



Impact of Physicochemical Parameters on Fishes in Dal Lake

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Abstract

Water is indispensable and one of the precious natural resources of this planet. Natural aquatic systems like Lakes, Rivers, Lagoons and Oceans form well balanced ecosystem with ambient Physico-chemical conditions forming an environment on which biotic system develops. Analysis of water quality in natural water bodies is necessary in order to determine its suitability for various aquatic creatures including Fish population. The quality of water may be described according to its Physico-chemical and Biological characteristics. The physicochemical parameters of water affect the number and abundance of flora and fauna of aquatic ecosystems. The distribution and production of fish and other aquatic animals are determined and affected by water quality and suitability of available water in their environment for normal life. It forms basic life supporting system of Fish right from its birth, growth to catch. Water acts as the medium in which fish carry their life functions such as Feeding, Swimming, Breeding, Digestion and Excretion. During the present study some Physicochemical Parameters of Dal lake were analysed and their impacts on the Fishes was discussed. Some parameters like temperature and pH were recorded on the site while other parameters like oxygen, carbon dioxide were fixed on site and analysed at Junior laboratory of ICSC Hawal Srinagar.

Keywords: Water quality, Physicochemical, Fish, Aquatic ecosystems, Temperature, pH

Introduction:

Water is a blue gold and a unique component on Earth's surface. It forms the basis for survival and existence of living beings. It covers 71% of Earth's surface and from this content Fresh water only contribute 3% by volume while remaining 97% is found in marine waters. Kashmir has both lotic as well as lentic Fresh water bodies such as the Jhelum river and its associated tributaries (Lidder, Vashaw, RambiAra) some streams like Sindh, Doodhganga, Sukhnag, and Kazinagnallah. The lakes include Dal lake, Nigeen lake, wular lake, Mansbal lake, Aanchar lake. The aquatic resources of Kashmir are inhabited by a number of fish species, Endemic as well as Exotic. Among the endemic species the most important genus which is exploited on large scale throughout the valley is *Shizothorax* which was reported by Heckel (1838). Exotic species comprise the Carp species. Fish is an inexpensive source of protein and an important cash crop in many regions of the world. Water quality is the important factor affecting fish health and performance in aquaculture production systems. It forms basic life supporting system of Fish right from its birth, growth to catch. Water acts as the medium in which fish carry their life functions such as Feeding, Swimming, Breeding, Digestion and Excretion (Bronmark and Hassan 2005). Water quality is the sum total of Physical and Chemical characteristics of a water body it is one of the most important factor influencing successful fish and fisheries across the globe. If the water quality is good survival, growth and reproduction of fish can reach to optimum values (ACTFR 2002). The interaction of physical and chemical parameters of water body play important role in composition, distribution, abundance and movement of aquatic organisms (Mustapha and Omotosho 2005).

The physico chemical parameters are interdependent on each other. To define water quality many researchers treated quality parameters individually by describing the seasonal variability and their causes. Their concentration increases due to human activities and lack of environmental regulation. Physicochemical parameters are limiting factors for the survival of aquatic organisms as they provide a way to understand the changes in the abundance and distribution of flora and fauna.

As water quality is most important factor affecting fish health and performance the main aim of present work is: Analysis of Physicochemical Parameters of dal lake and their impact on Fishes.



