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"Effects Of Physico-Chemical Parameters Of Gomati River On Morphometry Of *OMPOK PABDA*"

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Abstract

Present paper deals with the investigation on effects of physico-chemical parameters of Gomti on morphometry of *Ompok pabda* .The physical and chemical characteristics of River waters are crucial in establishing its viability for morphometry of *Ompok pabda.* it was determinperformance indices (f)that were acquired for *Ompok pabda* in Gomti River are seseaonal.

Keywords: Physico-Chemical, Crucial, Ompok pabda, Morphometry, Indices.

Introduction:-

In the face of increasing human pressure and deteriorating water quality, freshwater ecosystems are among the world's most precarious ecosystems. Many studies, both global and local, have been conducted in recent years on the effects of natural and human factors on aquatic biodiversity. These researches examine both regional and international elements that may be contributing to the diversification trends seen. Fish faunal patterns in southeast Asian tropical streams, such as India, and the significance of environmental and human-induced effects on community assemblages have received surprisingly little attention in the scientific literature. This comprehension is especially important now in view of the current human modifications to freshwater ecosystems. We analyzed the diversity and Spatio-temporal dynamics of fish communities in India's central and northeastern regions to determine what environmental factors are shared by these two ecoregions and consequently impact fish community structure. We utilized multiple linear regression to create prediction models for future fish diversity indices based on our study of the relationships between environmental factors and fish diversity. It is difficult to identify the ecological factors that shape patterns of diversity and distribution since the mechanisms by which communities form and the environmental factors that contribute to habitat degradation may differ from one location to the next. Many studies have shown the crucial impact played by environmental factors as temperature, climatic change, and physiochemical parameters. In recent years, freshwater ecosystems have been under more pressure than terrestrial ones, and fish have emerged as important bioindicators of ecosystem vitality.
Many human activities, such as dam construction, pollution, and changes to natural streams, have been identified as major contributors to biodiversity loss. In order to address worries about a decline in biodiversity, each of these causes must be assessed separately. Many studies have shown that regional and local factors interact to determine abundance and richness patterns. Several studies at different dimensions and with different functional units (species/functional characteristics) and degrees of disruption will produce different findings; hence, generalization is difficult without taking these factors into account. Research shows that in freshwater ecosystems, species richness is affected by a wide variety of environmental variables across spatial scales (for example, in Amazonian streams and European streams). Some research has

demonstrated that regional variables may have a significant impact on local factors, which in turn can have a significant impact on local species assemblages. Standardized methods for collecting data on fish diversity and abundance paired with information on local and regional environmental variables may help in understanding patterns of community structure across biological zones.
The distribution and presence of freshwater fishes in small and medium-sized stream settings in countries like India and China is poorly understood. Current estimates place the number of unique freshwater fish species in India's waters at over 2,200, making it one of the world's most endemism-rich countries. Lower-order streams in the Indian subcontinent have received less research than larger rivers due to the concentration on larger rivers. Two biodiverse locations, the Himalayas and the Western Ghats, have been demonstrated to include a vast variety of biodiversity and environmental elements in their lower, higher-order streams. There is a lack of information from many other sources other from a few specialized research. Studies of freshwater fish often concentrate on commercially valuable species. The destruction of aquatic ecosystems is an increasing cause for concern throughout the globe. The community structure of tropical aquatic ecosystems in India has to be studied in relation to local and regional characteristics in order to develop effective management and conservation strategies. We want to uncover environmental variables that affect the distribution patterns of stream fish populations and characterize the diversity of stream fish populations across two distinct landscapes.

Review of Literature:-

Nayek, Sayan & Das (2023) The basin of the Ganga River is home to an exceptionally wide variety of benthic flora and animals. The health of the Ganga River is degrading as a result of human activities such as the discharge of untreated rubbish, pollution from detergents and chemicals, bathing of animals, and immersion of idols, among other things. This research investigates the many assemblages of zooplankton communities that may be found in the Ganga River, which has a variety of physical characteristics, at a total of twelve different places throughout the river's southernmost reach. Both of the river's banks in the basin that runs through the state of West Bengal in India were taken into consideration for the research sites. All of the water's physical parameters, with the exception of temperature, are found to be considerably different amongst the several research sites. These characteristics include pH level, conductivity, total dissolved solids (TDS), and salinity. Throughout the river, there was a correlation between the physical variables and the quantity of zooplankton that was in the other direction. Throughout the course of our research, the most common types of creatures that we found were cyclops and daphnia. The variation in zooplankton diversity indices may be traced back to the presence of human activities, major sewage systems, and industrial belts in the areas where the research was conducted.

Kumar, Ankit & Bojjagani, Sreekanth & Maurya (2022) The use of water by humans, the satisfaction of residential requirements, agricultural and industrial operations, and the maintenance of aquatic life and ecosystems all rely heavily on the availability of water from surface water bodies. Under the scope of this investigation, research was carried out on a section of the Gomti River in Lucknow during the course of two distinct seasons in 2019. After performing an analysis of the physicochemical and bacteriological characteristics of the sediment and water samples, multivariate statistics were performed on the data. During the pre-monsoon period, the following variables had their mean values as follows: pH, turbidity, EC, TS, TDS, TSS, DO, BOD, COD, nitrate, phosphate, sulfate, total alkalinity, total hardness, chloride, and fluoride. These variables were measured in millimolar concentrations. 7.4 ± 0.2, 5.2 ± 3.3 (NTU), 444.4 ± 97.4 (µS/cm), 274.6 ± 61.6, 254.3 ± 50.2, 21.9 ± 11, 5.4 ± 1.6, 10.2 ± 5.9, 31.2 ± 13.3, 1.2 ± 0.5, 1.7 ± 1.1, 25.9 ± 3.7, 204 ± 41.8, 146.2 ± 11.5, 15.5 ± 8.7, and 0.5 ± 0.1 mg/l, respectively. The corresponding values during the post-monsoon season were 7.5 ± 0.2, 5.5 ± 3.2 (NTU), 436 ± 75.1 (µS/cm), 273.7 ± 124.2, 209.7 ± 82.5, 63.9 ± 43.4, 5.6 ± 1.6, 15.8 ± 8.9, 39.2 ± 23.5, 5.4 ± 4.6, 1.4 ± 0.9, 25.5 ± 5, 199.2 ± 36.6, 134 ± 8.6, 20.2 ± 8.9, and 1.7 ± 0.2 mg/l, respectively. Concentration of contaminants considerably increased by 5–15% from sampling station S1 (upstream) to S5 (downstream) (downstream). Enumerations of fecal coliform and Escherichia coli bacteria were low at S1 but much higher in the S5 location. WQI varied from 88 to 345 during pre-monsoon and 159 to 422 during post-monsoon period, suggesting poor water quality which was unfit for drinking reasons. Significant positive associations (≥ 0.9) were detected among pH, chloride, phosphate, sulfate, turbidity, conductivity, TS, TDS, BOD, and COD for water samples throughout both seasons. The results show that the load of pollution steadily rises from upstream to downstream owing to the rising flow of raw sewage. This is the cause of the increase. For the purpose of preserving and managing the quality of river water, regulatory organizations need to draft stringent rules and see to it that they are put into effect.

Kumar, Suresh & Veerwal, Bharati & Sharma (2022) Water is one of the most vital chemicals since it is absolutely necessary for living things of all kinds, including people, animals, and plants. Without water, there is no possibility of life. Period. Without water, it is impossible for any living thing on our planet to live; water makes up more than 70 percent of our bodies. Not only do we consume it through drinking, but water also has a variety of other applications in our lives. On the other hand, because of the excessive use of chemical pesticides and the hazardous wastes produced by industries, the quality of the water is deteriorating on a daily basis. The pure water is tainted with garbage and other rubbish from homes and businesses, as well as decomposing organic matter and chemical runoff from factories. As a result, this poses a threat of death to human beings as well as any associated flora or fauna. Diseases caused by contamination of water affect close to twenty percent of the world's population. It is absolutely essential to have access to water that is of an adequate quality in order to reduce the risk of illness and improve one's overall quality of life. In order to ensure that water retains its high standard of purity and quality, it is necessary to conduct periodic analyses of the physicochemical properties of the water. There need to be stringent regulations governing the monitoring of water supplies. When conducting a test to determine the quality of the water, it is important to have a thorough understanding of the various physicochemical parameters that are used, including temperature, total hardness (TH), pH, sulphate, phosphate, nitrate, chloride, fluoride, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total alkalinity, and total dissolved solids (TDS). Heavy metals such as lead, arsenic, chromium, ferromanganese, mercury, cadmium, and others cause water to become unfit for human consumption and can poison aquatic organisms over the course of their lifetime. Throughout the course of our current review, we have compiled records of water analysis with physicochemical parameters; these records will be of use in both the continuation of research operations and the upkeep of water purity.

Kumar, Rajesh & Yadav (2022) The length-weight connection of all seven species of fish that live in the Gomti River near Lucknow, India, was investigated in this research. We obtained a total of 271 specimens, with their lengths ranging from 15 to 57 cm and their weights varying from 25 to 155 g. According to these findings, the value of b in the Gomti River ranged from 2.54 for the Wallago attu to 3.2 for the Channa punctatus. In the Gomti, the value of b, taken as a mean across all species, was 2.99. Five out of a total of seven regressions provided r 2 values that were greater than 0.90. The coefficient of determination (r 2) for the Gomti River varied from 0.90 (Notopterus notopterus) to 0.95 (Channa punctatus), with a median value of 0.94. Every single linear regression turned out to be very significant statistically (P 0.001). The purpose of this research was to determine the length-weight relationships of the freshwater fishes found in the Gomti River in order to contribute to the conservation and management of the riverine population..

