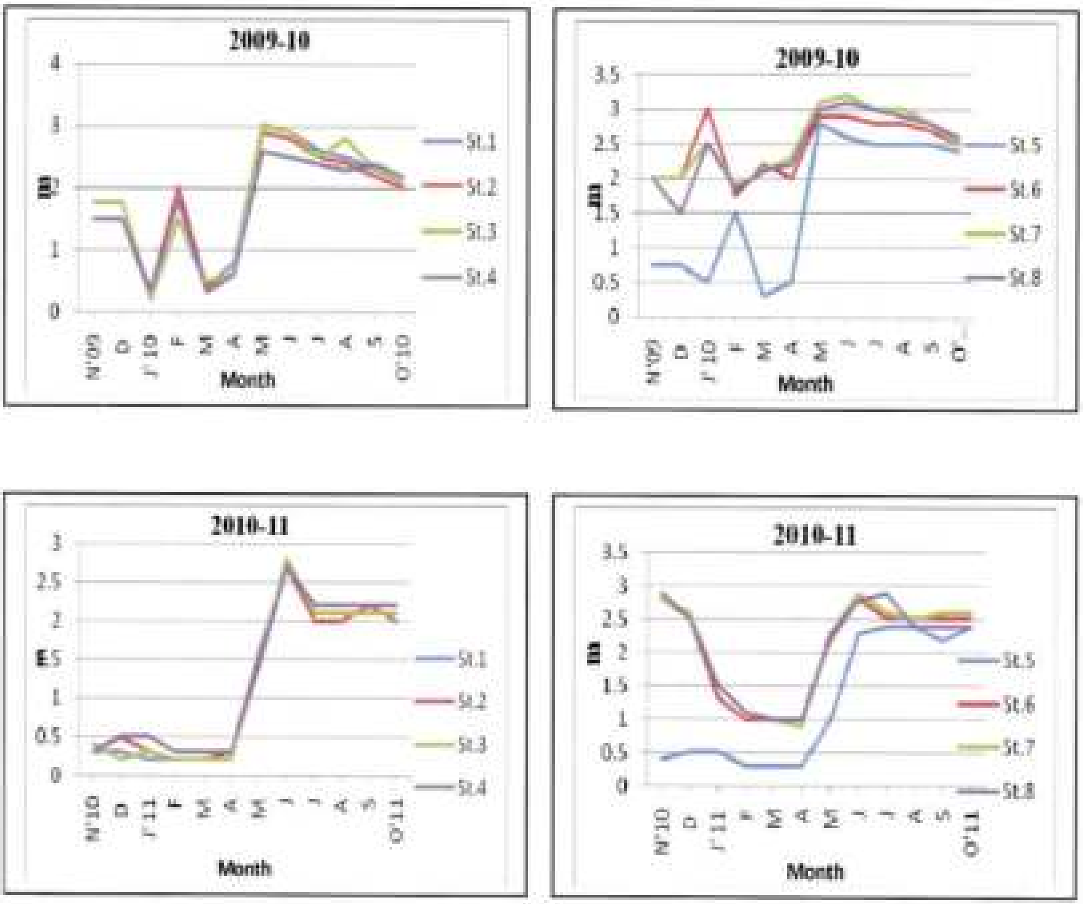


Fig.15. Seasonal variation in depth at Maranchery wetland during 2009-2011

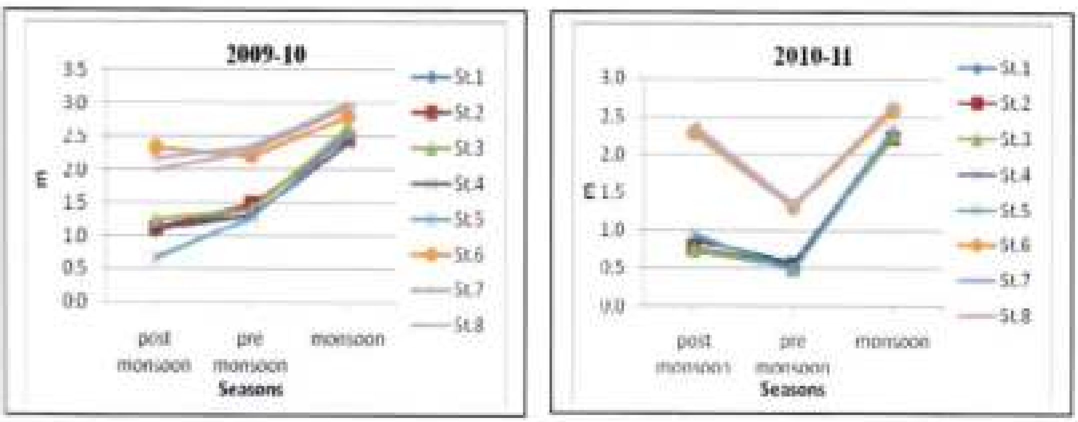


Fig. 16. Monthly variations in transparency at at Maranchery wetland during 2009-2011

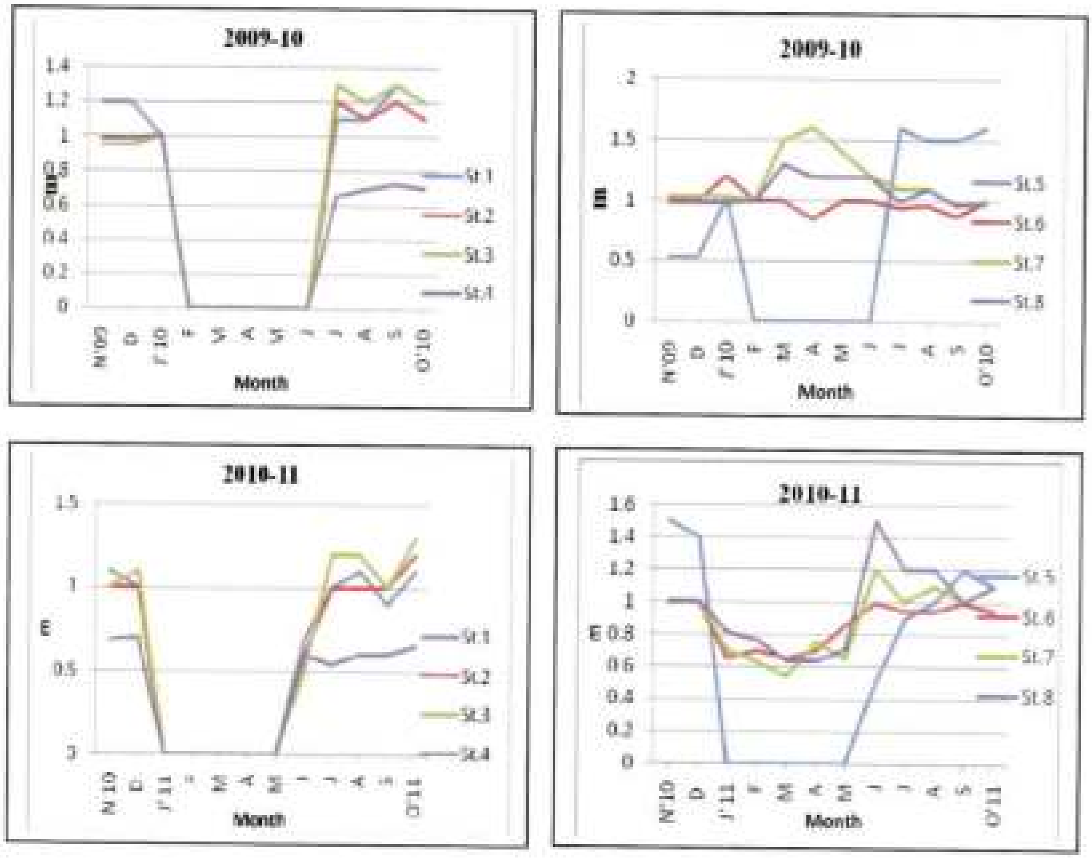


Fig.17. Seasonal variation in transparency at Maranchery wetland during 2009-2011

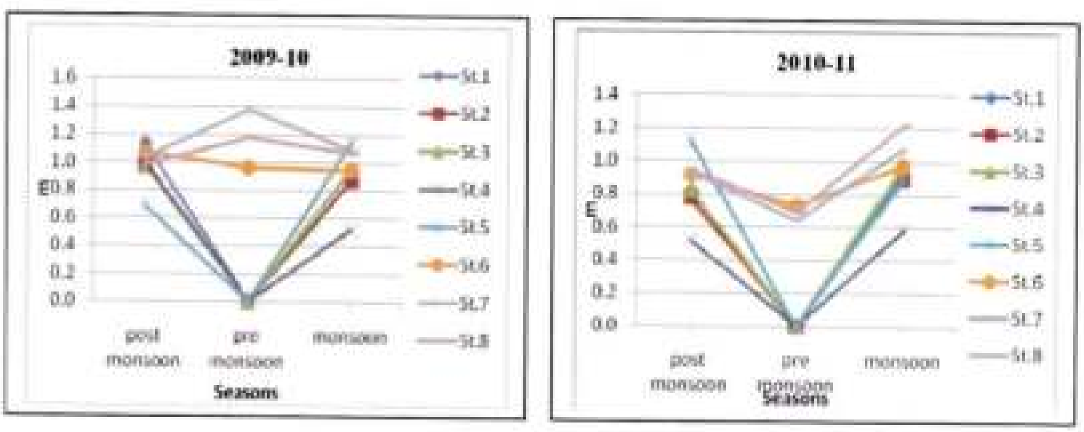


Fig.18. Monthly variations in pH at Maranchery wetland during 2009-2011

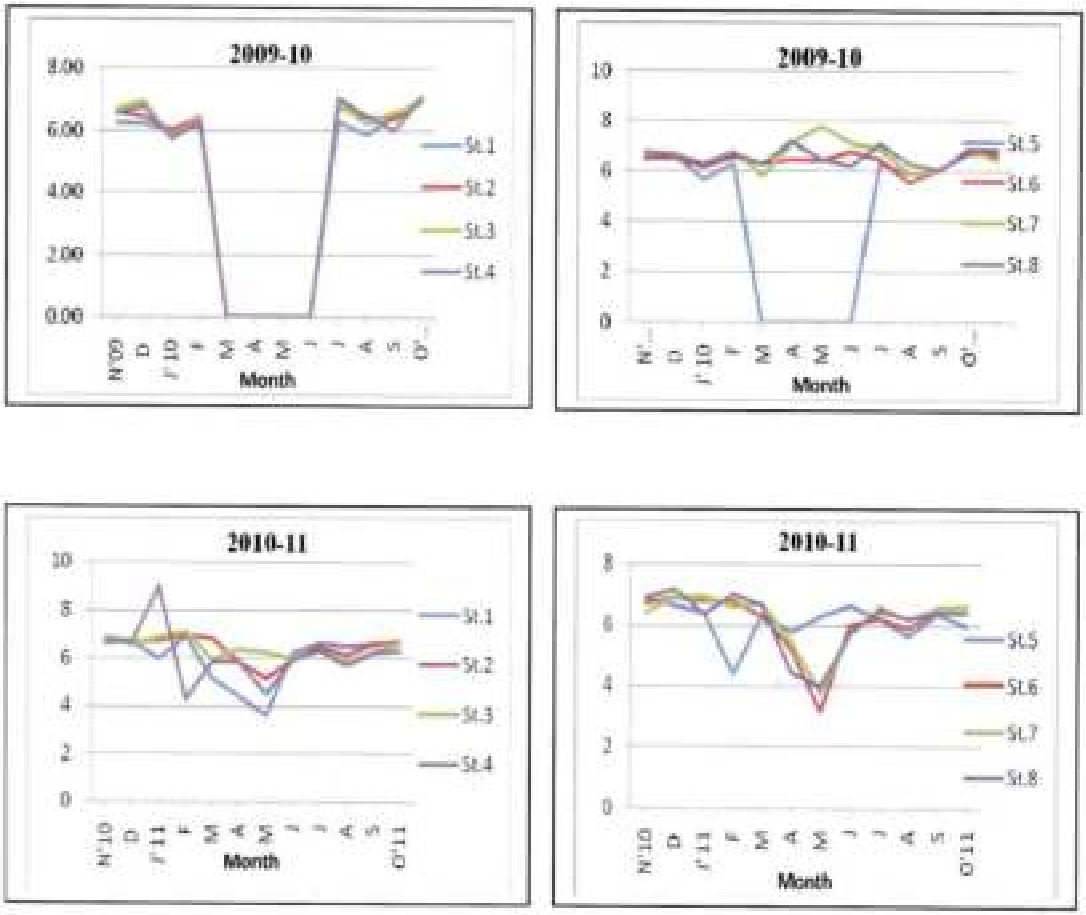


Fig.19. Seasonal variation in pH at at Maranchery wetland during 2009-2011

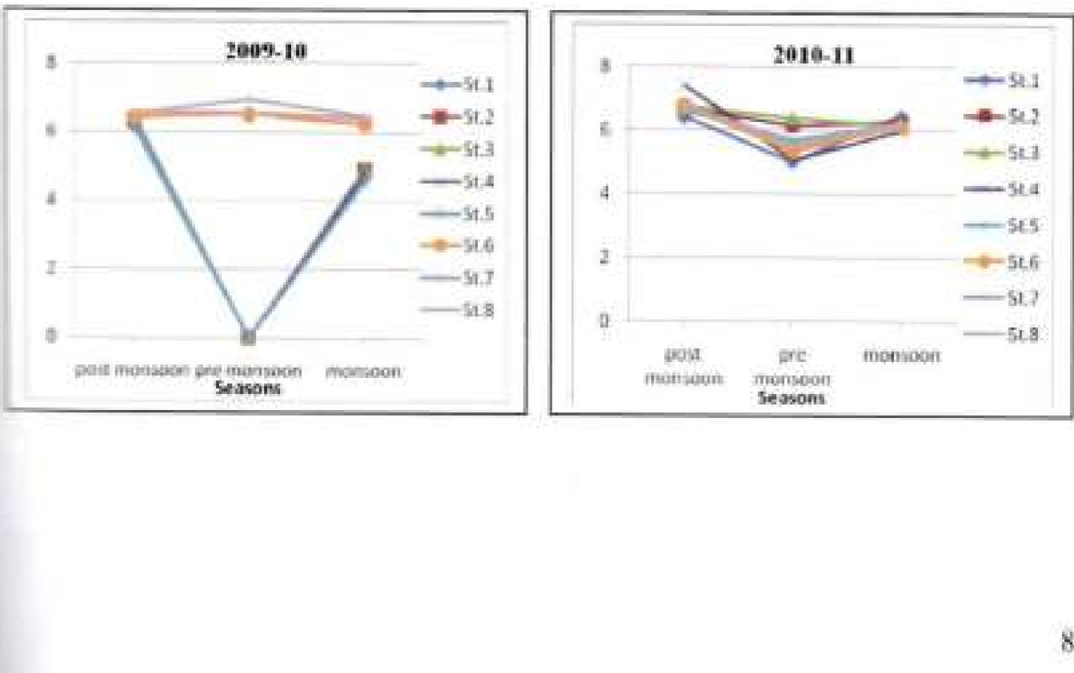


Fig.20. Monthly variations in conductivity at Maranchery wetland during 2009-2011

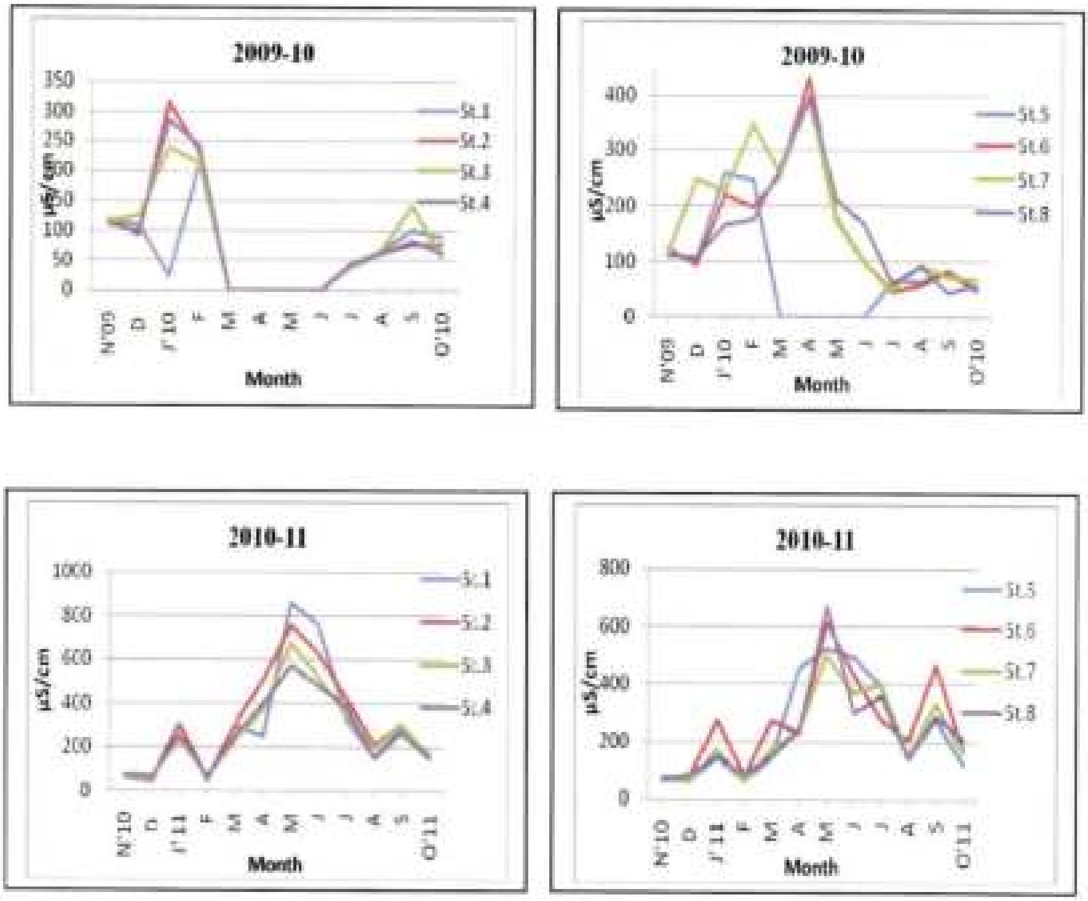


Fig.21. Seasonal variation in Conductivity at Maranchery wetland during 2009-2011

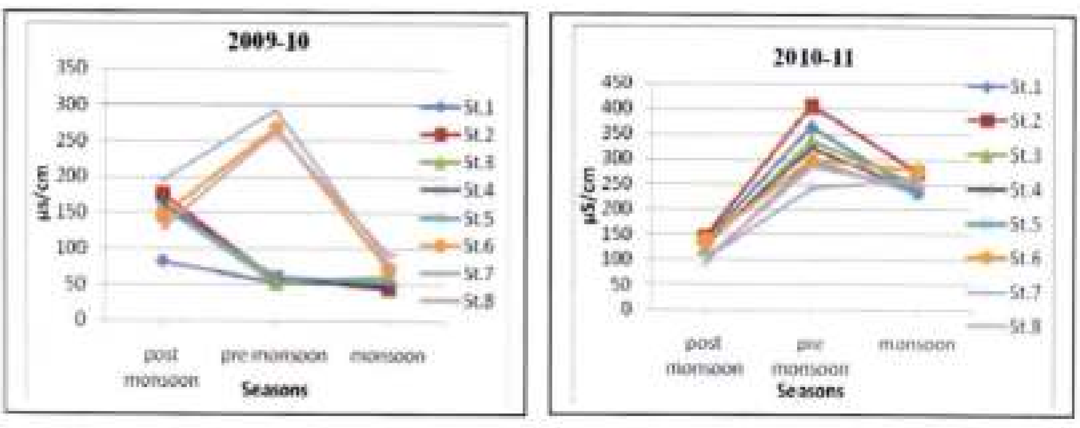


Fig.22. Monthly variations in total dissolved solids at Maranchery wetland during 2009-2011

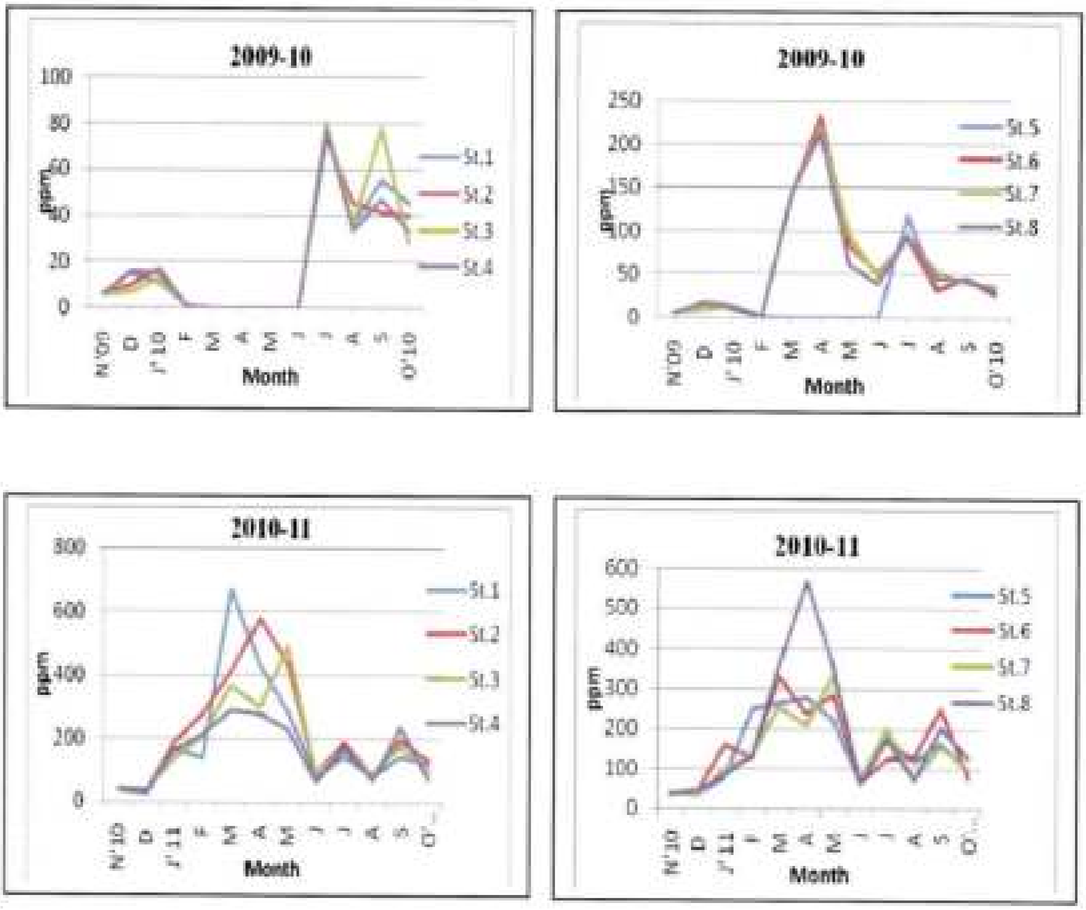


Fig.23. Seasonal variation in total dissolved solids at Maranchery wetland during 2009-2011