Dal lake is second largest lake in the J&K after Wular lake. It is integral to tourism and recreation in Kashmir and is named as Lake of Flowers, Jewel in the Crown of Kashmir. The lake has been the Cradle of civilization of Kashmir and is considered as Liquid heart of Srinagar (Masood and Kundangar). It is an important source of commercial operation in fishing and water plant harvesting. It has found its place amongst the most beautiful national heritage sites of India. The lake is located within a catchment area covering 316 square kilometres (122 sq mi) in the Zabarwan mountain valley in the foothills of the Shankaracharya Hill which surrounds it on three sides. The lake lies to the east and north of Srinagar city covers an area of 18 square kilometres (6.9 sq mi), including the floating gardens of lotus flowers it is 21.2 square kilometres (8.2 sq mi). The main basin draining the lake is a complex of five interconnected basins with causeways; the Nehru Park basin, the Nishat basin, the Hazratbal basin, the Nigeen basin and the Barari Nambal basin. Navigational channels provide the transportation links to all the five basins. The average elevation of the lake is 1,583 metres (5,194 ft). The depth of water varies from 6 metres (20 ft) at its deepest in Nigeen lake to 2.5 metres (8.2 ft), the shallowest at Gargibal. The length of the lake is 7.44 kilometres (4.62 mi) with a width of 3.5 kilometres (2.2 mi). The lake has a basin having shore length of 15.5 kilometres (9.6 mi) and roads run all along the periphery. Irreversible changes through urban developments have placed further restrictions on the flow of the lake and as a result, marshy lands have emerged on the peripheral zones, notably in the foothill areas of the Shankaracharya and Zaharbwanhills. These marshy lands have since been reclaimed and converted into large residential complexes. The hydrology of Dal lake is complicated due to diversity of the catchments contributing to its inflow. These include the urban catchment of Srinagar city, adjoining agricultural and mountainous catchments. Presently, the lake comprises an open water area and lake interiors comprising marshy land and floating gardens. The open water area is divided into three sub basins: the Hazratbal basin in the north, the central Bod dal basin, and the Gargibal basin in the south. Nigeen Lake on the west of Dal Lake appears to be a detached arm of the main lake. The sources of the lake include several streams and springs. Telbal Nallah is a large perennial stream that drains the Dachigam National Park on the eastern side of the lake and enters it from the northern end. Another major source of inflow is the Botkol, draining the northern and north-western catchment. It also collects water from the Sindh extension Canal, and irrigation overflows which enters the lake from the north-western end. Several smaller streams like the Meerakshah Nallah also add water to the lake. Inflow to the lake is also contributed by many springs arising from its bed as well as outwash from the surrounding mountains. Water flows out of the lake through two principal outlets a weir and lock system at Dalgate and the Nallah Amir Khan connecting Nigeen lake with Anchar lake via Khushalsar lake. A significant amount of flow from the incoming streams is diverted for agricultural purpose through a composite canal network. The

ecosystem of lake is rich in macrophytes and phytoplanktons. The fishing industry on the dal is the second largest industry in the region and is central to many of the people's livelihood who reside on the lake's periphery. Dal's commercial fisheries are particularly reliant on carp fish species which were introduced into the lake in 1957. Carp constitutes 70% of all fish caught in the lake While the Shizothorax constitutes 20% and other account for 10%.

The lake was once among the most beautiful lakes in the world (Lawrence 1895). However today the statement is hardly believable as the lake has been affected to a great extent in terms of both ecology and hydrology (Ganaie and Hashia 2020). The lake has already shown the impact of warming temperature variation in hydrology regime excessive nutrient load and invasion of exotic species. Discharge off untreated sewage from point and nonpoint sources how completely deteriorated the water quality of lake (Mushtaq et al 2020). The impact has been exacerbated by deforestation grazing agriculture and change in land use cover patterns in the lake catchment (Rashid et al 2017) in addition Large scale encroachment and discharge of wastes from house boats have led to serious weed infestations (Zhan and Ansaari 2005 zargar et al 2012). These activities have increased the sediment and nutrient load in the lake deteriorating the quality of water. The rapid and unchecked growth of weeds particularly azola has already affected the lake water and esthetic value (Kundangar and Abubakar 2004). The concentration of various pollutants in the lake water further increases due to lower hydrological inflows (Mushtaq et al 2020)

Materials and Methodology :

Study Area: The study is focused on Dal lake which is situated in Srinagar city of j&k. The division of lake is into four basins Bod Dal, Nigin, lokut Dal and Gagribal. The maximum depth of lake is approximately 6 meters which is in the Nigeen and the shallowest basin is Gagribal basin with a maximum depth of 2.5 mtr. The data was collected on monthly basis from November 2022 to April 2023. The collected data was for the following physiochemical parameters:

Temperature

Carbon dioxide

Transparency

PH .

Dissolved oxygen

Sampling was done on daily basis from as per standard guidelines (APHA 2005). For the study of physiochemical parameters of Dal lake three different sites were chosen. The location of sampling sites are shown in the figure and description of sites is given in table

Site 1	Dalgate
Site 2	Foreshore
Site 3	Dargah



Methodology:

Random water samples were collected from 3 Different selected sites Dal lake for determination of Physiochemical parameters. The standard methods were used for determination and calculation of various physicochemical parameters such as water temperature, pH, dissolved oxygen, transparency, free, carbon dioxide. The parameters like pH, Temperature, dissolved oxygen transparency and carbon dioxide were fixed recorded on site. The value of parameter were



analyzed in laboratory after sample preservation as per (Trivedi and Goel 1986) and American publication health association(APHA2005).

