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Fisherine Status and Their Link between Sediment CNP Content of Kadinamkulam Estuary at Kerala, India

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Abstract Sediment characteristics of the aquatic environment reflect the quality of overlying water. In this context the organic carbon (C), total nitrogen (N), total phosphorous (P) levels can be used as indicators of water condition. In the present study the CNP contents of the Kadinamkulam estuary (southern India) was analysed. Both the sediments and the survey of fin and shell fishes of the same estuary were carried on monthly for twelve months (April 2013-March 2014). The results were correlated by Karl-Pearson correlation coefficient. A total of 30 fish specimens and sediments needed for analyses were collected. As a result of the study some organisms showed certain level of significance with the C N P contents tested.

Keywords: *carbon, nitrogen, phosphorous, sediment and backwater*

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1. Introduction

Estuarine sediments are richer in organic matter than those of the adjacent sea. The richness of nutrients in an aquatic system is mainly dependent on the sediments and sediment water interactions [16]. The three most important basic elements which support the aquatic productivity are carbon (C), phosphorus (P) and nitrogen (N). These elements are trapped in sediments either by adsorption or undergo desorption into water column to be made available to the primary producers [8]. Fine grained bottom sediments are formed out of suspended material and have a composition that reflects the original suspended material with geochemical, biological and geological processes operating in the aquatic environment [7]. Total organic carbon of the sediment has a major role in keeping the fertility of soil and there by flourishing the biological productivity. One of the features of organic carbon in the sediments is that its concentration increases as the particle size of the sediments decreases [19]. Anila Kumary *et al.* [2] suggested that the organic carbon widely showed enrichment always at the polluted zone and organic carbon content was more than the prescribed limit in some unpolluted stations of an estuary. Biological activity may play a significant role in the phosphorus availability in the sediments. The surface sediments had significantly higher total concentrations of phosphorus compared to bottom [13]. It is necessary to understand how the diversity of life particularly at the species level is maintained and it is equally necessary to know how the terminal extinction of species takes place under natural conditions. Hence, the present study aims to quantify the fish and shellfish resources of the Kadinamkulam backwater to know the real stocks present in such environment and the influence of sediment CPN in the survival of fauna.

2. Material and Methods

2.1. Study Site

Kadinamkulam estuary is a shallow backwater with a mean depth of 2.11 ± 0.27m. The nature of the mouth depends on the extent of sand bar formation and it normally gets closed completely for varying periods during the premonsoon with the diminishing freshwater discharge. The bulk of the basin lies southwardly and it is connected with another small backwater namely the Veli Lake by Parvathiputhanar canal at the southern reaches. For the present study, three stations were selected. They are 1. Chanankara, 2. Kadathumuku and 3. Thonikadavu.

Station I - Chanankara: It is the southern part of the backwater. The Parvathi puthanar canal from Veli Lake enters the Kadinamkulam backwater at this region. The lake is being reclaimed for retting on a large scale as well as for land use in this region.

Station II - Kadathumuku: A broad segment of the lake on both sides has been flanked by the retting of coconut husks. This region is highly polluted due to retting process and there is regular draining, filling and reclamation of the backwater along the shallow peripheral areas.

Station III - Thonikadavu: The backwater opens to the sea at this place and remains open for about 8-10 months in a year exposing the entire ecosystem with the influence of tidal flux of the sea. Manual dredging of sand is prevalent in this region. The eastern bank of the lake at this area is protected by the granite blocks and on the west bank there is always heavy deposition of sand from the Vamanapuram River and it is a rich fishing zone.Three kilometers of distance was framed between each station.

2.2. Collection of Samples

Monthly survey of finfishes and the shellfishes of Kadinamkulam, Kerala coast were carried out in the present study. All specimens were sorted at the species level and were countedand weighed on board. The same net was used for all sampling; the mesh size for the net opening was 6.3 cm, the depth of the net opening was 6m, the width of the net opening was 22.6m, the mesh size of the cod end was 2cm, and the trawling speed was approximately 4.82 km/h (2.6 knots). The survey was carried out in fresh morning during 4 am. Every month three surveys were taken and made into mean values. Each species was countedseparately. The fishes needed for identification were taken assamples. Samples of fishes and shellfishes were preserved in 4% formalin for identification. Identification of fishes was carried out using standard keys [10,14,20].