Yadav Sheela & Mishra Dev Brat (2022) For over a billion people, Fish is the primary source of protein , Making it the sixth largest agricultural resource among vertebrates. Having a diverse aquatic fauna is important for preserving ecosystems and increasing future production potential. Aquatic species, both economically and non- economically valuable, actively contributed to sustaining complex interacting and ecosystem-based ecosystems, in addition to their commercial commodities worth. A big issue now is preserving fish populations and their habitats. Therefore, the fish and water of the Gomati River are connected to this study.

Khan, Ramsha & Saxena (2022) Since many decades ago, there has been an ongoing struggle between the vitality of naturally occurring ecosystems and that of artificially produced systems. Environmentalists and ecologists from all over the world have taken an interest in riverfront development along rivers due to the ecological sensitivity as well as the socio-economic issues involved with riverfront development. The Water Pollution Index (WPI) and a number of other statistical techniques were used during this investigation in order to come to a conclusion on the effects that channelization and riverside development have had on the water quality of the Gomti River. Even after the construction of riverside, seventy-five percent of the total areas that were investigated were found to fall into the "very contaminated" category. In the midstream locations of Kudiaghat and Daliganj, respectively, the WPI values were found to have increased by about 274.5% and 171.76% above the previous value. The fact that the WPI readings have increased is unequivocal proof that the river Gomti's water quality has declined as a result of the channelization. Even after a large amount of time has been spent developing the riverfront, the primary problem of residential sewage being discharged into the river after only receiving partial or no treatment seems to remain unsolved. This research has the potential to serve as a collection of references for the creation of similar initiatives all over the world.

Joshi, Pankaj & Chauhan, Akshansha & Dua (2022) The Yamuna is one of the most important rivers that feeds into the Ganga, and it flows right through Delhi, which is the capital city of India. During the last several years, it has gained a reputation for being one of the most polluted rivers in India.

Chandra, Sulekh & Singh, Arendra & Tomar (2011) the physical and chemical characteristics of water samples taken from a variety of rivers in India. During the months of July and August in 2009, water samples for the purposes of the inquiry were gathered from the following locations: Krishana Vijaywada, Gomti Lucknow, Hoogali Kolkata, Ganga Kasi, Mahanadi Katak, Cauveri river Tiruchirapalli station. In a number of the study locations, there is clear evidence of input from industrial sources in the form of considerable enrichment in the elements zinc, iron, nickel, calcium, and magnesium. The values that were observed for various physicochemical characteristics such as pH, temperature, turbidity, total hardness (TH), iron, chloride, total dissolved solids (TDS), Ca2+, Mg2+, SO42-, F- total alkalinity (TA), COD, BOD, phosphate, FRC (Free residual chlorine), total silica, and hydrazine of samples were compared with standard values that were recommended by the Bureau of Indian standard (BIS).

Sarkar, Uttam & Gupta, B. & Lakra, Wazir (2009) Thorough surveys were carried out in the upper, middle, and lower stretches of the river Gomti, which is a tributary of the river Ganga, in order to investigate the variety of fishes, distribution patterns, quantity, and danger, as well as the quality of the ecosystem. The total number of fish species that were obtained from the different sample locations was 56, and they belonged to 20 families and 42 genera. There are a total of 56 species, and out of them, five are considered to be in the "endangered" (EN) category, while 11 are considered to be in the "vulnerable" (VU) category. Six of the most important types of habitats have been classified, and the patterns of fish assemblage and dominating species in each environment have been investigated. There were noticeable discrepancies found between the fish species richness and the relative abundance (RA) of the species that were found in the various sample locations throughout the river Gomti. The Shannon–Wiener biodiversity index was computed for the fishes, and the results showed that there is a significant amount of variance (p 0.05) throughout the river. Other notable species are Chitala chitala, Notopterus notopterus, Ompok pabda, O. bimaculatus, Labeo bata, L. calbasu, Cirrhinus reba, Channa marulius, Bagarius bagarius, and Clupisoma garua. The Indian Large Carps include Labeo rohita, Catla catla, and Cirrhinus mrigala. This river is the first place anybody has ever seen any of these species, yet they are all present here. The variety of fish is under danger due to activities such as indiscriminate fishing, poisoning, the use of fine mesh sized nets, the dumping of sewage, siltation, water abstraction, shifting land use patterns, decreasing water flow, and the introduction of foreign species. Research on the most important fish species and the environments in which they live has to be started right now. With the purpose of conserving fish biodiversity, many restoration techniques that are based on ecosystem scale approaches have been suggested.

Trivedi, Priyanka & Thareja, Sukarma (2009) We provide the results of a comprehensive study on the physicochemical characteristics of water samples taken from the Ganges River at Kanpur. The Jalsansthan Benajhawar Kanpur sampling station was used to collect water samples for the inquiry in the months of April and May, July and August, and October and November of 2008. These months correspond to the pre-monsoon, monsoon, and post-monsoon seasons, respectively. In order to identify the water quality parameters that are highly correlated with one another and interrelated, correlation coefficients were calculated between different pairs of parameters, and a t-test was used to determine whether the results were significant. The values that were observed for various physico-chemical parameters such as pH, temperature, turbidity, total hardness (TH), Iron, Chloride, total dissolved solids (TDS), Ca 2+, Mg +2, SO4 -2, NO3 -, F - 1, total alkalinity (TA), Oxygen consumption (OC), and Suspended

Methodology:-

Life history traits of Ompok pabda
Body description
The head is tiny, wide, and flattened, while the nose is bluntly rounded and flattened. In standard distance, the body depth ranges from 3.9 to 5.7, while the head distance ranges from 4.1 to 6.7. Eyes are rather tiny, measuring between 1.25 and 1.5 millimetres in snout distance, 2.5-3.0 millimetres in inter-orbital width, and

3.3-5.1 millimetres in head distance. The occipital process is not connected to the bone at the base of the dorsal fin, and it is longer than it is wide at its base. The tip of the pectoral fin is covered by the rayed dorsal fin, and the fish has two sets of barbels. A long anal fin that is separated from the caudal by a notch. The caudal fin has two lobes, none of which tapers to a point. The upper lobe is more pointed or arched than the lower is a little bit longer than the other. The coloration of the body varies greatly, but it is often silvery and glossed with gold. It has a black shoulder spot that is located above the centre of the pectoral fins, and normally another one that is located near to the base of the caudal fin. When newly caught, it has a silvery green colour with a hint of yellow, and it is dark on the back and fades to a dull silver on the belly. Golden yellow anal and caudal fins with a few little black specks and a black line running around the base of each fin.

Systematic position of O. pabda
Kingdom - Animalia
Phylum - Chordata
Subphylum - Vertebrata
Infraphylum - Gnathostomata
Superclass - Osteichthyes
Class - Osteichthyes
Subclass - Actinopterygii
Order - Siluriformes
Family - Siluridae
Genus - Ompok
Specific name - pabda
Scientific name - Ompok pabda

Key characters for identification: Anal fin rays 48-56, the pelvic fin reaches the start of the anal fin. The maxillary barbels go all the way to the pectoral fin's middle point.
Fin formula: D.4; P. I, 11-13; V. I, 6-7; A. Ii-iii, 48-56; C. 17-19.

3.2.4 Distance-weight relationships
During the research, samples of Several O. pabda were collected from the Gomati River, and each sample site was representative of a different habitat type. A laboratory received all the samples and documented their total number as well as how much they weigh, how long their forks are, and how long their bodies are. The distances were determined to within 0.1 cm using a digital calliper, and the body weight was determined to within 0.1 g using a digital scale. Fish types in the samples were identified using the keys provided by Jayaram (1999). The correlation between fish distance and weight was calculated using the formula W= aLb and 3.5. This formula illustrated normal development parameters, or provided an explanation of relative prosperity.

This connection is often represented in the logarithmic form since it is more convenient for practical purposes:
Log W = Log a + b Log L
Where W = weight of fish in grams, a = intercept (constant),
L = distance of fish in centimeter and
b = regression coefficient (Slope).

Moreover (1) TL vs SL; (2) SL vs FL; and (3) FL vs TL relationships were calculated by linear regressions.

Condition Factor
The ponderal index, also known as the condition factor or the fatness (K), is a measurement that may be used to evaluate the health of an entire population. This measurement is based on the premise that the growing of fish in optimal circumstances results in fish that are the same distance and body weight throughout their lives. The following formula will calculate the overall health of the fish, as measured by the condition factor (K):
$K = W*100/L^3$

Where W = Weight of fish in g. and L = Total distance of fish in cm.

In both male and female cases, the value of K exhibited substantial swings due to random variation. Similarly, Ricker (1958) describes how fishes' K values fluctuate over time, arguing that the cube and the isometric growth do not apply to fishes because of the irregularities in their body proportions when they are growing. Ricker adds that this inconsistency is since fishes undergo changes in their body proportion while they are growing.