Temperature:

Air and water temperature of the lake were determined at the time of sample collection using mercury thermometer calibrated in degree centigrade .

Transparency:

Transparency of lake was determined with the help of secchi disc. First point areas where identified from where transparency was to be checked then secchi disk was immersed into the lake and reading was recorded at point where it disappeared then disc was raised slowly till it reappeared and reading was again noted.

Dissolved oxygen :

The water samples were randomly collected from the three different selected sites from November 2022 to March 2023 in winkler's Do bottle. The collection of water was gently performed to avoid the formation of bubbles inside the bottle. For the purpose of fixing, the water samples are immediately treated with 2.5ml of Manganese sulphate and 2.5ml of potassium iodide azide was added resulted in the formation of cloudy precipitate. After few minutes samples were closed by lids and again shaking was performed for uniform mixing of samples. The samples were left undisturbed until the precipitate were settled completely. The concentrated sulphuric acid (2.5ml) was added to the mixture to make it a homogenous by the dissolution. After that the water samples were transported within 24 hours of collection to junior laboratory of ICSC Srinagar for further process . (Winkler's Method) Procedure for determination of dissolved oxygen In the junior Laboratory of ICSC Srinagar the 50ml of water was taken from the Winkler's bottles having fixed water sample. The subsample was taken in a conical flask and 1-2 drops of starch were added to subsamples (50ml). Thereafter the mixture was titrated against Sodium thiosulphate till it becomes colorless. The amount of titrant consumed were noted carefully .

Free carbon dioxide:

The samples were randomly collected From three different selected sites in clean jars. To know either carbon dioxide is present or absent few drops of phenolphthalein were added to the same . This showed no colour change indicating the presence of carbon dioxide then the sample was carried to the laboratory junior laboratory of ICSC Srinagar for further analysis.

pH:

pH of the water sample was measured with the help of pH paper. The pH paper was dipped at the three different sampling sites and then compared with the indicator to note down the result.

Observations

A total of 5 parameters were evaluated in this investigation to determine the water quality of the lake. All the experiments were carried out at Junior laboratory of Department of zoology ICSC . The carbon dioxide and pH of the water have increased in the Dal lake which is an indicator of pollution, which indicates that the water of Dal lake is polluted .

Temperature: Temperature of lake ranged from 6-17°C. The lower temperature was recorded in January and highest was recorded in April.

Transparency: The transparency of the lake ranged from 1.1-1.5. The maximum transparency was found at (S1) and minimum at Dargah site (S3).

Dissolved oxygen: The Do ranged from 6- 7.5 mg/l . The highest was recorded at Dalgate site (S1) and the lowest was at Dargah site (S3). 4.4. Carbon dioxide: Ranged from 10-15 mg/l. The highest was at Dargah site(S3) and lowest was at Dalgate site(S1).

PH: The pH ranged from 8.6 to 10.5. The value was high at Dargah(9.5) and low at dalgate site (8.6).



Table depicting Temperature in (°C) at diff. Selected sites from Nov. 2022-April 2023.

Name of site	Nov	Dec	Jan	Feb	March	April	Mean
Dalgate	14	8	7	10	12	15	11
Foreshore	14	9	6	9	11	13	10.3
Dargah	15	8	7	11	13	17	11.3

Table depicting Transparency at different selected sites from Nov. 2022 -April 2023.

Name of site	Nov	Dec	Jan	Feb	March	April	Mean
Dalgate	1.3	1.3	1.5	1.4	1.3	1.3	1.3
Foreshore	1.2	1.3	1.4	1.3	1.3	1.2	1.2
Dargah	1.2	1.0	1.2	1.1	1.0	1.0	1.1

Table depicting pH at different selected sites from Nov. 2022-April 2023.

