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# Seasonal Variations in Physicochemical Parameters and Primary Productivity of Shelar lake Bhiwandi, Thane, Maharashtra

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## Abstract:

**Water has unique physico-chemical properties. It serves both as a factor and an environmental medium or substratum in which organisms live. Water in the ponds, lakes and river basins is economically more important as it is medium that serves the members of a community who use it. Shelar Lake is a fresh water body with its prime earlier use for drinking and irrigation. Now a day, this water body is undertaken for fish cultivation. Water quality plays an important role in productivity of lake. In present investigation, physical and chemical parameters of the water body such as temperature, pH, turbidity, conductivity, TDS, DO, BOD, COD, free $CO_2$, alkalinity, nitrates, nitrites, sulphate and phosphate along with primary productivity were analyzed seasonally. The productivity of the lake was found to be influenced by some of the physical and chemical parameters of the lake water.**

**Keywords:** Fresh water body, primary productivity, Water quality.

## 1.0 Introduction:

Limnological investigations on water bodies were generally aimed to assess the water quality and its interaction with biotic and abiotic factors. The role of water in nature is unique not only from the point of human consideration; even the numerous organisms make aquatic medium their habitat. The physical and chemical properties of freshwater bodies are characterized by the climatic, geochemical, geo-morphological and pollution conditions. The quality of aquatic life depends on the water quality. In order to utilize fresh water bodies successfully for fish production, it is very important to study the physico-chemical factors which influence the biological productivity of the water body. Physical parameters for water quality such as turbidity, conductivity and water mass influence the chemical nature of the water. The Indian environmental researchers has recently described the condition of Indian freshwater resources and their management as a prominent environmental problem with nutrition enrichment, acidification and domestic waste, sewage, agricultural and industrial effluents contamination by toxic substances identified as major impact (Murthy and Yajurudi, 2006).The requirement of water to all living organisms from microorganism, to man, is a serious challenge today because all water resources are polluted due to unplanned urbanization and industrialization(Kamatand Sima, 2000; Shidda Mallayya and Pratima, 2008). This makes them vulnerable for human impact and changes day by day, measuring which would probably give a clear picture about the pollutions stress on them (Raja et al,2008). Lakes and reservoirs hold a great promise as a source of fresh water. Unfortunately, these ecosystems are being neglected and destroyed in rural as well as in urban areas. Thane are a district in North of Maharashtra state in Western India. Many artificial lakes have been constructed in this area to supply drinking water to Mumbai. There are many small lakes and ponds in these areas. Despite the fact that, a good clean fresh water body bestows incalculable economical, ecological and aesthetic benefits to a place very little efforts have been made for the protection and conservation of the aquatic ecosystem. Shelar Lake is a fresh water body

situated in the rural area of Thane district. It lies between $18^0$42'and $20^0$20' North latitude and $72^0$45'and $73^0$45' East longitude. Earlier this water body was used for drinking and for irrigation. Now a day it is used for fish cultivation. Enhanced population explosion, rapid rate of encroachments and increase in utilization of lake water for disposal and dilution of sewage etc have not only deteriorated the water quality of lake but has also affected the biotic flora. The ability to bring about a change prior to total loss of a system depends largely on the prior information pertaining to the background conditions of the system. Hence base line monitoring of aquatic systems is of critical importance. It was in this context that, this pioneering study from the Shelar Lake discusses the intricate variations in water quality seasonally in relation to primary productivity.

**Sampling Station towards North- West of the Lake**

## 2.0 Material and Methods:

The water samples were collected from already fixed three sampling stations of the lake considering the topographic dissimilarities, human activities at these sites. The samples were collected monthly from all stations of the lake in the polythene cans which were washed with tap water, rinsed with HCL and then thoroughly washed with distilled water and dried. These water samples were preserved for further studies in the laboratory. The physico-chemical parameters analyzed as per standard methods mentioned in the standard methods by Trivedi and Goel (1986) and APHA (2005). Parameters such as Free $CO_2$, temperature, transparency were recorded on the spot only. The water samples for dissolved oxygen were fixed by using Winkler's reagents on the spot.