Stratified random sampling method was followed to assess the count of each species. In statistical surveys, when subpopulations within an overall population vary, it is advantageous to sample each subpopulation (stratum) independently. Stratified random sampling is a probabilistic sampling option. The first step in stratified random sampling is to split the population into strata, i.e. sections or segments. The strata are chosen to divide a population into important categories relevant to the research interest. Stratified random sampling method was followed to assess the count of each species [12].

A stainless steel, plastic lined grab was used to collect sediment samples. Collected samples were oven dried and carefully transferred to polythene bags. A part of the collected samples were at 80 ± 1°C. The dried samples were grained to fine powder with the help of a mortar and pestle. They were then packed for sediment analysis.

2.3. Analysis of Sediments

The total organic carbon from sediment samples were made by the Walkley and Black method modified by Trivedy and Goel [21]. Total phosphorous by modified method of Murphy and Riley and the total nitrogen content was determined by microkjeldahl method [9].

The analytical study of sediments and the survey study of fishes were carried out for a period of one year (April 2013 to March 2014). Stratified random sampling method was followed to assess the count of each species [12]. The percentage of the species and correlation between the C N P contents and each species were analyzed by Karl Pearson Correlation Coefficient [11].

3. Results

The monthly distribution of C N P values are presented in Figure 1, Figure 2 and Figure 3 and Table 4. The mean distribution of the organic carbon in the sediment was 3.41 mg/g which ranged between 3.08 mg/g in station I and 3.68 mg/g at station II. The mean total nitrogen of sediment was 0.53 mg/g ranging from 0.45 mg/g in station II to 0.6 mg/g in station III. The mean phosphorous content of sediment was 3.67 mg/g with a minimum of 3.08 mg/g in station II and a maximum of 4.49 mg/g in station III.

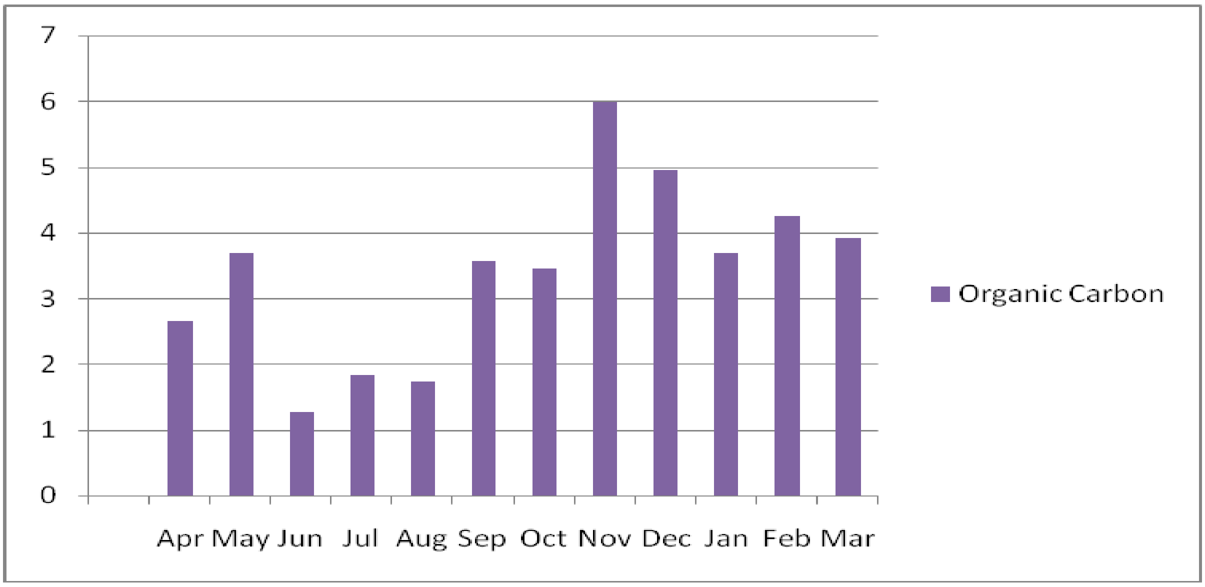

Figure 1. Bar graph showing monthly variations of sediment Carbon (mg/g) in Kadinamkulam backwater

The occurrence of fin and shellfishes in Kadinamkulam backwater and its correlation significance with sediment C N P contents are presented in Table 1, Table 2 and Table 3. A total of thirty species of fin and shellfishes were recorded from Kadinamkulam backwater. The mean occurrence of *Terapon jarbua* showed a significant negative correlation with organic carbon. The percentage of *Caranx sehfsciatis* showed a significant positive correlation organic carbon. The percentage of *C. ignobilus* showed a highly significant negative correlation with organic carbon. *Puntius filamentosus* showed a significant positive correlation with organic carbon and the percentage of *Anguilla bengalensis* showed a significant positive correlation with organic carbon. The percentage of *Scylla serrata* showed a significant positive correlation with total nitrogen.