Name of site	Nov	Dec	Jan	Feb	March	April	Mean
Dalgate	8	8.5	8	8	8.5	9.5	8.4
Foreshore	9	9	9.5	9	9	10	9.2
Dargah	10	10.5	10	9.5	10	10.5	10

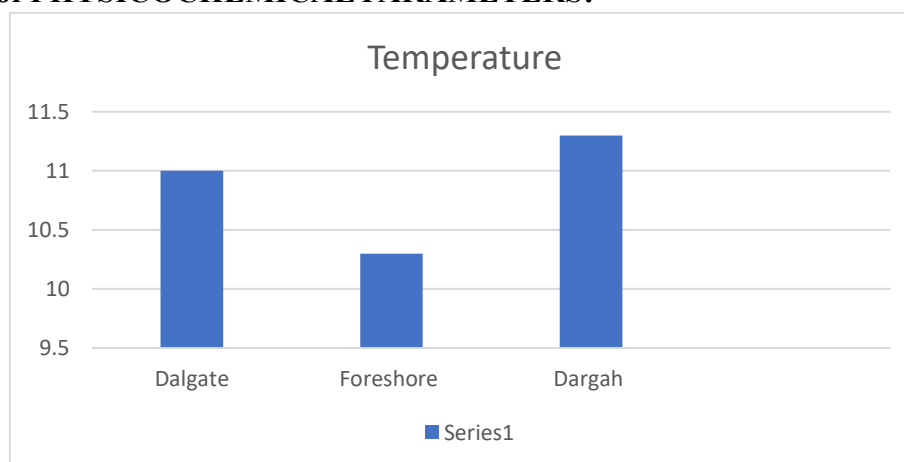
Table depicting Dissolved oxygen at different selected sites from Nov. 2022-April 2023

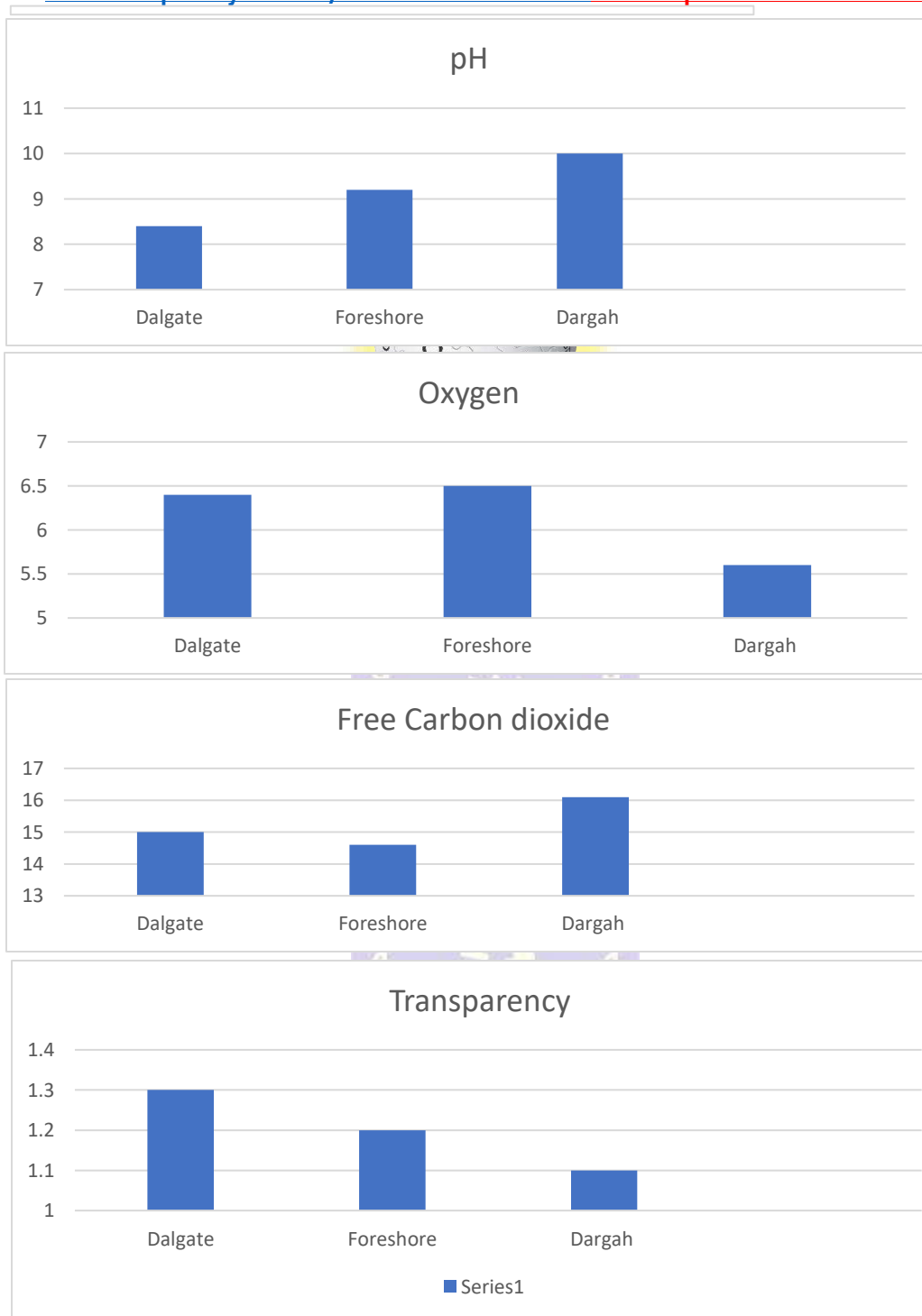
Name of site	Nov	Dec	Jan	Feb	March	April	Mean
Dalgate	7	7.3	7.5	6	6.5	6	6.4
Foreshore	6.5	6.5	7	6.5	6	6.5	6.5
Dargah	6	6	6	5.5	5.5	5	5.6