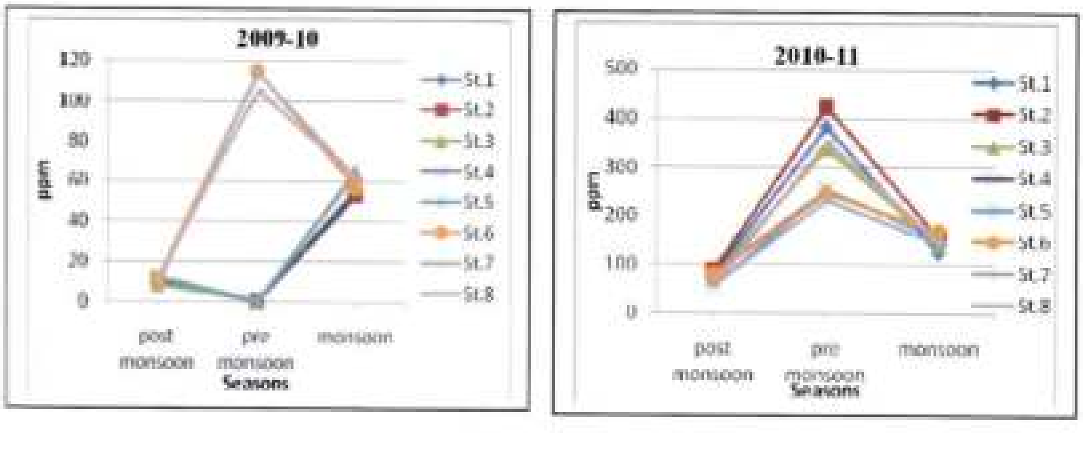


Fig.24. Monthly variations in turbidity at Maranchery wetland during 2009-2011

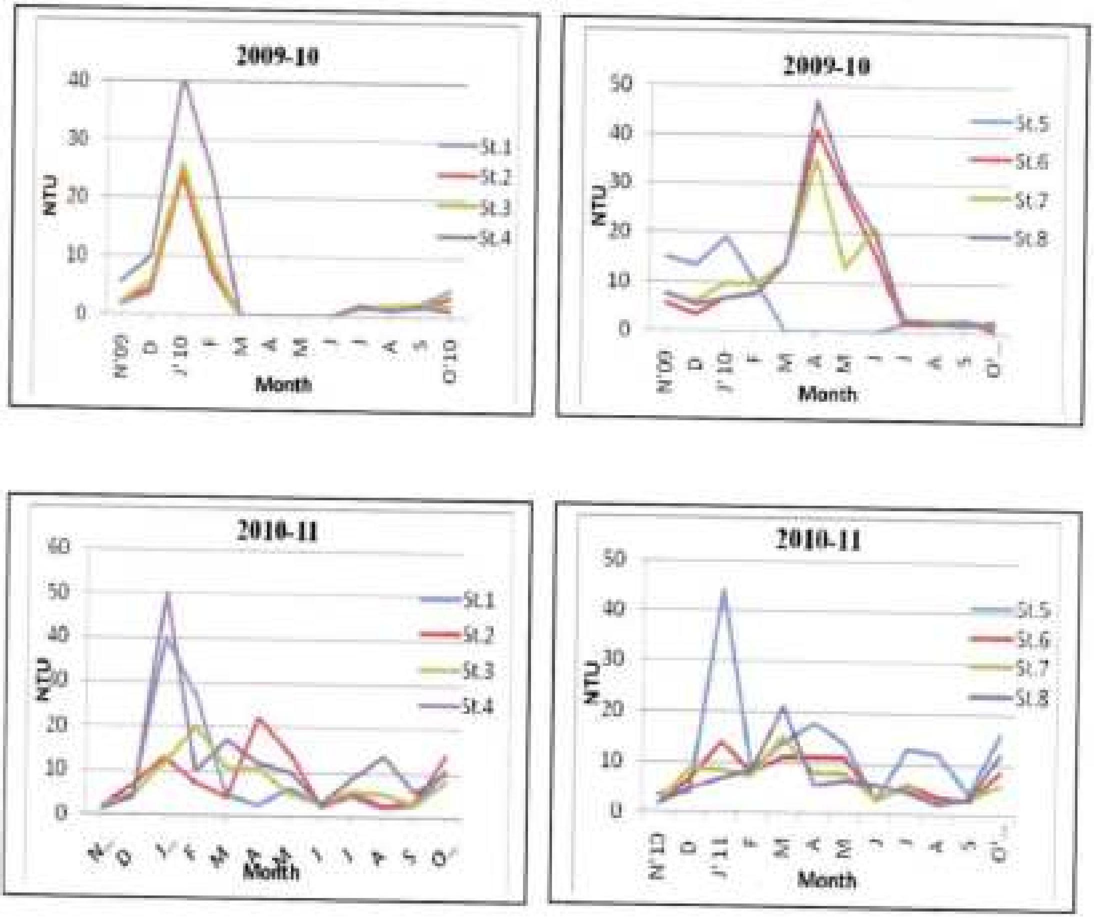


Fig.25. Seasonal variation in turbidity at Maranchery wetland during 2009-2011

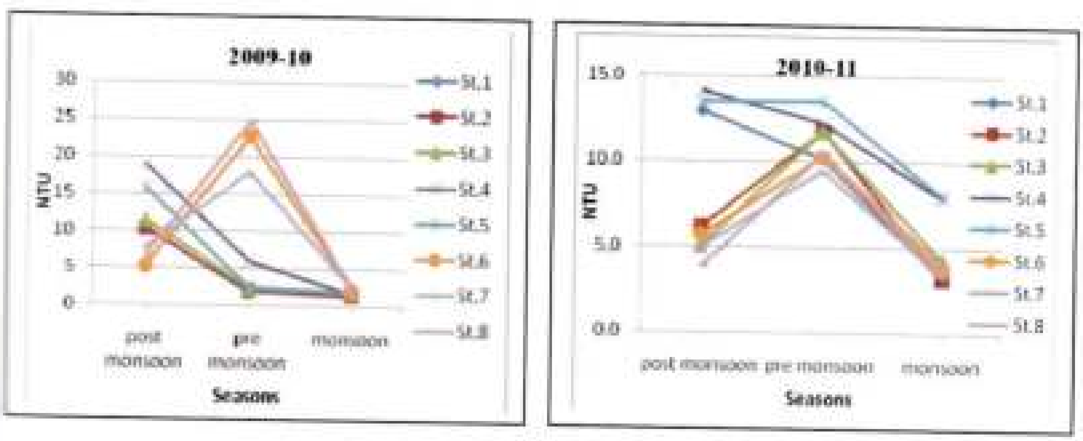


Fig.26. Monthly variations in salinity at Maranchery wetland during 2009-2011

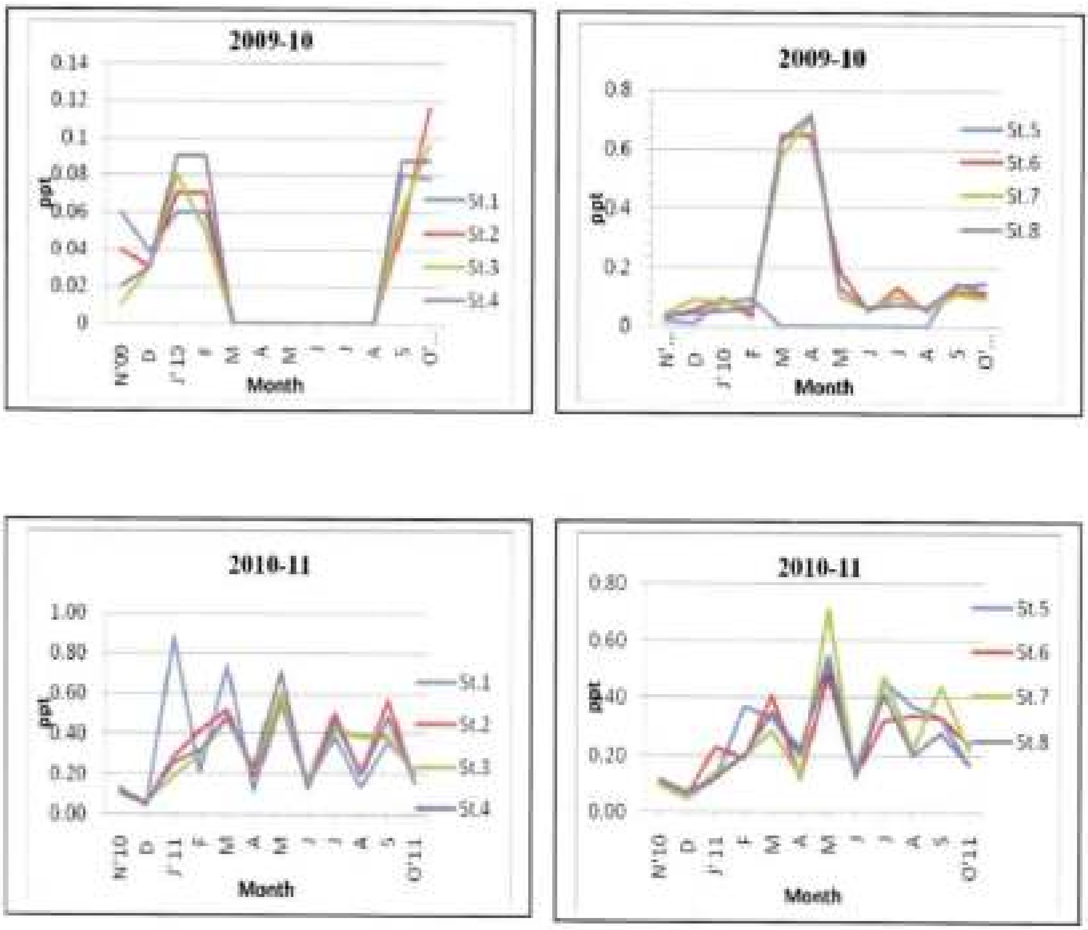


Fig.27. Seasonal variation in salinity at Maranchery wetland during 2009-2011

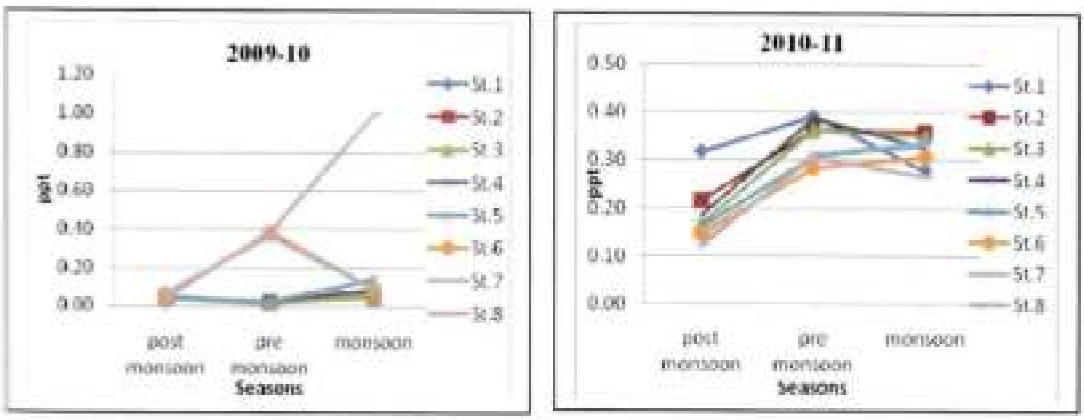


Fig.28. Monthly variations in chloride at Maranchery wetland during 2009-2011

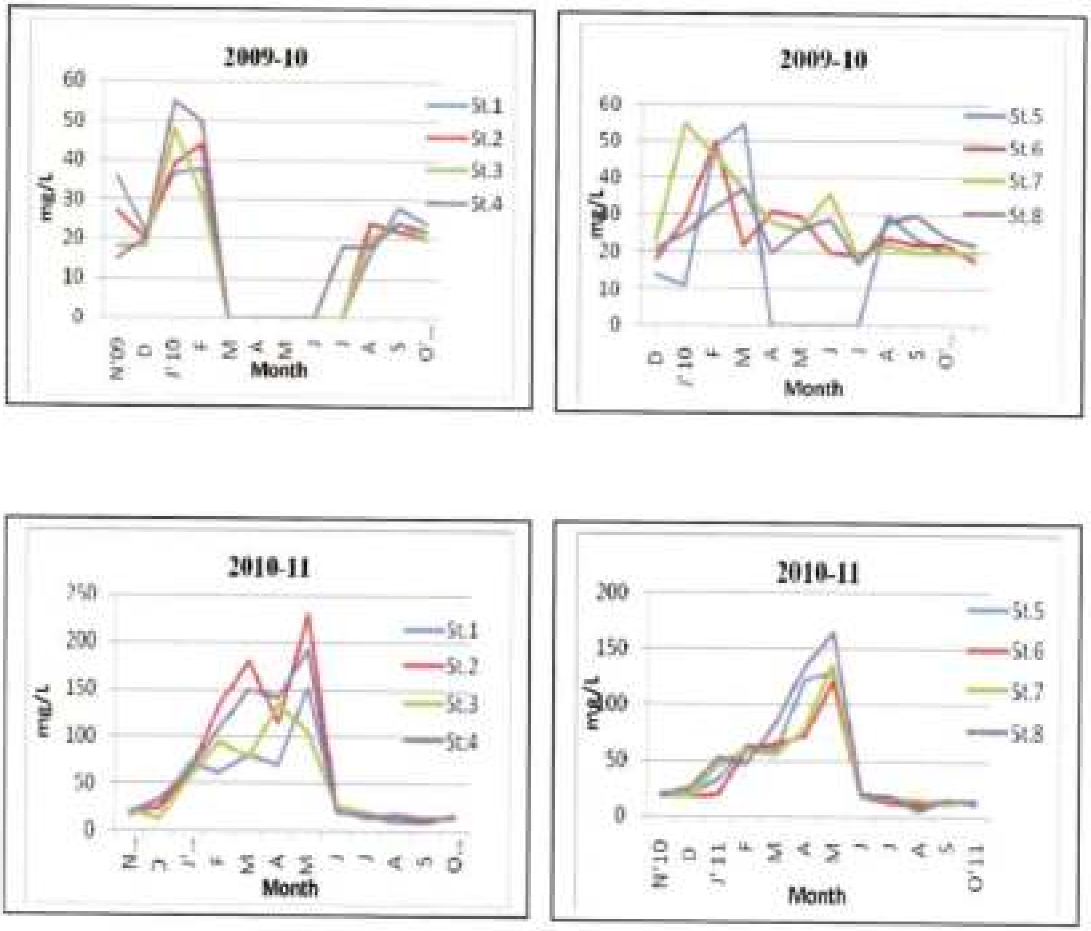


Fig.29. Seasonal variation in chloride at Maranchery wetland during 2009-2011

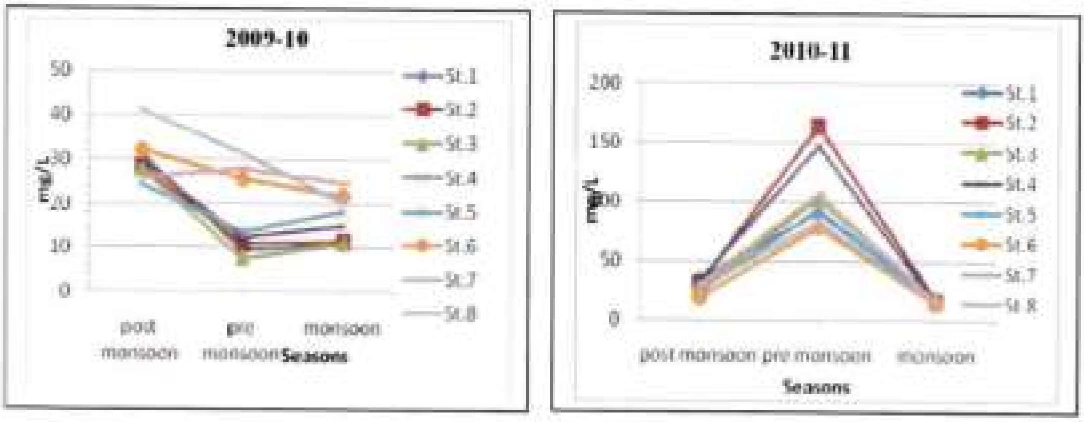


Fig.30. Monthly variations in alkalinity at Maranchery wetland during 2009-2011

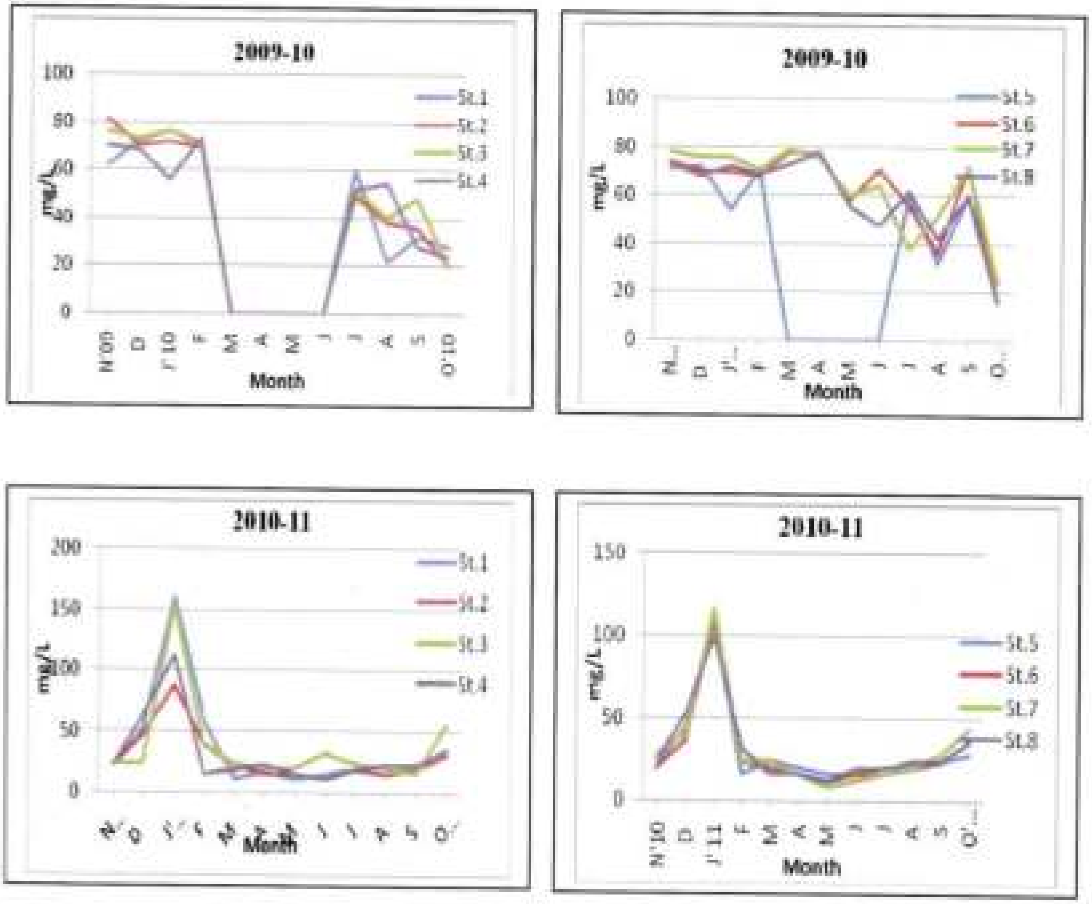


Fig.31. Seasonal variation in alkalinity at Maranchery wetland during 2009-2011

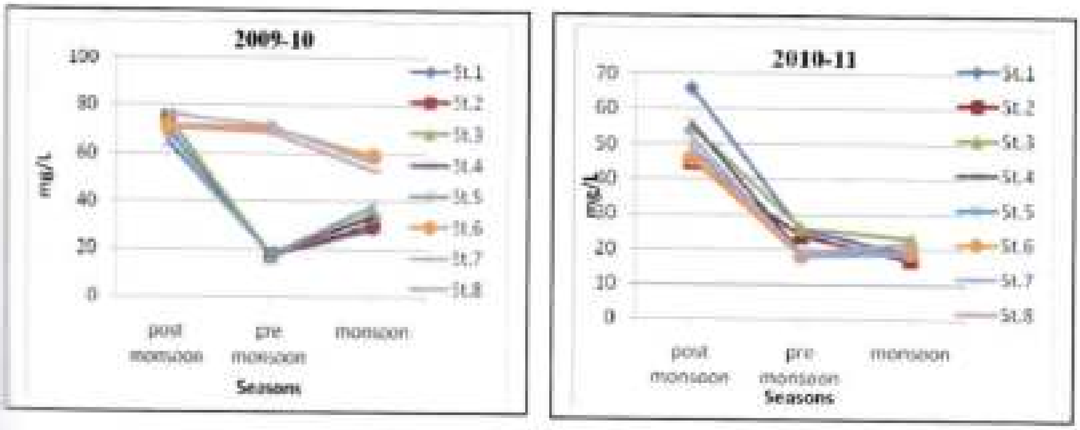


Fig.32. Monthly variations in total hardness at Maranchery wetland during 2009-2011

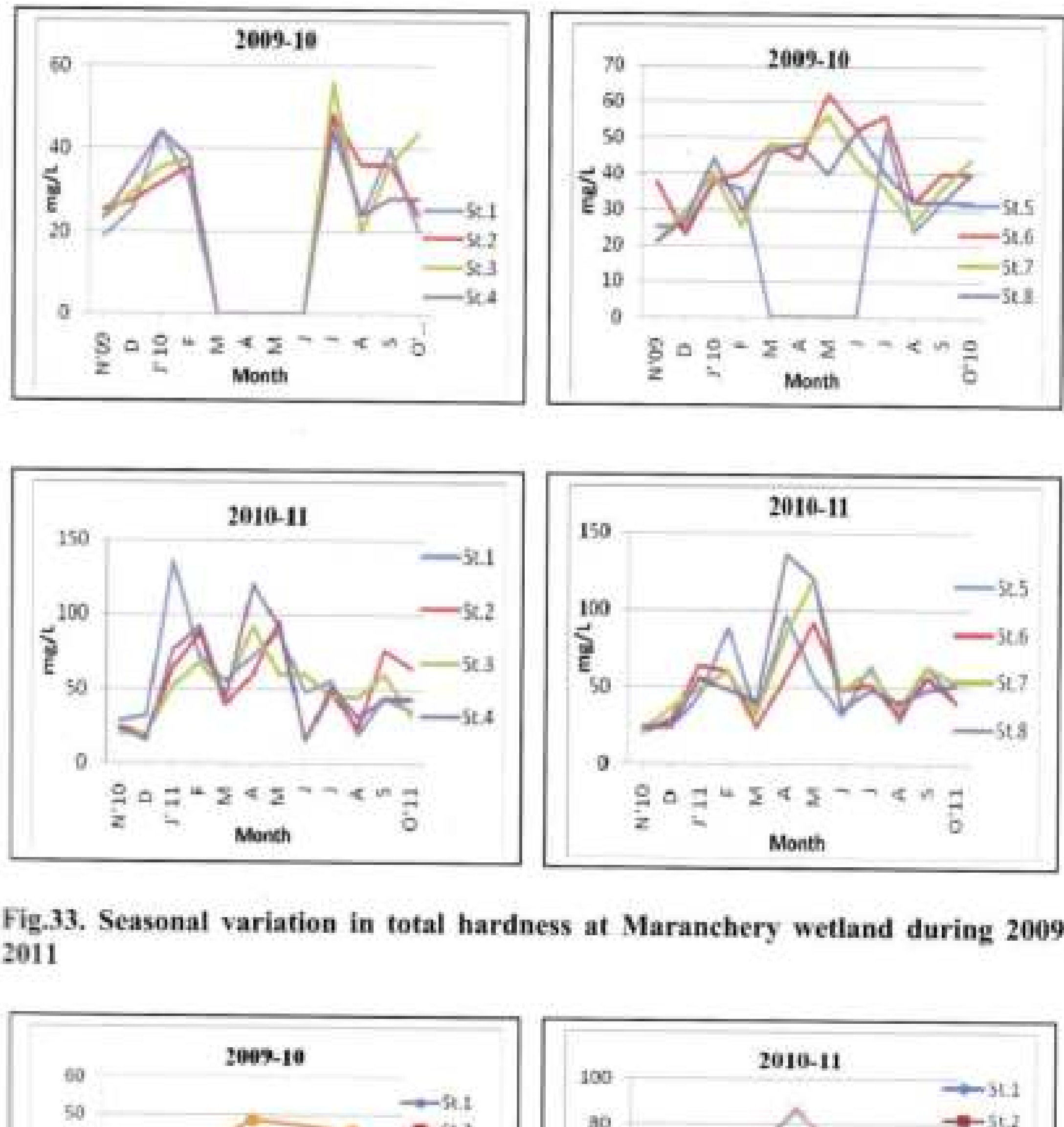
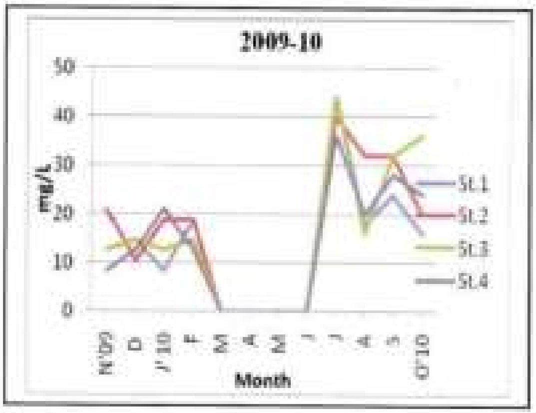
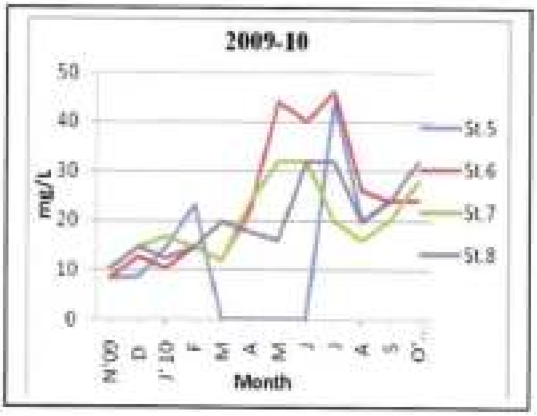
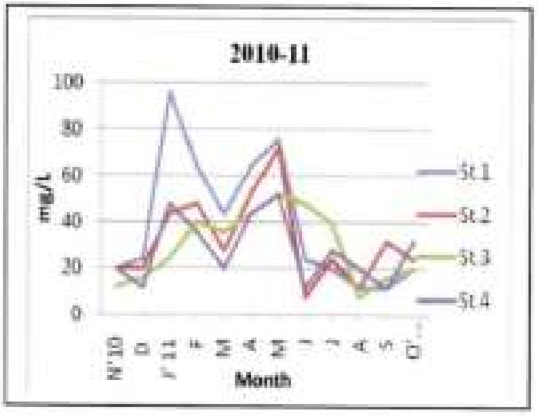


Fig.33. Seasonal variation in total hardness at Maranchery wetland during 2009-2011

Fig.34. Monthly variations in Ca hardness at Maranchery wetland during 2009-2011







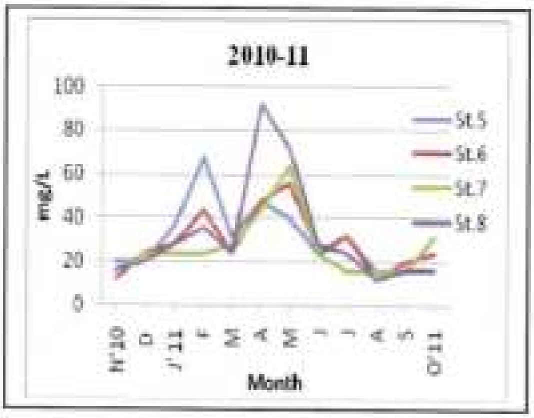
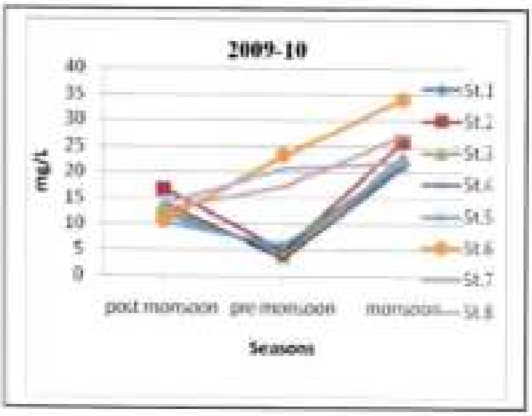