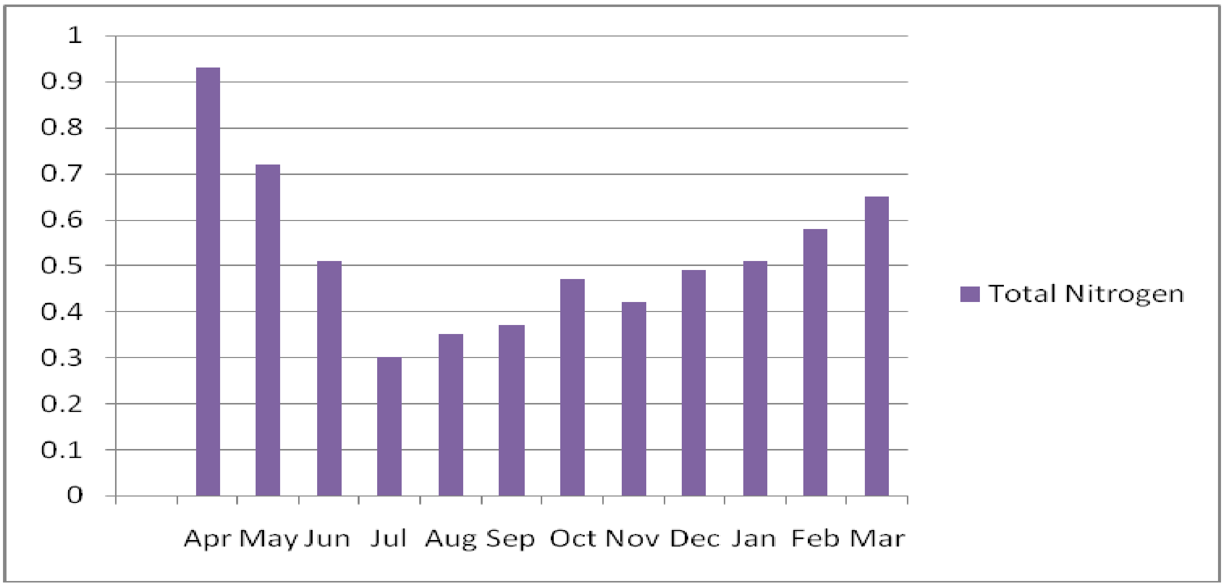

Figure 2. Bar graph showing monthly variations of sediment Nitrogen (mg/g) in Kadinamkulam backwater