## 3.0 Results and Discussion:

On the basis of standard methods Physico-chemical parameters of three seasons (pre-monsoon, monsoon and post monsoon) from February 2010 to January 2011 are studied. Monthly data was collected from three sites. Arithmetic mean of all the values of the parameters was calculated and given in Table-1

### *3.1 Physical Parameters*

Surface water temperature has pronounced effect on chemical and biological processes of water body (Prasad, 1956). It also reflects to the dynamics of the living organisms such as metabolic and physiological behavior of aquatic ecosystem. In the present study temperature was found ranging between 25.6 $^{0C}$ to 29.3$^{oC}$ of which maximum value was noticed in pre monsoon and the minimum value in post monsoon. Many workers observed similar trends while working on different water bodies (Dwivedi and Pandey, 2002 and Singh and Mathur, 2005). The surface water temperature varied according to the seasonal fluctuations of atmospheric temperature being higher in pre-monsoon and lower in post monsoon (Saxena and Chouhan 1993).All parameters detail s are given in the Table and the graphs explaining the monthly fluctuation in their values.

Transparency ranged from 50 cm to 94 cm. The maximum transparency was found in the post monsoon and minimum was noted in monsoon. According to Raut (2006), transparency increases with increase in temperature. Total solids content of the lake is highly influenced by the plankton and organic matter. Minimum total dissolved solids content was observed as 81 mg/l in monsoon while maximum value as 142 mg/l was noted in pre-monsoon. These values indicate productive nature of water (Sreenivasan, 1971).

### *3.2 Chemical Parameters*

The chemical parameters of the water body were studied on the basis of standard methods. The minimum conductivity of water samples was obtained as 200µmhos/cm in the post monsoon where as maximum value as 339 µmhos/cm was noted in pre-monsoon. The conductivity of electrolyte reflects the nutrient status of the water body. The pH of the aquatic body is important as it is

closely linked to biological productivity. The pH of water was noted in the range of 7.14 to 9.13 which was alkaline throughout the study period. The pH was found lowest in the post monsoon where as highest in the pre-monsoon period. The constant transformation process of organic matter accumulated at the bottom into humus substance becomes the buffering factor which may help in maintaining alkaline pH. Slightly alkaline conditions are favourable for primary production. Oxygen distribution is important for the divert needs of most of the organisms. It affects the solubility and availability of many nutrients and therefore the productivity of aquatic ecosystem (Wetzel, 1983). The dissolved oxygen was observed as 4.81 mg/l which was minimum in pre monsoon and 7.78 mg/l as maximum in post monsoon. The importance of free $CO_2$ in the natural water can be understood by three factors such as its role as a buffer, regulation of trilogical process in aquatic communities and its carbon content. Monawar (1970) reported that free $CO_2$ concentration varies from 1.4 mg/l to 5.8 mg/l minimum was noted in the post monsoon while maximum was in the monsoon which may be due to diffusion of $CO_2$ from atmosphere with rain water and by decomposition of organic matter.

Chlorides helps in assessing the limits of distribution of various species of organism and it also an important factor indicating stress in a system (Wetzel,2001) Normally the concentration of chlorides in fresh water lakes is less than 50 mg/l and any increase is indication of possible organic pollution( salaskar,1996).Minimum chloride content was obtained as 39.49 mg/l in the post monsoon whereas maximum 81.85 mg/l was noted Monsoon which may be due to reduction in water level by evaporation. The alkalinity of any water is mainly due to carbonates, bicarbonates & hydroxide. It is an index of nutrient status in a water body. The alkalinity of lake water was found to be maximum as 184 mg/l in post monsoon whereas maximum as 184 mg/l in post monsoon whereas minimum value noted as 97 mg/l in monsoon. Water bodies having total alkalinity above 50 mg/l can be considered as productive (Moyle, 1946).The availability of CO2 for primary production is related to alkalinity. According to Boyd, (1984) the water body contain adequate quantity of $CO_2$. Total hardness was observed in the range of 64 mg/l to 131 mg/l the minimum value was revealed in post monsoon and maximum value in pre-monsoon. All natural water shows presence of magnesium but its level in a water body depends on catchment geology. Minimum content of magnesium were observed during late monsoon i.e. 11.7 mg/l where as maximum value noted in pre monsoon which is 23.23 mg/l. Calcium contents in the range of 23 mg/l to 36 mg/l minimum in pre monsoon and maximum in monsoon due to excessive silt discharged during inflow of water from catchment area. Phosphate is one of the major nutrients responsible for biological productivity. In the present study the phosphate content was ranging from 1.46 mg/l to 3.6 mg/l where minimum content was observed in post monsoon & maximum value recorded in pre-monsoon. According to Jhingran (1991) phosphorus content more than 0.2 mg/l are likely to be quite productive. High content of Phosphate in the lake water may be due to runoff from surrounding crop fields or low level of water during pre-monsoon. Sulphate forms an important constituent of hardness and used by organisms for protein synthesis. It enters into water body by the weathering of sedimentary rocks and by bathing and washing clothes (Jain et al, 1996). Minimum Sulphate content was observed as 40.33 mg/l during post monsoon season while maximum as 77.66 mg/l in monsoon. In the present study the Nitrate value ranged from 0.003 mg/l to 0.150mg/l. The maximum value obtained in post monsoon while the minimum obtained in monsoon. It is an indication of unpolluted water according to Shastri et al (2008).The present study shows decrease in the concentration of Nitrate in post monsoon which may be due to utilization of Nitrogen by phytoplankton. The Nitrate content increase during monsoon was also noted by Salaskar and Yeragi (1997).

