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WATER QUALITY PARAMETERS OF NANGAL WETLAND

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ABSTRACT: The Nangal Wetland (31°24’N; 76°22’E) at Ropar (Punjab)is ecologically important as it is the entry of the river Sutlej into the plains and aesthetically importantas many migratory birds make it their destination for the winter season. The establishment of the National Fertilizer Limited (NFL) and other human settlements, this water body has been subjected to an increased pollution load. Ayearlongstudy (June 2018 – may 2019) examined the physico-chemical water parameters, occurrence, abundance and diversity richness of fish species, at four selected sites of this wetland. The sites were selected upstream of NFL (S1), downstream of NFL (S2), NFL (S3) and confluence (Site 4). Analysis of the various water parameters revealed decreased dissolved oxygen and total alkalinity, increased free CO_2 and electrical conductivity at Sites 3 and 4.Variation in water parameters affects water quality, food web and lowers fish diversity but the water quality of the Nangal wetland is within safe limits favoring productivity of the resource, and further conservation of habitat and monitoring of the discharge from industry and sewage should be enforced.

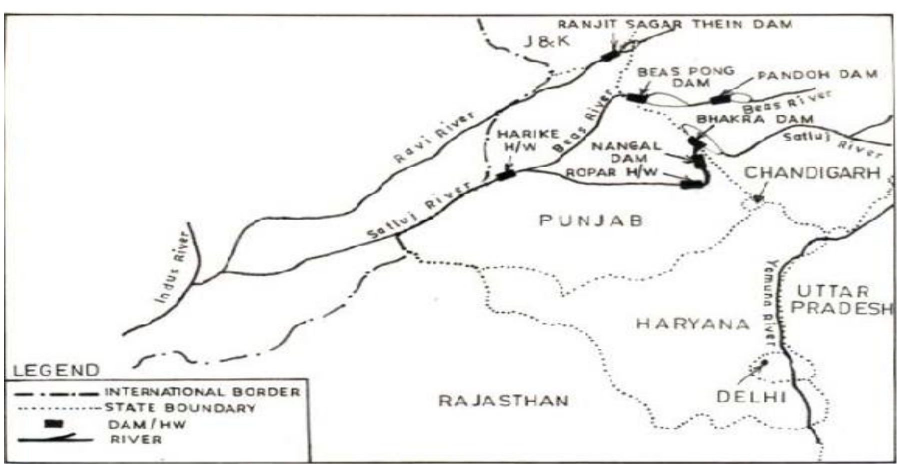
Keywords: physiochemical factors, water quality, wetland.

Water- the most important natural resource, sustains life across the globe, has a vital role in the ecosystem providing crucial services to support animal and human productivity. Wetlands which occupy nearly 6.4% area of earth's surface (IUCN 1999; Mitsch & Gosse link 1986, 2002) are important repositories of aquatic biodiversity supporting a diverse and unique habitat (Prasad *et al* 2002) and are one of the most productive ecosystems. The Nangal Wetland (31°24’13.52” N; 76°22’03.05” E) is situated in the Shivalik foothills in the Punjab State (India) on the Sutlej River with an elevation of 1172 ft above mean sea level and spread over an area of 700 acres.

Pollution of water bodies alters the physicochemical parameters like pH, electrical conductivity, transparency, biochemical oxygen demand (BOD), dissolved oxygen (DO), total alkalinity, free carbon dioxide (CO_2). Therefore, it is very important to study the physicochemical parameters to know the quality of water, for effective pollution control and resource management (Patil*et al* 2012, Koklu*et al* 2010). The standard water quality parameters of the Nangal Wetland have evaluated and compared Chetan and Sagar (2003) and Brraich and Saini (2014) with WHO standards (2011). The results indicated that the values were tolerant in nature and probably the load of pollution was not high which probably led to the hypothesis of self purification. However, when the water quality at the different stretches of the river Sutlej was analyzed (Jindal and Sharma 2011) on nine parameters - viz. pH, total alkalinity, total hardness, DO, BOD, chlorides, nitrates, phosphates and TDS–and the mean values of compared with WHO, ICMR and ISI standards, it indicated that the river water was unsafe for human consumption and could only be used for aquaculture, irrigation and for industrial purposes. Keeping in view these observations, and the development activities in the region, the present study was carried out to assess the physico-chemical water parameters of Nangal wetland and to identify as well as to relate with the possibility of changed fish diversity in wetland.

