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Ecological Study in the Fisheries Status of Yamuna River

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Abstract - The current research was conducted from August 2018 to July 2019 in Uttarakhand, India, to examine the variety of species and the influence of pollution on the limnological conditions of the Yamuna River. Water samples were collected weekly from Kalsi (S1), Dakpathar (S2), and Asan Lake (S3) along the Yamuna River over the duration of the investigation. Phytoplankton, zooplankton, and icthyofaunal diversity were among the many biological and physico-chemical characteristics examined in the samples. There are 35 taxa in the phytoplankton, divided among three families. Bacillariophyceae has the greatest level of diversity, followed by Chlorophyceae and Myxophyceae. As with Zooplankton, 29 species from four distinct genera, including Protozoa, Rotifera, Copepoda, and Ostracoda were identified, with Rotifera having the most diversity. It was found that 24 taxa belonging to seven families and four orders were documented in the Icthyofauna. Aquatic creatures thrived in the ideal physico-chemical environment. Analyzing the acquired data, it was discovered that the biological and physico-chemical variables were strongly correlated. The presence of plankton populations and a wide variety of fish indicates that the River Yamuna's water quality is excellent, with the expansion of these ecological markers of the aquatic environment being positively influenced by physico-chemical parameters.

Keywords - Fish Biodiversity, Yamuna River, Conservation, Ecological, Population Structure

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INTRODUCTION

For a basin to function ecologically, rivers must play a significant role in both integrating and arranging its terrain. They are the most dynamic transport agents in the hydrologic cycle and the primary controllers of the global water cycle. Depending on their physico-chemical nature, rivers deposit elements in a sequential order dependent on whether or not they are suspended or dissolved as they travel from their source. Depending on the circumstances, the river's suspended load might operate as a sink or a source for nutrients and other elements. Despite their many benefits, rivers are now under grave danger owing to a variety of human-caused factors. Observing river surface runoff on a regular basis offers vital information on the ecological and hydrologic aspects of the basin. When it comes to gauging a river's health, water quality and quantity may be used as a gauge of how well it's doing. The Yamuna is a significant tributary of the Ganges in northern India, sometimes known as "Jamuna" or "Jumna." Snowmelt runoff, rainfall runoff, and groundwater all flow into it, making it perpetual in nature. As a result, each of the three components is unique. As a result, a greater knowledge of the River Yamuna's water intake may disclose its behavior in various regions, which might be of considerable benefit to both the river and the groundwater. During the months of May and June, the river receives the most snowmelt. Precipitation, on the other hand, is the primary source of this river.

Human activities that impact the environment, especially freshwater, have grown significantly in recent decades. Water resources are affected by a broad range of socioeconomic activities, including urbanizations, industrial operations, and agricultural output. This has resulted in complicated interrelationships between social, economic, as well as environmental elements. Several factors influence the physical and chemical qualities of freshwater bodies, including the climate, geology, morphology, and pollution. Environmental variables influence the whole surface water biota.The creatures that dwell in a river are affected by the quality of the river's water. The capacity of the aquatic ecosystem to adapt to environmental change and preserve its stability depends heavily on the presence of a diverse array of aquatic organisms. The river food chain's principal producer is phytoplankton. They may change inorganic chemicals like nitrate and phosphate into new organic compounds via photosynthesis(such as lipids and proteins). Microorganisms called zooplankton play a critical role in aquatic ecosystems. They're a favorite meal for fish of all ages, but especially for young ones. Algae, bacteria, and small invertebrates are the primary foods of choice for these predators. We may use changes in zooplankton species diversity or community composition as a significant indicator of environmental change or disturbance since

zooplankton are very sensitive to changes in their environmental conditions.