Primary production is the basis of the entire metabolic activity in natural aquatic habitat. Productivity is the rate of production of organic carbon. The gross primary productivity was observed as 93.67 mg/m3/hr in the post monsoon which was minimum while maximum as 181.06 mg/m3/hr was recorded in monsoon.Net primary productivity is the storage product available for the next tropic level. Its values where minimum as 26.15 mg/m3/hr in the pre monsoon while maximum as 73.33 mg/m3/hr in post monsoon.

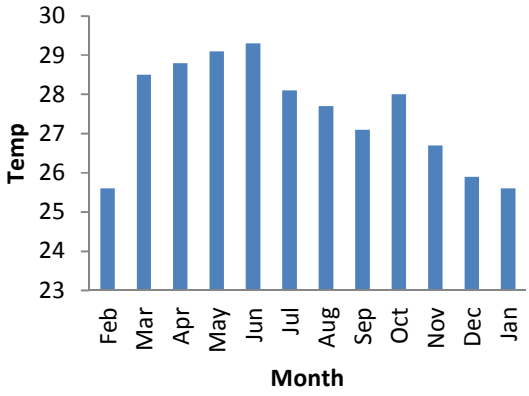


**Fig 1 Histogram showing monthly variation of temperature ($^0$C)**

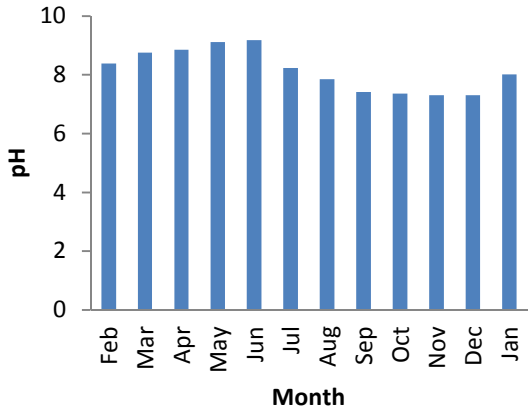


**Fig 2 Histogram showing monthly variation of pH**

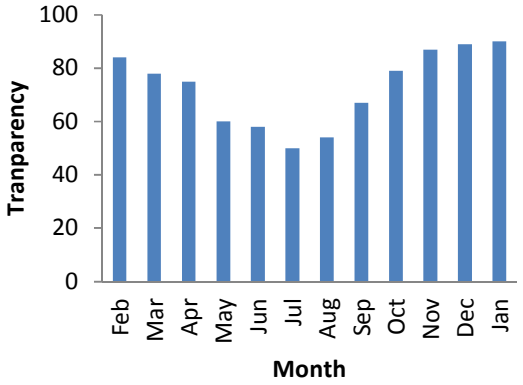


**Fig.3 Histogram showing monthly variation of transparency(cm)**

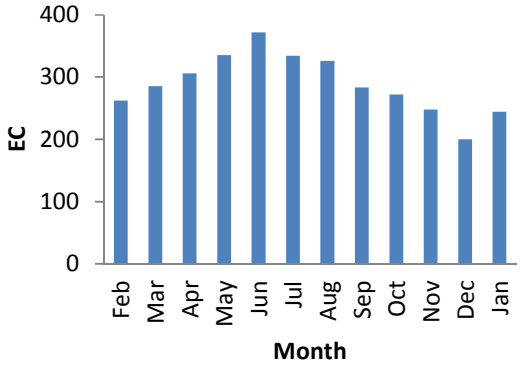


**Fig.4 Histogram showing monthly variation of Conductivity(µmho/cm)**

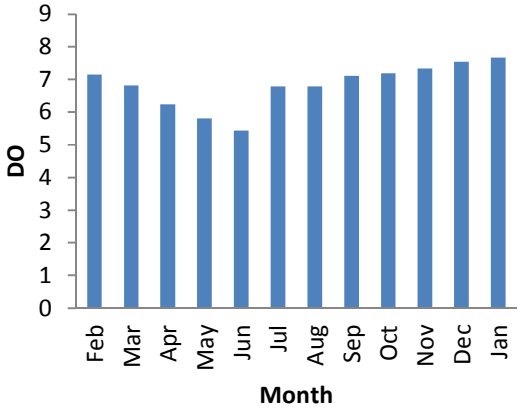


**Fig.5 Histogram showing monthly variation of DO (mg/l)**

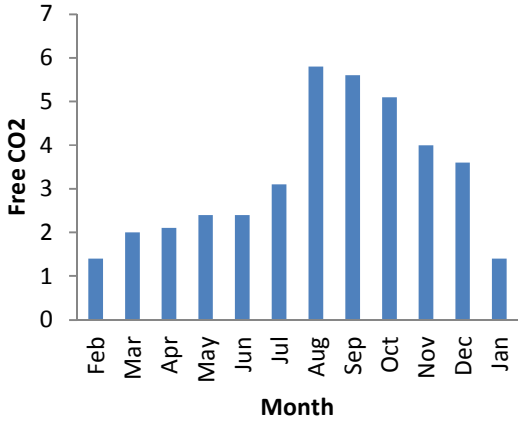


**Fig. 6 Histogram showing monthly variation of $CO_2$ (mg/l)**

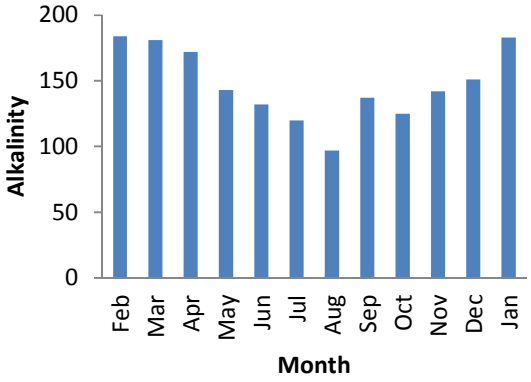


**Fig 7 Histogram showing monthly variation of Alkalinity(mg/l)**

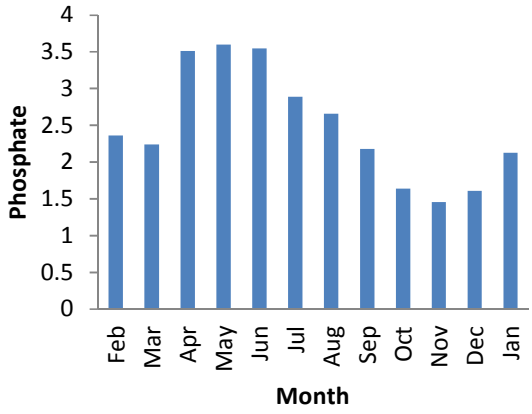


**Fig 8 Histogram showing monthly variation of Phosphate (mg/l)**

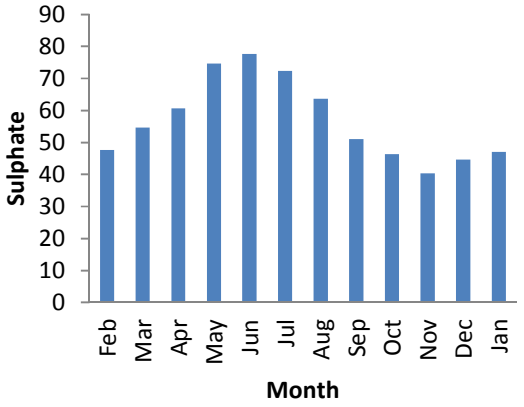


Fig.9 **Histogram showing monthly variation of Sulphate (mg/l)**

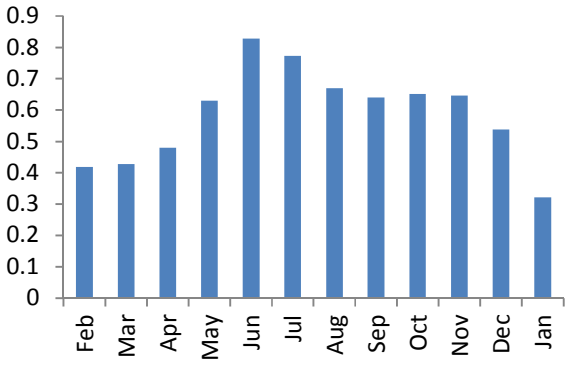


**Fig 10 Histogram showing monthly variation of Nitrate (mg/l)**

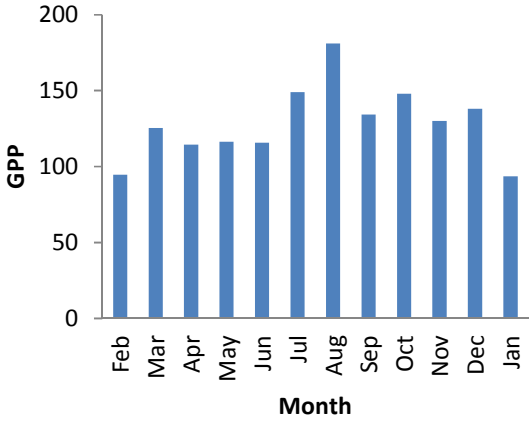