Relative condition factor
The relative condition factor, also known as Krel, was determined by the following formula in order to account for variations in form or condition that occur with an increase in distance:
$K_{rel} = W/aL^b$
Where, W = Observed weight, L = distance of fish

Three distinct time periods were identified: three distinct times of year: (a) spring (March to June), (b) summer (July to September), and (c) fall (October to February). Dimensional differences were broken down into their component parts: dimensions, mass, and state of health. To test if the regression was statistically significant, an analysis of variance (ANOVA) was performed, and t-tests were performed on the seasonal b-values to see whether they were notably dissimilar to the isometric expansion (b=3). SPSS version 13 was used throughout each stage of the statistical analysis.

Initial size at puberty
In order to determine the size of this types when it first reached maturity, the following processes were followed:
1. During the height of the breeding season, we collected a number of fish, measured their distance (in centimetres) and weight (in grammes), and then cut open a number of fish of varied sizes.
2. Using the approach that was prescribed for the types, we recorded the stage that the maturation process had reached.
3. Arranged the fish into appropriate size groups based on their characteristics.
4. Kept a tally of how many adult fish were found in each size category.
5. Determine the size group at which fifty percent of the fish have reached maturity.

To determine the minimal weight required for maturity, create a comparable plot that compares the proportion of mature fish to their weight. Plotting options may be narrowed down to the appropriate weight category.

Results and Discussion

Table 4.5 provides a description of the physical environment parameters as well as the morphology of the chosen locations. The average water depth was between 1.2 and 3.2 metres, while the speed of the current ranged from 0.35 to 0.64 metres per second. The substrate varied from being significantly coarser (>6.5 mm) than pure sanity (0.05-1 mm) to being mostly composed of pebbles and cobbles with sizes ranging from 16 to 256 mm. The average size of the substrate was a little bit greater than gravel. The values of the physicochemical parameters of each sample site's mean and range are shown in Table 4.6. These values were determined by measurement. The water temperature varied from 26.2 to 27.6 degrees Celsius on average. Nitrate concentrations ranged from 0.87 to 3.34 mgL-1, nitrite concentrations from 0.03-0.10 mgL-1, total hardness from 113.8 to 295.5 mgL-1, phosphate concentrations from 0.05-0.67 mgL-1, ammonia concentrations from 0.08 to 1.03 mgL-1, and alkalinity from $CaCO_3$ from a mean of 6.5-8.2., 49.5- 232.9 mgL-1. In order to determine which set of values was most prevalent in the river Gomati, the global values for each parameter were divided into four to five categories and then depicted in figure 4.13. The water from the Gomati River fulfilled all of the physicochemical standards that the World Health Organisation (WHO) considers to be either the highest desired level or the maximum permitted limit.

There was a wide range of variation in the physicochemical properties among the sample locations (Table 4.6). There were significant differences ($p < 0.05$) in the physicochemical characteristics across the different locations. Surajghat (S2), Gular Ghat (S4), and Suraj ghat Mandir (S6) all have year-round DO readings in excess of 5 mgL-1. In contrast, the downstream site at Balua Ghat city (3.6 mgL-1) and the downstream site at Ramghat (1.8 mgL-1) have the lowest levels. This is since excessive oxygen demand is caused by the discharge of untreated municipal and industrial wastewater. The middle distance of the river at Gular Ghat was found to have the highest levels of electrical conductivity (546.6 Scm-1), followed by S3 (Ramghat) (460.8 Scm-1), Balua Ghat (458.6 Scm1), and Suraj ghat Mandir (417.6 Scm1). Electrical conductivity was tested at site S1 in Hanuman ghat during the whole year and found to have relatively low values (mean 92.4 Scm-1), coming in at less than 132 Scm-1. In the whole course of the river Gomati, comparable patterns of fluctuations in TDS were also detected at the same time as conductivity.

4.2.2 Changes in physical and chemical measurements over the seasons

Table 4.7 displays, along with their respective mean values, the total monthly fluctuations that occur. Most of the physicochemical characteristics exhibited significant seasonal shifts (Fig. 4.14). The recorded temperature range for the air was between 21 and 41 degrees Celsius, while the water temperatures fluctuated according to seasonal climates and averaged 26.65 degrees Celsius. January had the lowest recorded mean water temperature of 19.8 degrees Celsius, while June had the highest recorded mean water temperature of 30.4 degrees Celsius. Like the temperature, the water's clarity changed with the seasons and the different ecosystems it was in, ranging from very muddy (visibility of 1.5 cm) to relatively clear (38.0 cm) with a moderate average of 18.5 cm. There was also a wide range of variation in the monthly mean values of water conductivity, which ranged from 234.5 to 564.0 Scm-1. The dry seasons saw the conductivity of the whole river distance reach its highest point, whereas the wet seasons saw a large drop in conductivity as a result of the increased dilution. In June, the electric conductivity was measured at its highest point (564), and it dropped to its lowest point (234.5 S/cm) in September.

Readings of turbidity were found to be all over the place, ranging from 4.8 to 32 NTU. It seems that floods and rain are to blame for the greatest level of turbidity (32 NTU) being recorded in August and the lowest level of turbidity (4.8 NTU) being recorded in May occurred during this month. In the month of May, the average water velocity was 0.15 metres per second, whereas in the month of November, the average velocity was 0.81 metres per second. The pH fluctuated between 7.2 and 8.3 during a month. The months of January, February, and May saw pH values that were at their highest (8.3), while the months of September saw pH values that were at their lowest (7.2). The alkaline nature of the Gomati river water is reflected in the pH range of the surrounding environment, which extends from 7.2 to 8.3. DO levels were observed to vary throughout the year, with the greatest values recorded in January and February (7.4 mgL-1) and the lowest levels reported in May and June (4.5 mgL-1). The lowest amount was reported in July (325 mg L-1), while the highest was recorded in April (325 mg L-1). Total dissolved solids readings covered the gamut from 141.8 to 198.0 mgL-1. In June, total dissolved solids were measured at a high of 410 mgL-1, while in September, they were measured at a low of 141.8 mgL-1. Nitrate concentrations ranged from a low of 0.88 mgL-1 in September to a high of 4.87 mgL-1 in May. Nitrate concentrations varied from 0.88 to 4.87 millimoles per liter. In March, the average phosphate content was 0.77 mgL-1; it fell during the monsoon and again after the monsoon (Fig. 14).

4.2.3 Interrelationships of environmental factors

A Pearson correlation coefficient was determined to be present between the several water quality measures. Table 4.8 displays the values of the correlation coefficients (r) that have been found between the various environmental variables.

The current investigation found that the temperature of the water had an inverse relationship with both the amount of dissolved oxygen ($r = -0.61$) and the conductivity ($r = -0.45$). This demonstrated that changes in the values of water temperature indicate either a drop or a rise in the levels of electrical conductivity and dissolved oxygen. A major advantage connection ($r = 0.512$) was also found between depth and turbidity.

There is a very substantial positive association between TDS, pH, phosphate, and alkalinity all correlate positively with electrical conductivity ($r = 0.90$). TDS, pH, and alkalinity levels may be interpreted as follows likewise display a reduction or rise in accordance with changes in the values of EC, whether such changes are positive or negative. Conductivity also has a considerable inverse relationship with overall hardness ($r = -0.640$), as the correlation between the two variables states. The pH exhibited a statistically significant inverse relationship ($r = -0.798$) with the overall hardness. The TDS had a modest significant positive connection with alkalinity ($r = 0.458$) and a negative correlation with total hardness ($r = -0.512$). Nitrate levels and alkalinity were shown to have a statistically significant and positive connection ($r = 0.579$). There was a positive and substantial connection between ammonia and alkalinity ($r = 0.579$), which means that when there is a rise or decrease in the values of ammonia, there is also an increase or reduction in the values of alkalinity. In the river Gomati, there was no significant link between the levels of nitrate and any of the other criteria.

4.2.4 Relationships between environmental factors and patterns in types composition

All 18 environmental components main component analysis was used to examine. Table 4.9 displays the results of a principal component analysis, which resulted in three axes that explained 60.23 percent of the difference in environmental conditions across the sites. No matter what the percentage of fines, fine gravel, coarse gravel, cobble, or sand existed in the substrate, all indicated considerable loadings along the first axis. Water flow, conductivity, total dissolved solids, and total hardness exhibited substantial loadings along the second axis, whereas Significant loadings were seen along the third axis for temperature, dissolved oxygen, pH, and canopy cover. Fifteen out of eighteen environmental variables (Water velocity, electrical conductivity, temperature, factors such as total hardness, dissolved oxygen, pH, and canopy cover) were found to have high loadings. Substrate water flow, gravel size, cobble size, sand size, and coarseness of gravel all have a role. However, none of the first three axes had very high loadings for riparian vegetation, rowcrops, or rangeland land use. The habitat structure varied considerably across the different sample sites, as shown by the results of the repeated-measures analysis of variance ($F = 8.55$, $p< 0.05$) conducted on the environmental variables.