LITERATURE REVIEW

Mishra N et. al, (2021): Fish populations are susceptible to natural resource management procedures and resources may be replenished throughout time if they are utilised properly. For the investigation, a random sample of Cyprinus carpio fish was collected. In this research, 548 fish specimens of varying ages and sizes were analyzed, ranging from 97 to 687 mm in length. Between February 2019 and January 2020, for this study, scientists at the Sirsa Fish Landing Center in Prayagraj, Uttar Pradesh, India studied the invasion capability and population structure of C. carpo.Fishermen in Sirsa, Uttar Pradesh, rely on C. carpio for their livelihoods in around 100 to 200 fishing communities, making it a significant socioeconomic factor in the area. The C. carpio in the Tons River had been heavily invaded, as shown by the age groups (0+ to 9+). Males accounted for 49.63 percent of the total catch, while females accounted for 50.36 percent. Pooled samples showed that 24.09 percent of the population was in the 1+ age group. The Tons River was the best place to find this kind of fish. This age group was also more likely to gather nets with larger mesh sizes and longer lengths than other age groups. Only 2.19 percent of the population in the 7+, 8+, and 9+ age brackets were in the 7+, 8+, and 9+ age brackets, respectively. Those in these age ranges are considered elderly. Ages 0+, 2+, 3+, 4+, 5+, and 6+ each contributed 6.35 percent, 21.35 percent, 18.61 percent, 13.87 percent, 7.85 percent, and 3.83 percent to the pooled samples, which were analyzed as a single group for statistical purposes.

Priyank Pravin Patel et. al, (2020): Yamuna's tributary near Delhi is regarded to be the dirtiest river in India, and pollution levels have worsened despite various repair initiatives. Although the COVID-19 epidemic is still going on, the implementation of a statewide lockdown may bring a glimpse of hope. The lockdown's effect on water quality along this length is examined using a combination of measured measurements and indices produced from satellite photos. During the lockdown period, the Class C Water Quality Index rose by 37 percent at nine locations. More than 40% less Faecal Coliforms were found as compared to the pre-lockdown period, while Biological Oxygen Demand dropped by 42.83% and Chemical Oxygen Demand dropped by 39.53%. Effluent loads dropped and drain contamination quality improved in a hierarchical cluster analysis of 20 major drains that reach the Yamuna, the research found. SPM, turbidity, and algal indications may be measured along 117 channel segment zones using multi-temporal Landsat-8 images from previous and ongoing lockout periods. Although the extents of these declines were regionally variable, these metrics also decreased significantly in most sections. Despite the fact that most industries were in a partial or non-operational state throughout the lockdown, a substantial reduction in effluent loads and an improvement in river water quality may be attributed to the continued flow of household sewage via different drains. Potential river recovery and improvement may be estimated in this research if harmful pollution and pollutants are adequately controlled.

Praveen Ojha (2019): Because of the high frequency of invasive fish species such as Oreochromis nilocticus and Clariasgeripineus in many river sections, it is clear that the problem of invading fish species is a significant one. Mathura's waters have so far been home to 48 different species of fish from 13 different families, according to the available data. Cyprinidae, Bagaridae, Schilbeidae, Clupeidae, and Ophiocephalidae were the most common families. Vegetarian and herbivorous fish were second and third in the food chain in terms of trophic use by fish. The current situation has altered in terms of native fish fauna, which are steadily dwindling. A breeding population of invading fishes is steadily taking over the Indian Native Fish Fauna, according to records. Water pollution, irrigation, and hydal projects using Yamuna River water, as well as other human activities, are the primary risks to the habitat of native species, and this has helped alien fish thrive. So, for present, the Yamuna River's water quality should be monitored to determine whether it has been contaminated by alien fish. Alien species were reported for four of the 19 species found in this research, which included 16 genera and nine families.

K. D. Joshi et. al, (2016): The Ken and Betwa rivers, which flow across central India, are the Yamuna's primary tributaries. The Vindhya area is home to both rivers, both of which begin over 550 m above sea level. As part of an interconnecting project for the rivers, water from the Ken basin will be redirected to the Betwa basin. Both rivers have alkaline sediments that are dominated by sand (78–89 percent of the total). Because of their alkaline water and adequate levels of chemical qualities, it is apparent that both rivers are clean and fertile. There were no significant variations in water quality between the Ken and Betwa rivers, save from total alkalinity. The biotic parameters were found to have equal values and to be in a moderate condition. Phytoplankton constituted 55 of the 61 planktonic species found in the rivers. 89 fish species belonging to 10 orders, 26 families, and 62 genera were found in the Ken River, which was sampled for the first time. Both rivers' downstream reaches were also found to have a variety of exotic fish species. There was a total of 77 fish species that could be found in both rivers, although only 12 could be found in the Ken River, and 4 could only be found in the Betwa. The Betwa River's Labeoboggut predominates in the Ken and Osteobramacotios. When comparing the Shannon–Wiener Variety and Evenness Indices of fish diversity, the Ken scored higher than the Betwa.The rivers included nine species of fish that are on the verge of extinction. The planned interlinking of the two rivers, which have already been hindered by several construction

projects, would further harm the ecosystem and fisheries.