**Fig 11 Histogram showing monthly variation of GPP(mg/m$^3$/hr)**

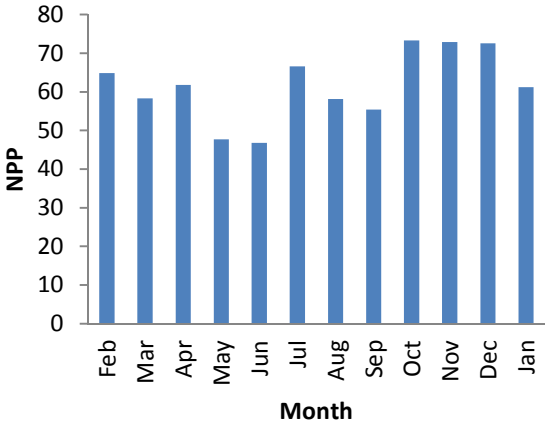


**Fig 12 Histogram showing monthly variation of NPP (mg/m3/hr)**

**Table1: Monthly variation of Physico-chemical parameters of Shelar Lake**

| Month | Temp | EC | Transparency | TDS | pH | DO | Free CO2 | Alkalinity | Cl | Phosphate | Sulphate | Nitrate | GPP | NPP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pre monsoon** | | | | | | | | | | | | | | |
| **Feb** | 25.6 | 262 | 84 | 105 | 8.38 | 7.15 | 1.4 | 184 | 50.27 | 2.36 | 47.66 | 0.419 | 94.74 | 64.88 |
| **Mar** | 28.5 | 285 | 78 | 116 | 8.75 | 6.82 | 2 | 181 | 63.43 | 2.24 | 54.66 | 0.428 | 125.46 | 58.35 |
| **Apr** | 28.8 | 306 | 75 | 116 | 8.85 | 6.24 | 2.1 | 172 | 72.9 | 3.51 | 60.66 | 0.48 | 114.26 | 61.76 |
| **May** | 29.1 | 335 | 60 | 136 | 9.12 | 5.81 | 2.4 | 143 | 79.84 | 3.6 | 74.66 | 0.63 | 116.42 | 47.78 |
| **Monsoon** | | | | | | | | | | | | | | |
| **Jun** | 29.3 | 372 | 58 | 142 | 9.18 | 5.44 | 2.4 | 132 | 81.85 | 3.55 | 77.66 | 0.828 | 115.76 | 46.74 |
| **Jul** | 28.1 | 334 | 50 | 101 | 8.23 | 6.79 | 3.1 | 120 | 80.57 | 2.89 | 72.33 | 0.773 | 149.02 | 66.64 |
| **Aug** | 27.7 | 326 | 54 | 96 | 7.84 | 6.79 | 5.8 | 97 | 72.18 | 2.66 | 63.66 | 0.67 | 181.06 | 58.12 |
| **Sep** | 27.1 | 283 | 67 | 81 | 7.41 | 7.11 | 5.6 | 137 | 50.04 | 2.18 | 51 | 0.64 | 134.35 | 55.42 |
| **Post monsoon** | | | | | | | | | | | | | | |
| **Oct** | 28 | 272 | 79 | 86 | 7.36 | 7.19 | 5.1 | 125 | 44.72 | 1.64 | 46.33 | 0.652 | 148.01 | 73.33 |
| **Nov** | 26.7 | 248 | 87 | 106 | 7.3 | 7.34 | 4 | 142 | 41.1 | 1.46 | 40.33 | 0.647 | 129.99 | 72.93 |
| **Dec** | 25.9 | 200 | 89 | 84 | 7.3 | 7.55 | 3.6 | 151 | 39.49 | 1.61 | 44.66 | 0.538 | 138.13 | 72.60 |