Fig.35. Seasonal variation in Ca hardness at Maranchery wetland during 2009-2011



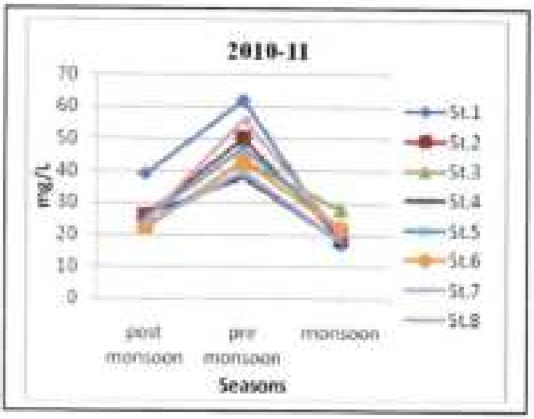


Fig.36. Monthly variations in Mg hardness at Maranchery wetland during 2009-2011

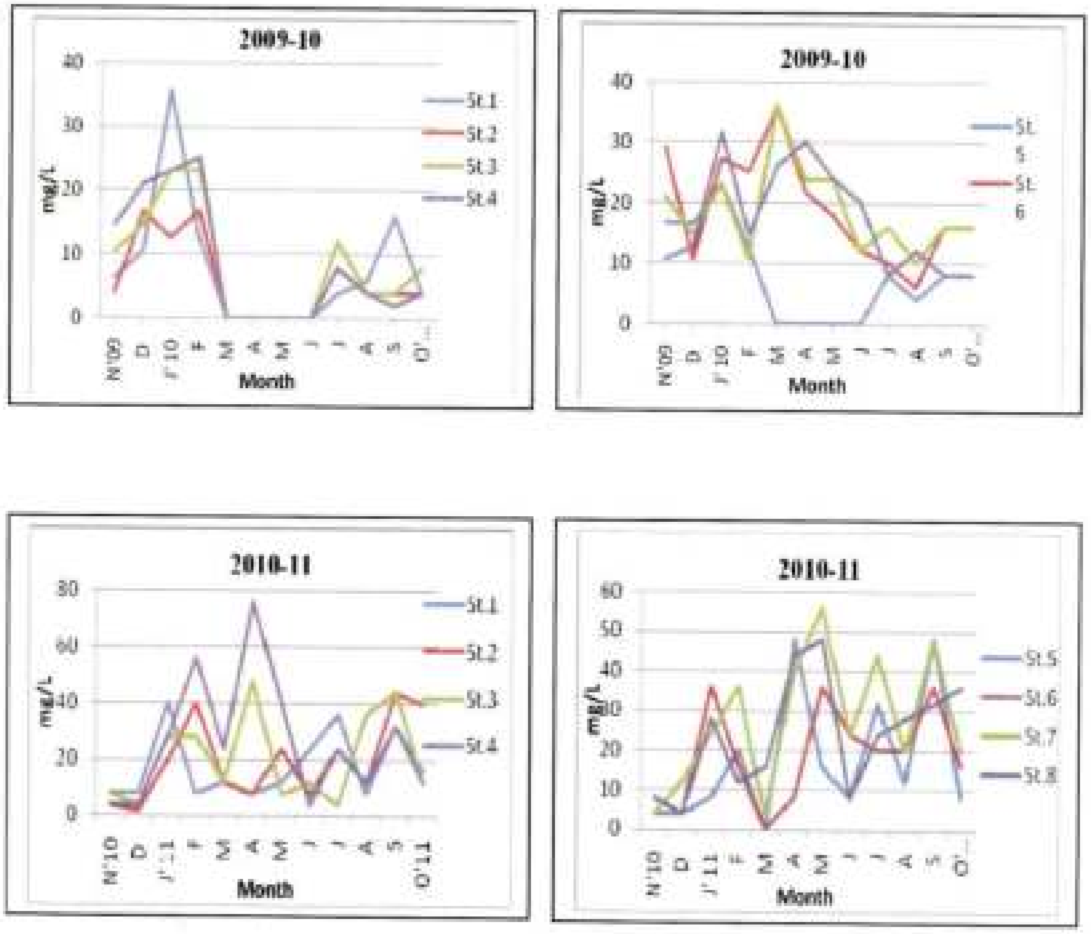


Fig.37. Seasonal variation in Mg hardness at Maranchery wetland during 2009-2011

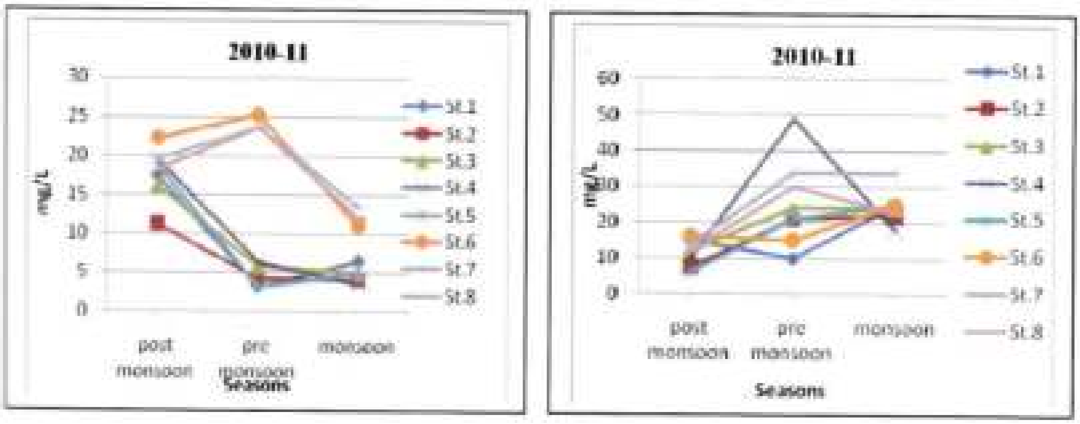


Fig.38. Monthly variations in dissolved CO_2 at Maranchery wetland during 2009-2011

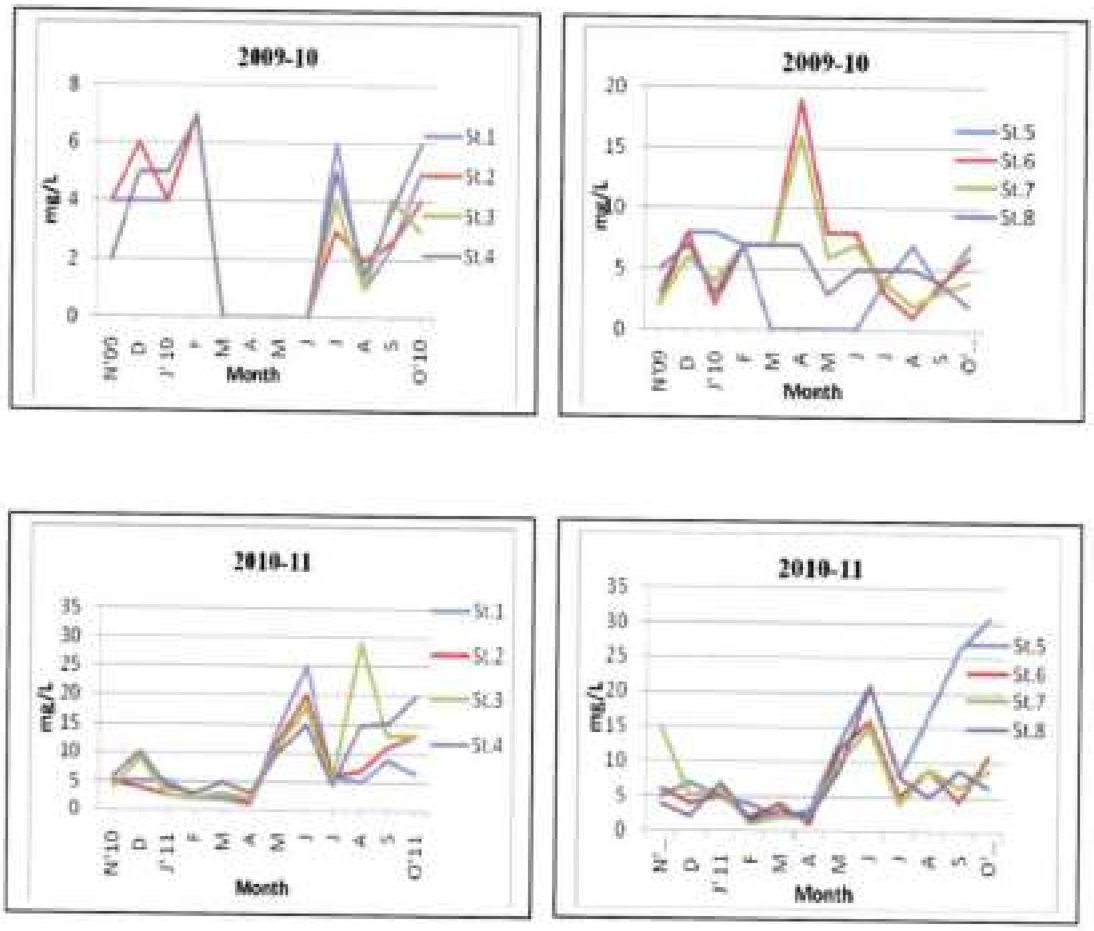


Fig.39. Seasonal variation in dissolved CO_2 at Maranchery wetland during 2009-2011

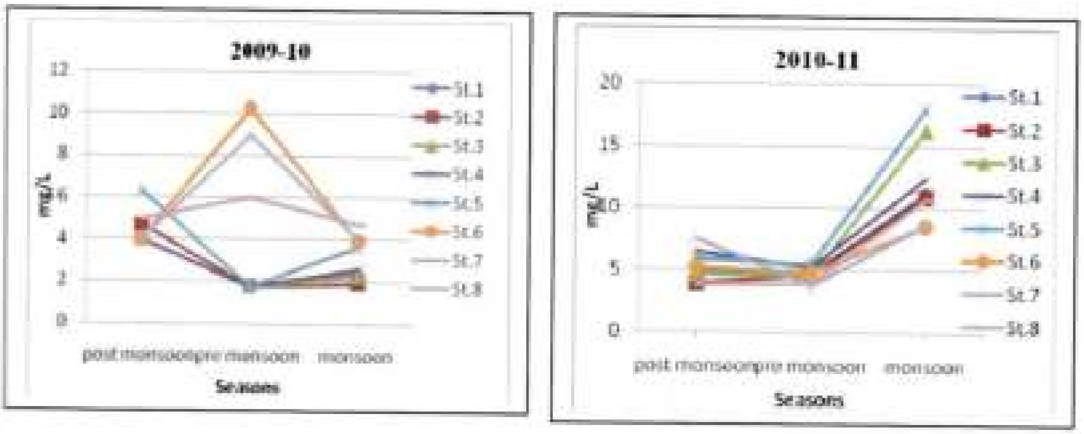


Fig.40. Monthly variations in nitrate at Maranchery wetland during 2009-2011

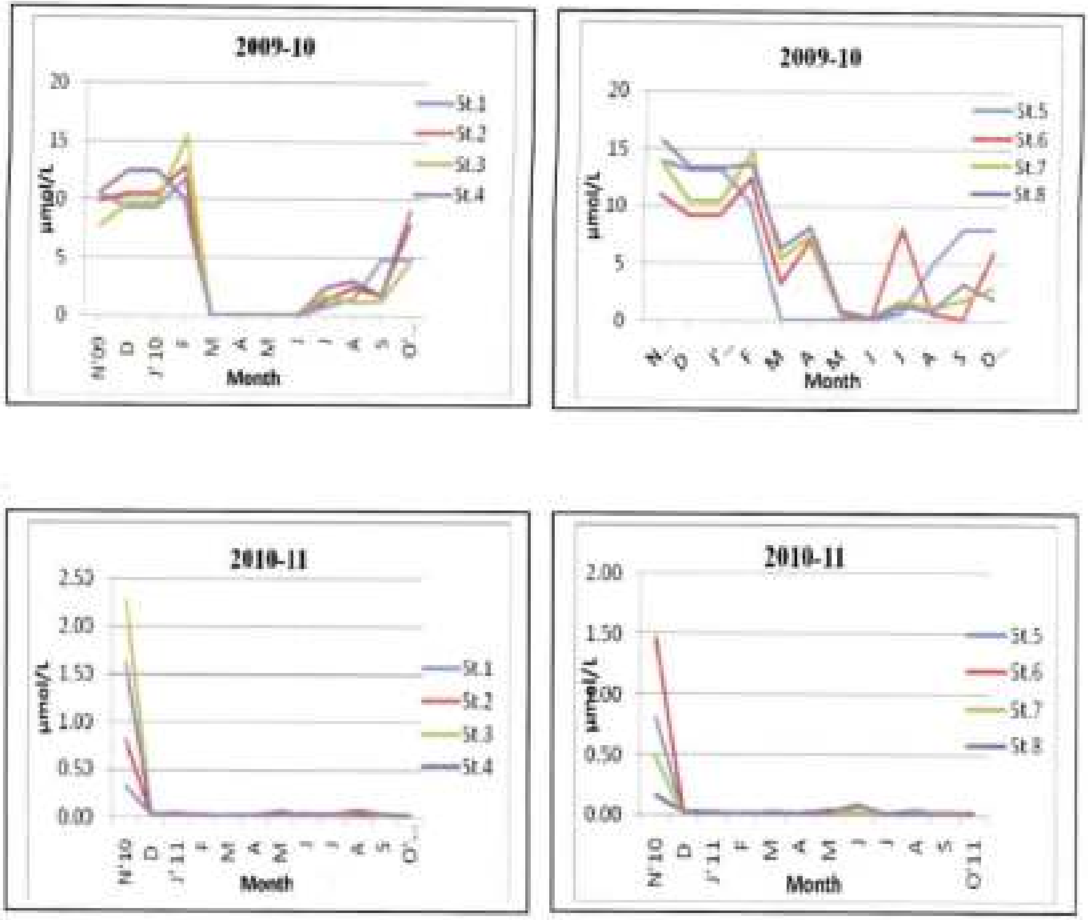


Fig.41. Seasonal variation in nitrate at Maranchery wetland during 2009-2011

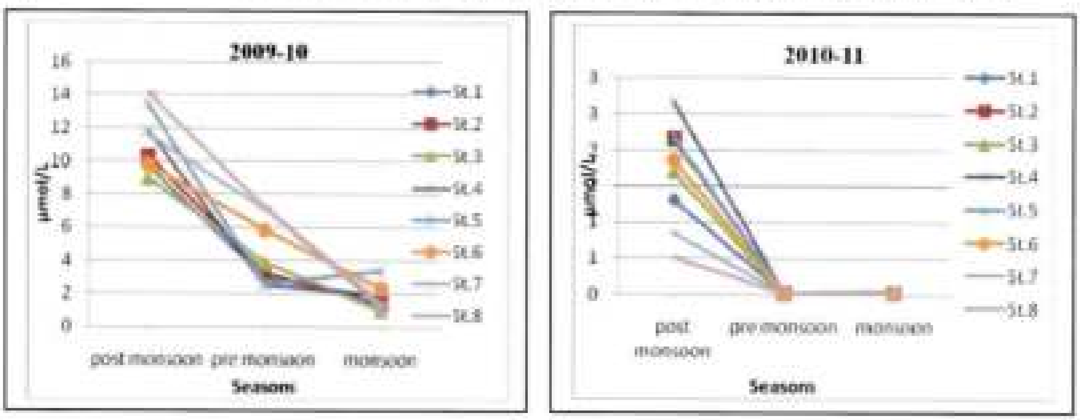


Fig.42. Monthly variations in nitrite at Maranchery wetland during 2009-2011

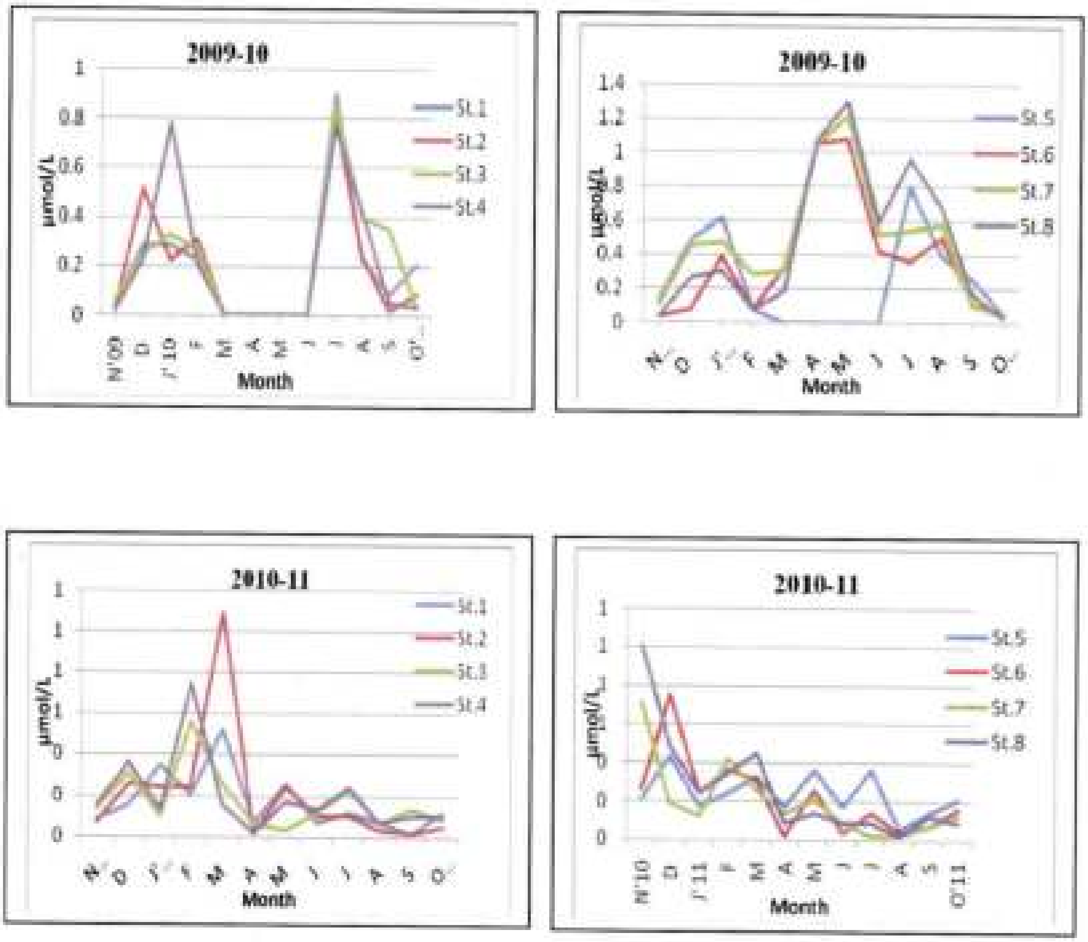


Fig.43. Seasonal variation in nitrite at Maranchery wetland during 2009-2011

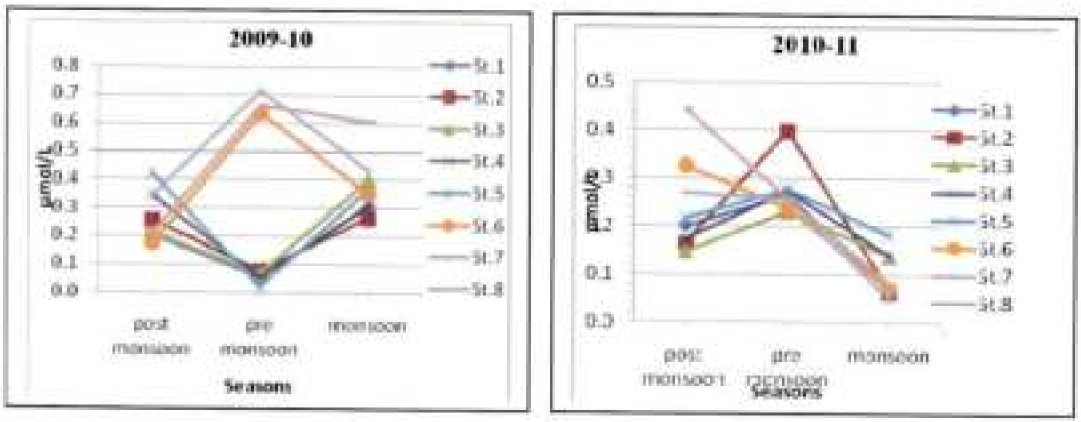
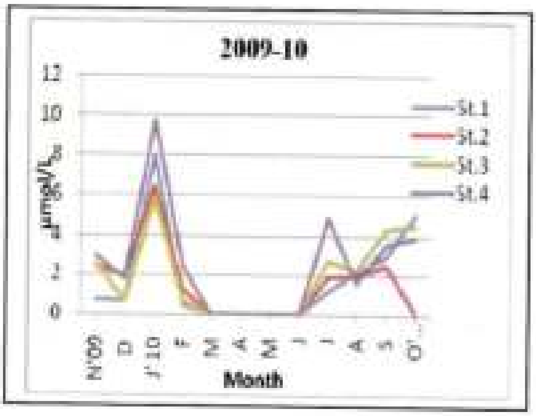
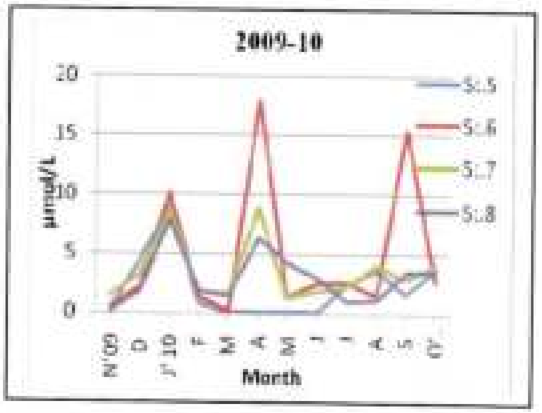
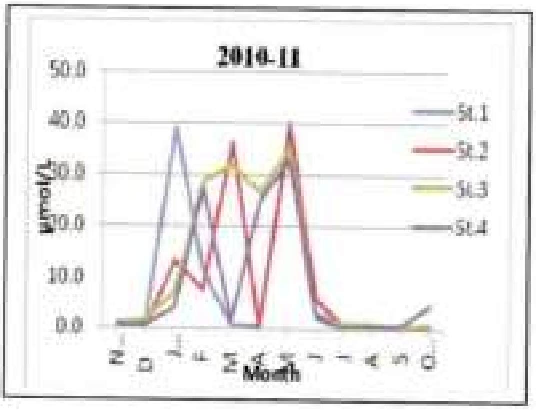


Fig.44. Monthly variations in ammonia at Maranchery wetland during 2009-2011







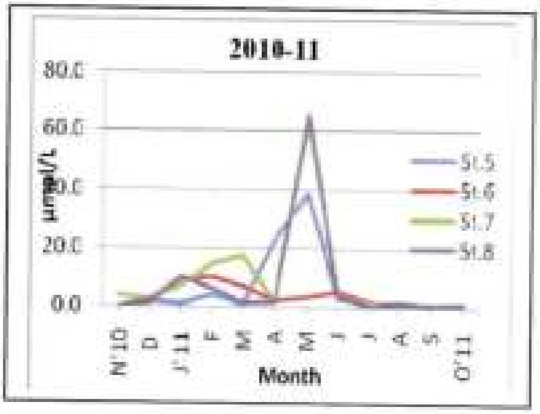
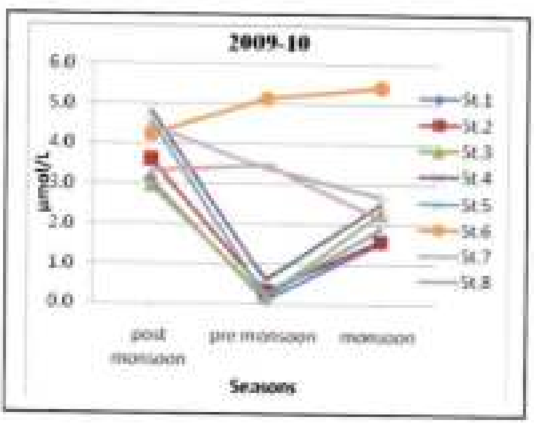