Priyanka Mayank and R. K. Tyagi (2013): In Allahabad, Uttar Pradesh, a recent study on fish biodiversity and conservation focused on the Yamuna River. Fish samples were collected from the lower Yamuna River in Allahabad every month from August 2011 to July 2012.From eight orders and twenty-eight families, Allahabad's Yamuna River is home to 90 species of fish. It was the Cypriniformes and Cyprinidae family that has the greatest species. Four hundred and forty-four (44.44%) of the species belonged to the Cypriniformes order, while Siluriformes had twenty-five (277.78%) and Perciformes had fifteen (11.0%). (16.67 percent). In the order Clupeiformis, there were 5 species (5.56%) and 2 species (2.22%), respectively, that were shared by these two families. Only one species each was supplied by the orders Anguiliformes, Synbranchiformes, and Tetradontidae. Family Cyprinidae contributed the most to biodiversity (41.11%), followed by Bagridae (7.78 percent) and Sisoridae (2.5 percent). Cyprinidae (6.67 percent). Total biodiversity was 5.55 percent dominated by the Schilbeidae family.

METHODOLOGY

The current investigation was done on the Yamuna River, which spans a distance of around 40 kilometers. Kalsi (S1), Dakpathar (S2), and Asan Lake are three of the river's most prominent stopovers (S3). The research was conducted on a monthly basis for a year, from August 2018 to July 2019. Every month, sterile sampling vials were used to collect water samples, twenty-two distinct physical and chemical characteristics were assessed on each sample. Thermal (C), optical (C), velocities (m/s) and pH were all recorded on-site. Free CO2 (mg/l) and dissolved oxygen (mg/l) were also measured.Aside from that, turbidity (JTU), electrical conductivity (mho/cm), total solids (mg/l), TDS (mg/l), and TSS (mg/l) were tested as well. In order to assess temperature, transparency, and velocity, we employed a Celsius thermometer (0–110 0C), the Secchi disc, and a flow metre.Measurements of all three parameters were made using the Jackson Turbidity and Conductivity Meters and digital pH metres. Volumetric analysis was used to determine the total solids (TDS and TSS). Total alkalinity, total hardness, calcium, magnesium, chloride, free CO2, DO BOD, and COD were all determined by the use of titration techniques. UV-VIS Spectrophotometer was used to measure phosphate and nitrate, whereas Fame photometer was used to measure sodium and potassium. Phosphate and nitrate concentrations were also measured.

$$No.\ of\ Species/l = \frac{C \times 1000mm3}{L \times D \times W \times S}$$

Here,

C= 0 organisms were found.

L= For each stripe, the total length (mm)

D= Each stripe's depth of field (mm)

W= Every stripe's breadth (mm)

S= Stripe count

ANALYSIS

Physico-Chemical parameters of water

Chemical and physical characteristics (Avg. SD) derived from the three Yamuna River locations. S1 had the lowest temperature (17.252.45 0C) while S3 had the highest temperature (18.582.31 0C) from upstream to downstream, according to the data. In terms of velocity, S2 recorded the greatest value (1.710.50 m/s) while S3 recorded the lowest value (0.392/0.10 m/s). S2 had the highest pH (8.40.28), while S3 and S1 (8.270.25) had the lowest pH (8.40.14) and S1 (8.270.25), respectively. S3 had the greatest total alkalinity (171.8324.29 mg/l), whereas S2 had the lowest (150.7522.34 mg/l). Dissolved oxygen concentration was determined to be highest at S2 (11.240.71 mg/l) and lowest at S3 (10.180.83 mg/l), respectively. Transparency, Conductivity, and Turbidity all increased from S1 to S3, however Transparency dropped from S1 to S3.

Water's physical and chemical properties River Yamuna's physical and chemical characteristics (Avg. SD) from the three study locations. Temperatures varied greatly from upstream to downstream, with the lowest being discovered at station S1 (17.252.45 0C) and the highest being found at station S3 (18.582.31 0C). In terms of velocity, S2 recorded the greatest value (1.710.50 m/s) while S3 recorded the lowest value (0.392/0.10 m/s). S2 had the highest pH (8.40.28), while S3 and S1 (8.270.25) had the lowest pH (8.40.14) and S1 (8.270.25), respectively. S3 had the greatest total alkalinity (171.8324.29 mg/l), whereas S2 had the lowest (150.7522.34 mg/l). S2 had the highest value of Dissolved Oxygen (11.240.71 mg/l) while S3 had the lowest (10.180.83 mg/l). Conductivity and Turbidity exhibited a rising trend when other characteristics like Transparency decreased from S1 to S3.