Table 1. Species composition of selected backwaters

Sl. No.	Order	Family	Species
1	Elopiformes	Elopidae	*Elops machnata* (Forsskal)
2	Elopiformes	Megalopidae	*Megalops cyprinoids* (Broussonet)
3	Elopiformes	Tachysuridae	*Tachysurus subostratus* Valenciennes)
4	Siluriformes	Bagridae	*Mystus gulio* (Hamilton)
5	Siluriformes	Hemiramphidae	*Hyphorhampus improvis* (Valenciennes)
6	Siluriformes	Mugilidae	*Mugil cephalus (*Linnaeus)
7	Siluriformes	Mugilidae	*Liza parsia* (Hamilton-Buchanan
8	Siluriformes	Mugilidae	*Valamugil Cunnesius* (Valenciennes)
9	Siluriformes	Teraponidae	*Terapon jarbua* (Forsskal)
10	Siluriformes	Carangidae	*Caranx ignobilus* (Forsskal)
11	Siluriformes	Carangidae	*Caranx sehfsciatis* (Bloch)
12	Siluriformes	Lutjanidae	*Lutjanus johni* (Bloch)
13	Siluriformes	Gerridae	*Gerrus filamentosus* (Cuvier)
14	Perciformes	Cichlidae	*Oreochromis massambica* (peters)
15	Perciformes	Cichlidae	*Etroplus suratensis* (Bloch)
16	Perciformes	Cichlidae	*Etroplus maculates* (Bloch)
17	Perciformes	Gobiidae	*Glossogobius giuris* (Hamilton-Buchanan)
18	Perciformes	Anabantidae	*Anabas testudineus* (Bloch)
19	Perciformes	Ambassidae	*Chanda nama* (Hamilton-Buchanan)
20	Perciformes	Ambassidae	*Chanda ranga* (Hamilton-Buchanan)
21	Cypriniformes	Anguillidae	*Anguilla bengalensis* (Gray)
22	Cypriniformes	Cyprinidae	*Calta calta* (Hamilton-Buchanan)
23	Cypriniformes	Cyprinidae	*Puntius filamentosus* (Valenciennes)
24	Cypriniformes	Scatophagidae	*Scatophagus argus* (Bloch)
25	Cypriniformes	Aridae	*Arius arius* (Hamilton-Buchanan)
26	Decapoda (class: crustacea)	Penaeidae	*Metapenaeus brevicornis* (Milne Edward)
27	Decapoda (class: crustacea)	Penaeidae	*Metapenaeus dobsoni* (Meirs)
28	Decapoda (class: crustacea)	Penaeidae	*Penaeus monodon* (Fabricius)
29	Decapoda (class: crustacea)	Penaeidae	*Penaeus indicus* (Milne Edward)
30	Decapoda(class: crustacea)	Portunidae	*Scylla serrata (Forsskal)*

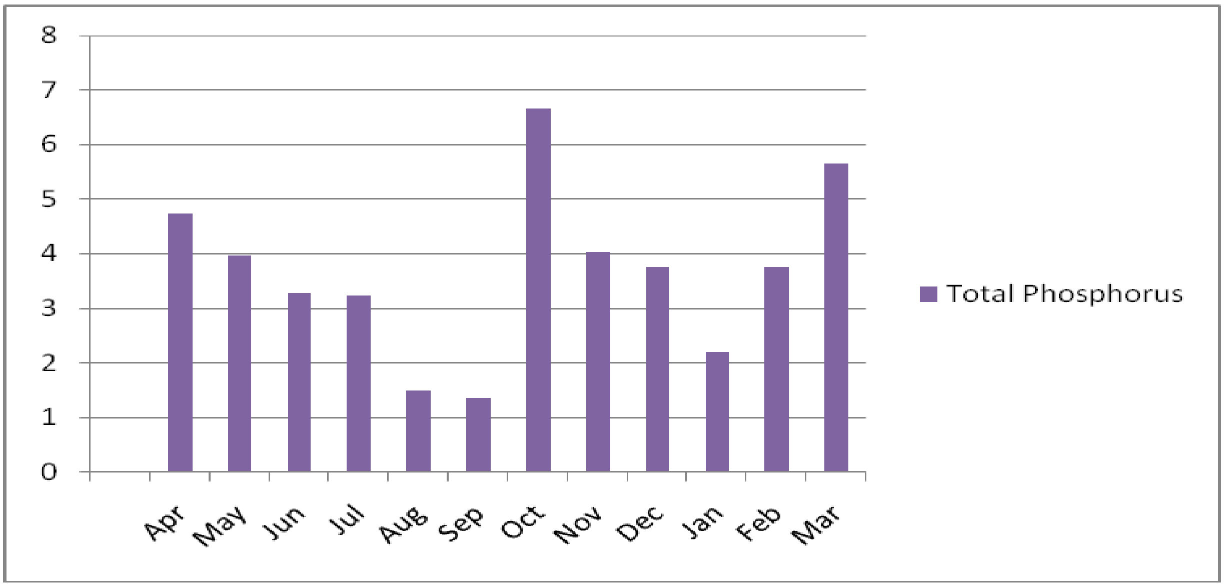

Figure 3. Bar graph showing monthly variations of sediment Phosphorus (mg/g) in Kadinamkulam backwater

Table 2. Biodiversity of Fin and shellfishes of Kadinamkulam backwater (%)