Fig.45. Seasonal variation in ammonia at Maranchery wetland during 2009-2011



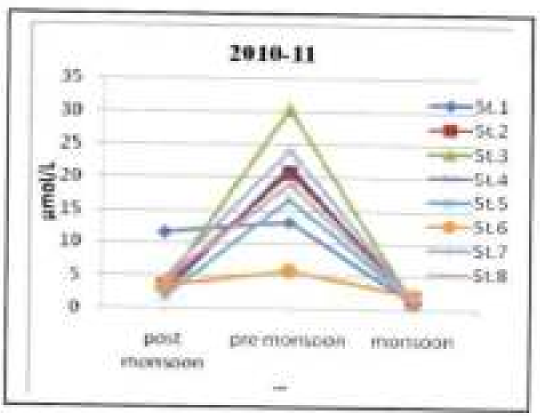


Fig.46. Monthly variations in silicate at Maranchery wetland during 2009-2011

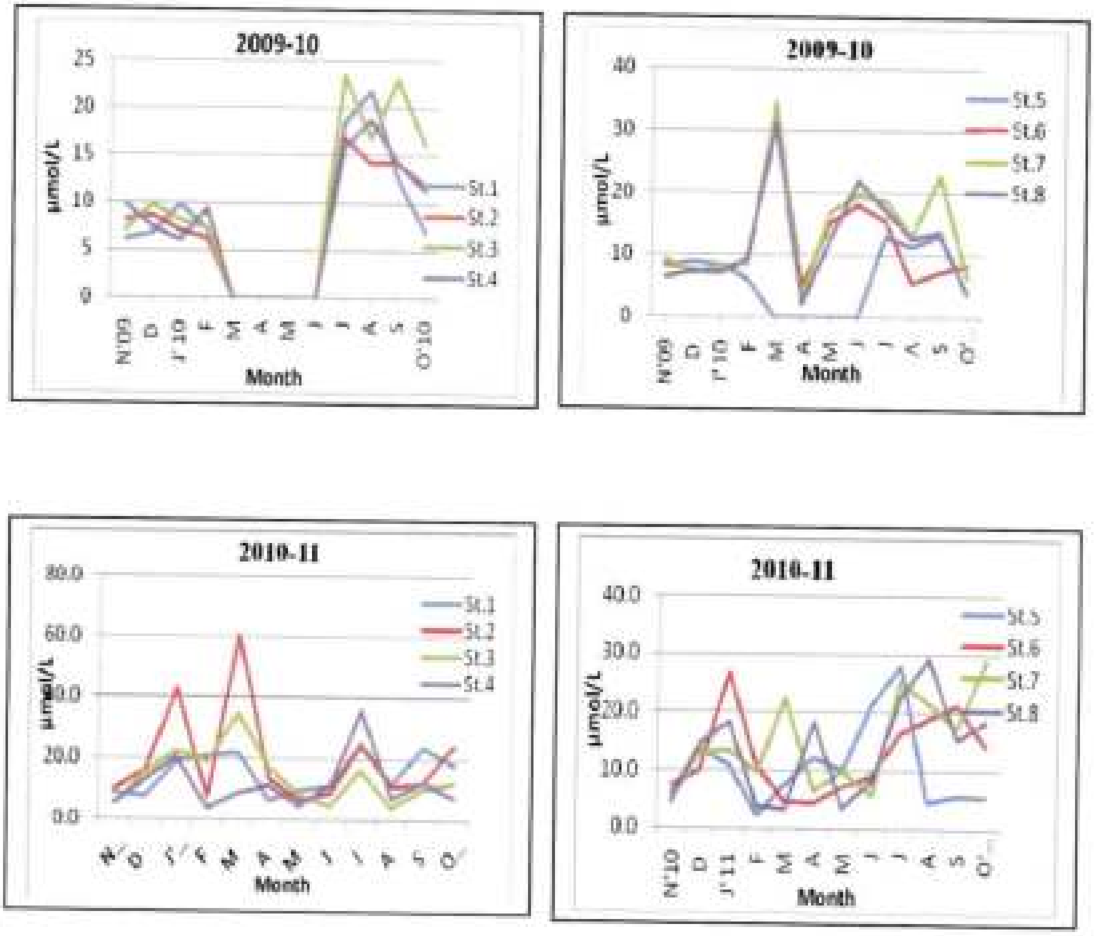


Fig.47. Seasonal variation in silicate at Maranchery wetland during 2009-2011

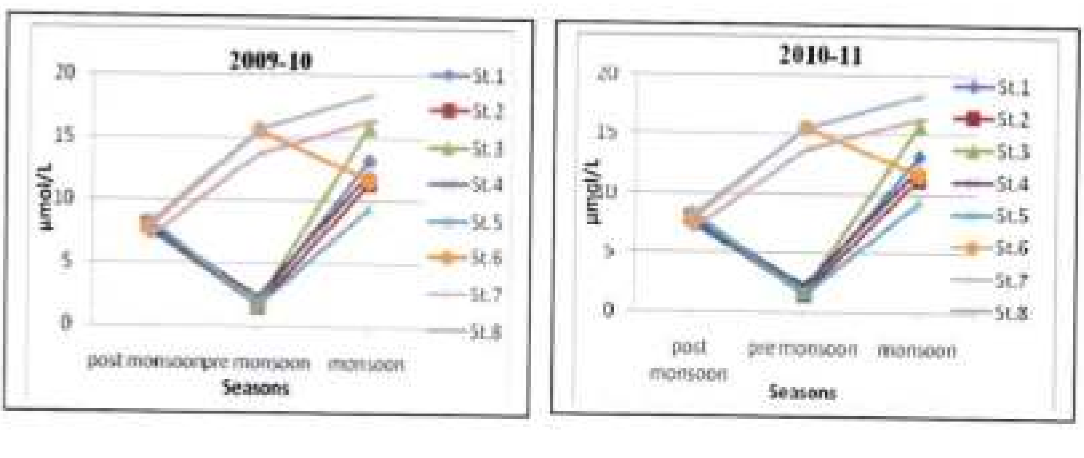


Fig.48. Monthly variations in phosphate at Maranchery wetland during 2009-2011

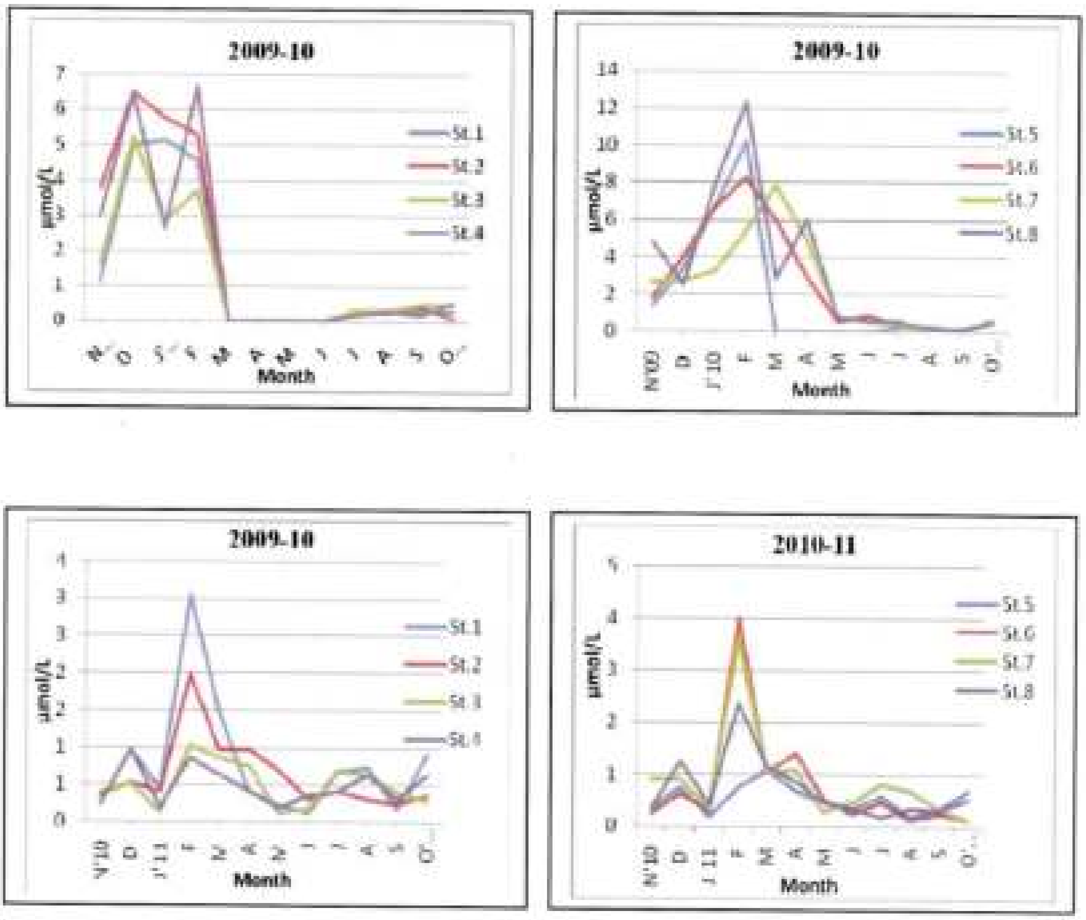


Fig.49. Seasonal variation in phosphate at Maranchery wetland during 2009-2011

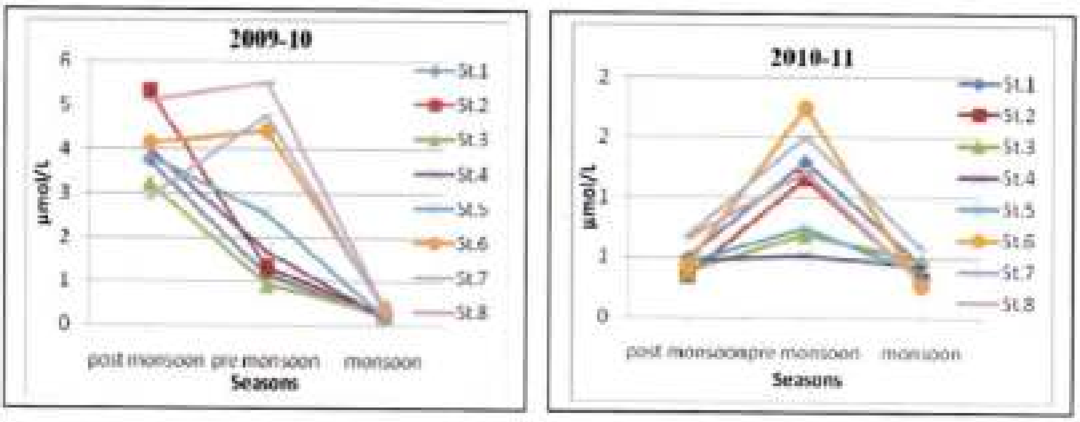


Fig.50. Monthly variations in dissolved oxygen at Maranchery wetland during 2009-2011

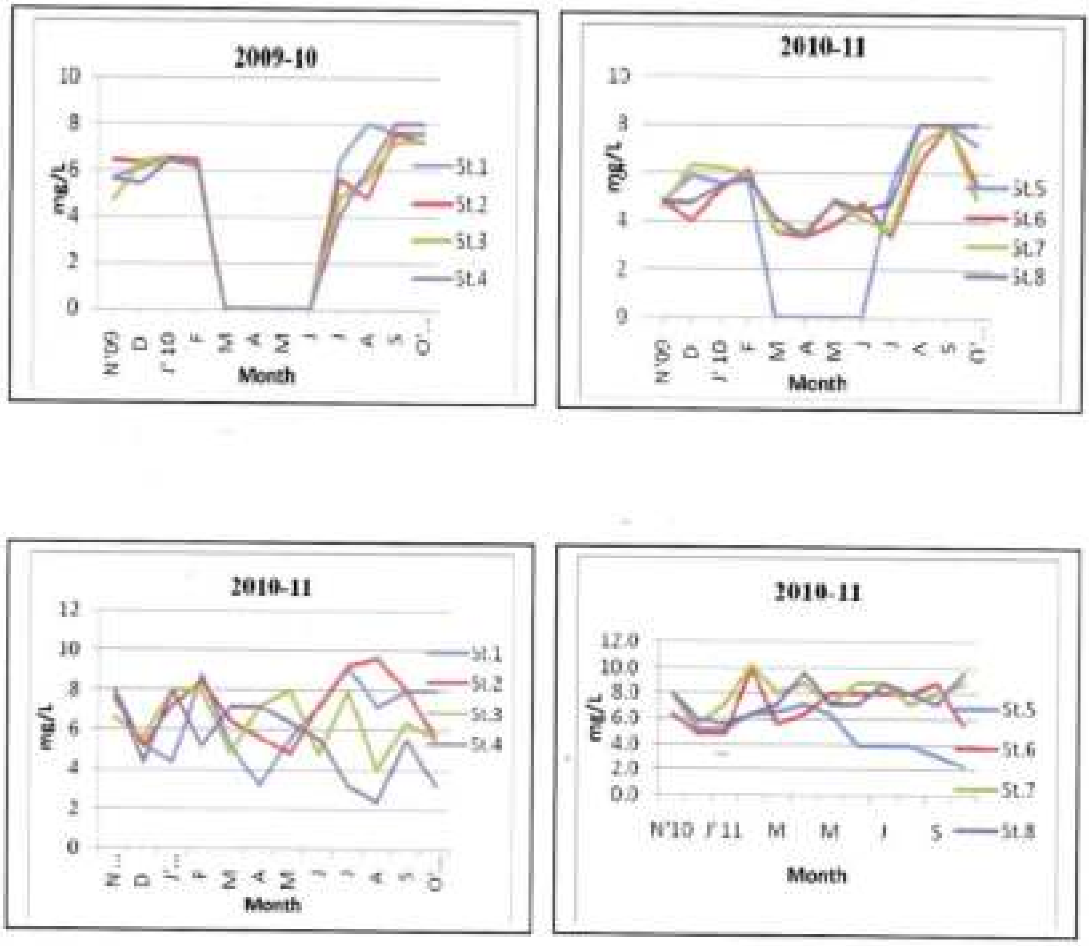


Fig.51. Seasonal variation in dissolved oxygen at Maranchery wetland during 2009-2011

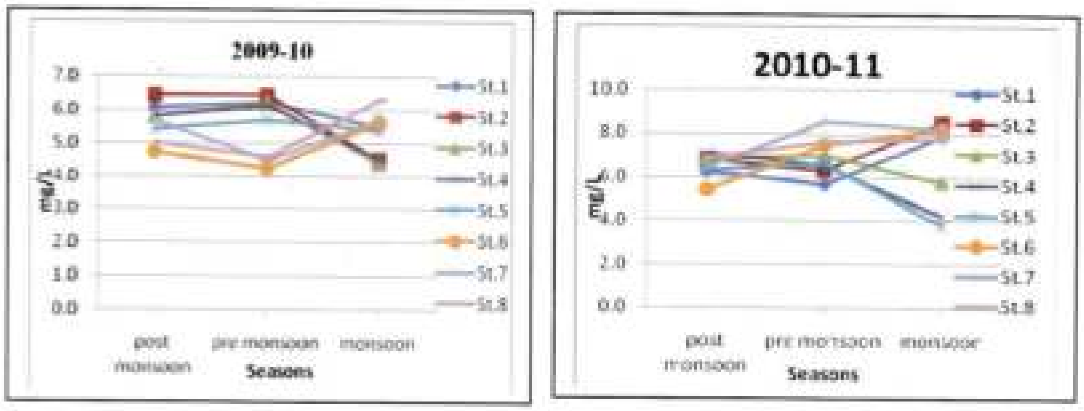
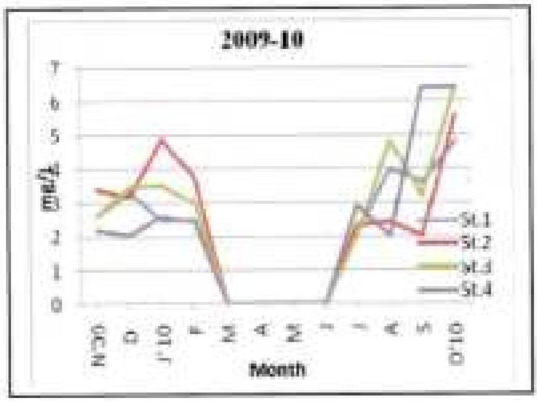
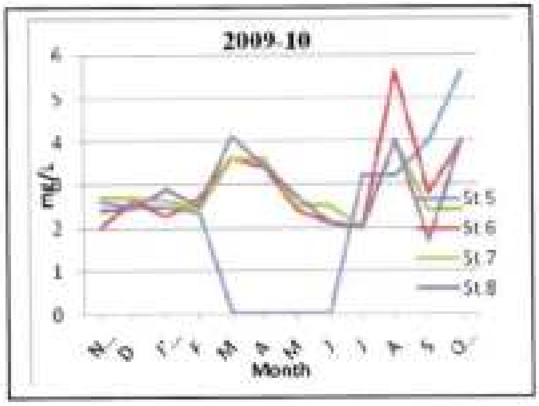
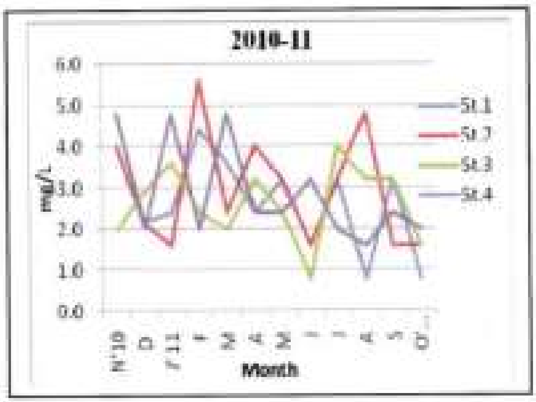


Fig.52. Monthly variations in biological oxygen demand (BOD) at Maranchery wetland during 2009-2011







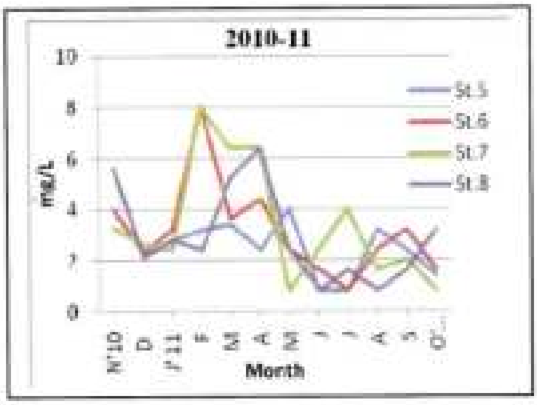
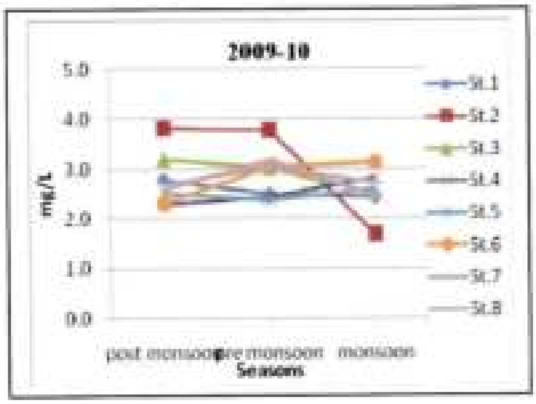
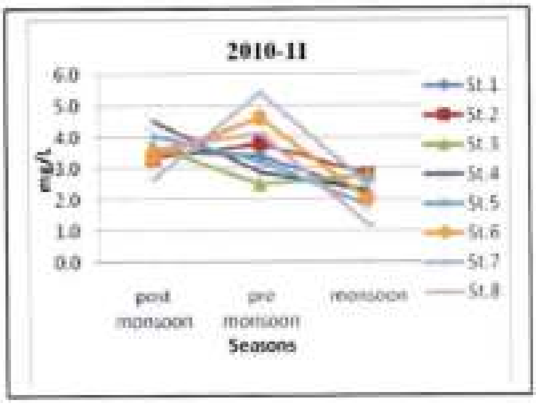


Fig.53. Seasonal variation in biological oxygen demand (BOD) at Maranchery wetland during 2009-2011





8. 2 Productivity

The value of GPP and NPP was assessed in Maranchery wetland. The overall maximum value of GPP and NPP (4.15gC/m^3/day, 2.10gC/m^3/day) was found in pre-monsoon months (Fig.55&58). Temperature, light and nutrients are important limiting factors for primary productivity. Ali and Khan (1976) have reported higher values of productivity in warm season and lower value in cool seasons. Chlorophyll 'a' ranged from.70 mg/m^3 to 15.28 mg/m^3.compared to other stations, Station 4 showed higher variation in monsoon period (Fig. 59). Earlier studies on chlorophyll 'a' conducted in Vembanad lake reported an annual range of 2-21 mg/L, similar results were observed in Thrissur kole wetlands (Tessey and Sreekumar, 2008). The maximum chlorophyll b recorded was 3.22 mg/m^3 and chlorophyll c recorded was 3.56 mg/m^3 in late summer period (Fig. 61 & 633).

Fig.54. Monthly variations in gross primary productivity at Maranchery wetland during 2009-2011

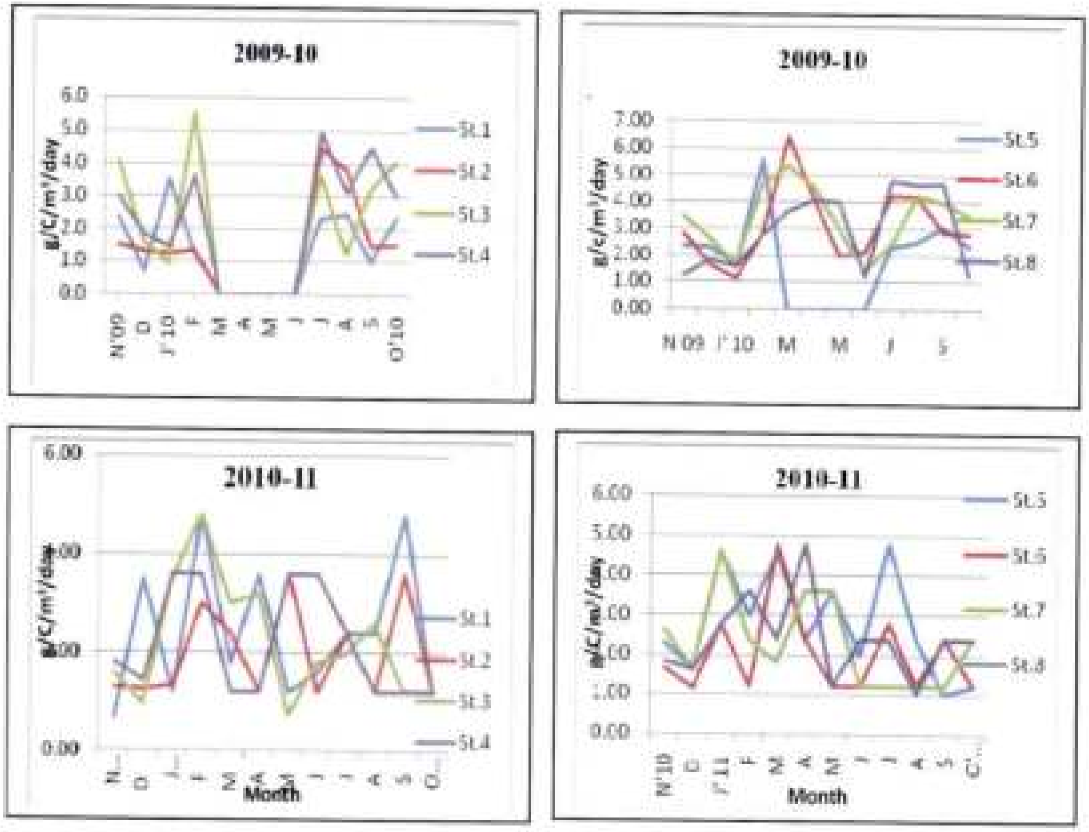


Fig.55. Seasonal variation in gross primary productivity at Maranchery wetland during 2009-2011

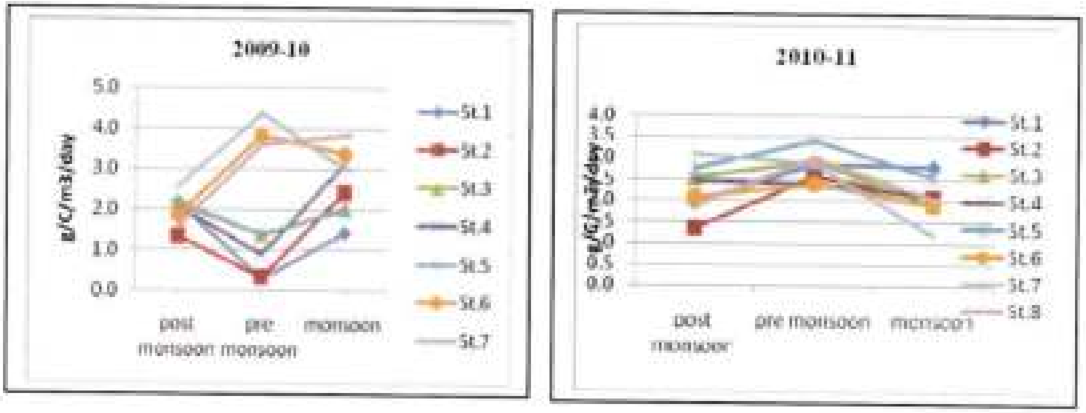


Fig.56. Monthly variations in net primary productivity at Maranchery wetland during 2009-2011