Table depicting free carbon dioxide in (mg/ml) at different selected sites from Nov. 2022-April 2023

Name of site	Nov	Dec	Jan	Feb	March	April	Mean
Dalgate	8	15	18	18	15	16	15
Foreshore	10	13	15	15	17	18	14.6
Dargah	12	15	20	20	15	15	16.1

Mean value of PHYSICOCHEMICAL PARAMETERS:





Discussion

The main perspective of the study was to analyse some Physicochemical parameters of Dal lake and their impact on fish fauna.

Temperature:

The temperature plays a keystone role in the aquatic habitat. The air temperature had the direct influence on the variation of water temperature (Michael, 1968). Water temperature is the most important physical variable affecting the metabolic rate of fish and is therefore one of the most important water quality attributes in aquaculture (Khanna et al., 2015). During the present study the water temperature was found from 06-17°C. It was found suitable for the fish species present in the lake. Minimum temperature was recorded in January 2023 and maximum in April



2023. Maximum temperature may be due to clear atmosphere, greater solar radiation and less rainfall. Fishes are ectotherms, their physiology is strongly affected by temperature. Each fish has its own Temperature range within which it grows normally and is called the optimal Temperature range which varies from 23°-27°. Temperature affects their metabolic rate and thus their energy balance and behavior, including locomotion and feeding behavior. Temperature influences the ability/desire of the fish to obtain food, and how they process food through digestion, absorb nutrients within the gastrointestinal tract, and store excess energy. As fish display a large variability in habitats, feeding habits, and anatomical and physiological features, the effects of temperature are complex and species-specific. The effects of temperature depend on the timing, intensity, and duration of exposure as well as the speed at which temperature changes occur. Whereas acute short-term variations of temperature might have drastic, often detrimental, effects on fish physiology, long-term gradual variations might lead to acclimation, e.g. variations in metabolic and digestive enzyme profiles. The impact of temperature on feeding vary depending on the species. Usually food intake increases with moderate increase in temperature and decreases when temperature is outside the optimal range of fish. Most fish species have a specific temperature range that is required for healthy and successful reproduction. If their environment has a sudden shift in temperature, they will either leave the area or simply not reproduce when temperature levels are too far out of the optimal range. Consequently, fish populations begin to drastically decline in the absence of normal reproduction rates.

pH:

The measure which indicates whether water is acidic or basic is known as pH. The pH value ranges from 0-14 .pH value=7 indicates water is neutral, greater than 7 indicates water is Alkaline and less than 7 indicates water is Acidic. The present study shows the pH of dal lake ranges from 8 -10.5. The values of pH depict water of Dal Lake is alkaline in nature. The higher values of pH are due to addition of hydroxyl, bicarbonate and carbonate anions, production of salicylic acid by hydrolysis of silicates in the rock beds of the catchment areas . It may also be attributed due to increased organic compound degradation which is high in the lake. The acceptable range for fish growth is normally between pH 6.5 and 9.0. Fish will grow poorly and reproduction will be affected at consistently higher or lower pH levels. Very high and very low pH values, respectively, greater than 9.5 and less than 4.5, are unsuitable for most aquatic organisms. Young fish and immature stages of aquatic insects are extremely sensitive to pH levels. Fish cannot survive in waters below pH 4 and above pH 11 .