MATERIALS AND METHODS

The present study was carried out at different selected sites of Nangal Wetland and it’s downstream zones for collection of water samples which were analyzed for physico-chemical parameters, following the standard methods of APHA (2005) at the Department of Zoology, Punjab Agricultural University (PAU), Ludhiana.



Location of Nangal Wetland in Punjab, India

Temperature - was measured using mercury glass thermometer at the site which was dipped into the water and kept undisturbed for 1 minute; while **electrical conductivity (EC)**was measured with the help of specific

probes of electrical conductivity meter.

Secchi Disc Transparency is a measure of depth to which light can penetrate in water and is a measure of turbidity determination. The Secchi disc is lowered into the pond water until to the point where it just disappears and the depth is noted down (A). The Secchi disc is then pulled up gradually until it starts to reappear and again the depth is noted down (B).

Calculations

$$\text{Secchi disc transparency} = \frac{A+B}{2}$$

Chemical quality parameters of the **w**ater samples were tested for the chemical parameters like pH, free CO_2, total alkalinity, dissolved oxygen (DO), biological oxygen demand (BOD) using standard methods.

pHof the water samples was estimated with the help of portable digital pH-meter and the f**ree carbon-dioxide (FCO_2)**of water samples were determined by titrimetric method using Standard alkali titrant (0.02N NaOH) and Phenolphthalein indicator solution.

Calculations

$$FCO_2\ (mg / L)\ 2 = \frac{\text{Volume of sample taken}}{\text{Volume of titrant used}} \times 1000$$

Total Alkalinity is the capability of water to neutralize acidand is determined by titration method using 0.02 N $H_2SO_4$and two indicators –Phenolphthalein and methyl orange.

Calculations

$$\text{Phenolphthalein alkalinity} = \frac{A \times 1000}{\text{Volume of Sample}}$$

$$\text{Methyl Orange alkalinity} = \frac{B \times 1000}{\text{Volume of Sample}}$$

Total alkalinity = Phenolphthalein alkalinity + Methyl Orange alkalinity (A+B)

Dissolved Oxygen (DO)was estimated by the modified Winkler's method using Sodium thiosulphate titrant (0.025N): 40% $MnSO_4$ solution: Alkaline iodide azide reagent: Starch indicator and concentrated H_2SO_4.Volume of the titrant used was recorded and the dissolved oxygen was calculated as given below:

$$DO\ (mg / L) = \frac{8 \times 1000 \times N}{V} \times v$$

Where,

V = Volume (ml) of water sample.

v = Volume (ml) of the titrant (sodium thiosulphate)

N = Normality of the titrant (0.025N).

The**Biochemical Oxygen Demand (BOD)** was also estimated by modified Winkler's method and calculated as per the formula below:

$$BOD\,(mg/L) = \frac{(D_1 - D_2)}{P}$$

D_1 = Initial DO (mg/l)

D_2 = DO after 5 days of incubation (mg/l)

P = Decimal fraction of sample used.

Statistical analysis - The water samples were compared and subjected to SPSS (version 25) and factorial CRD for finding the significance of difference with respect to sites. All the data was calculated by using CPCS I and SPSS software.

RESULTS AND DISCUSSION

Physical parameters

Temperature

During present investigations, water temperature was recorded throughout the year and observed to range across he Sites between 11.10°C – 25.50°C. Site wise it was found to fluctuate between 11.10±0.10 (January 2019) to 23.25±0.05 (July 2018) at Site 1, 11.40±0.1(January 2019) to 22.80±0.1 (July 2018) at Site 2, 11.55±0.05(January 2019) to 23.75±0.05 (May 2019) at Site 3 and 12.50±0.1(December 2018) to 25.50±0.1 (May 2019) at Site 4 (Figure 1).The temperature at Site 4 has a significant difference in comparison to other sites, but non-significant difference was found between Site 1 and Site 2. Water temperature has been observed to be lowest in the month of January (2019) and highest in the month of May (2019) which are quite on expected lines (Figure 1).Similar ranges of temperature between 1°C-1.5°C at polluted sites over a non-polluted area in river Ganga was reported by Mishra and Tripathi (2007) and in the Kolar river (Khare and Unni 1986). Among all the sites, the highest temperature were seen at Site 4 might be due to the mixing of water from various sources which would have led to the high pollution load. Seasonal analysis revealed maximum values during summer season followed by monsoon and winter season, which is a normal feature in fresh water bodies and aquatic weeds and algal blooms (Gupta and Sharma 1993; Zafar 1968). It is one of the important factors in the aquatic environments as it affects the physical and chemical properties of water also affecting the growth and survival of aquatic vegetation, organisms and biological activities (Dwivedi and Pandey 2002, Singh and Mathur 2005).