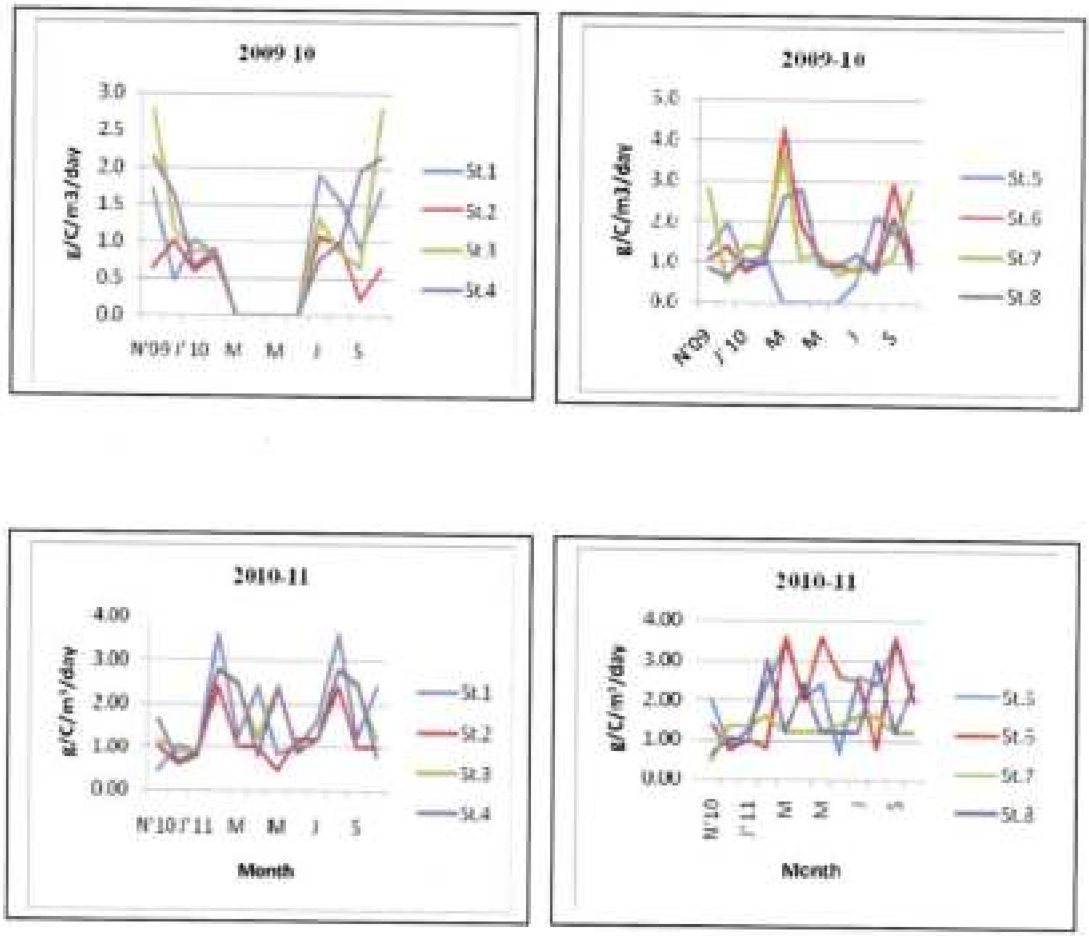


Fig.57. Seasonal variation in net primary productivity at Maranchery wetland during 2009-2011

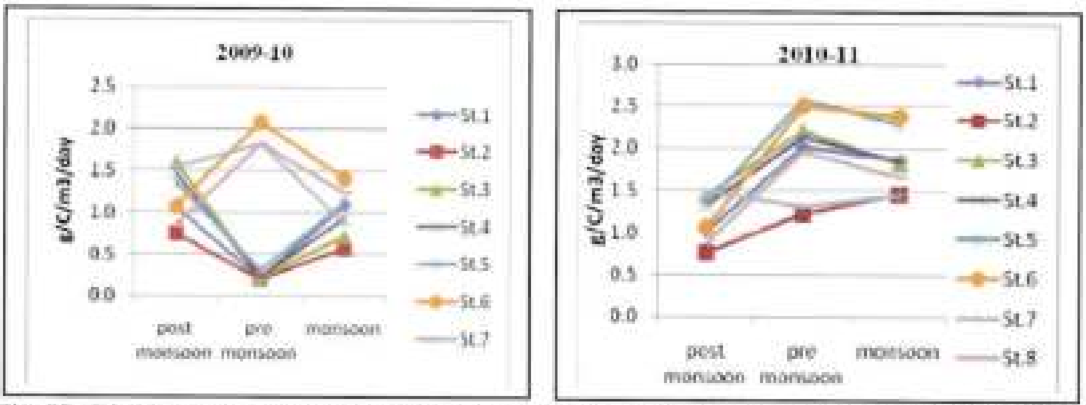


Fig.58. Monthly variations in Chlorophyll 'a' at Maranchery wetland during 2009-2011

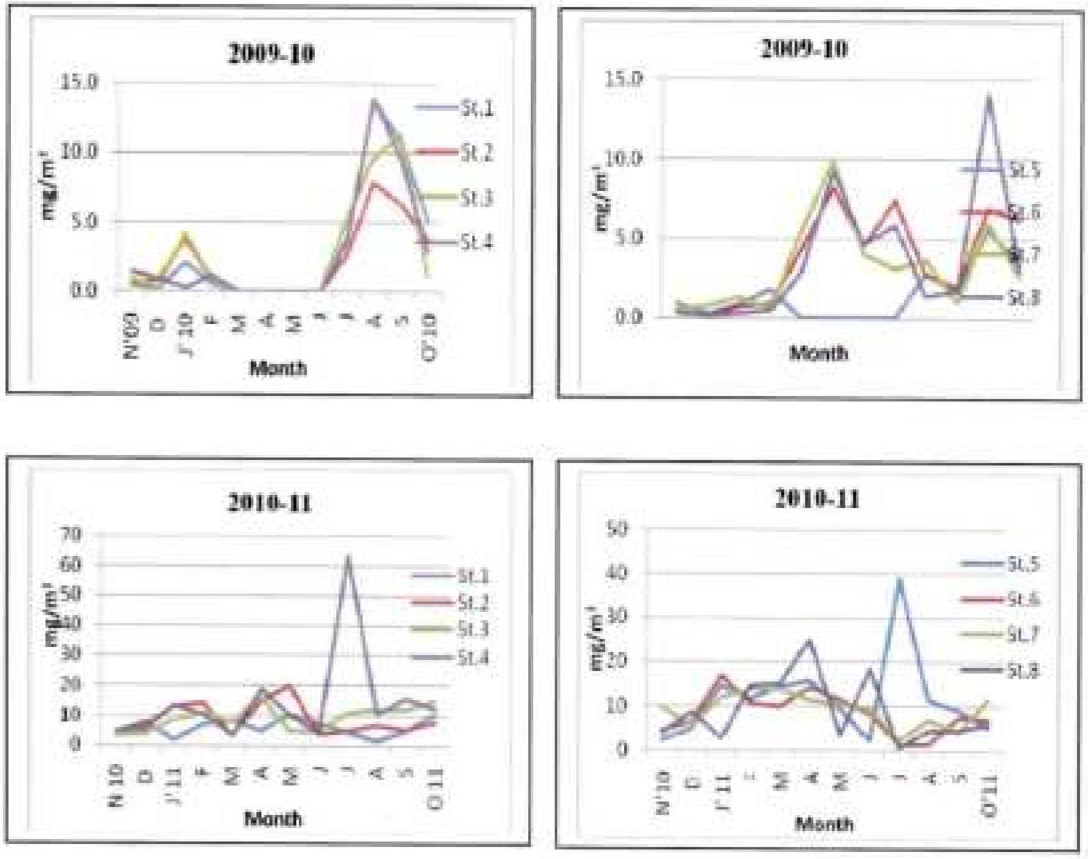


Fig.59. Seasonal variation in Chlorophyll 'a' at Maranchery wetland during 2009-2011

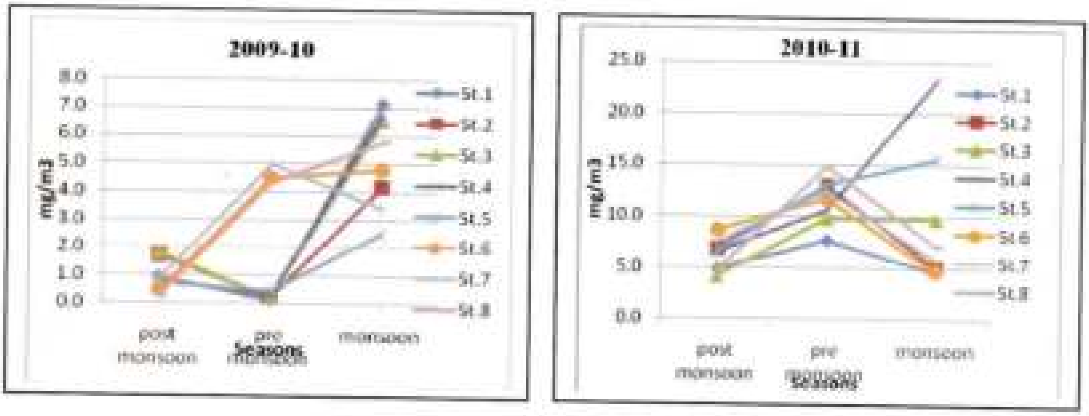


Fig.60. Monthly variations in Chlorophyll 'b' at Maranchery wetland during 2009-2011

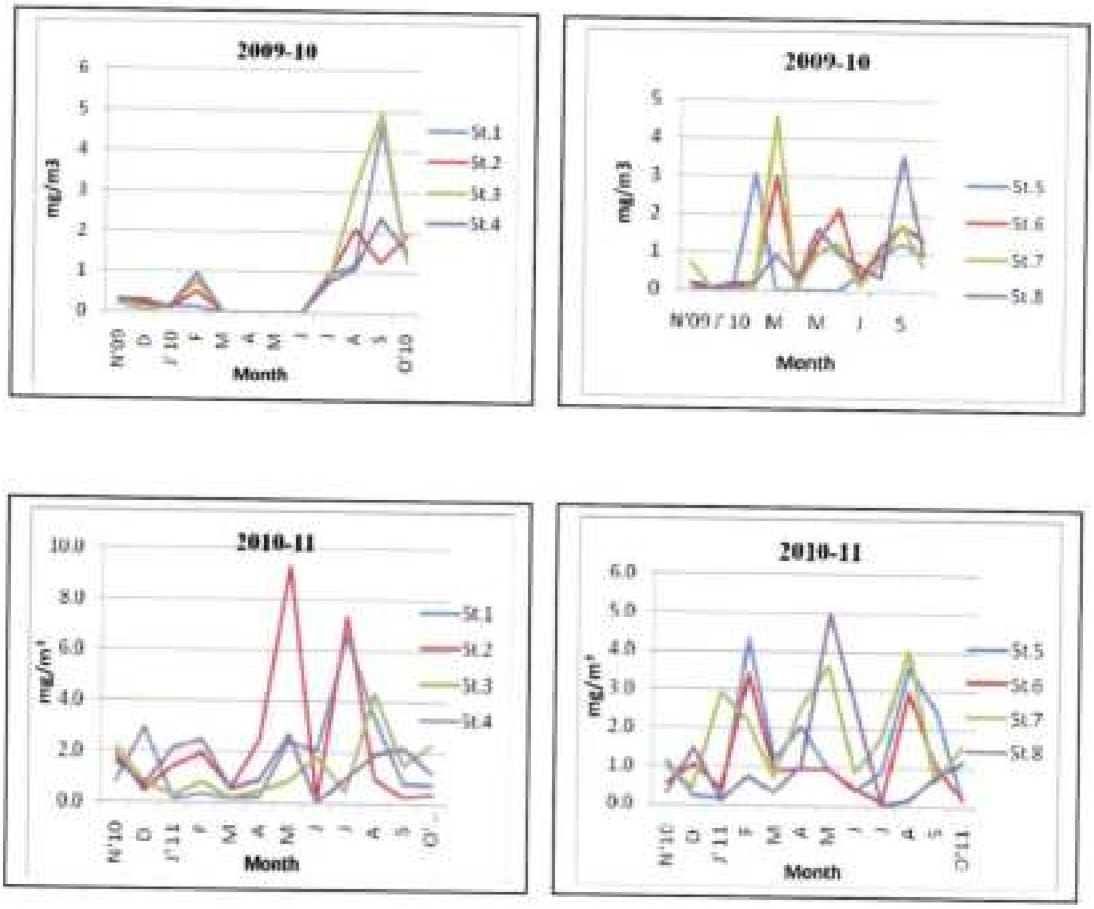


Fig.61. Seasonal variation in Chlorophyll 'b' at Maranchery wetland during 2009-

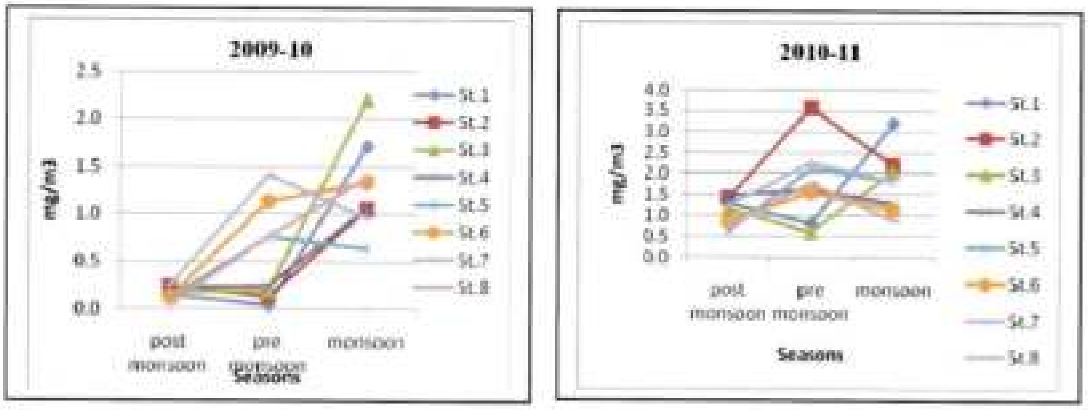


Fig.62. Monthly variations in Chlorophyll 'c' at Maranchery wetland during 2009-2011

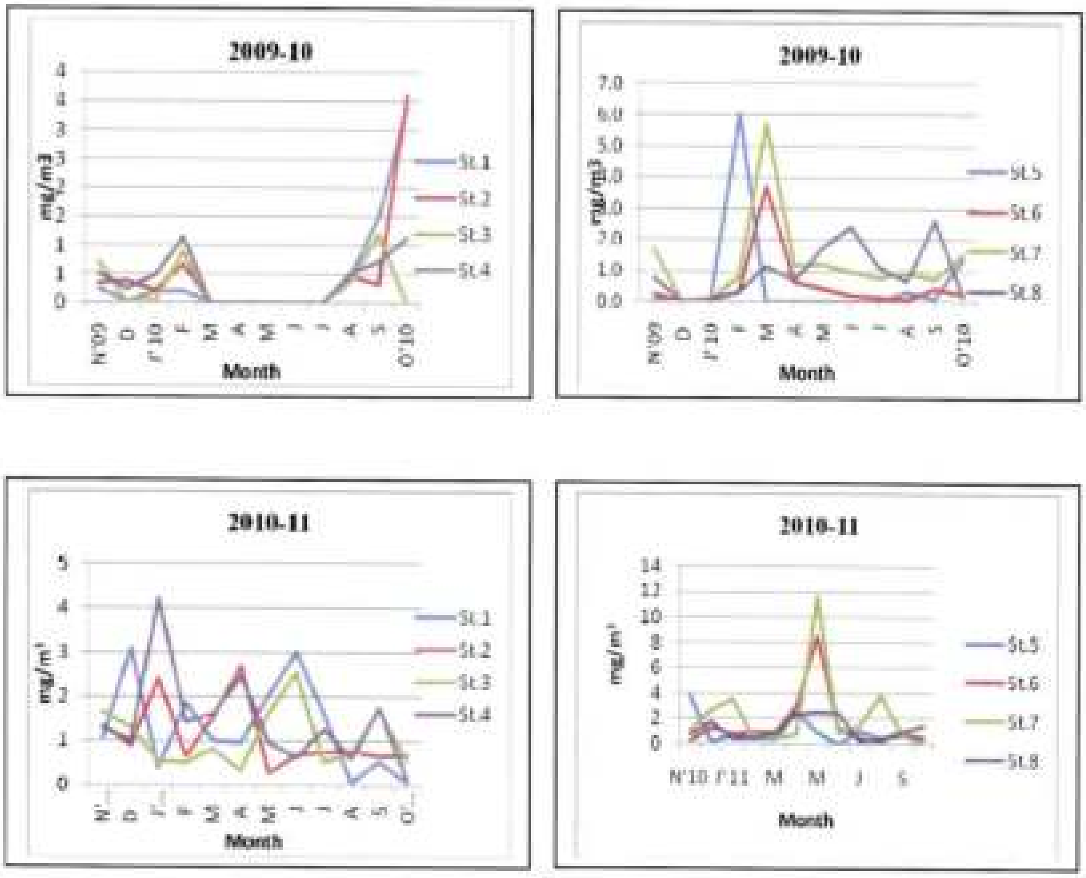
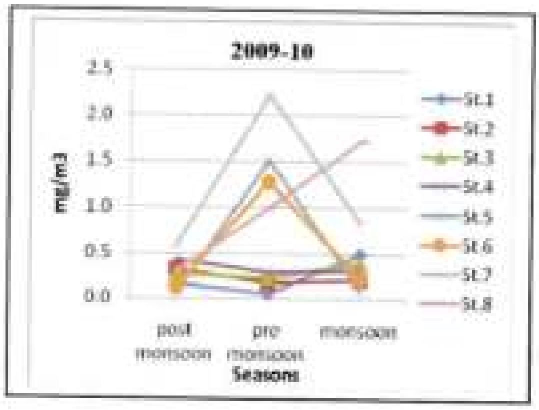
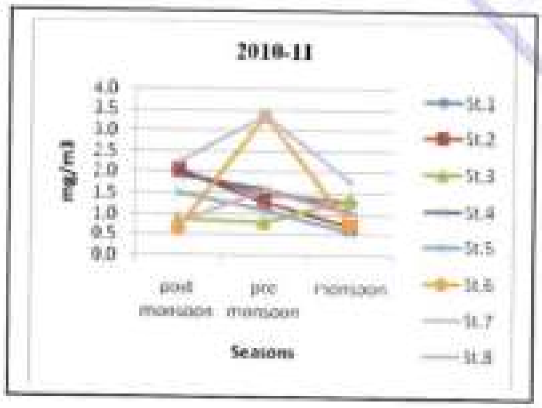


Fig.63. Seasonal variation in Chlorophyll 'c' at Maranchery wetland during 2009-2011





8. 3 Sediment quality

Sediment pH showed no much variation during the study period (Fig. 66). compared Organic matter buffers the soil pH in the slightly acidic, neutral and alkaline soils, which helps to maintain relatively constant pH. In most wetlands pH is buffered against nuetrality (Ramesh and Ronald 2008). The Eh values showed a highly reducing trend in most stations(Fig. 73). Eh undergoes dynamic changes as wetlands are subjected to hydrologic fluctuations (Ramesh and Ronald 2008). The soil in the study area can be classified as high organic carbon availability class. In wetland ecosystems, the primary productivity often exceeds the rate of decomposition processes, resulting in net accumulation of organic matter. The decomposition process occurs significantly at slower rates due to predominance of anaerobic conditions. (Ramesh and Ronald, 2008). Phosphorous release from oxyhydroxide flocs under reduced condition caused by continues flooding and the organic matter hydrolysis accelerated under aerobic conditions for dry soils following reflooding may be the reason for the maximum available phosphorous during monsoon((Fig. 77). Warming increased the potential of P release from sediment to pore water and further to overlying water which can be the reason for the minimum P levels during pre monsoon.

Fig.64. Monthly variations in sediment temperature at Maranchery wetland during 2009-2011

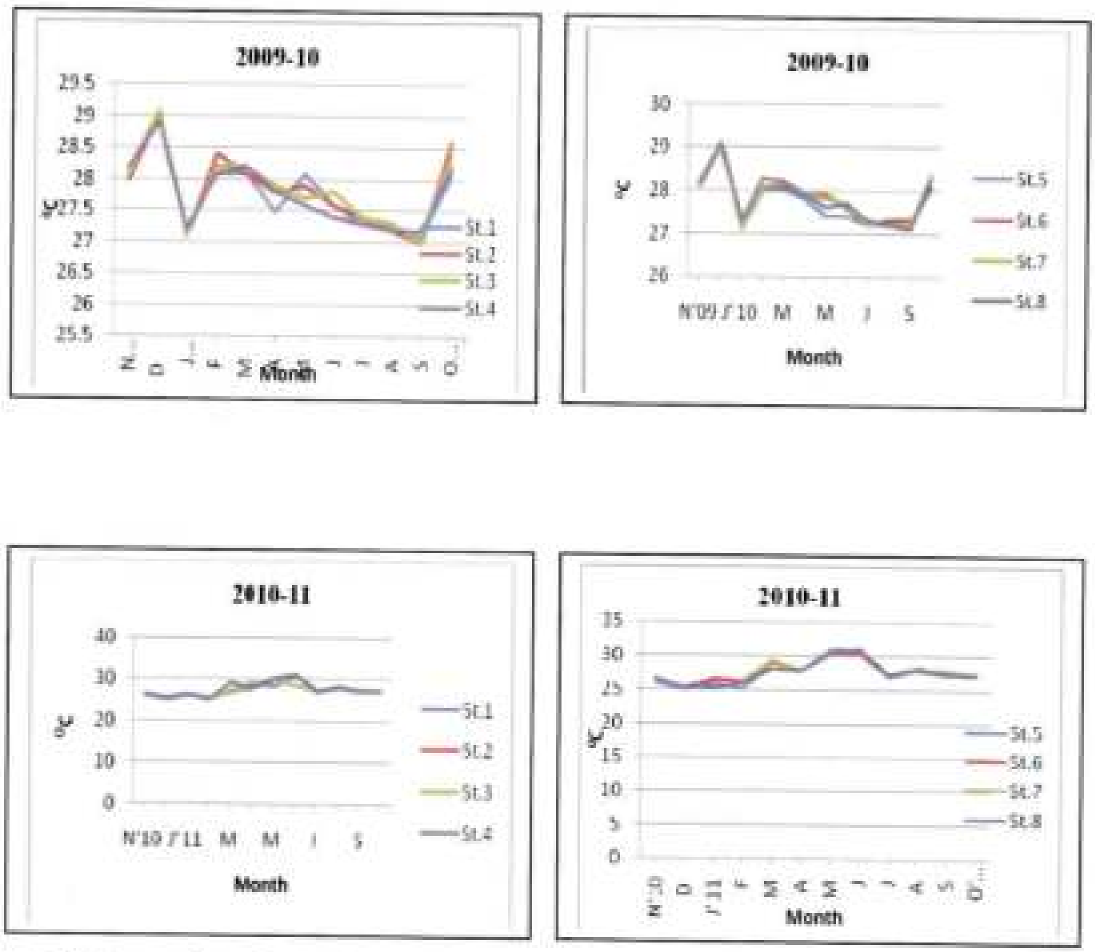


Fig.65. Seasonal variation in sediment temperature at Maranchery wetland during 2009-2011