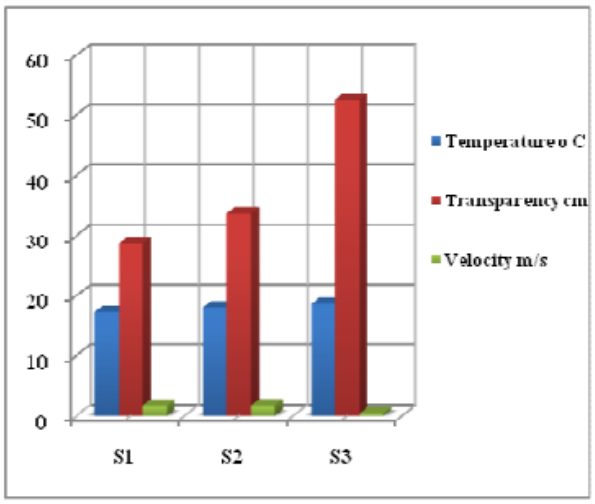

Figure 1:Yamuna River Speed, Transparency and Temperature at S1-S3

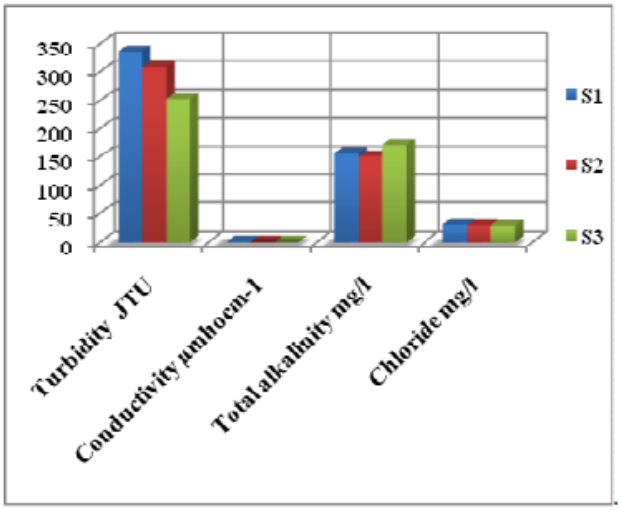

Figure 2: Shows the River Yamuna's turbidity, conductivity, total alkalinity, and chloride levels at S1, S2 and S3.

Phytoplankton, Zooplankton and Ichthyofaunal diversity and density

At S1, S2, and S3, the phytoplankton in the Yamuna River is composed of 35 taxa, with 15 genera of Chlorophyceae, 14 genera of Bacillariophyceae, and 3 genera of Myxophyceae (6 genera). Table 2 shows the average variation of the three locations. Bacillariophyceae had the most diversity (812.75351.51), followed by Chlorophyceae (241.7572.07), while Myxophyceae (59.7529.40) had the lowest diversity (59.7529.40). A total of 677.25–264.53 Bacillariophyceae were found at S2, followed by 226.91–106.59 Chlorophyceae, and 77.83–24.12. Bacillariophyceae had the highest phytoplankton diversity at S3 with 897.6–327.68, followed by Chlorophyceae (290–95.87) and Myxophyceae (104–49.20). In terms of density, S3 (1291.96) had the greatest density, followed by S1 (1114.25) and S2, which had the lowest density (981.99), indicating a pattern of S3 being higher than S1 and S2. Phytoplankton in the Yamuna River in Doon Valley belonged to the family Chlorophyceae, which included Chlorella, Chlaymydomonas, Spirogyra, and others, according to a qualitative investigation.