pH - In the present investigation, the range on pH was 6.16-8.09 during which was within the acceptable permissible limits of pH (6.5-8.5) for healthy fish production (Chandrasekhar *et al* 2003). However, pH values fluctuated at all Sites (Figure 2) but maximum values observed during summer season are supported by the findings of other investigators (Kumbhar *et al* 2009, Sangpal *et al* 2011, Shinde *et al* 2011, Ramesh Babu and Selvanayagam 2013). The increase and decrease in the pH values could be attributed to the fact that rainfall increases the levels of carbonic acid and diluted the lake water (Kamble *et al* 2008, Senthilkumar and Sivakumar 2008, Pawar 2010), as also with the discharge of alkaline detergents and waste water laden effluents from residential and industrial areas.

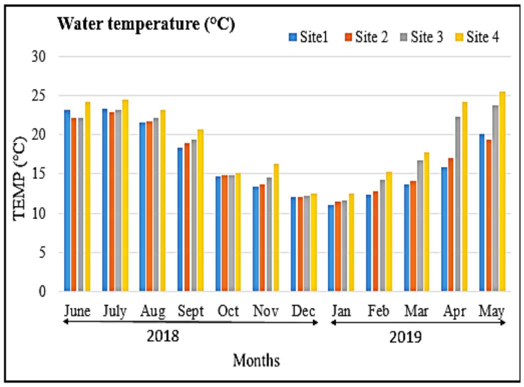


Fig.1.Monthly variation in temperature (°C) at four sampling sites

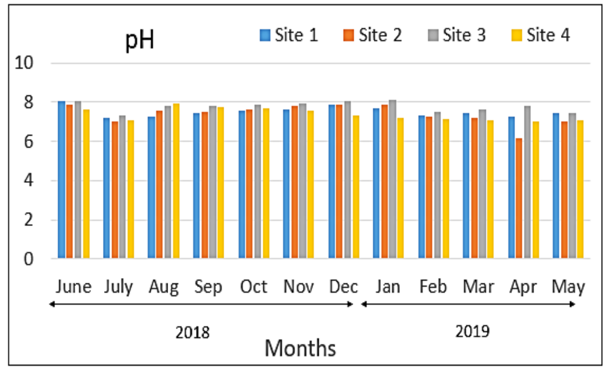


Fig.2- Monthly variations in pH at four sampling sites

Secchi Disc transparency (SDT)

Water transparency directly affects the amount of light penetration into a water body due to algae and suspended particles from erosion which make the water cloudy and decrease the Secchi transparency; therefore, more the Secchi disc depth value, lesser will be the algal concentration andlake productivity.

The maximum SDT (Figure 3) was recorded in February from Site 1 (154.17 ± 1.15 cm) while minimum value was observed at Site 3 in the month of (44.10±1.10 cm).Low water transparency works to block most sunshine at the surface of the water body (Mwaura 2003).Suspended matter blocks the sunlight available during monsoon, thus giving it a status of lethal factor (Ayodele and Anjani 1999), the resulting reduction of sunlight intensity in the water decreases the productivity of a water body.

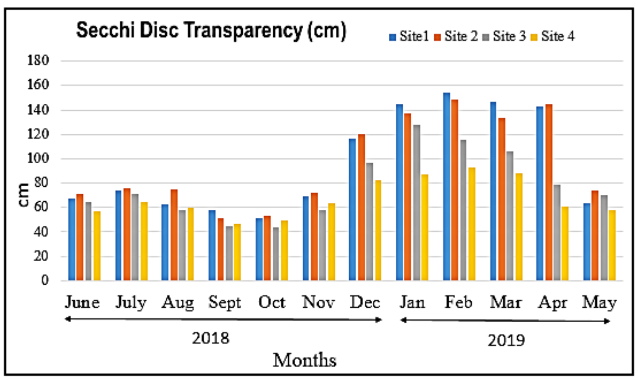


Fig.3. Monthly variations in SDT at four sampling sites

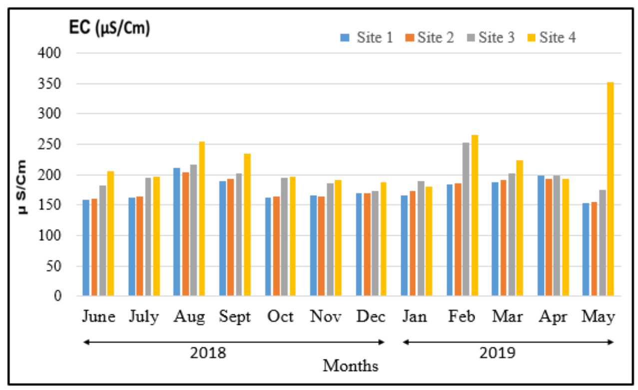


Fig.4 Monthly variations in EC at four sampling sites

Electrical conductivity (EC)