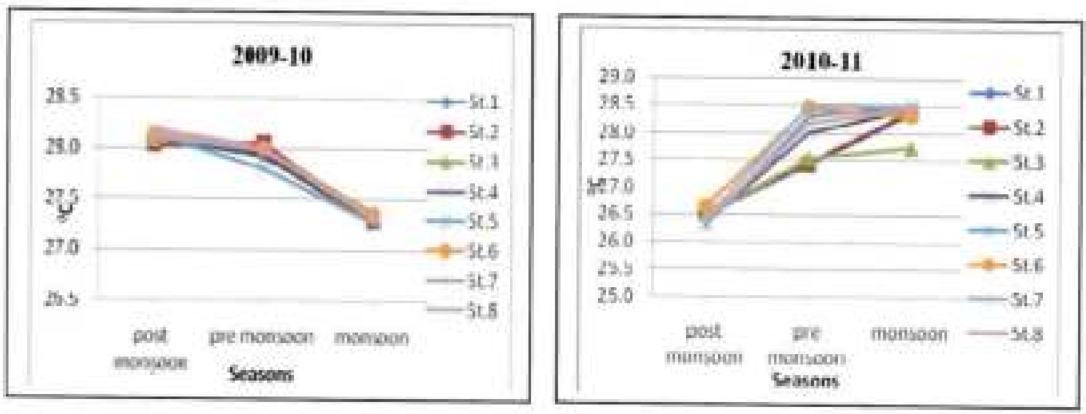


Fig.66. Monthly variations in sediment pH at Maranchery wetland during 2009-2011

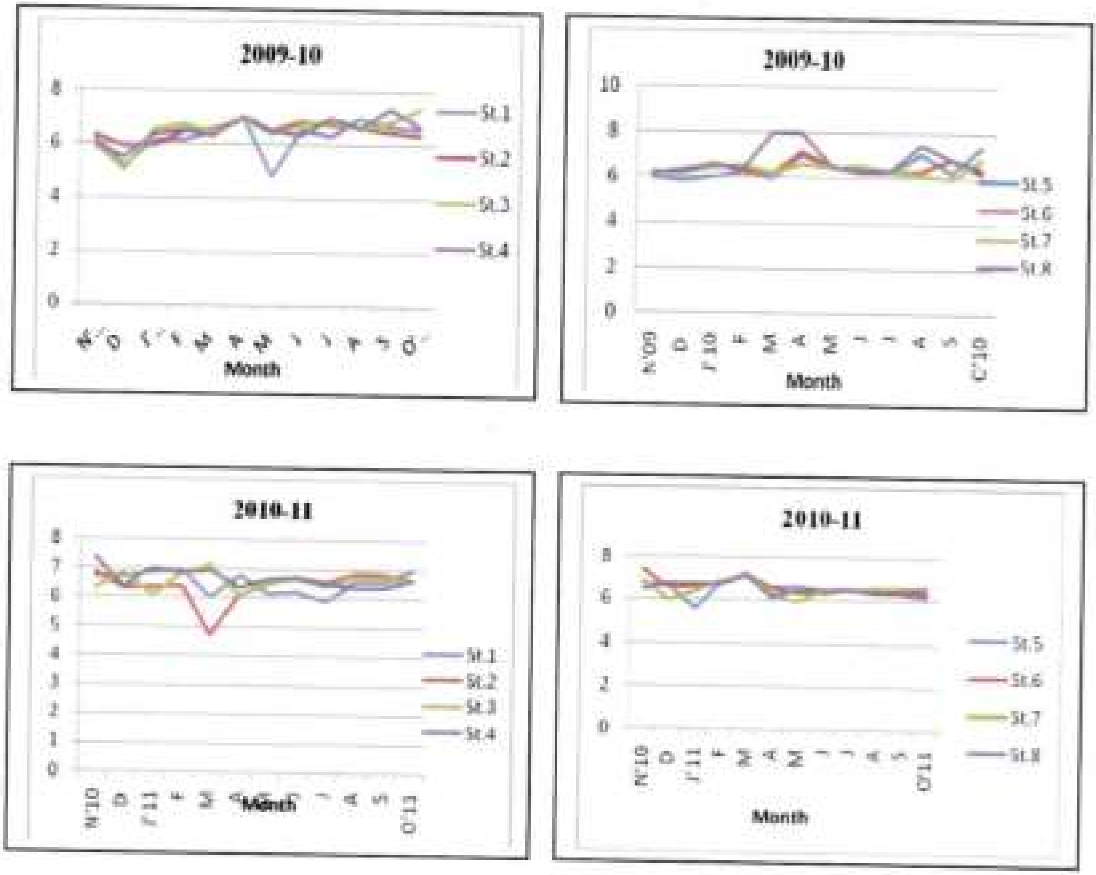


Fig.67. Seasonal variation in sediment pH at Maranchery wetland during 2009-2011

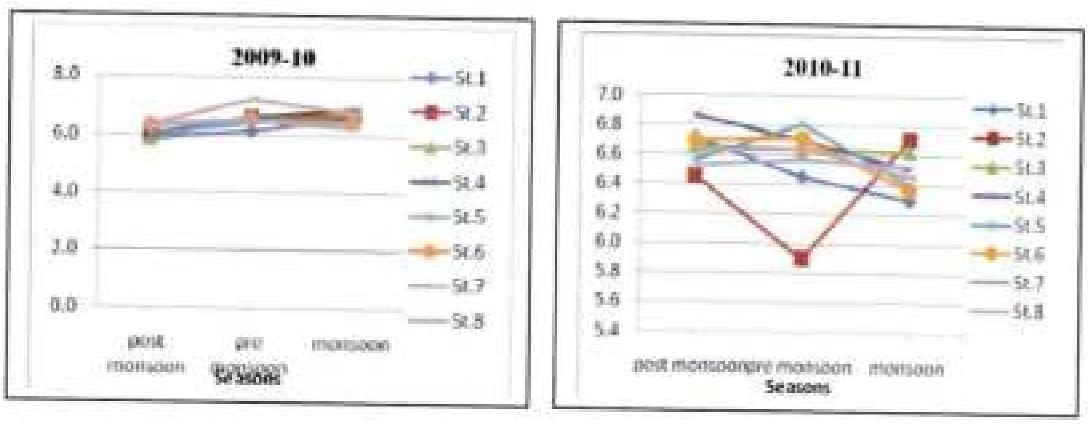
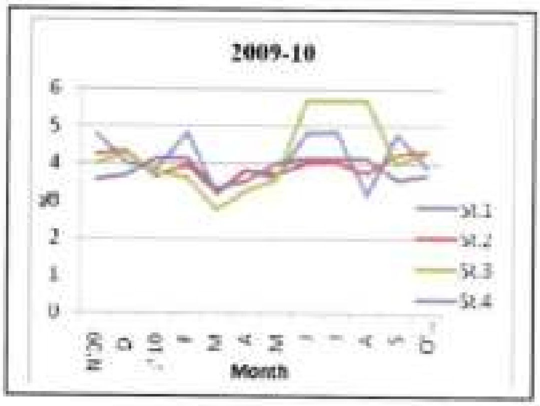
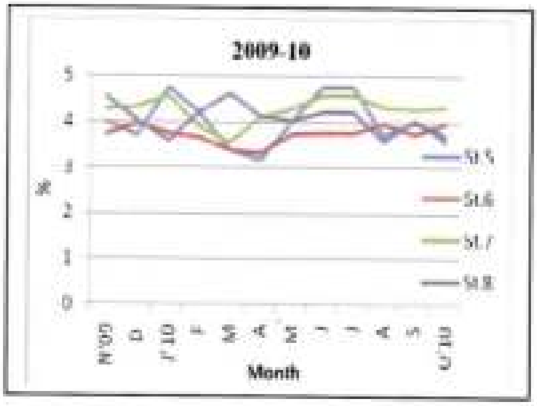
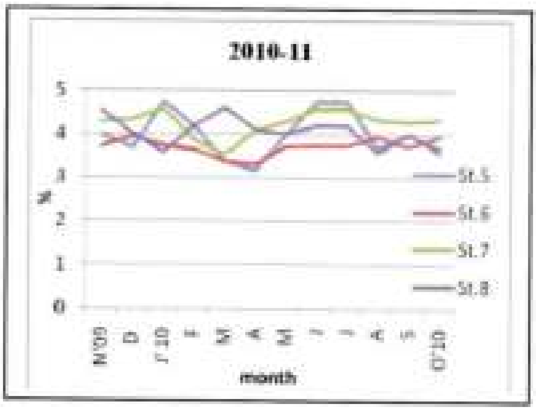


Fig.68. Monthly variations in organic carbon at Maranchery wetland during 2009-2011







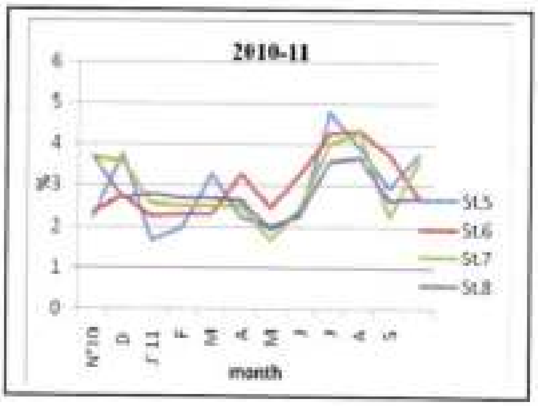
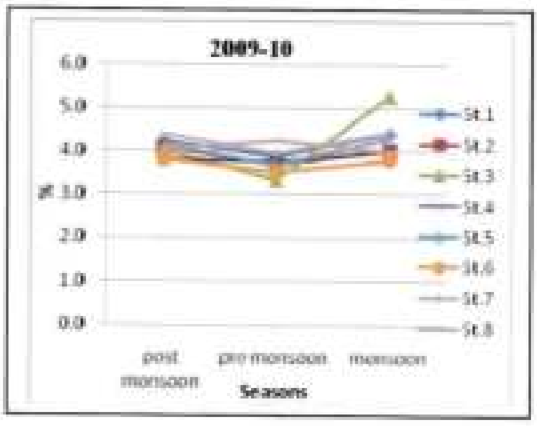


Fig.69. Seasonal variation in organic carbon at Maranchery wetland during 2009-2011



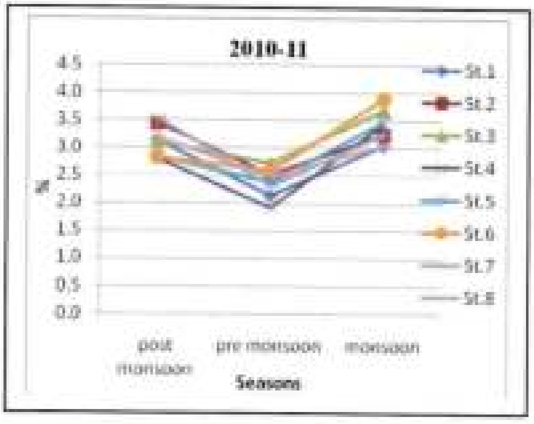


Fig.70. Monthly variations in moisture content at Maranchery wetland during 2009-2011

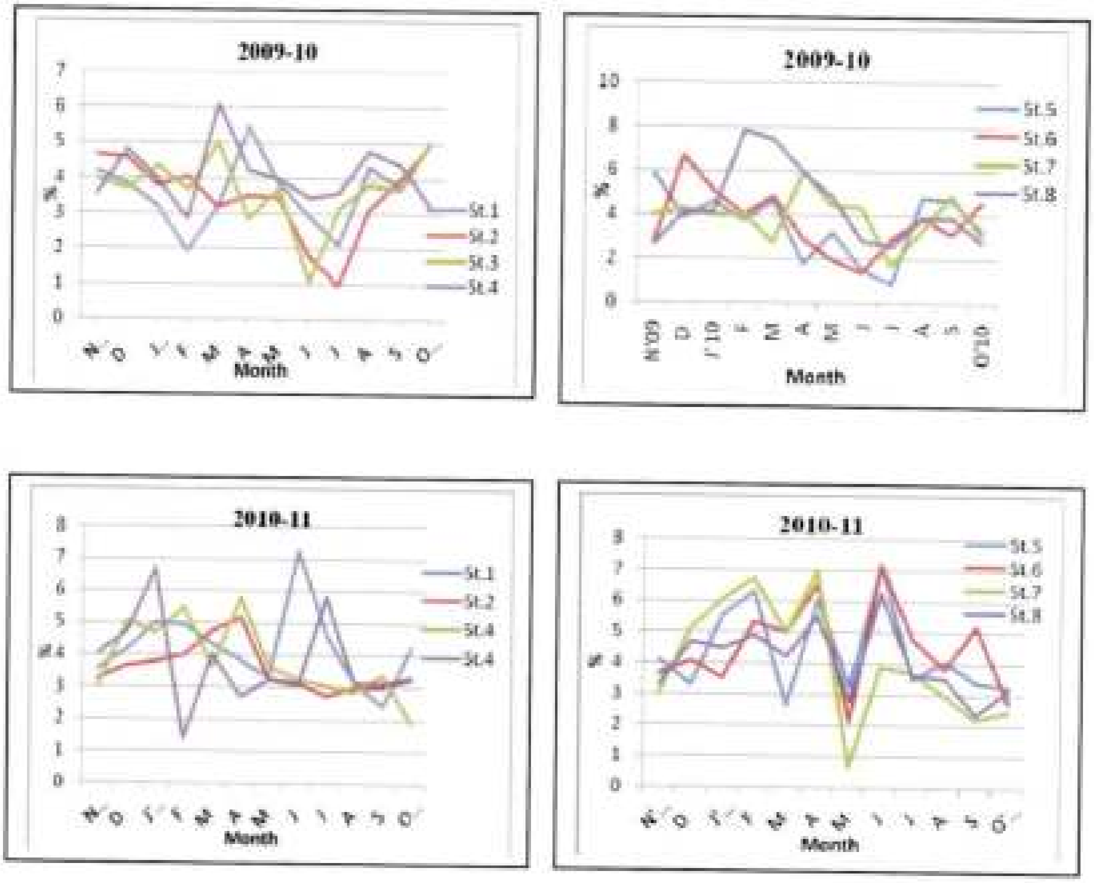


Fig.71. Seasonal variations in moisture content at Maranchery wetland during 2009-2011

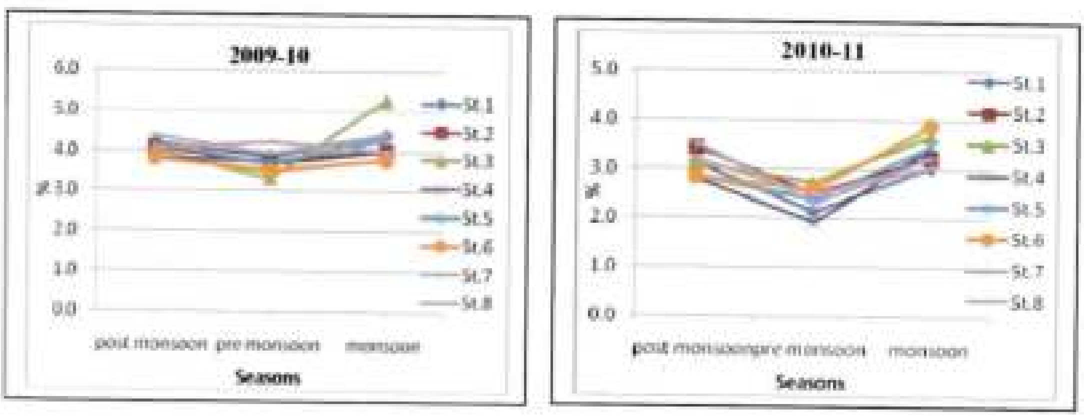


Fig.72. Monthly variations in Eh at Maranchery wetland during 2009-2011

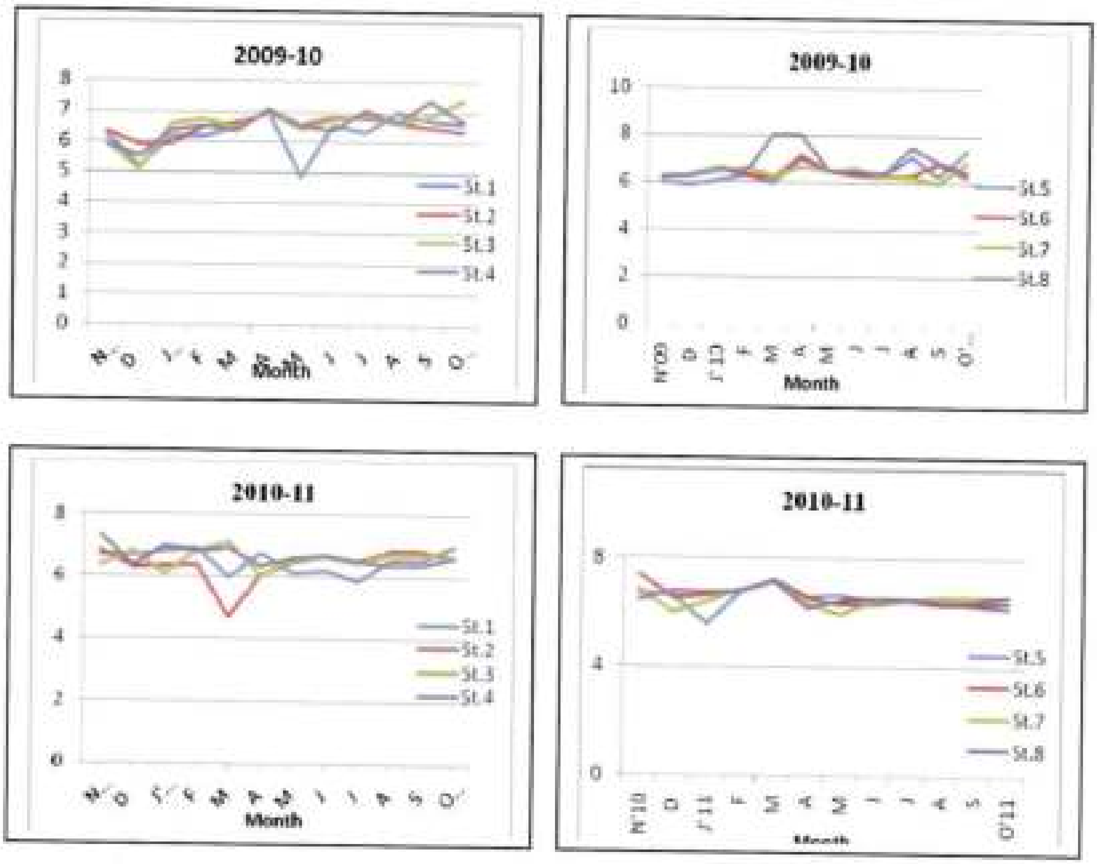


Fig.73. Seasonal variations in Eh at Maranchery wetland during 2009-2011

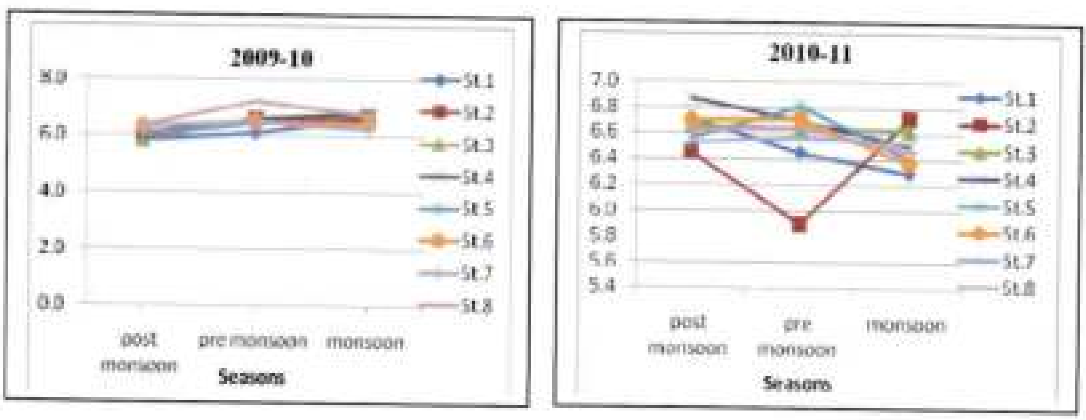


Fig.74. Monthly variations in available nitrogen at Maranchery wetland during 2009-2011

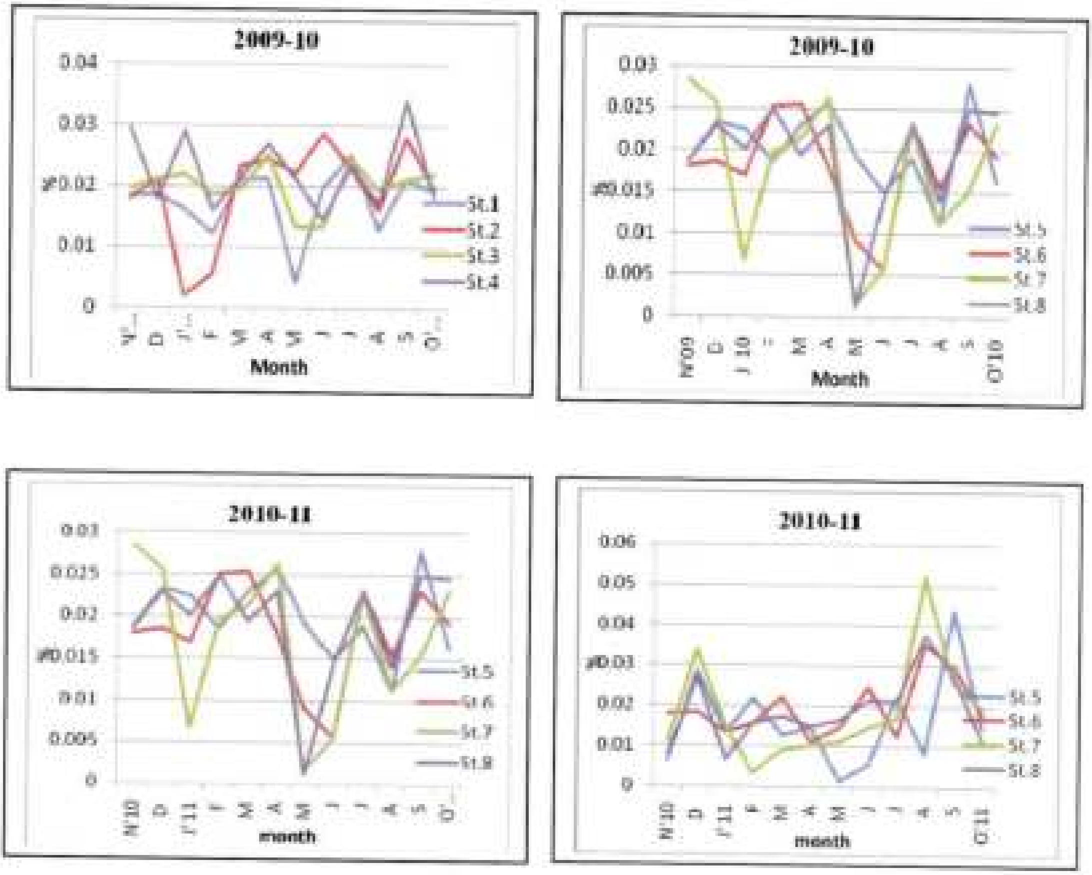


Fig.75. Seasonal variations in available nitrogen at Maranchery wetland during 2009-2011

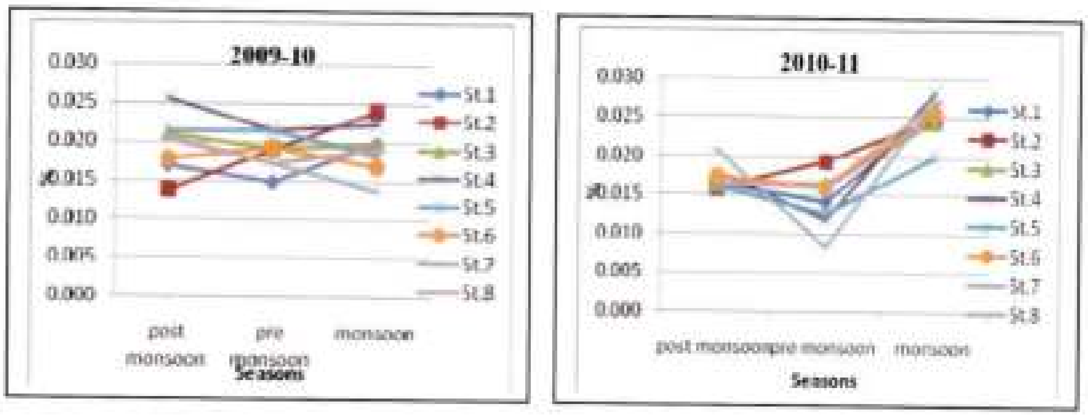


Fig.76. Monthly variations in available phosphorus at Maranchery wetland during 2009-2011

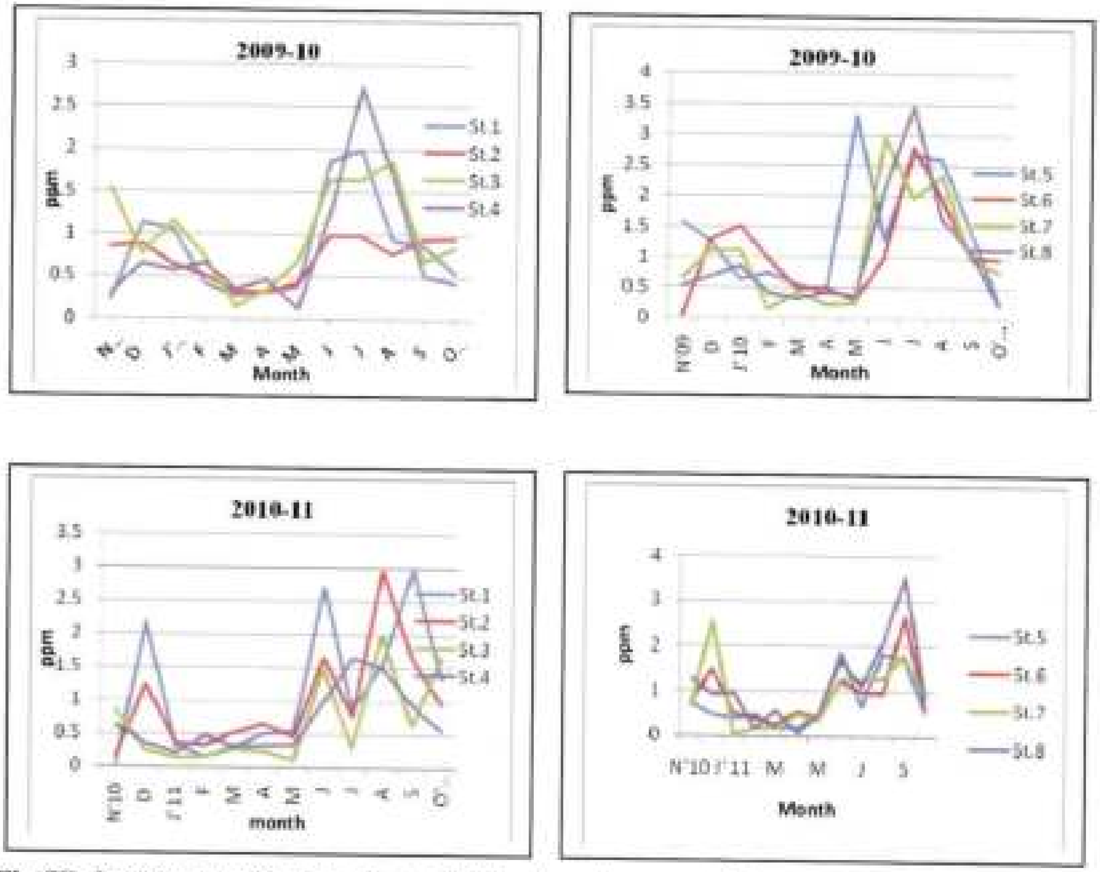
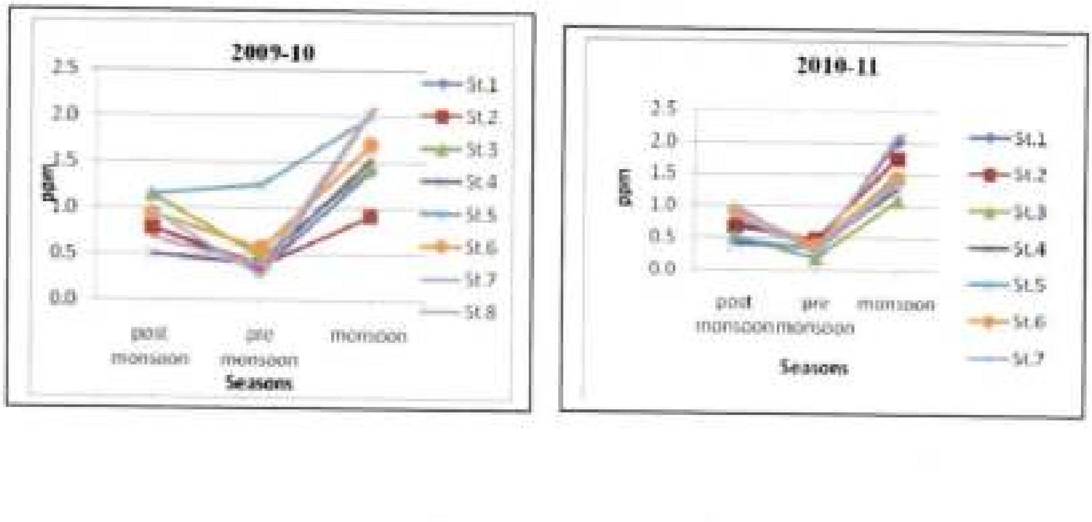


Fig.77. Seasonal variations in available phosphorus at Maranchery wetland during 2009-2011



8. 4 Phytoplankton diversity

Algae are important components of water quality. Algal and nutrient dynamics are closely linked together since nutrient uptake during algal growth is the main process that removes dissolved nutrients from the water, and algal respiration and decay are major components of nutrient recycling (Tina and Branisalv, 2009). Ivor Norlin (2006) have noticed that, phytoplankton composition was responsible for patterns in zooplankton community structure. The mean seasonal biomass value ranged from 0.45ml/m^3 in Station 7 in premosoon period to 15 ml/m^3 in Station 4 and 5 during monsoon period. The overall maximum biomass was found higher in monsoon period in Station 4 and 5 respectively. Bijoy Nandan (2008) also reported the maximum plankton during monsoon period in Kadinamkulam backwater which was due to the high amount of detritus sediment and other suspended materials collected along with the plankton samples during monsoon showers. Total phytoplankton density ranged from 5000no./m^3 to 25000 no./m^3 in Maranchery wetland. Chlorophyceae had higher representation in all seasons and stations. Mean percentage composition of chlorophyceae was maximum in post monsoon period (47%). Compared to other stations, Station 4 showed the highest percentage abundance of chlorophyceae (51%) followed by Station 1(44%) and Station 3(41%). Pathak *et al*,(2004) studied plankton diversity of 14 wetlands of Utter Pradesh, where chlorophyceae dominated all the wetlands range:35.6% to 72.9%. In the present study, among chlorophyceae, *volvox* colony dominated in all the stations followed by *oedogonium*, and *spirogyra* with other genera. Bacillariophyceae (18%), Cyanophyceae(27%), and Euglenophyceae(16%) were moderately represented, in all the study stations. Sugunan *et al* (2000) studied the ecology and fisheries of Beels in West Bengal. In this study it was reported that Chlorophyceae and Bacillariophyceae dominated the phytoplankton. It is possible that dominance of these two groups was facilitated by rapid removal of plant nutrients by macrophytes from soil and water. This agrees with the present study. Euglenophyceae showed least representation in all stations. Compared to other stations, Station 2 showed higher percentage abundance (15%) of Euglenophyceae.