The nature of the connection between key fish types and different environmental circumstances was determined using canonical correspondence analysis. CCA's prospective pick method identified 15 variables as major factors in the ordination's overall variability. Third and fourth ordination axes were not studied (Table 4.10). The types data showed that 9.61% of the variance could be attributed to the first ordination axis and 18.35% could be attributed to the second ordination axis. Environmental characteristics significantly correlated with both the types present and their abundances ($P<0.001$ along axis 1 and 2, Monte Carlo test with 1,000 permutations). Positive correlations were found between the first ordination axis and correlating positively with flow, total hardness, fine gravel, and cobble substrates unfavourable correlations with conductivity, TDS, and sand substrates. Considerations for sand substrate, water temperature, turbidity, overall hardness, and depth all had significant positive correlations with the second ordination axis. Environments of the types were shown to have correlations of 0.92 with Axis 1, and 0.87 with Axis 2. The distance of the vector extending out from the origin represented the relative size of each component of the environment.

Types were classified into one of four groups according to most salient characteristics of their environments. (Fig. 4.15) Ompok bimaculatus and Chitala chitala were the two types that made up Group 1. The water current, dissolved oxygen level, and proportion of cobble in this group's environment were all rather high. Channa marulius, Clupea garua, Rita rita, and Puntius ticto are the four types involved were shown to prefer locations with a slower water current, a greater concentration has a sandy bottom, strong conductivity, and plenty of TDS. Catla catla, Bagarius bagarius, Notopterus notopterus, and Ompok pabda make up group three, and they were shown to be linked to areas with high turbidity and deep waters at higher temperatures. Group 4 was discovered to include fish such Gudusia chapra, Puntius sarana, Cirrihinus mrigala, and Eutropiicthys vacha, and was distinguished from Group 3 by its shallow depth, low levels of turbidity (cloudiness) in the water and a gravel bottom with varying sizes.

4.2.5 Major habitat types with their fish types preferences

The Ganga River floodplain river channels are quite like the Gomati River's tested ecosystems. According to the findings of this research, we can classify fish habitat into six broad classes (Table 4.11): (a) Fast-moving water: Ompok, Sperata, Bagarius, Glyptothorax, and Danio, among others, call this stretch of the river home because of the high flow and shallow depth. Moderately sized pools with modest amounts of current flow are seen in (b) backwater and shallow pools. Notopterus, Cirrhinus, Rita, and Labeo are four types that thrive in this area. Types like as the Chitala, Wallago, Ompok, Clarias, and Channa call environments with Home is where the water is deep, cloudy, and the ground is rocky. A deep pool is defined here as a region with a depth that is at least twice the prevailing depth. (d) River meandering and channel confluence: fish thrive in the environment found at the meeting of two rivers. Table 4.11 shows that at most forty types have been seen in the habitat formed by the river's meanders and the convergence of its channels at site 3. An open river is one in which the channels do not converge or form pools. Locations that are at risk of floods. The fish communities that live in open water and floodplains are both best exemplified by diverse assemblages of fish types. The middle section of the river Gomati in the study area showed a great deal of diversity in terms of the types of habitats that were present (more riparian vegetation, more wetlands, and more tiny channels and linked channels) whereas the higher parts had less unique features (few riparian vegetation, fewer tiny canals, etc.). The floodplain area in the middle section of the river Gomati in the study area.

Table 4.5 physical habitat features of the river Gomati locations used for the samples

Sites	**Depth (m)**	**Current Velocity (M)**	**Current Width (m)**	**River Width (m)**	**Habitat type**	**Substrate (inferred composition)**	**Riparian vegetation**
Hanumanghat (S1)	1.2±0.4 (0.8-2.0)	0.35±0.28 (0.02-0.8)	95 (70-120)	30 (20-50)	Pools, water flow moderate, narrow channel width	Homogenous fine	Shrubs 37.5% (10-50%) herbs, trees, and cultivable crops
Surajghat (S2)	1.74±1.1 (0.7-4.6)	0.6±0.33 (0.2-1.1)	225 (200-250)	42.5 (25-60)	Channel confluence, lateral scour pool, low water flow	Nearly Homogenous fine	Shrubs 41.6% (30-50%) herbs, trees, and cultivable crops
Ramghat (S3)	3.2±1.34 (1.2-6.0)	0.4±0.35 (0.1-1.4)	375 (300_450)	175 (150-200)	Back water pools, moderate water flow	Homogenous fine	Shrubs 26% (10-30%) herbs, trees, and cultivable crops
Gular ghat (S4)	2.8±1.14 (1.5-4.0)	0.6±0.34 (0.3-1.1)	250 (200-300)	95 (150-250)	Lateral and straight scour pool	Heterogeneous mixture of gravels, sand, slit and clay	trees 30% (15.5-45.8%) herbs and shrubs
Balua bhat (S5)	2.4±0.7 (1.3-3.5)	0.6±0.36 (0.2-1.2)	350 (250-450)	200 (150-250)	Straight scour pool, riffles and moderate flow	Nearly Homogenous fine	Shrubs 37.5% (10-50%) herbs, trees, and cultivable crops
Suraj ghat Mandir (S6)	3.0±1.1 (2.1-5.3)	0.64±0.36 (0.4-1.2)	390 (280-500)	275 (150-300)	Channel confluence, straight scour & backwater pools	Homogenous fine	Trees 46.2% (10-55%) shrubs, herbs and cultivable crops

Table 4.6 averages, standard deviations, and ranges for water-quality indicators at several locations along the Gomati River

Parameters (mean value)	Hanuman ghat (S1)	Suraighat (S2)	Ramghat (S3)	Gular Ghat (S4)	Balua Ghat (S5)	Suraj ghat Mandir (S6)
Water temp. (°c)	26.8 ± 5.4 (15.7-30.4)	26.2 ± 6.0 (16.0-31.6)	27.6 ± 7.0 (16.4-32.1)	26.9 ± 5.2 (17.3-30.9)	27.0 ± 5.6 (16.6 - 31.5)	26.3 ± 6.4 (15.2-31.3)
pH	6.5 ± 0.4 (6.0-6.9)	7.8 ± 0.5 (6.9-8.6)	7.5 ± 06 (5.8-8.7)	7.9 ± 0.2 (7.8-8.2)	7.7 ±0.4 (7.2-8.3)	8.2 ± 0.4 (7.6-8.6)
D.O. (ppm)	5.7 ±0.6 (4.6-6.7)	6.5 ± 1.1 (5.0-8.2)	5.3 ± 2.6 (1.8-7.2)	6.8 ± 1.2 (5.4-8.2)	56.0 ±2.2 (3.6-8.4)	6.7±1.2 (5.2-8.4)
Conductivity (µS cm-1)	92.4 ± 32.2 (54-132)	352 ± 86.1 (260-442)	460.8 ±87.1 (360-693)	546.6 ± 38.8 (490.575)	458.6 ± 122 (220-525)	417.6±135 (220-505)
TDS (ppm)	64.9 ± 21.2	304.2 ± 6.9 (300-320)	324.9 ± 71.2 (225-510)	360 ± 21 (330-380)	304 ± 77.5 (160-360)	277.1±100.6 (130-340)
Turbidity (FNU)	8.2 ± 0.9 (7.1-9.4)	8.4 ± 4.7 (4.1-15)	14.6 ± 8.1 (4-35)	9.9 ± 4.3 (5.9-15.7)	16.7 ± 8.8 (8-35)	24.6±20.5 (10-64)
NO3 (mg L-1)	0.87 ± 0.4 (0.6-1.3)	1.8 ± 1.1 (0.6-3.5)	3.34 ± 2.9 (0.5-7.8)	1.4 ± 0.4 (1.0-1.8)	1.3 ± 0.3 (1.0-1.6)	1.5 ±0.5 (0.9-1.8)
NO2 (mg L-1)	0.04 ± 0.03 (0.03-0.08)	0.03 ± 0.01 (0.01-0.04)	0.06 ±0.04 (0.01-0.14)	0.07 ± 0.04 (0.04-0.12)	0.07 ± 0.03 (0.04 - 0.11)	0.10±0.03 (0.06-0.13)
Total hardness (mg -1)	115 ± 84 (80-164)	227.4 ± 137 (120-410)	295.5 ± 156 (110-507)	113.8 ± 41.2 (85.4-161.1)	203.5 ± 101.2 (136.2 - 320)	235±169.3(125.8-430)
Ortho phosphate (mg L-1)	0.19 ± 0.04 (0.15-0.22)	0.05 ± 0.01 (0.03-0.06)	0.31 ± 0.28 (0.07-0.92)	0.67 ± 0.13 (0.52-0.77)	0.31 ± 0.21 (0.21 - 0.98)	0.33 ± 0.16 (0.14-0.43)
NH4 (mg L-1)	0.08 ± 0.06 (0.04-0.15)	0.14 ±0.11 (0.06-0.32)	1.03 ± 0.96 (0.09-2.6)	0.26 ± 0.15 (0.1-0.39)	0.48± 0.4 (0.21 - 0.98)	0.83 ± 1.1 (0.18-2.1)
Alkalinity (mg L-1)	49.5 ± 4.3 (42-56)	194.7 ± 54.7 (135-250)	232.9 ± 78.1 (80-330)	147.5 ± 29.9 (120-190)	194 ± 49.9 (100-230)	74.3 ± 34.9 (50-125)