Conductivity, being an index of total ionic content of water, is a useful tool to evaluate the freshness and purity of water (Acharya*et al* 2008). According to Bureau of Indian Standards (2012) permissible limit for EC is 300 µS/cm; while as per WHO (2011) standards EC value should not exceed 400 µS/cm. The values of conductivity recorded during present studyin the figure show non-significant difference in Site 1 and Site 2, whereas Site 3 and Site 4 show significant difference (Figure 5) with the minimum EC recorded as 153.85±0.65 of Site 1 and maximum from 351.55±0.55 of Site 4. Sources of high EC values might be the abundance of dissolved salts due to minerals from rain water run off or other domestic discharges (Dixit *et al* 2015), high anthropogenic pressure and pollution and could be due to high rate of decomposition and mineralization by microbes (Egborge 1994). The results of present study were under acceptable guideline limit.

Dissolved Oxygen (DO)

The seasonal analysis clearly revealed that maximum value of DO is 23.40 mg/L during the month of April 2019 i.e., spring season (Figure 5) while minimum value was 0.00 mg/L during the pre-monsoon months of 2018. Furthermore, there was a reflection of maximum DO in winters and minimum/less DO in summers. The changes in DO (mg/L) among the sites showed a significant difference (Figure 5), with values falling in the range from 4.40±0.4 (June 2018) to 23.40±0.6 (April 2019) of Site 1, 2.60±0.20 (August 2018) to 11.50±0.30 (May 2019) of Site 2, 3.80±0.20 (August 2018) to 14.80±0.4 (April 2019) of Site 3 and Site 4 showed 0.00±0.00 (June, July, August 2018) to 10.20±0.60 (February 2019). This is supported by the observations by Shukla *et al* (1992) while studying the water quality of river Ganga at Ghaziapur where the concentration of dissolved oxygen at Site 1 as being well within safe limits (> 4 mg/L; CPCB, 2010), hence supports aquatic fauna.

The low value of DO concentration is an indication of deterioration of water quality as aresult of various anthropogenic activities. The presence of DO is essential to maintain the higher forms of biological life and to keep proper balance by break of various pollutants, thus making the water bodies healthy (Vaishnav and Sahu 2006, Dixit *et al* 2015). Decline in values of dissolved oxygen from winters to summers depicts the established inverse relationship between DO and water temperature (Jain *et al* 1996, Roselene and Paneerselvam 2008, Kumbhar *et al* 2009, Toufeek and Korium 2009, Garg*et al*2010, Manjare *et al* 2010, Singh *et al* 2010, Hulyal and Kaliwal 2011, Sinha and Biswas 2011, Tiwari and Ranga 2012).

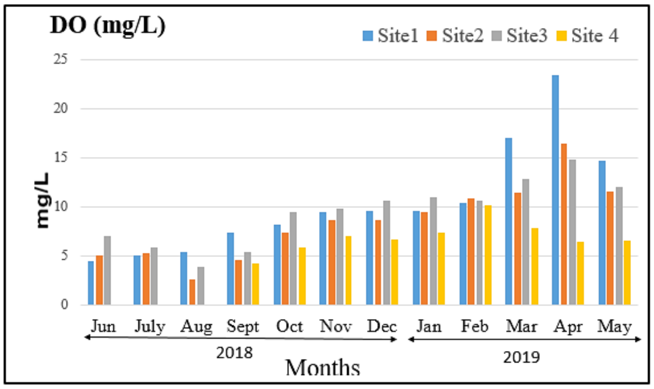


Fig.5. Monthly variations in DO at four sampling sites

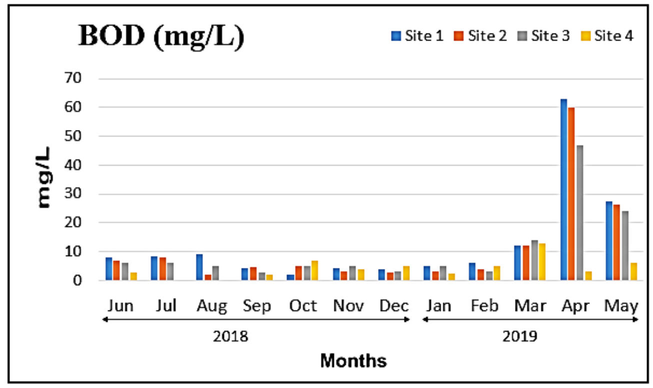


Fig.6. Monthly variations in BOD at four sampling sites

Biological oxygen demand (BOD)