8. 5 Zooplankton diversity

Zooplankton are excellent indicators of both biotic and abiotic influences because they are the center of the aquatic food web and therefore respond to both top down processes, such as predation, and bottom up processes, such as food availability (Lampert1997; Zimmer *et al.* 2000). When zooplankton are subject to strong predation pressures, they need aquatic plants as refugium. When they are living in very dilute environments, such as the wetlands with low nutrients, the zooplankton need to be efficient competitors for food sources (Lampert, 1997). The mean seasonal biomass value ranged from 3.0 ml/m^3 in Station 2 to 17 ml/m^3 in Station 3. The maximum biomass was found in pre monsoon period in Station 3. Zooplankton community of the Maranchery wetland comprised of 18 genera belonging to Rotifera (6 families) Cladocera (5 families) Copepoda (2 families) Ostracoda (1 familiy), Nematoda and insect larvae. Table 37 depicts the occurrence of different zooplankton genera during different seasons of the study period. Copepods dominated the zooplankton population during all the seasons followed by Daphnia and Rotifera. Lowest diversity was exhibited by ostracods being represented by only one family, cyprididae. The nauplii were found to occur in large numbers during premonsoon period. Majority of the rotifers recorded in the wetland were of thecate type. A total of nine species of crustaceans and eight species of rotifers were reported in Nepal lakes (Smriti Gurung *et al*, 2009). Compared to other stations, copepods showed highest percentage in Station 4 (92%). Among copepods cyclopoidae family showed higher abundance. Bijoy Nandan (2008) reported that in Neeleswaram backwater, 50% of the plankton were contributed by copepods. According to Harris (1986), the species composition and abundance changes would be associated randomly and controlled by external factors. Compared to other stations St. 1 showed maximum mean percentage of rotifers(12%). Large cladoceran daphnia were observed in pre monsoon period in Station 2 and 3. Percentage abundance of cladocerans were maximum in Station 3(48%) and minimum in Station 4 (3%). Ivor Norlin (2006) characterized zooplankton composition and ecology in western boreal shallow water wetlands. In this study it was reported that, the large cladoceran grazers, Daphnia showed high abundance and dominance. This agrees with the present study. Abundance of large Daphnids are associated with clear lakes with healthy sport fish populations (Mazumdar, 1994). Among the insect larvae, chironomids were dominant and present in Stations 4 and 5 in post monsoon period. In Stations 4 and 5 large Potamageton and nymphyea macrophytes were common, and this insect larvae like chyronomids were found to be associated with these macrophytes.

8.6 Macrophytes diversity

The macrophytes of Maranchery wetlands were sampled and identified to gain an understanding of the biodiversity and species richness of the area. The assemblage of aquatic macrophyte from Maranchery wetland is represented by a variety of biological types (submerged, floating, and emergent taxonomic group were determined). The emergent weeds like reed grass, Nymphyea sps, was observed in Stations 4 and 5. Main floating type of macrophytes observed was Utricularia, Lemna, water hyacinth, and Salvinia. Water hyacinth was common in Stations 6 and 7 during three seasons. The submerged plants like Lymnophyllum sps, and Hydrilla were mainly represented in the freshwater ecosystem. Hydrilla was observed in Station 8. Large number of macrophyte species which grow in dense populations is evident in areas where in waters of those aquatic ecosystems input of organic and inorganic materials are enormous (Trajce Talevski *et al*, 2010).

8.7 Macrobenthos

Numerical abundance of macrobenthos was maximum in monsoon in all the study sations. The results are comparable to results of similar studies from Kadinamkulam backwater where maximum benthic production was observed in monsoon (Nair *et al.* 1984) which can be due to the changes associated with rain fall. The decay of vegetation present in the area might have contributed for food for benthos which also could have resulted in high numerical abundance of benthos during monsoon. Numerical abundance of macrobenthos was minimum in premonsoon. The water level was very low during this period, reduced numerical abundance of macrobenthos has been observed in previous studies during reduced water depth (Wills *et al.* 2006).

Fig.78. Monthly variations in phytoplankton biomass at Maranchery wetland during 2009-2011

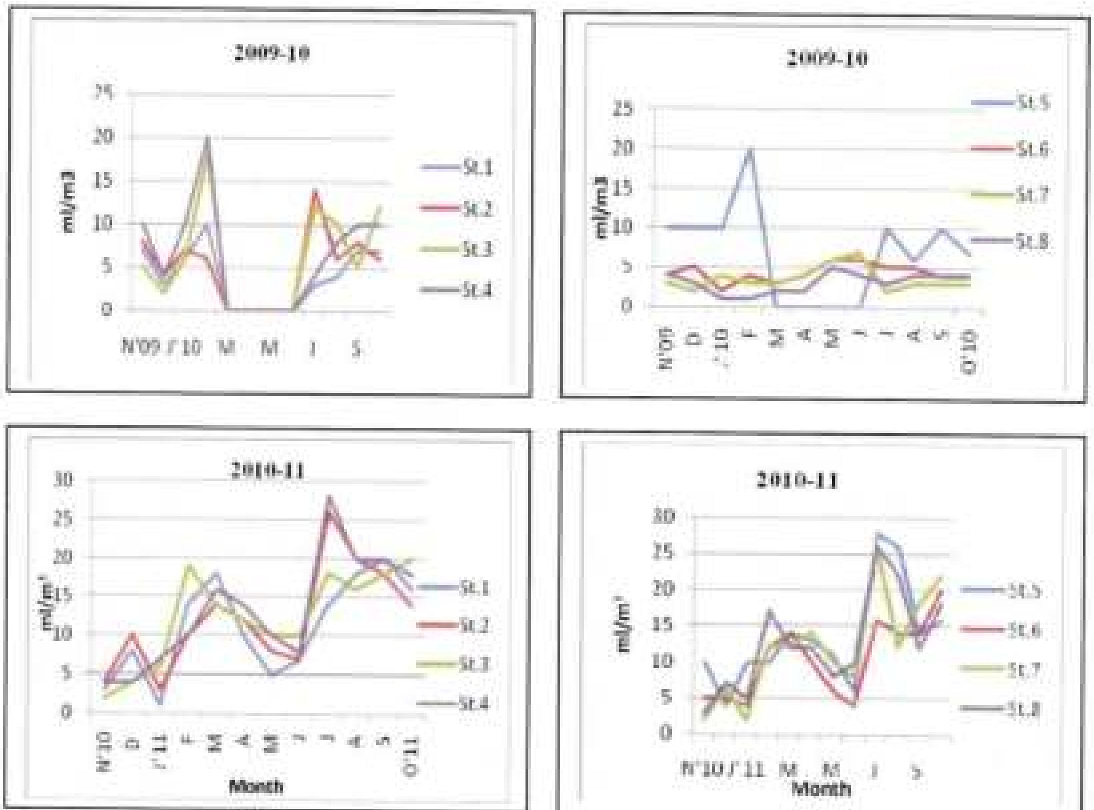


Fig.79. Seasonal variation in phytoplankton biomass at Maranchery wetland during 2009-2011

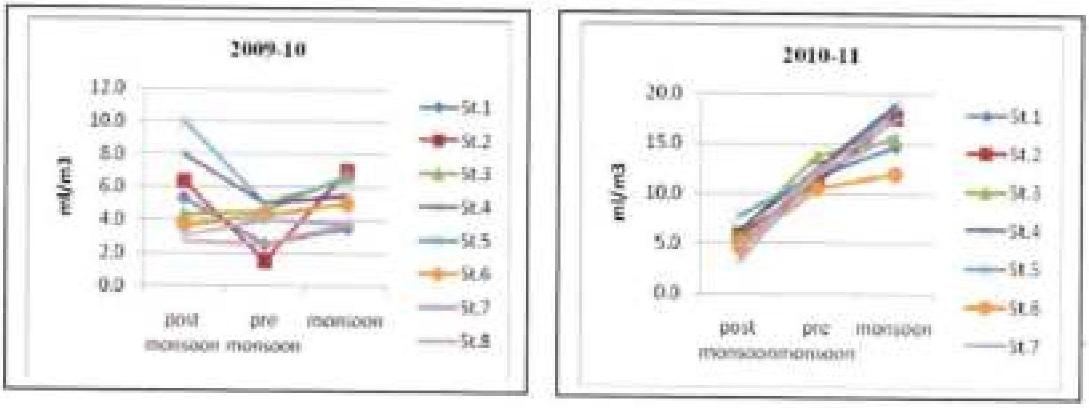


Fig.80. Monthly variations in zooplankton biomass at Maranchery wetland during 2009-2011

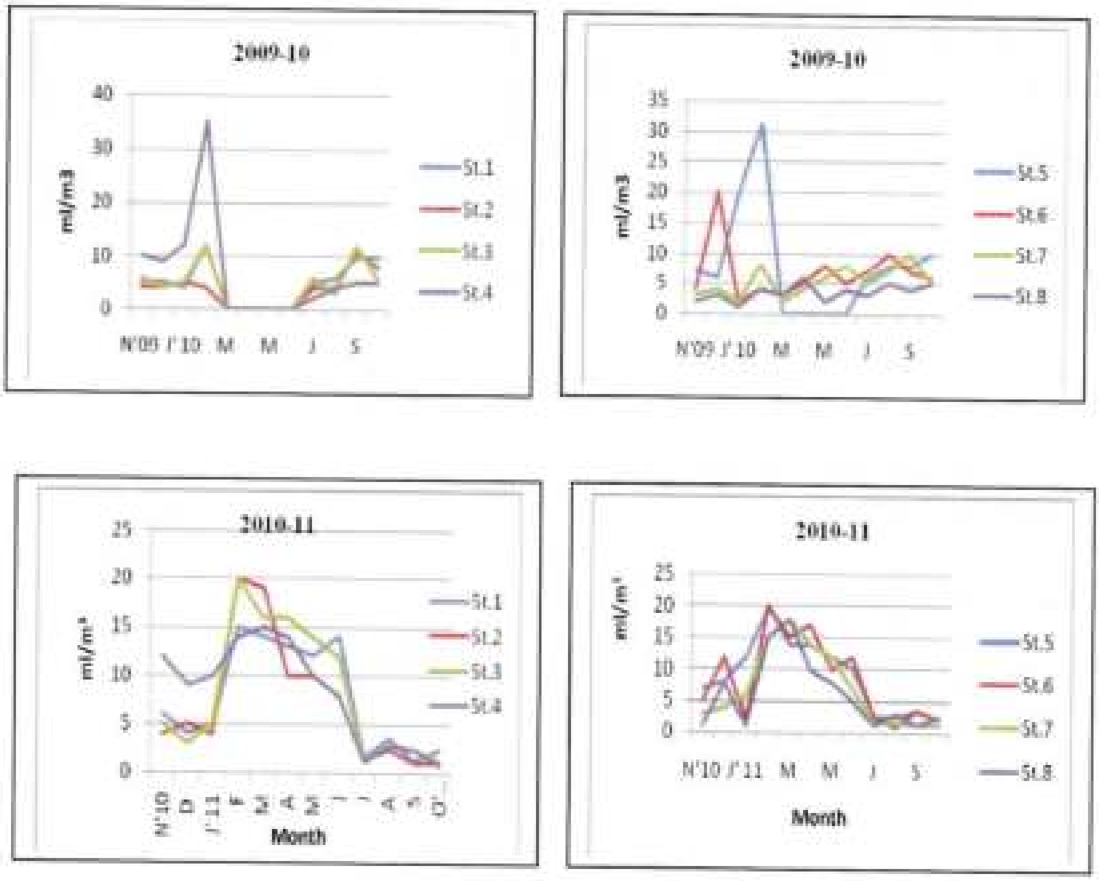


Fig.81. Seasonal variation in zooplankton biomass at Maranchery wetland during 2009-2011

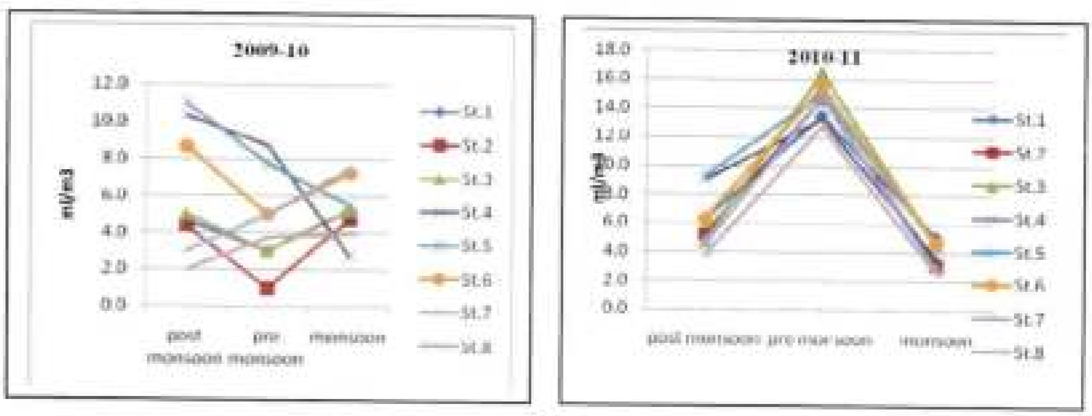


Fig.82

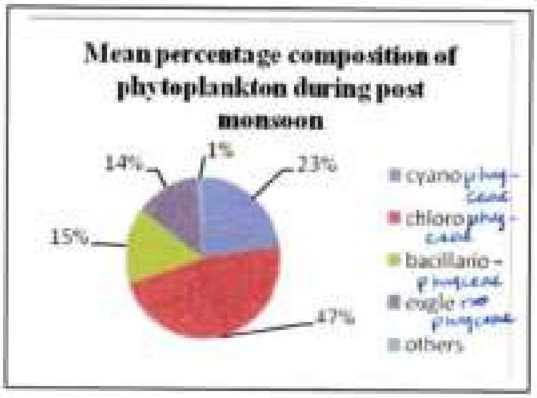
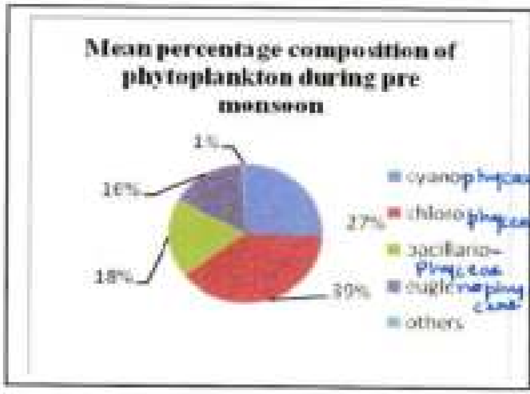


Fig.83



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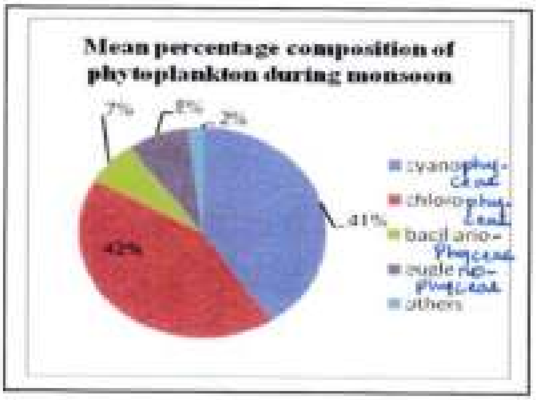

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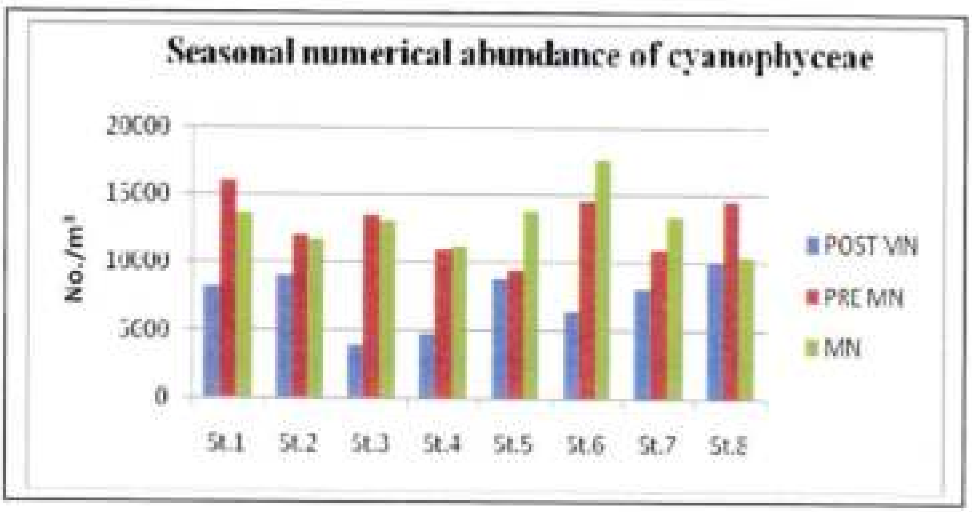


Fig.86

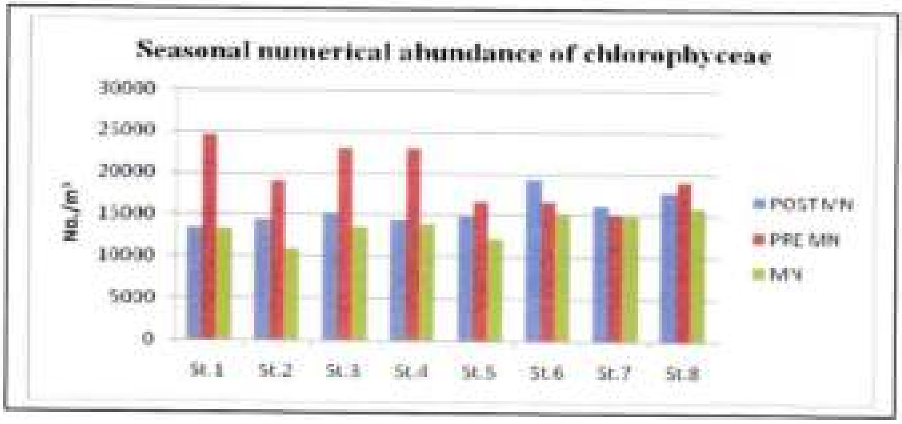
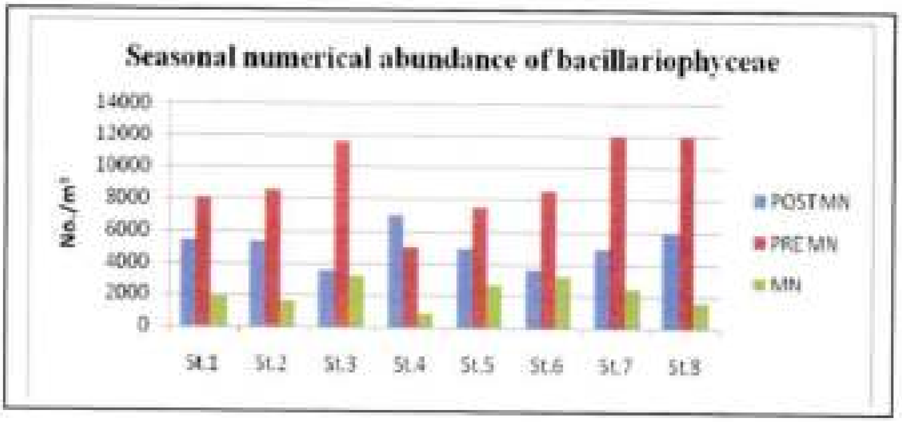


Fig.87



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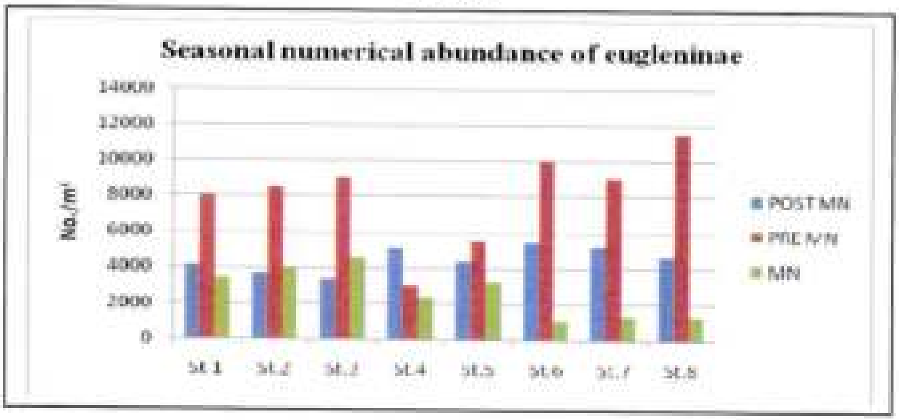

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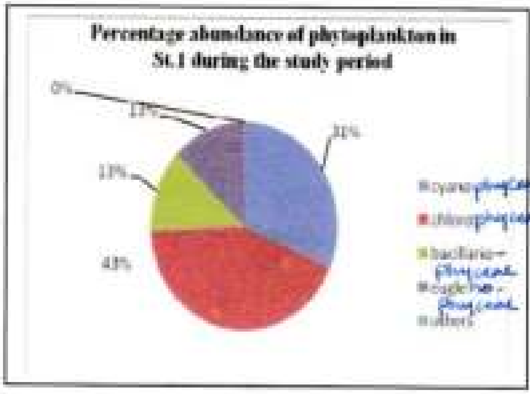

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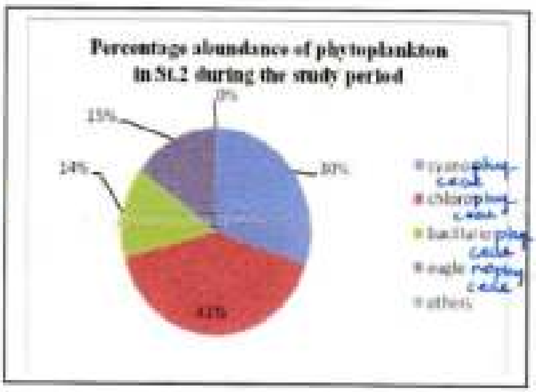