Name of fish	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Oreochromis mossambica	34.34	29.43	50.50	8.19	1.81	0.00	0.00	42.55	40.47	11.24	26.10	28.26
Etroplus suratensis	28.62	30.66	12.29	11.13	1.04	2.62	3.88	5.00	3.04	38.32	5.22	2.77
Etroplus maculatus	0.00	0.00	5.05	0.82	0.64	1.56	1.97	2.47	1.21	1.33	0.52	0.13
Terapon jarbua	0.57	0.00	0.63	0.82	0.00	0.51	0.82	0.00	0.00	0.00	0.00	0.15
Caranx sehfsciatis	1.72	0.00	3.79	3.24	1.82	2.82	3.95	0.00	0.00	0.00	0.42	0.10
Caranx ignobilus	2.29	3.68	7.68	8.29	3.61	2.89	3.95	0.00	0.00	1.57	0.42	0.15
Chanda ranga	0.97	2.15	0.63	0.40	0.00	0.87	0.90	0.84	0.66	0.00	0.00	0.00
Chanda nama	0.00	0.00	3.79	0.40	0.00	1.78	2.18	3.34	0.56	0.26	0.16	0.21
Mugil cephalus	11.45	14.71	2.56	8.19	1.81	3.61	7.89	5.19	4.88	0.00	1.04	0.41
Channa marulius	0.00	0.00	2.56	0.16	0.10	0.00	0.00	1.01	0.32	1.53	0.52	0.36
Channa striatus	0.00	0.00	0.00	0.65	0.17	0.51	0.00	0.57	0.22	0.00	0.00	0.00
Megalops cyprinoides	6.87	4.29	1.89	1.01	0.31	2.11	3.95	1.31	1.67	1.55	0.63	0.28
Gerrus filamentosus	0.00	0.00	1.89	2.48	0.00	5.66	7.89	2.47	3.54	3.07	0.42	0.28
Puntius filamentosus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.67	0.00	0.00	0.00
Anabas testudineus	1.14	2.45	2.56	0.49	0.00	0.00	0.00	0.00	0.73	1.02	0.21	0.31
Mystus gulio	5.72	3.07	0.50	1.62	0.00	0.00	0.00	0.61	0.56	1.59	0.15	0.07
Arius arius	0.00	0.00	0.76	0.82	0.00	0.00	0.00	0.00	0.00	1.61	0.21	0.07
Tachysurus subostratus	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.26	0.00	0.00	0.00
Valamugil cunnaecius	5.72	6.13	1.28	1.66	0.00	8.71	7.87	2.85	2.25	0.00	0.00	0.00
Liza parsia	0.00	0.00	0.38	0.00	0.00	7.84	7.89	2.55	2.67	0.00	0.21	0.13
Elops machnata	0.00	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.32	0.00	0.00	0.28
Hyphoramphus improvis	0.00	0.00	0.50	0.32	0.00	2.71	0.82	0.87	0.30	0.00	0.00	0.00
Periophthalmus weberi	0.00	0.00	0.50	0.16	0.18	0.33	0.40	0.20	0.00	0.00	0.00	0.00
Glossogobius giuris	0.00	0.00	0.00	0.00	0.00	0.87	0.40	0.09	0.36	0.00	0.00	0.00
Anguilla bengalensis	0.00	0.00	0.00	0.00	0.00	0.53	0.40	0.61	0.79	0.00	0.00	0.00
Scylla serrata	0.57	0.67	0.26	0.08	0.18	0.20	0.19	0.15	0.10	0.05	0.03	0.26
Penaeus monodon	0.00	0.00	0.00	0.00	0.16	0.03	0.03	0.09	0.02	0.05	0.05	0.00
Penaeus indicus	0.00	2.76	0.00	49.06	88.19	48.15	38.84	25.73	34.40	36.79	63.69	65.77
Metapenaeus brevicornis	0.00	0.00	0.00	0.00	0.00	2.56	3.67	0.49	0.00	0.00	0.00	0.00
Metapenaeus dobsoni	0.00	0.00	0.00	0.00	0.00	2.56	1.89	0.49	0.00	0.00	0.00	0.00

Table 3. Karl Pearson correlation showing the significance (5%) by relating the number of fishes and sediment parameters of Kadinamkulam backwater