During the present investigations, BOD values had high non-significant difference among all the sites, with 0 mg/L in the month of June and July (2018) to 63 mg/L in the month of April 2019.

Seasonally summer season revealed maximum BOD values i.e. 63.00 mg/L (±3.00) during April 2019 followed by winter and monsoon season (Figure 6). During summer (April-May'19) high values of BOD was observed due to rainfall, decomposition of organic matter at high temperature and sediment load; this trend is as per that of earlier hydro biological studies of Mahish (2015) and Rajguru and Deshmukh (2017). The previous observations by (Admoroti 1996 and Gupta *et al* 2003) suggested that the BOD is basically a measure of amount of biochemically oxidisable carbonaceous matter, being a direct indicator of organic pollution which adversely affects the water quality (Jonnalagadda and Mhere 2001).

Total Alkalinity

The details of alkalinity measured in this study is the measure of total alkalinity at different sites which arerepresents the shift during different months of year from June 2018 to May 2019 (Figure 7). It fluctuated between 4.0 ± 0 to 33.00 ± 3mg/L(April 2019) at Site 1, 4.0 ± 0mg/L (August) to 21.0 ± 3mg/L (May), 5.0 ± 1mg/L(October) to 41.0 ± 1 mg/L (April 2019) at Site 3 and 4.0 ± 0 to 12.0 ± 0mg/L (April 2019) at Site 4. The maximum value of alkalinity was observed at Site 3 in April 2019.

It plays an important role in controlling enzymatic activity and is thus more significant than pH because it takes into account the principle constituent that influences thewater's ability to regulatethe pH of the medium.Alkalinity represents the buffering capacities of water with higher values indicating eutropic nature of the water bodies (Raut*et al* 2011), which is unsafe both for ecosystem as well as for potable use and these may be due to discharge of waste, microbial decomposition of organic matter in the water body itself.

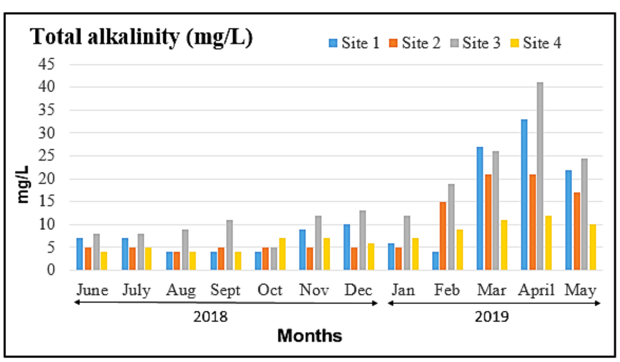


Fig.7-Monthly variations in total alkalinity at four sampling sites

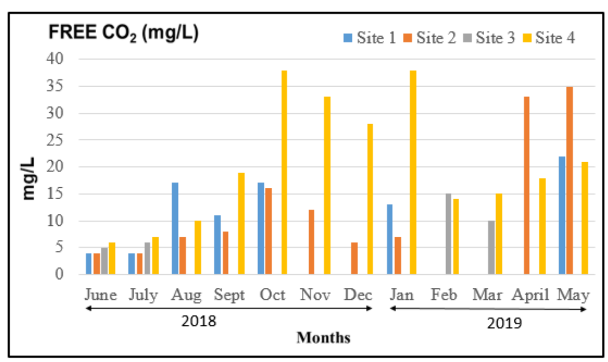


Fig. 8-Monthly variations in freeCO_2at four sampling sites

There are various criteria mentioned by various authors for categorization of lakes on the basis of alkalinity. According to Moyle (1946), water bodies having total alkalinity above 50 mg/L can be considered productive, while Sugunan (1995) reported water bodies with value above 40mg/L indicate high productivity. A minimum of 20 mg/L alkalinity in the water body is crucial for maintenance of healthy aquatic biota (USEPA 1976; 1986) and the Nangal Wetland, is thus an area of high productivity.