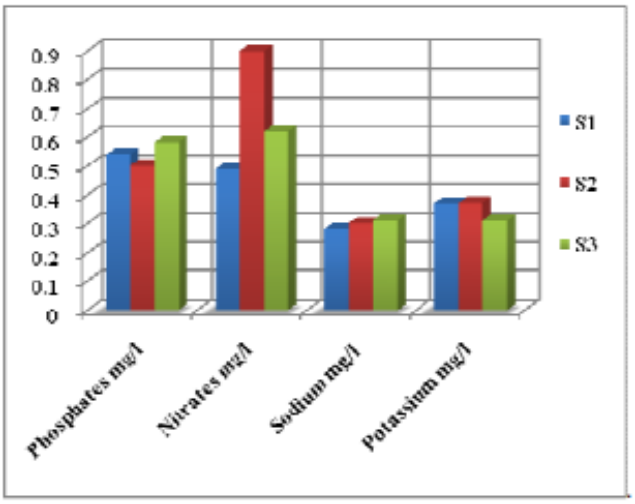

Figure 3: phosphate, nitrate, sodium, and potassium concentrations in River Yamuna's S1, S2, and S3 sections

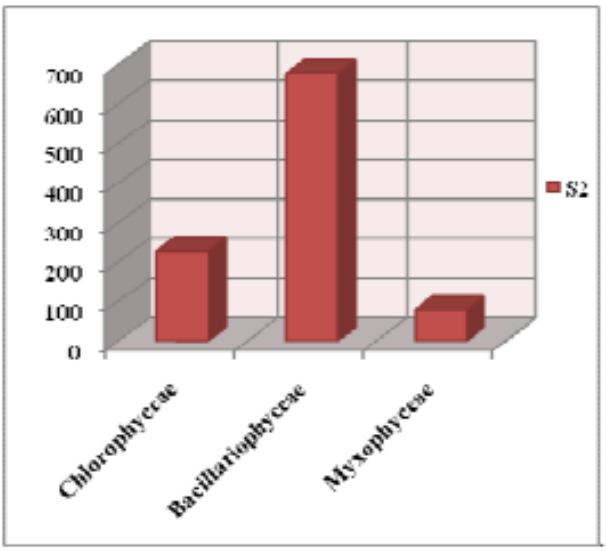

Figure 4: displaying the average phytoplankton concentration in the River Yamuna at S2 from August 2018 to July 2019.

Zooplankton in the Yamuna River at S1, S2, and S3 consists of 29 different species, including 10 genera of protozoa, 11 genera of rotifera, 6 genera of copepods, and 1 genus of ostracods (2 genera). Table 3 shows the average variation of the three locations. Rotifera (188.08100.37), Protozoa (119.75 82.26), Copepoda (75.75 46.93) and Ostracoda (14.66 12.01) had the highest diversity at S1. For the Rotifera (136.080.31), Protozoa (87.08 60,07), Copepoda (57.1630.91), and Ostracoda

(10.1507.21), the diversity measured at S2 was at its highest.

CONCLUSION

Physico-chemical and biological investigations demonstrated obvious monthly and seasonal fluctuation in River Yamuna. As a lake ecosystem, the river's biodiversity is particularly rich at S3, where the circumstances are ideal for the development of the lake's flora and animals. Yamuna River tributaries S1, S2, and S3; the Yamunotri Glacier is the source of the Yamuna River, have the least human contamination. Sand and stony sediment on the riverbed indicate a pollution-free habitat. The research area's altitudinal, geographical, mountain slope, river valley extension, and plant cover all influenced the River Yamuna's physico-biochemical characteristics, and all of these abiotic and biotic variables interacted. The velocity, gradient, river bottom, and effect of the previous night's weather were among the physicochemical characteristics that affected water temperature. Monsoon rains impacted transparency, as did TSS, sand, plankton, and sandstorms. As the snow melts, the river's velocity rises, and this rise was seen again during the monsoon. There was a clear correlation between the quantity of dissolved oxygen (DO) in the water and the aquatic vegetation and fauna. The river's nitrate and phosphate concentrations were within the range that demonstrated to be beneficial to plankton growth. The aquatic ecosystem's trophic levels are influenced by the interactions of several external elements. Fundamental to ecology is the concept of synchronicity between organisms and their surroundings. As a community's lifeline, freshwater resources need community involvement and interconnection to ensure their existence without compromising their biological habitat. The River Yamuna in Uttarakhand must be protected for its intended purpose, and a sustainable and comprehensive management strategy is important for the protection of this aquatic environment, according to this research. For the sake of long-term sustainability of the Himalayan aquatic ecosystem, it is necessary to reduce habitat damage, overexploitation, and wanton devastation, and to raise environmental consciousness among the region's residents and visitors.

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