| **Jan** | 25.6 | 244 | 90 | 96 | 8.01 | 7.67 | 1.4 | 183 | 51.71 | 2.13 | 47 | 0.322 | 93.67 | 61.2 |
| **Min** | 25.6 | 200 | 50 | 81 | 7.3 | 5.44 | 1.4 | 97 | 50.27 | 1.46 | 40.33 | 0.322 | 93.67 | 46.74 |
| **Max** | 29.3 | 372 | 90 | 142 | 9.18 | 7.67 | 5.8 | 184 | 81.85 | 3.6 | 77.66 | 0.828 | 181.06 | 73.33 |
| **Mean** | 27.53 | 288.91 | 72.58 | 105.41 | 8.14 | 6.82 | 3.24 | 147.25 | 60.67 | 2.48 | 56.71 | 0.585 | 128.35 | 61.64 |
| **SD** | ±1.33 | ±48.03 | ±14.28 | ±19.36 | ±0.71 | ±0.87 | ±1.57 | ±27.86 | ±16.03 | ±0.76 | ±12.8 | ±0.150 | ±27.56 | ±10.23 |

(temp in $^0$C,EC in µmhos/cm, transparency in cm, GPP&NPP in mg/m$^3$/hr, other parameters in mg/l)

## 4.0 Conclusion:

The study carried out at Shelar Lake indicate that the physico-chemical parameter of the water body shows its partial or wholly association with the season and the water level in the lake,

- Surface water temperature ranged from 25.6°C to 29.3°C throughout the study period. The average temperature was27.53$^0$ C.
- Maximum secchi dish transparency was observed at 94.00cm.in postmonsoon period and minimum was observed 50.00 cm. in monsoon.
- During the study period pH was recorded in the range of 7.14 to 9.18.which was found to be alkaline. The high values of pH recorded during pre monsoon could be attributed to increase in primary productivity. The lower pH during monsoon may be due to turbidity.
- The conductivity value of the lake varied from 200µmho/cm to 339µmho/cm which is in the productive range.
- The maximum value of dissolved oxygen content was noticed in the post monsoon as 7.78 mg/l. whereas minimum value of 4.81mg/l was recorded in premonsoon.