Free Carbon-dioxide (mg/L)

Carbon-dioxide is the principal parameter necessary for photosynthetic process in plants and also one of the major end products released during respiratory activity and due to decay of organic matter. The resultant variation in its rate is often a measure of net ecosystem metabolism (Hopkinson 1985).

In the present investigation, concentration of carbon-dioxide has been observed to vary between 0 to 38 mg/L (Figure 8).Seasonal analysisrevealed a clear picture with maximum values in the winter season followed by spring, rainy and summer season. This seasonal fluctuation in free CO_2 (max. in winter and min. in summer) was further supported by Singh *et al* (2013), who too observed the highest free CO_2 concentration during winter and lowest during summer in Nambul river situated in Manipur (India). Higher values of free CO_2 during summer and monsoon months were observed by Nath and Srivastava (2001) and Gurumayum *et al* (2002) because of high summer temperature which accelerated the process of decay of organic matter and respiratory activities of organisms resulting in addition of large quantities of CO_2 to the water.

The concentration of free CO_2 in the present investigation has been observed to vary between a minimum of 0 mg/L to a maximum of 38 mg/L (Figure8). The value of free CO_2 ranged from 0 ± 0 to 22±2 (May) at Site 1, 0± 0 to 35±1 at Site 2, 0 ± 0 to 15.00±1 at Site 3 and 6±0 to 38±2 at Site 4. The highest value of free CO_2 was recorded from Site 4 (38.00 ± 2mg/L) in October (2018) and January (2019), which may be due to discharge of domestic wastes, sewage and decomposition of organic matter while minimum (0 ± 0) from all the other three sites during different months. Similarly, free CO_2 at Site 3, was found only during the months of June and July 2018, February and March 2019 which could be correlated with the explanation that probably a higher utilization of CO_2 by phytopanktons, than the amount of CO_2 released by zooplankton and other aquatic animals resulted in these values (Joseph and Yamakanamardi 2011). Patil *et al* (2011) believed that reason for high concentration during summer may be attributed to the fact that rate of decomposition increases due to rise in temperature and this process got reversed during winter. Summer highs and winter lows were observed by earlier investigators (Nautiyal *et al* 2012) and contrasting results were observed by Kumbhar *et al* (2009), Manjare *et al* (2010), Simpi *et al* (2011).

The content of free CO_2 in a water body depends upon various factors amongst which water temperature, water depth, rate of respiration, decomposition of organic matter, chemical nature of the bottom and geographical features of the terrain surrounding the water body are the major one as per Sakhare and Joshi (2002). It fluxes across the air-water or sediment water interface and is the most important concerns in global change studies and are often a measure of the net ecosystem production/metabolism of the aquatic system. Carbon-dioxide so liberated either way is highly soluble in natural waters. FreeCO_2, being highly soluble gas in water and main source of carbon pathway in nature, is contributed by the respiratory activity of animals and can exist in water as bicarbonate or carbonates in the dissolved form (Bhatnagar and Devi 2013).indicating that the water of this site not appropriate for aquaculture.

The permissible limits of freeCO_2 for fish culture is 6 mg/L as observed by Lentz- Cipollini and Dunson (2006) so values of freeCO_2 concentration prevailing in Nangal wetland fall outside the range as prescribed for healthy aquatic fauna. Higher values free CO_2, can be related to higher degree of pollution of a water body (Todda 1970, Coole 1979).High value for free CO_2 was noted in summers and low in winters; also supported by Bohra and Bhargava (1977). Free CO_2, was found to be negatively correlated to pH as increase in CO_2 concentrations lead to reduction in pH which may be due to formation of carbonic acid (Chandler 1970; Jindal and Rumana 2000), while Singh (1960) working on the inland waters of Uttar Pradesh, concluded that free CO_2 and pH are not interrelated in any manner and behave independently.

The results of the present study indicate that environmental contaminants systematically disturb an aquatic ecosystem, which induce severe water quality and ecological changes. This results in leading to accumulation of toxicants and posing natural resource concern such as pollution of vital water resources, flora and fauna, loss of fishes, ecological productivity and associated factors including wildlife. This could significantly put potential health risk to humans as well. Monitoring of the discharge sites should be of greater concern to prevent pollution of the streams and channels. The overall water quality of Nangal Wetland has been found to be within acceptable limits and comprising of standards for maintaining productivity in the water resource

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