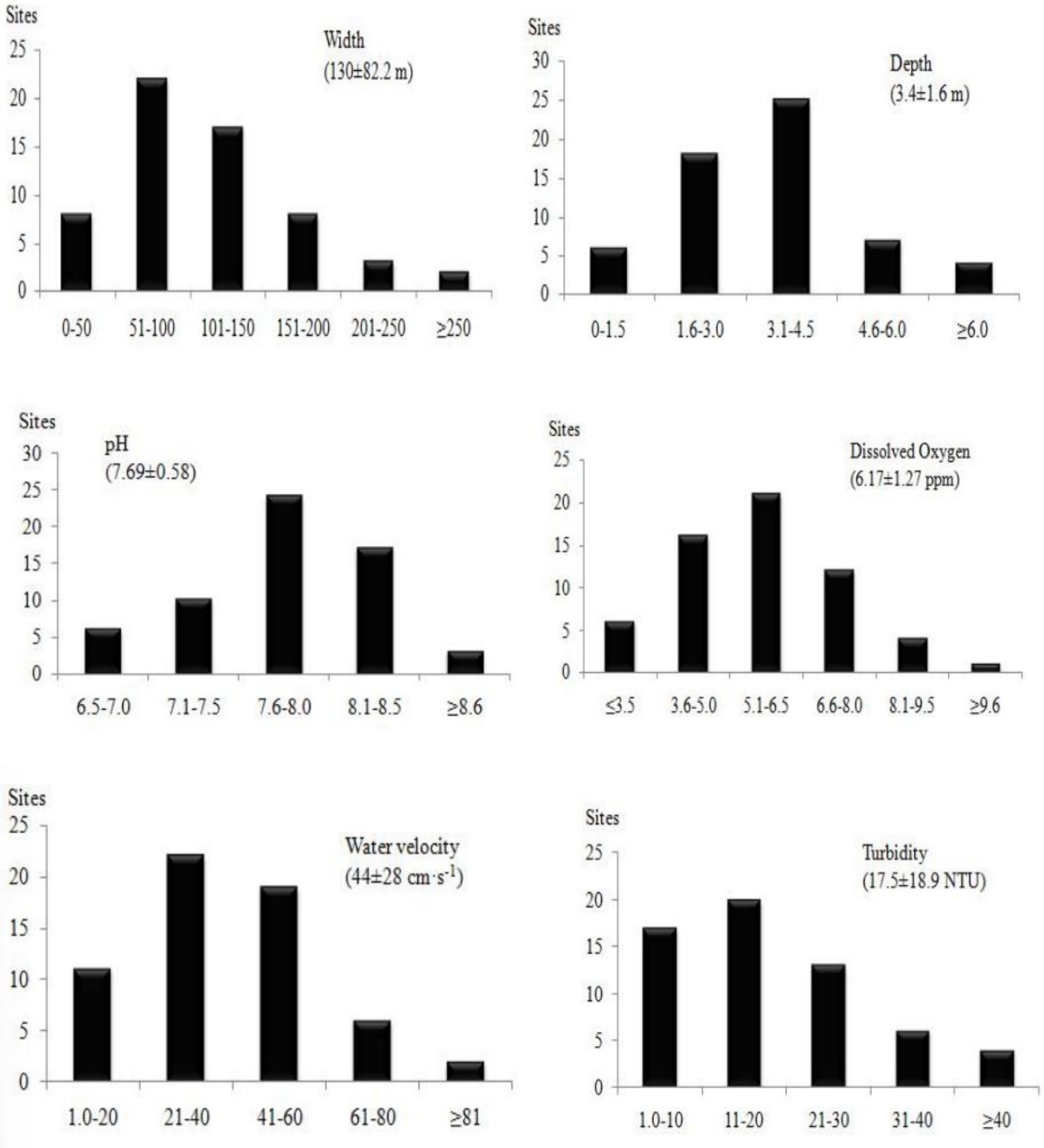
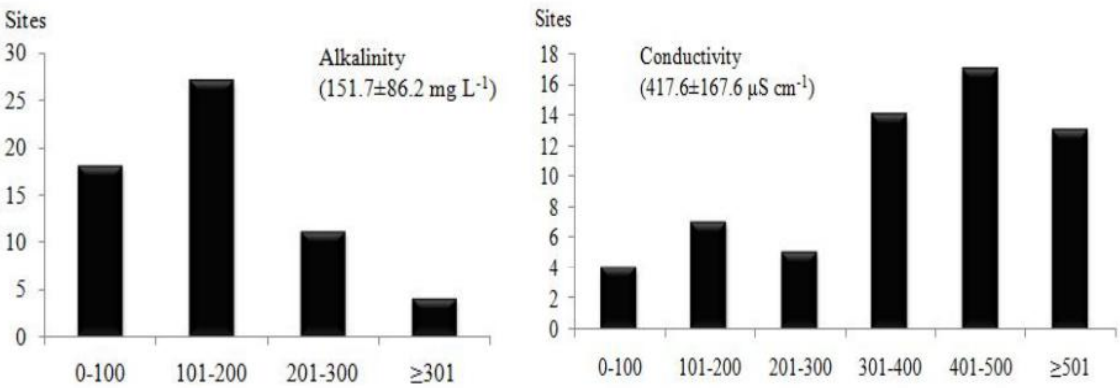
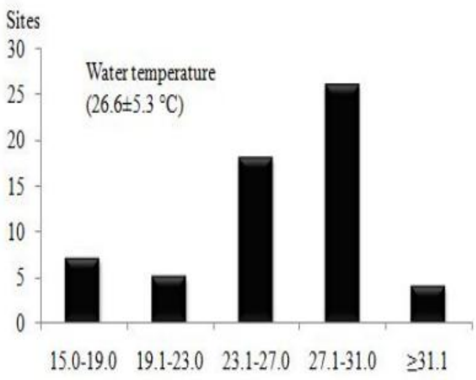
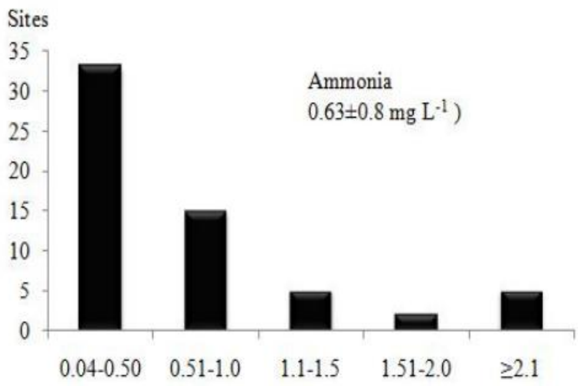
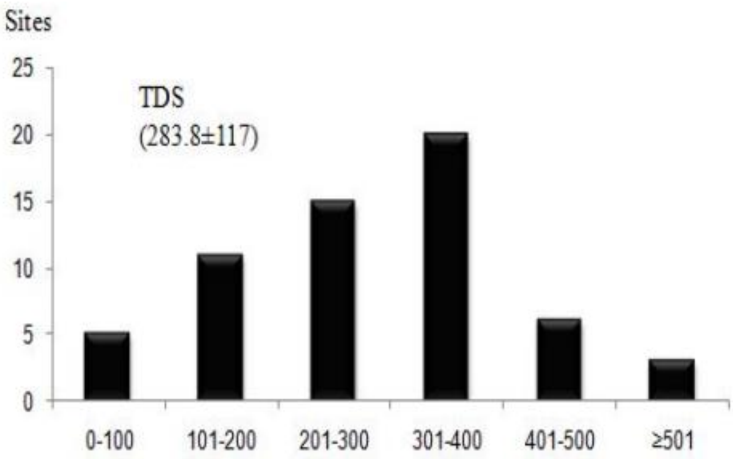


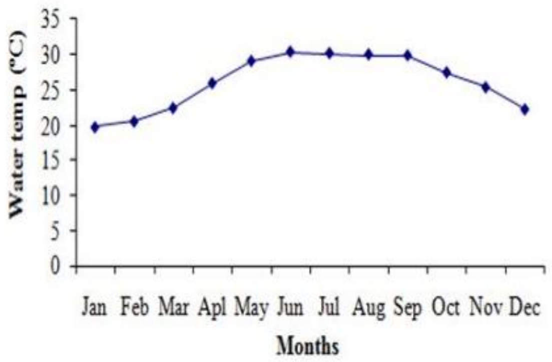
Fig. 4.13 The following table presents the distribution of sites (point data) according to the categories of values for each physicochemical property throughout the course of 2017–2019. The GM±SD for each variable is shown in brackets after its name.