- Free carbon-di-oxide concentration was maximum in monsoon as 5.8 mg/l and minimum as1.4mg/l in post monsoon.
- The chloride content in the present study shows marked seasonal variation, where lower in post monsoon and higher content in pre monsoon..
- The range of Net primary productivity was between 26.15mg/m$^3$/hr to 73.33mg/m$^{3/}$hr an average was 61.64mg/m$^{3/}$hr. The minimum was noted in pre monsoon while maximum was post monsoon.
- The range of gross Primary Productivity between 93.67 to 181.06mg/m3/hr.The variations observed among the rates of primary production in any water body is mainly due to the difference among the nutrient content such as phosphorus and nitrate.
- The organic productivity of the lake depends upon its nutrient content. The ratio of GPP:NPP was indicator of good health of the water body.
- The preservation of aquatic resources for ecosystem and human health and wellbeing is a paramount concern worldwide. The management of ponds and lakes which are natural ecological sources has become the need of the hour. The investigation of the water quality of Shelar lake was carried out for 2 years. The seasonal variation in physico-chemical parameters indicate that the lake is found to be mesotrophic and slightly eutrophic during premonsoon. The productivity of the lake was found to be average. The conductivity observed in the water body indicates the productive nature of lake.
- In order to maintain the lake in the proper condition the water level should be maintain throughout the year by increasing the depth of the lake domestic sewage should not be allowed to enter into it.

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