Transparency:

Transparency is the measure of how clear the water is . It is important because aquatic plants need sunlight for photosynthesis. The clearer the water the deeper the sunlight will penetrate. In any aquatic system the degree of penetration of light has a significant impact on biological processes and consecutively its productivity. Dal lake exhibits various varying transparency during different seasons. Transparency is minimum in summer and spring while it increases to a significant extent during winter. The changes in transparency of the Lake may be attributed to various factors like plankton populations and suspended matter. In present study the transparency of the lake varies from 1.1-1.6 with maximum at dalgate Site (S1) and minimum at Dargah site(S3). Transparency reduction is due to the presence of particles in the water. When light attenuates, it alters or limits the capacity of life of some of the biological communities that live in the lake. It reduces the possibility of photosynthesis (a process that produces the oxygen vital to the ecosystem). It implies as well a reduction of visibility which prevents fishes and zooplankton to see their prey and their predators.

Dissolved oxygen: .

Dissolved oxygen is a measure of the amount of gaseous oxygen dissolved in an aqueous solution that plays a vital role in the biology of cultural organisms .It is crucial among the Physicochemical



Parameters as it directly affects the survival of aquatic living beings. According to Bhatnagar et al. (2004) and Bhatnagar and Singh (2010) DO level more than 5 mg/L is essential to support good fish production. Thirupathaiah et al 2012 reported that DO level in the range between 5.18 to 9.72 mg/l is good for survival of aquatic organisms. The values of DO fluctuate with the change in water temperature and due to water pollution (Koshy and Nayer 2000). The amount of DO present in water body depends on atmospheric and photosynthetic input of plants and depletion of oxygen during respiration, decomposition and mineralisation of organic matter. The DO content of Dallake was found in the range of 5.5g/l to 7.5 mg/l. The lower values of dissolved oxygen observed at site-3 could be due to cumulative effect of human activities like dumping of organic wastes from floating gardens where oxygen is used in decomposing these organic wastes. Oxygen level is depleted in water bodies due to decomposition of organic wastes. In contrast high dissolved oxygen at site-1 could be due to more photosynthesis as there was presence of excessive growth of macrophytes this site was located in open area of the lake. Further comparatively high dissolved oxygen content at this site may be due to the aeration of water by mechanical aerators. Dissolved oxygen is an important regulator of metabolic processes of the organisms (Hutchison 1967, Untoo et al 2006). During present study the dissolved oxygen concentration marked a fluctuation from winter to Summer. The higher concentration of dissolved oxygen during winters could be due to the fact that cold water contains more oxygen as compared to warm water as the DO is inversely proportional to the water temperature (Hynes, 1960). Dallake is a shallow water body that displays negligible fluctuations in the oxygen levels from surface to bottom (Mushtaq et al 2018). The dissolved oxygen and thermal cycle of lake has been found closely related (Trisal 1987). Dissolved oxygen levels of Dal lake have declined significantly since 1990s. The primary cause of this decline is increased nutrient load, profuse growth of macrophytes and thriving weeds. The decrease in dissolved oxygen content has been one of the most significant impact is lake pollution (Mushtaq et al 2018). The requirement of dissolved oxygen differs from species to species in fishes. The optimum concentration of dissolved oxygen that supports fish survival must be from 5 mg/l to 8.5 mg/l. When Dissolved oxygen drops below this level it results in hypoxic condition. The anoxia and hypoxia are known to be primary cause of stress, poor appetite, slow growth illness susceptibility and mortality (Timmmons et al 2001). Hypoxia limits the swimming performance of fish, feeding habits and other bodily functions. As a result the growth rate slows down and the fish becomes unable to absorb the nutrients. The growth rate of fish reaches maximum at higher oxygen levels and growth rate becomes slowest at low oxygen concentration. Dissolved oxygen has significant impact on fish reproduction. Reduced amount of oxygen affects the growth and development of eggs, fry, fingerlings. Hypoxia affects courtship behavior, mate choice and reproductive efforts of fish. When Dissolved oxygen raises the air saturation it causes hyperoxia which causes alteration in acid balance of fish blood.