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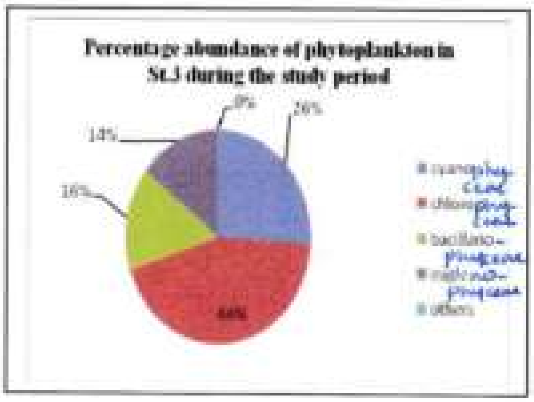
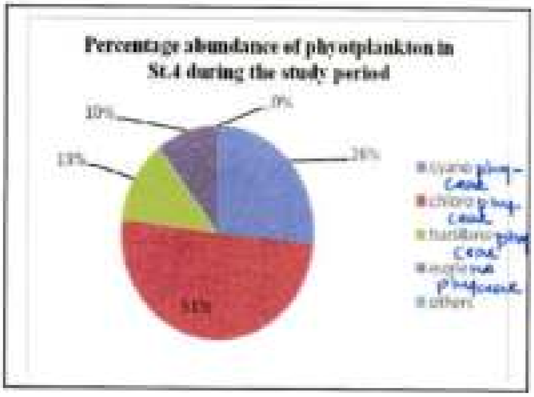


Fig.92



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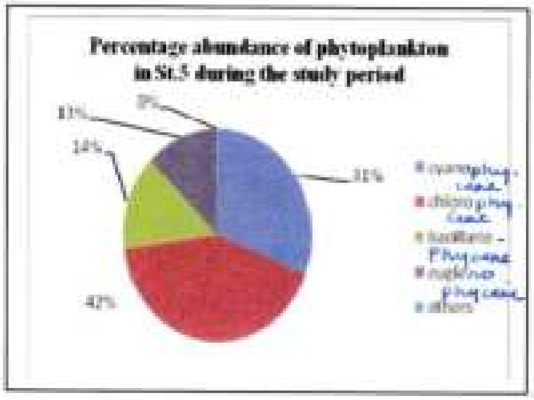

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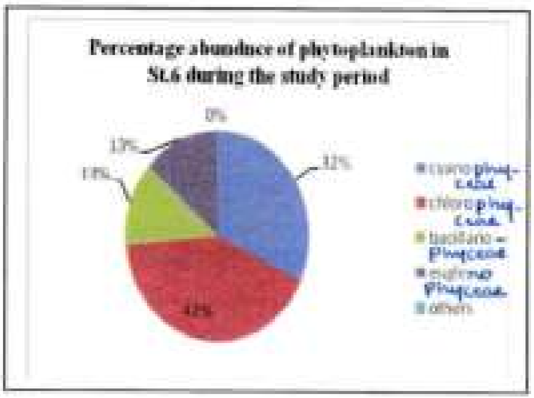

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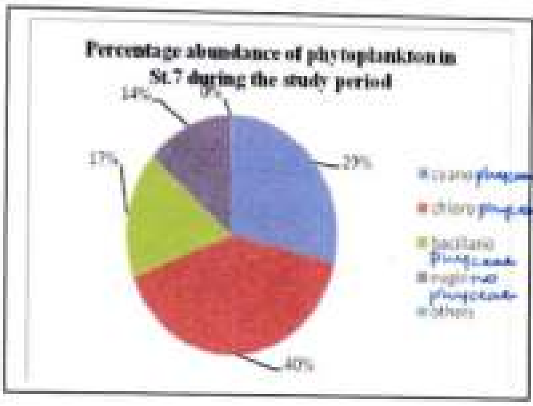

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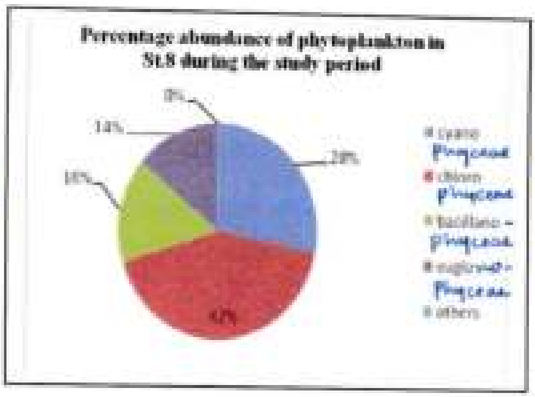

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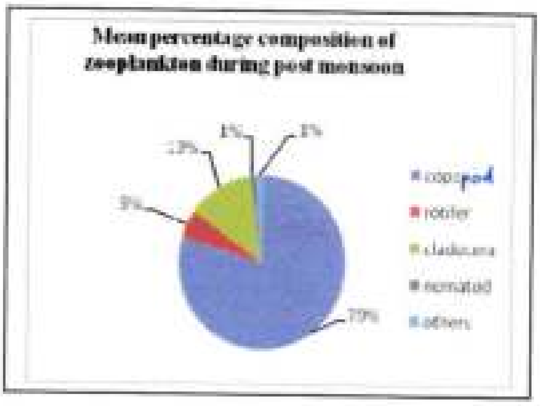
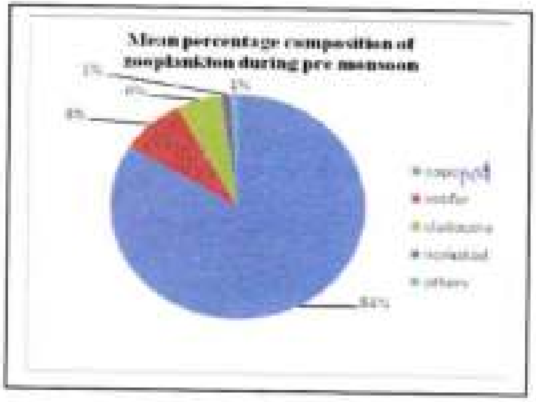


Fig.98



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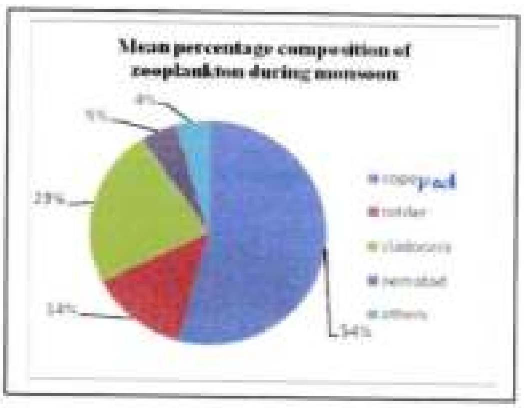

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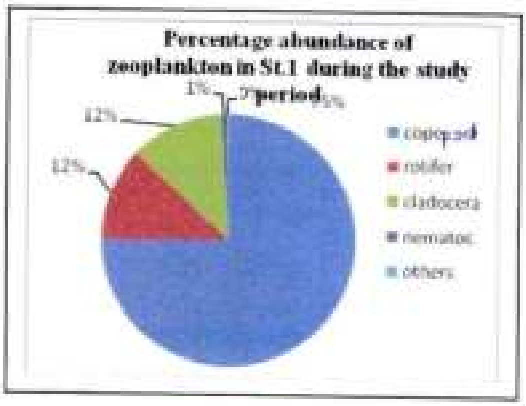


Fig.101

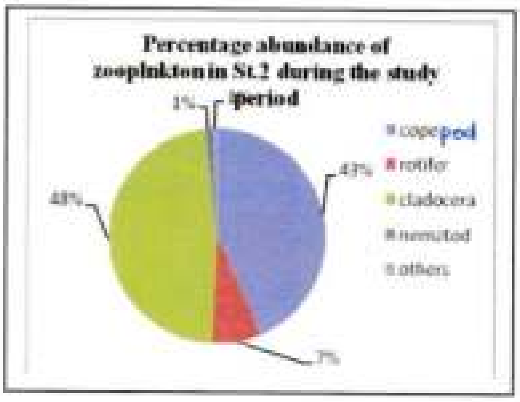


Fig.102

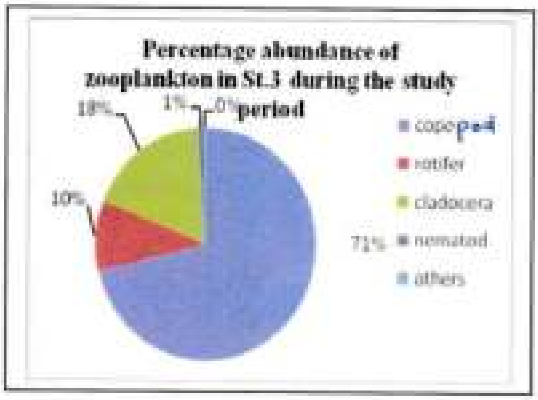


Fig.103

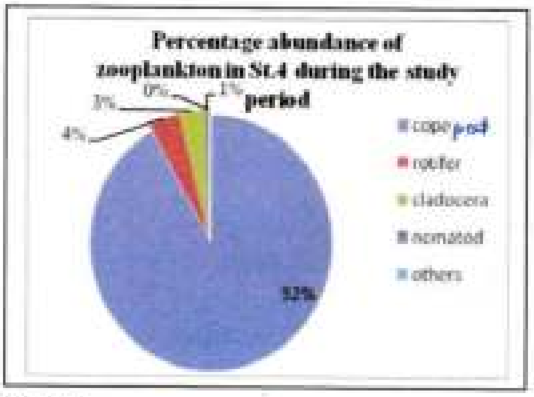
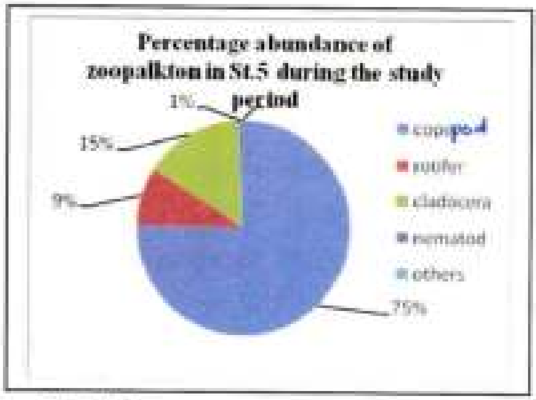


Fig.104



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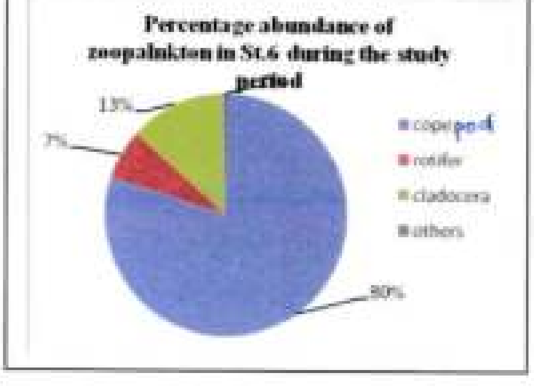

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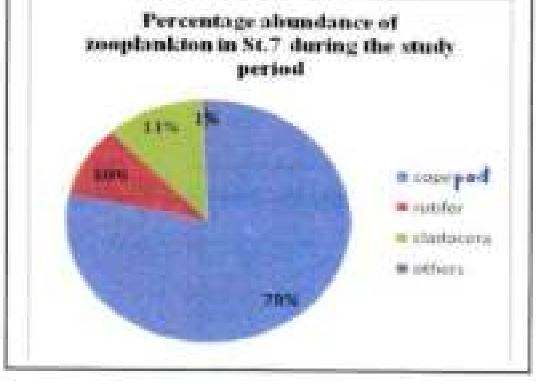

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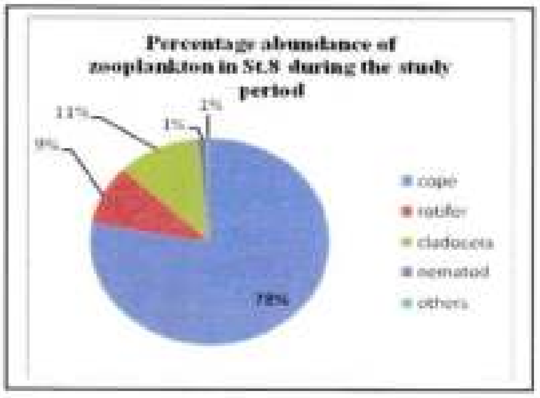


Fig.108

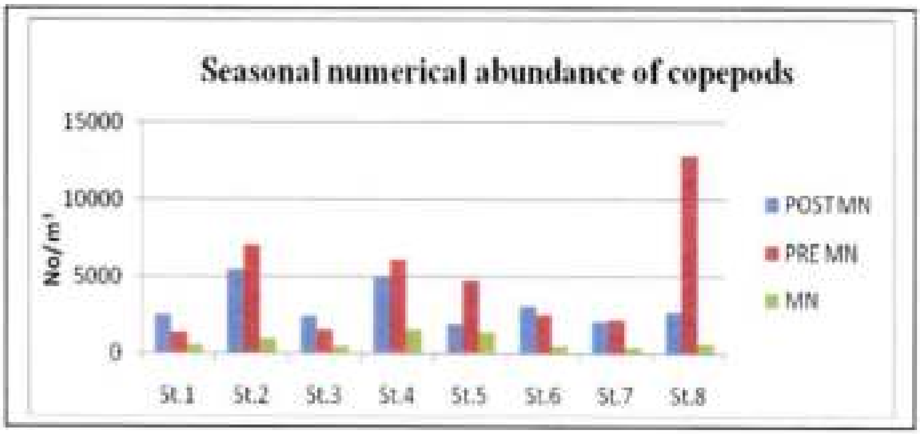
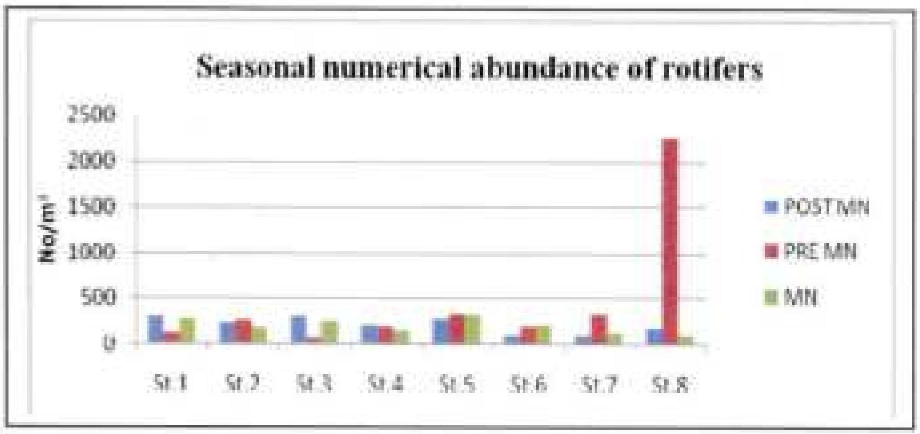


Fig.109



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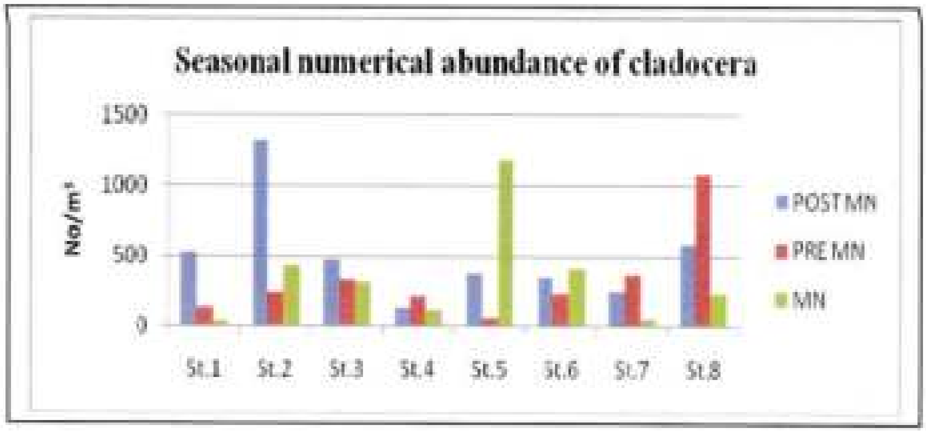


Fig. 111. Mean percentage composition of Aquatic Macrophytes at different sampling sites of Maranchery wetland

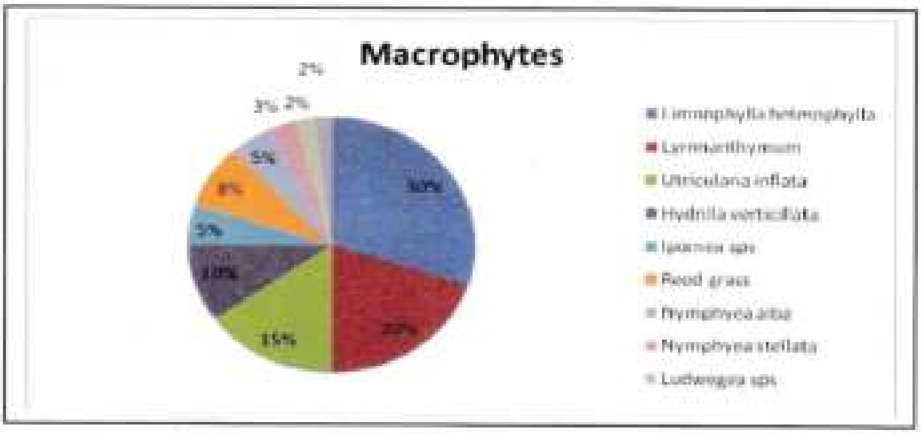


Fig.112

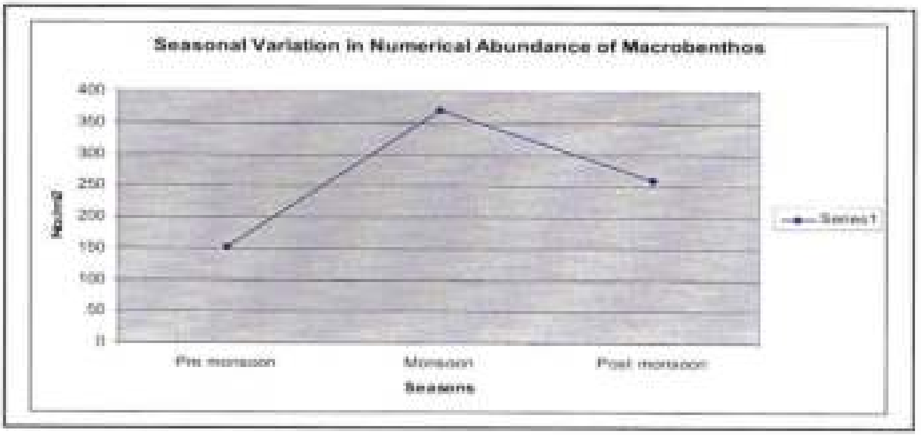
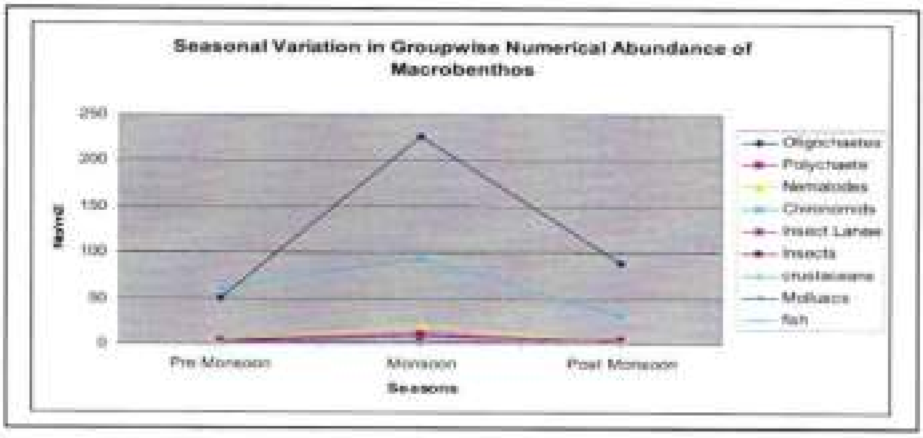


Fig.113



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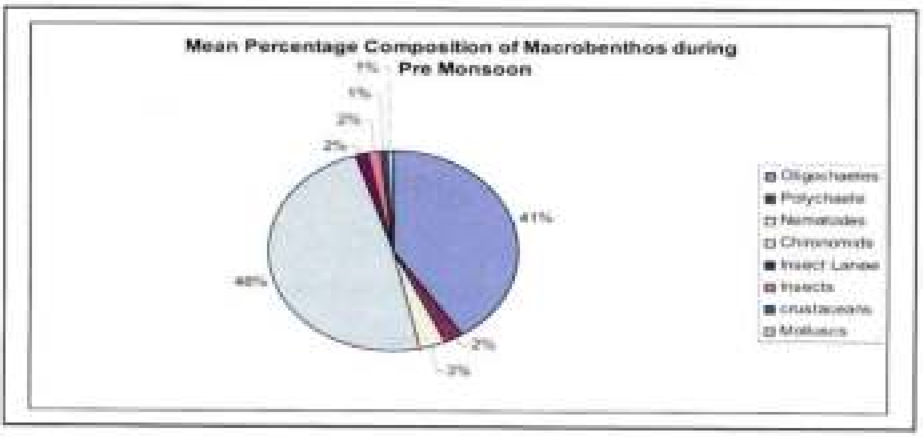

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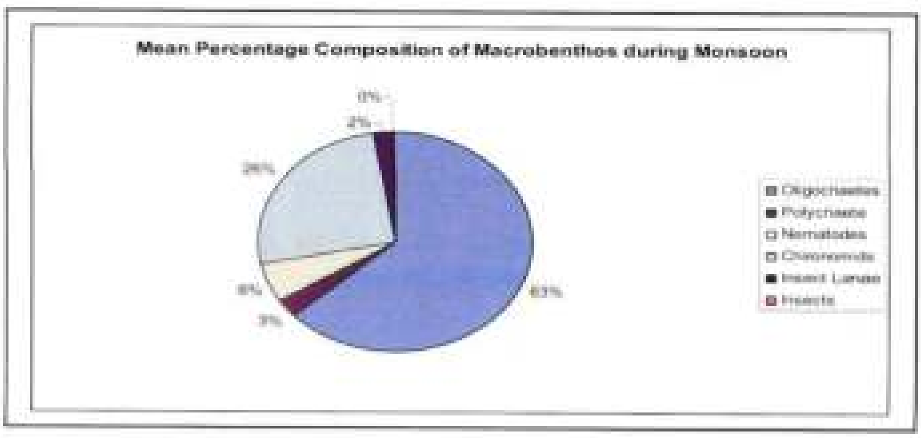
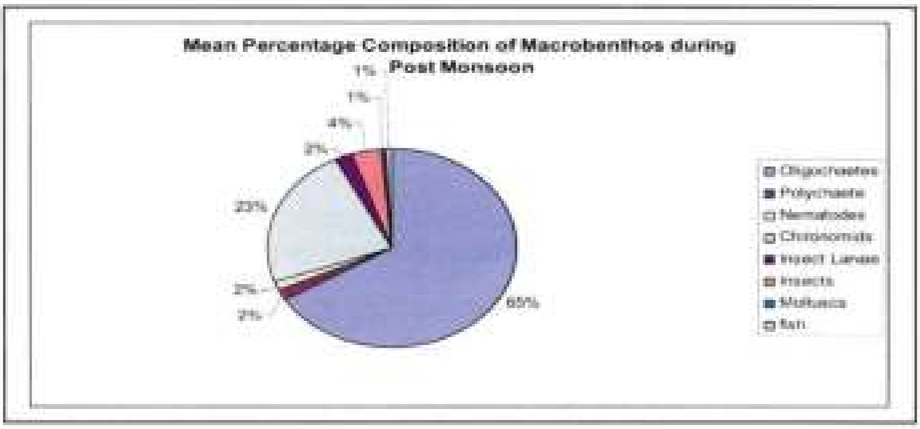


Fig.116



9. Summary and Conclusion

Thus from the study, it could be observed that the physico-chemical condition mainly represented by the temperature, pH, alkalinity, bicarbonates, calcium, dissolved oxygen, and dissolved nutrients showed that they were moderate and conducive for biotic production. Comparatively good primary production and chlorophyll content as well as the secondary productivity represented by the zooplankton and benthic fauna was a notable aspect of the study in the wetland system. High abundance of algae and several species of macrophytes also helped in fish production, which should also be considered seriously while implementing fish culture and harvesting operations in the water body. The presence of these macrophytes and the moderate algal growth helped to provide the required productivity and energy at the primary level which inturn gave sufficient turnover efficiency for the next trophic level represented by smaller zooplankton, insects and benthic organisms. This was very characteristics of the Maranchery wetland suitable for fish farming operations. Therefore, the stable nature with regard to the physico-chemical parameters and the biotic components showed that, the ecosystem is ideally suited for culture and native fish resources, like mullets, catfishes, puntius sps and common carp. It is suggested that, the Maranchery wetland ecosystem needs to be protected for the present primary and secondary production of the system for sustainable fishery production and its management in a long term basis.

10. Achievements: Publications

1.1 S. Vineetha, S. Amal Dev, T.A Thasneem, Akhilesh Vijay & S. Bijoy Nandan. 2010. **"Water Quality and productivity status of Maranchery Kole wetlands, Kerala, India"** in Green Path to Sustainability Prospects and Challenges *ISBN:978-81-907269-9-3* Proceedings of the International Conference on "The Green Path to Sustainability Prospects and Challenges" Regimol C Cherian, N Chandramohanakumar, S. Bijoy Nandan, O.V Reethamma, I'ma Neerakkal, Arun Augustine Editors. Organized by Assumption College, Changanassery from 7th to 9th July 2010.

1.2 S Vineetha, S Bijoy Nandan, Rakhi Gopalan, S Amaldev. 2010. **"Composition and abundance of benthic fauna in a tropical kole wetland, Kerala, India"** paper presented in first Indian Biodiversity congress IBC 2010 held at Trivandrum from 28th to 30th December.

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