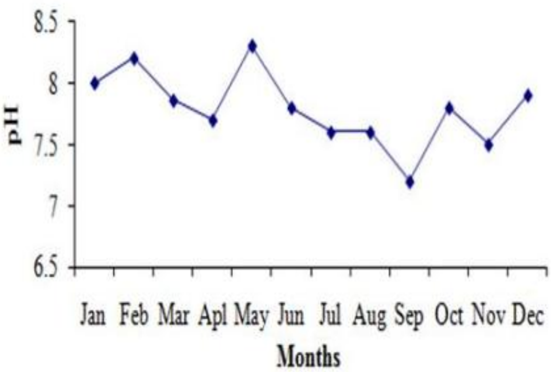


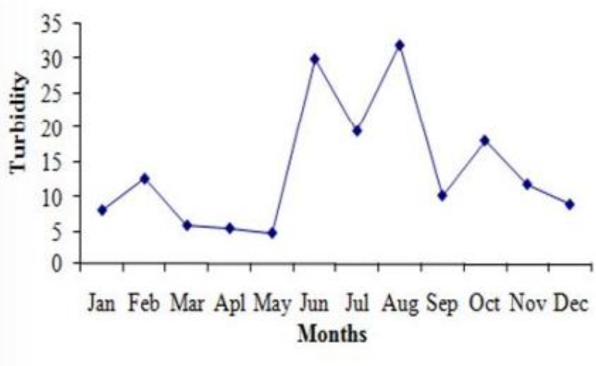

Sites
Water temperature
(26.6±5.3 °C)
30
25
20
15
10
5
0
15.0-19.0
19.1-23.0
23.1-27.0
27.1-31.0
≥31.1

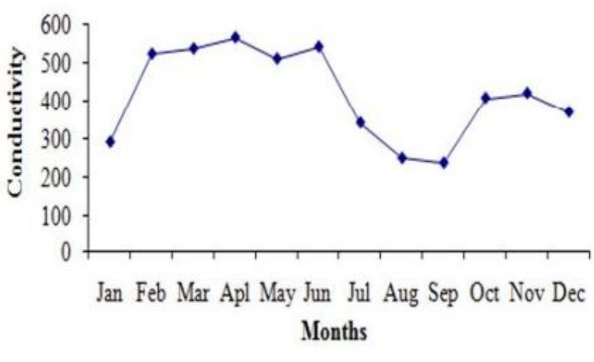

Sites
Ammonia
0.63±0.8 mg L-1)
35
30
25
20
15
10
5
0
0.04-0.50
0.51-1.0
1.1-1.5
1.51-2.0
≥2.1


Sites
TDS
(283.8±117)
25
20
15
10
5
0
0-100
101-200
201-300
301-400
401-500
≥501


Water temp (°C)
35
30
25
20
15
10
5
0
Jan Feb Mar Apl May Jun Jul Aug Sep Oct Nov Dec
Months


pH
8.5
8
7.5
7
6.5
Jan Feb Mar Apl May Jun Jul Aug Sep Oct Nov Dec
Months


Turbidity
35
30
25
20
15
10
5
0
Jan Feb Mar Apl May Jun Jul Aug Sep Oct Nov Dec
Months


Conductivity
600
500
400
300
200
100
0
Jan Feb Mar Apl May Jun Jul Aug Sep Oct Nov Dec
Months

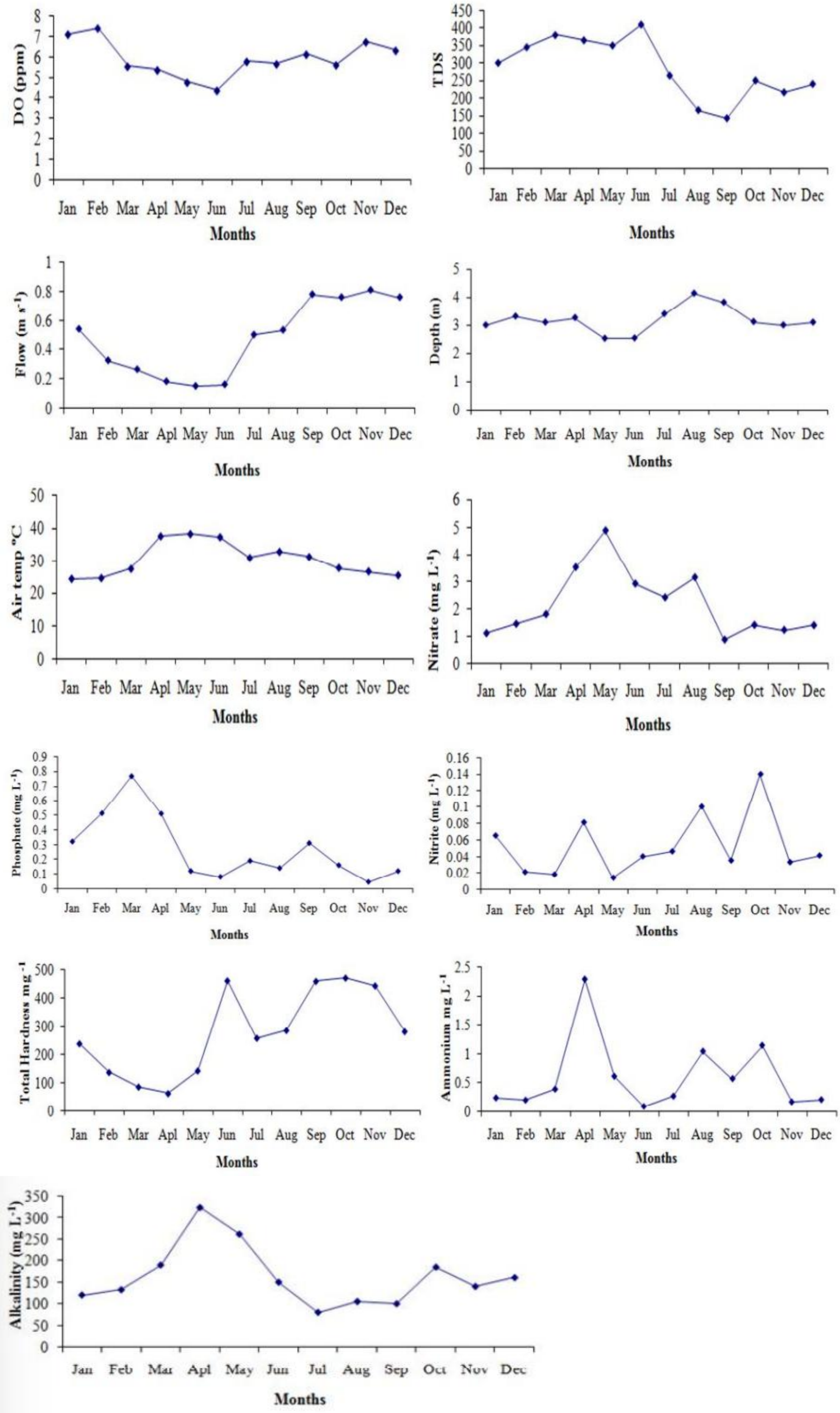


Fig. 4.14 Monthly variations in water parameters of river Gomati during 2017-19.

Table 4.7 seasonal variation (mean values with SD in paranthesis) of physico-chemical properties of river Gomati during 2017-19

Parameters	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Water temp. (°C)	19.8 (2.3)	20.6 (2.8)	22.5 (2.1)	26 (1.8)	29.1 (2.0)	30.4 (1.5)	30.2 (1.9)	30.2 (1.2)	29.9 (1.1)	27.5 (0.9)	25.5 (1.6)	22.3 (2.4)
pH	8.0 (0.6)	8.2 (0.5)	8.8 (0.3)	7.7 (1.1)	8.3 (1.3)	7.8 (0.8)	7.6 (1.1)	7.6 (0.9)	7.2 (0.8)	7.8 (1.1)	7.5 (0.7)	7.9 (1.2)
D.O. (ppm)	6.4 (1.5)	7.4 (1.2)	4.53 (2.1)	5.35 (2.4)	4.75 (1.9)	4.86 (2.5)	5.77 (2.9)	5.65 (1.9)	6.12 (2.1)	5.6 (2.3)	6.73 (2.0)	6.31 (2.1)
Conductivity (μScm^{-1})	289 (30)	521.6 (35)	535 (53)	564 (28)	508.8 (76)	540 (80)	340 (52)	246.8 (36)	234.5 (26)	406 (40)	419 (36)	368 (45)
TDS (ppm)	300 (22)	345 (34)	380 (18)	365 (38)	350 (45)	410 (42)	264 (74)	165 (68)	141.8 (52)	250 (37)	216 (32)	240 (47)
Turbidity (NTU)	8.1 (1.8)	12.6 (1.5)	5.9 (1.3)	5.5 (2.1)	4.8 (1.3)	30 (3.5)	19.5 (5.6)	32 (6.7)	10.2 (2.6)	18.1 (3.4)	11.8 (2.5)	8.9 (2.1)
Alkalinity (mgL^{-1})	120.3 (12.6)	132.5 (11.1)	190 (10.3)	325 (16.1)	262.5 (22.3)	150 (12.6)	80 (22.3)	105 (16.1)	100 (13.7)	185 (8.9)	140 (10)	160.6 (22.3)
NO_3 (mgL^{-1})	1.11 (0.1)	1.45 (0.3)	1.8 (0.11)	3.5 (0.42)	4.87 (0.26)	2.9 (0.13)	2.4 (0.11)	3.13 (0.22)	0.88 (0.18)	1.41 (0.23)	1.23 (0.13)	1.4 (0.11)
NO_2 (mgL^{-1})	0.065 (0.012)	0.21 (0.031)	0.18 (0.05)	0.018 (0.03)	0.014 (0.03)	0.04 (0.011)	0.046 (0.02)	0.1 (0.014)	0.035 (0.01)	0.14 (0.03)	0.033 (0.01)	0.041 (0.01)
Total hardness (Ca & Mg) (mgL^{-1})	238 (12.8)	136.9 (22.1)	85.3 (8.9)	62.12 (13.2)	142.2 (11.9)	461 (28.9)	257.3 (24.1)	284.8 (18.3)	259.4 (22.6)	471 (16.3)	443.3 (32.1)	281 (22.5)
Ortho phosphate ($mg L^{-1}$)	0.32 (0.08)	0.513 (0.12)	0.77 (0.18)	0.51 (0.09)	0.12 (0.03)	0.08 (0.07)	0.19 (0.11)	0.14 (0.026)	0.31 (0.11)	0.16 (0.065)	0.045 (0.01)	0.12 (0.018)
NH4 (mgL^{-1})	0.24 (0.05)	0.2 (0.08)	0.39 (0.04)	2.28 (0.15)	0.61 (0.06)	0.09 (0.02)	0.27 (0.04)	1.04 (0.51)	0.57 (0.07)	1.14 (0.12)	0.17 (0.05)	0.21 (0.03)