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Carbon dioxide (CO₂) is a highly water-soluble, biologically active gas. Carbon dioxide is produced during respiration and consumed in photosynthesis. Thus, concentrations of dissolved carbon dioxide usually vary inversely with dissolved oxygen. The concentration of dissolved carbon dioxide in surface waters depends on the relative rates of respiration, photosynthesis, diffusion of the gas to and from the atmosphere. Optimum free carbon dioxide level for the survival of organisms is less than 5 mg/l (Huq, 2002). Surface waters normally contain less than 10ppm free carbon dioxide. Free CO₂ is released during the decomposition of certain substances and metabolic activity of the living organisms. In the present study the free carbon dioxide was found in the range of 08-20mg/l. Free carbon dioxide contributes the fitness of the natural waters and it serves as buffer to the environment against rapid changes in pH and also regulates biological processes in aquatic communities. Carbon dioxide is one of the most life supporting gases just like other gases. It has been found that carbon dioxide is vitally important for survival of an aquatic



resource similar to that of oxygen. Carbon dioxide apparently seems to be an undesirable waste product but the fact is that its presence is vitally important for the betterment of an aquatic ecosystem, when present in desirable amounts. Large quantities of carbon dioxide released in an aquatic resource have been found detrimental for growth and development of aquatic organisms. Fishes can thrive best the levels of carbon dioxide in water below 5 mg/l. Rise in level causes stress, and other physiological abnormalities. High concentrations of carbon dioxide in water interfere with carbon dioxide excretion through the gills of fish. This causes elevated concentrations of carbon dioxide in the blood plasma, which decreases blood pH. This condition lessens the ability of hemoglobin to bind oxygen and reduces oxygen uptake by blood at the gills, even when dissolved oxygen concentration is high. The overall effect of elevated carbon dioxide concentration in water reduces respiratory efficiency and the tolerance of aquatic animals to low dissolved-oxygen concentrations. Thus, high carbon dioxide concentrations are particularly undesirable when dissolved oxygen concentration is low – less than about 25 percent of saturation. Fish, and other water-breathing animals are more susceptible to a rise in environmental CO₂ than terrestrial animals because the difference in CO₂ partial pressure (PCO₂) of the body fluid of water-breathing animals and ambient medium is smaller. Hypercapnia acutely affects vital physiological functions such as respiration, circulation, and metabolism, and changes in these functions are likely to reduce growth rate and population size through reproduction failure and change the distribution pattern due to avoidance of high-CO₂ waters or reduced swimming activities.

Conclusion:

The quality of the water is determined by certain parameters that directly affect the nature of the water body and also these parameters control the fauna dwelling in that water body. The primary and keystone parameter was the temperature that directly or indirectly controls the other parameters. The other limiting factor was found to be the dissolved oxygen that form the base line of any living organism. Over the years the water quality of Dal lake has deteriorated causing adverse impacts on its Fish fauna. Survival and growth of fishes in the Dal lake depends totally upon its physicochemical parameters. Physicochemical parameters like water temperature, pH, DO, was found to be suitable for fish survival and good reproduction rate. Thus physicochemical quality of the lake in study area was fit for fish diversity, growth, reproduction and fish cultivation during study period. As majority of fishes present in Dal lake constitute the Carp Species which thrive best in these Physicochemical Parameter ranges. The endemic Shizothorax fish populations have declined considerably owing to the pollution and introduction of exotics (Carp). At the same time, the total fish production of the lake has not much increased over the last few decades. The lack of proper governance, policy regulations and coordination between agencies and fisherman adds more negative impact to this. The present day catch of Dal lake comprises more than 80% Carp. The decline in Fish diversity and yield is contributed to changes in hydrological regime and loss of critical habitats. Changes in species richness may be attributed to heavy loads of incoming sewage thereby leading to increased eutrophication which has an adverse impact on growth and development of sensitive fish species like Shizothorax. Recent discovery of Alligator garfish in Dal lake is another major concern the fish is rayfinned euryhaline species with a predatory nature commonly found in North America and some parts of India like Bhopal and Nepal. Being Carnivorous it poses threat to the native fish species like Shizothorax. To improve water quality of the lake it is must to, stop pollution creating activities like discharge of municipal sewage, industrial effluents, mass bathing, cattle bathing, in nearby areas and agricultural runoff. Periodic survey and follow up programme are also recommended to sustain pristine water quality.

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