Name of fish	Organic carbon	Total Phosphorous	Total Nitrogen
Oreochromis mossambica	0.27	0.23	0.23
Etroplus suratensis	-0.13	-0.10	-0.10
Etroplus maculatus	-0.17	-0.09	-0.09
Terapon jarbua	-0.56*	0.24	0.24
Caranx sehfsciatis	-0.69*	0.00	0.00
Caranx ignobilus	-0.83**	-0.18	-0.18
Chanda ranga	0.15	0.21	0.21
Chanda nama	0.08	0.08	0.08
Mugil cephalus	-0.05	0.34	0.34
Channa marulius	-0.14	-0.18	-0.18
Channa striatus	0.17	-0.36	-0.36
Megalops cyprinoides	-0.09	0.38	0.38
Gerrus filamentosus	0.18	0.12	0.12
Puntius filamentosus	0.67*	0.06	0.06
Anabas testudineus	-0.37	-0.03	-0.03
Mystus gulio	-0.17	0.13	0.13
Arius arius	-0.30	-0.33	-0.33
Tachysurus subostratus	0.30	0.38	0.38
Valamugil cunnaecius	0.10	0.18	0.18
Liza parsia	0.27	0.12	0.12
Elops machnata	0.26	-0.23	-0.23
Hyphoramphus improvis	0.14	-0.29	-0.29
Periophthalmus weberi	-0.39	-0.06	-0.06
Glossogobius giuris	0.23	-0.17	-0.17
Anguilla bengalensis	0.65*	0.04	0.04
Scylla serrata	-0.18	0.26	0.26
Penaeus monodon	0.10	-0.44	-0.44
Penaeus indicus	0.00	-0.25	-0.25
Metapenaeus brevicornis	0.10	0.24	0.24
Metapenaeus dobsoni	0.14	-0.02	-0.02

* Significant ** highly significant.

Table 4 Monthly mean distribution of sediment CNP in Kadinamkulam backwater (mg/g)

Sediment parameter	Station-I	Station-II	Station-III	Mean
Carbon	3.08 ± 8.46	3.68 ± 9.43	3.48 ± 7.18	3.41 ± 0.31
Nitrogen	0.53 ± 0.15	0.45 ± 0.14	0.60 ± 0.28	0.53 ± 0.08
Phosphorous	3.43 ± 1.65	3.08 ± 1.03	4.49 ± 3.01	3.67 ± 0.73

4. Discussion

Total organic matter accumulated in soils form a major portion of world's fixed carbon reserves. Study of organic carbon in the sediments is of potential significance for a proper understanding of water flow in aquatic ecosystems [15]. Abrupt changes of carbon values were noticed in most seasons due to dynamic nature of the substratum [16]. The present study results illustrated that in most of the month's carbon values were found fluctuating irrespective of seasons. Organic carbon in the present study can be attributed to the presence of larger sand fractions and less silt content. Organic carbon content increases with increasing finer fractions and decreases with increasing coarser fractions in sediments. Our studies agree that sediment particle size and organic carbon revealed a significant positive correlation of organic carbon with silt fraction [19].

According to Cai et *al*. [3] heavy erosion and high sedimentation with heavy siltation altered the fisheries both in the newly created lacustrine environment and downstream areas. The present findings revealed that organic carbon and sand content were found to be higher during premonsoon, while available nitrogen, and available phosphorous were maximum during monsoon. The post-monsoon season was characterized in having lowest available phosphorous, available nitrogen and moderate level of other parameters [4].

In the present study irregular pattern of sediment nitrogen is due to the movement of sediment particles by the mixing process and river discharges. A considerable amount of it may be leached downward into the bottom mud from where it is either lost through leaching by further downward movement or gets denitrified into the aerobic zone and escapes into the atmosphere [6].

Organic phosphorus constitutes about 30-40% of the overall phosphorous and is of little significance in supplying phosphorus to plankton because of slower rate of mineralization under anaerobic condition at the bottom. The bound phosphorus content of the study sites reflects higher values than dissolved phosphate content of water. Phosphate is strongly absorbed by clay hydrous oxides of iron, aluminium and calcium carbonate. When a soil undergoes reduction, some of the adsorbed phosphate is released into the soil solution because of reduction of ionoxide and the release of Ph [1]. The high level of phosphorus in our study refllects the above findings.

The extent of onshore migration of fish and shellfish are dependent on their extreme tolerance level of the environmental parameters [5,22]. In the present results the significance level tested by Karl Pearson correlation coefficient (5% level) also proves the above statement. According to Sinha [18] heavy erosion and high sedimentation with heavy siltation altered the fisheries both in the newly created lacustrine environment and downstream areas. The immeasurable quantities of organic wastes added to these water bodies increase the BOD and caused depletion of dissolved oxygen levels. The high level of phosphate and nitrates present in domestic sewage and agricultural run off accelerated the process of eutrophication.

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