Table 4.8 Pearson correlations of river Gomati's environmental factors

	Temp	Depth	Flow	pH	DO	Cond.	TDS	Turb	NO_3	NO_2	T. Hard	Phos.	Ammon.	Alk.
Temp	1.000		0.087	-0.446**	**-0.610****	-0.446**	-0.304	0.203	-0.195		0.307	-0.465**	0.277	0.177
Depth	0.109	1.00	-0.185	-0.068	-	0.268	0.365*	**0.512****	-	0.058	0.094	0.118	0.226	0.208
Flow	0.087	-0.185	1.000	-0.366*	0.193	-0.0572**	-0.491**		0.044	-0.465**	**0.575****	-0.290	-0.131	-0.376*
pH	-0.446**	-0.068	-0.366*	1.000	0.194	**0.577****	**0.409***	-	0.184	0.371*	**-0.798****	0.306	0.033	**0.289**
DO	**-0.610****	-0.092	0.193	0.194	1.000	0.043	-0.011	-0.103	0.064	-0.209	-	0.174	-0.281	-0.284
Cond.	-0.446**	0.268	-0.057**	**0.577****	0.043	1.000	**0.900****	-0.271	0.102	0.347*	**-0.640****	**0.499****	0.207	**0.584****
TDS	-0.304	0.365*	0.491**	**0.409***	-0.011	**0.900****	1.000		0.006	0.261	**-0.512****		0.069	0.458**
Turb.	0.203	0.512**	0.230	-0.197	-0.103	-0.271	0.256	1.000	-0.108	-0.294	0.393*	-0.150	0.195	-0.187
NO_3	-0.195	-0.098	0.044		0.064		0.006	-0.108	1.000	0.122	-0.074		0.191	-0.133
NO_2	0.239	0.058	0.465**	0.371*	-0.209	0.347*	0.261	-0.294	0.122	1.000	-0.534**	0.017	0.370*	**0.548***
T. Hard		0.094	0.575**	-0.798**	-0.022	**-0.640****	**-0.512****	0.393*	-0.074	-0.534**	1.000	-0.300	-0.010	-0.398*
Phos	-0.465**	0.118	-	0.306	0.174	0.499**	0.317	-0.150	0.181	0.017	-0.300	1.000		0.306
Ammon.		0.226	-0.131	0.033	-0.281		0.069	0.195	0.191	0.370*	0.330	-0.010	1.000	**0.579****
Alk.	0.177	0.208	-0.376*	0.289	-0.284	0.584**	0.458**	-0.187	-0.133	0.548*	-0.398*	0.306	0.579**	1.000

Table 4.9 PC Loadings from a PCA of 60 Sampling Points for Physical, Physiochemical, and Surrounding Terrain Features of a Habitat

Variables	PC1	PC2	PC3	PC4
Water flow (cm s^{-1})	-0.15	**0.36**	**0.27**	0.1
Depth (m)	0.2	-0.1	-0.21	**0.49**
Temp (°C)	-0.14	0.16	**-0.42**	**-0.31**
Dissolved oxygen (ppm)	0.01	0.06	**0.55**	0.23
pH	-0.03	-0.14	**0.33**	-0.1
Turbidity (NTU)	-0.13	0.21	-0.12	**0.52**
Conductivity (μS cm^{-1})	0.14	**-0.46**	0.06	0.21
Total dissolved solids (ppm)	0.16	**-0.43**	0.05	0.19
Total Hardness ($mg L^{-1}$)	-0.08	**0.45**	0	0.26
Fine substrate (%)	**0.27**	-0.1	-0.06	-0.08
Fine gravel (%)	**-0.47**	-0.14	-0.02	-0.07
Coarse gravel (%)	**-0.45**	-0.13	0.03	0.07
Cobble substrate (%)	**-0.46**	-0.12	0.01	0.09
Sand substrate (%)	**0.47**	0.17	0.01	-0.03
Overhanging vegetation (%)	-0.09	0.06	**0.33**	-0.12
Row crop land use (presence/absence)	-0.06	-0.18	-0.1	0.01
Rangeland land use (presence/absence)	0.04	-0.15	-0.14	0.18
Rip-rap (presence/absence)	-0.04	-0.08	**0.36**	-0.18
Eigenvalue	**3.71**	**3.37**	**1.97**	**1.79**
Per cent variance explained	**20.59**	**18.74**	**10.95**	**9.96**
Cumulative variance explained	**20.59**	**39.33**	**50.28**	**60.23**

Table 4.10 The fish types and environmental factors collected from the river Gomati, summarized using a canonical correspondence analysis. Eigen analysis with a 1E009 tolerance

	Axis 1	**Axis 2**	**Axis 3**	**Axis 4**
Eigenvalues	0.29	0.26	0.25	0.2
Species.-environment. correlations	0.92	0.87	0.91	0.78
Cumulative percentage variance				
Explained by species only	9.61	18.35	26.70	33.25
Explained by species + environmental variables	17	32.47	47.24	58.82
Interset correlations with axis				
Water flow (cm s^{-1})	0.16	0	-0.2	0.15
Depth (m)	0.02	0.34	-0.12	0.18
Temp (°C)	0.15	0.18	-0.16	-0.15
Dissolved oxygen (mg L^{-1})	0.18	-0.08	0.14	0.2
pH	-0.03	-0.28	-0.13	-0.27
Turbidity (NTU)	0.02	0.56	-0.39	0.1
Conductivity (µS cm^{-1})	-0.41	-0.2	-0.06	-0.01
Total dissolved solids (ppm)	-0.35	-0.19	0.07	0.02
Total Hardness (mg L^{-1})	**0.29**	0.49	-0.23	0.19
Fine substrate (%)	0.14	-0.2	-0.09	-0.21
Fine gravel (%)	0.4	-0.47	-0.25	0.25
Coarse gravel (%)	0.22	-0.35	-0.28	0.3
Cobble substrate (%)	**0.26**	-0.25	-0.55	0.32
Sand substrate (%)	**-0.44**	**0.36**	0.36	-0.26
Overhanging vegetation (%)	-0.1	-0.15	-0.27	0.01
Variables loadings with absolute values				

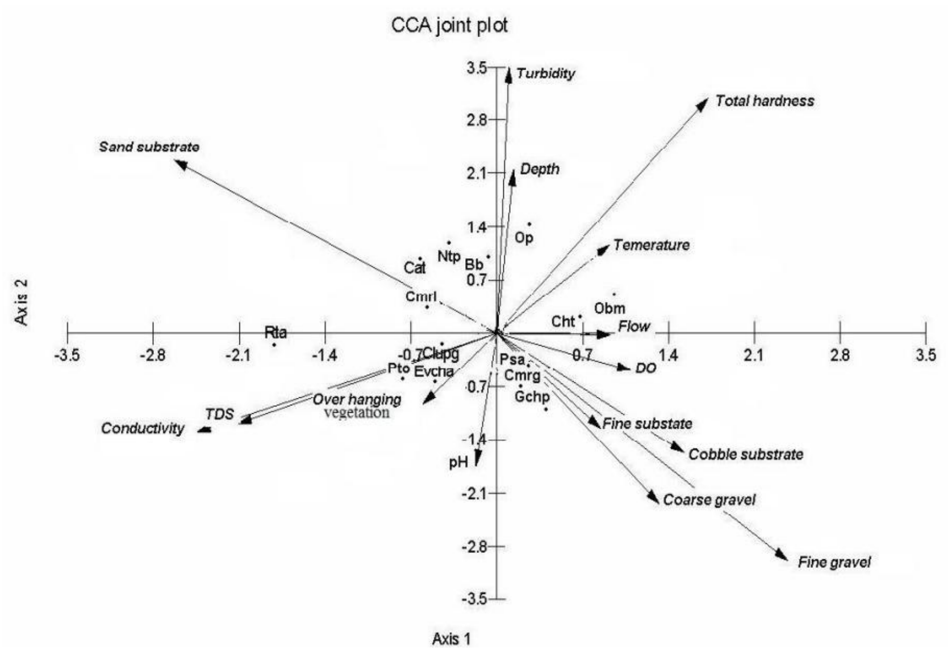


Fig. 4.15 Analysis of types composition and environmental factors using canonical correspondence
ID : OP = O,pabda, Cht=C.chitala, Obm=O,bimaculatus, Psa=P.sarana, Cmrg=C. Mrigala, Cchp=G.Chapra, Evcha=E.vacha, Clupg=C. Garua, Cmrl=C.marulinus, Cat=C. Catla, Ntp=N. notopterus, Bb=B.bagarius, rta=R.Rita,Pto=P.ticto.

Table 4.11 The most joint fish types in the river Gomati and the main kinds of fish habitat

Major Habitat	Types of fishes	Dominant genera	Total no. of fish species in six sites					
			S1	S2	S3	S4		S6
Fast flowing water	Cat fishes & carps	*Ompok, Sperata, Bagarius, Rita, Labeo, Clupisoma, Eutropiichthys, Wallago, Glyptothorax, Mystus, Devario*	6	17	37	10	20	28
Backwater & shallow pools	Medium sized species	*Rita, Sperata, Notopterus, Wallago, Cirrhinus, Mystus, Ompok*	2	12	35	0	18	0
Deep pools	Large size species	*Chitala, Wallago, Cyprinus, Labeo, Ompok Notopterus, Sperata, Clarias*	0	4	19		10	15
Meandering of river & channel confluence	Mixed assemblage	*Clupisoma, Notopterus, Puntius, Labeo, Channa*	16	34	40	24		34
Open river	Mixed assemblage	*Labeo, Channa, Cyprinus, Mystus, Sperata, Notopterus, Clupisoma, Salmostoma*	10	23	33	18		20
Flood plains	Mixed assemblage	*Notopterus, Wallago, Cirrhinus, Mystus, Ompok, Rita, Sperata*	8	10	20	0	15	0
Fish species richness (FSR)			22	41	53	36	41	37

4.3 Life History Traits of Ompok Pabda

4.3.1 Morphometric parameters

4.3.1.1 Weight and distance relationships

In conclusion, there were a total of 201 individuals of the O. pabda types that were utilized to calculate the condition factor and distance weight relationship. Table 4.12 presents the particulars of the seasonal shifts that take place in the regression parameters, including the lowest and maximum total distance range. The distance of the fish that was measured during the sample period ranged from 7.1 to 16.8 centimetres, and their weight varied from 6.8 to 31.7 grammes. The estimations of parameter 'b' revealed clear evidence of seasonal difference and varied from 2.81 to 3.32. The fact that the value of 'b' during pre-monsoon periods was 3.08 (close to around 3), suggesting isometric growth, but that the value of 'b' during post-monsoon and monsoon seasons was somewhat variable, showing allometric growth, is indicative of the fact that growth occurred during those times. It is possible that the identical body shape and circumstances as well as a very limited size range of specimens of O. pabda contributed to the isometric growth seen during the pre-monsoon period ($b = 3$), which had a low $r2$ value of 0.9. The 'b' value being less than three during monsoon times indicates that the smaller specimen size being considered is in better condition than the larger ones.

Changes Indicating that this types' distance-weight correlations adhered to the cube rule, in 'b' values starting at 3.0 throughout the monsoon and post-monsoon seasons. Appetite and the composition of the testes may both play a role in these associations of fish, as shown by the fluctuations in 'b' values. The changes in condition factor may also be attributed to these variables. Allometric development may be inferred from the b-value of the total distance-weight ratio, which was 2.87. All of the calculated values for the allometric coefficient (b) were found to fall within the predicted values of 2.5 and 3.5. The results of every linear regression of distance-distance connections that was provided in (Table 4.13) were very significant ($p > 0.001$), and the $r2$ values were more than 0.992.

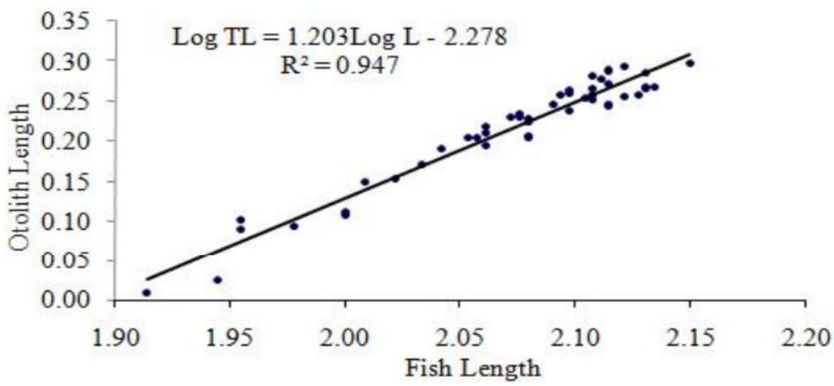
After inspecting the otoliths, also known as sagittae, the maximum distance of each otolith was measured and noted. The maximum distance of each sagittae was plotted on the y-axis, and the total fish distance was shown on the x-axis, so that the connection with total fish distance could be determined. Between total fish distance and maximum sagittal distance, there is a linear link with a high degree of correlation coefficient ($r2>0.95$). This association is linear. This finding makes it abundantly evident that the size of the otolith grows in a manner that is directly proportional to the growth of the fish in question. In addition, the linear link between otolith distance and weight was determined, and the results showed a very significant correlation coefficient ($r2>0.97$) between the two variables (Fig. 4.16).

Table 4.12 Distance distribution of O. pabda over the year, including seasonal distance ranges, regression coefficients, and 95% certainty intervals

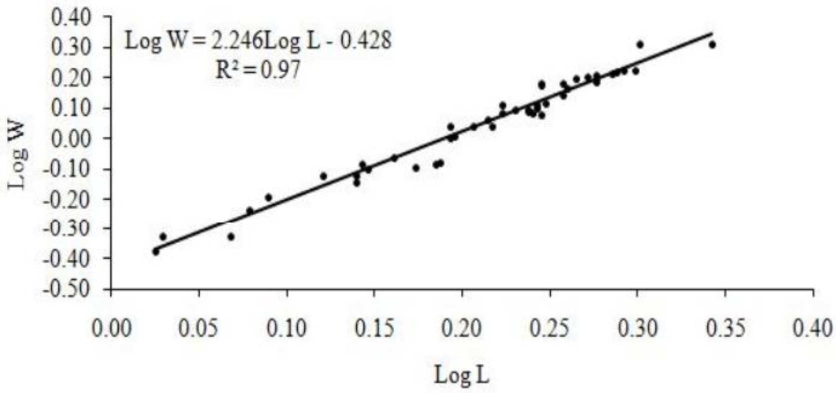
Seasons	n	Total length (cm)		Regression parameters		95% CI of a	95% CI of b	r^2
		Min	Max	log a	b			
Pre-monsoon	50	10.5	15.5	-2.22	3.08	-2.54 to -1.89	2.79 - 3.37	0.90
Monsoon	64	7.1	16.8	-1.99	2.81	-2.15 to -1.83	2.67 - 2.94	0.96
Post-monsoon	87	7.6	14.1	-2.48	3.32	-2.62 to -2.34	3.18 - 3.46	0.96
Overall	201	7.1	16.8	-2.02	2.87	-2.11 to -1.94	2.79 2.95	0.96

Table 4.13 The correlations between O. pabda's Dimensions Overall, From Fork, and Average.

Seasons	Equation	n	a	b	r^2
Pre-monsoon	TL=a+bSL	50	-0.056	1.011	0.995
	SL =a +bFL		0.029	0.991	0.989
	FL=a+bTL		-0.031	1.005	0.992
Monsoon	TL=a+bSL	64	-0.106	1.044	0.996
	SL =a +bFL		0.055	0.972	0.999
	FL=a+bTL		-0.051	1.016	0.998
Post-monsoon	TL=a+bSL	87	-0.057	0.998	0.993
	SL =a +bFL		0.016	1.009	0.995
	FL=a+bTL		-0.044	1.031	0.993



a)



b)

Fig. 4.16 Linear regressions a) between total fish distance and otolith distance, b) between total otolith (Sagittae) distance and weight.

4.3.1.2 Condition factor

Before the monsoon, during the monsoon, and after the monsoon, the types had an average value of 0.75, 0.71, and 0.62 for Fulton's condition factor (k), respectively. These values were determined for each season. The levels of O. pabda showed statistically significant variations ($p < 0.001$) between each group. The fact that we are approaching the monsoon season implies that the fish are in healthy condition. It's possible that this is because to variations in the riverine ecosystem's stages of maturation and availability of types that fish feed on.

The Evolutionary trade-off between the advantages and disadvantages of reproduction at an early or late age determines the age at which an organism is deemed mature. Baltz and Moyle (1984) found a correlation between the age at which a population of the perch Hysterocarpus traski produced its first brood and the longevity of the population, as well as the size of its broods. Sarkar et al. (2018) found that male and female Chitala chitala (a featherback) varied in size at maturity and mean maturity% throughout the several river basins studied. It is common practice to compute the GSI for both sexes at the same time. In a 1982 publication, De Vlaming et al. analyzed GSI's potential as a measure of a stock's reproductive health. The GSI is at its highest point when fish are at their most productive, and then it drops down sharply because the fish have exhausted their potential. Fish ovarian activity fluctuates monthly, and this is reflected in the GSI. The results of this experiment established that O has a GSI of. July and August are prime months for pabda since that's when the fish reach full maturity. Lows seen throughout the months of October through December were indicative of a tired state. The results matched what O saw. bimaculatus is a unique type of catfish of the genus Silurus aristiletis. O. Using artificial propagation, Chakrabarti et al. (2019) found that pabda mature a little bit faster than females. Several factors, such as, but not limited to, those listed above, have been linked to fish spawning and reproduction. Fish maturity might be influenced by environmental variables such the availability of fish food, water flow, and floods. Males attained median adult height of 12.9 cm, while girls reached median adult height of 13.9 cm. Males are shorter at 10-11 centimeters and females at 11-12 centimeters, as was previously documented.

People who identify as O. The pabda data showed a wide range of reproductive behaviors. Similar variance was recorded for the other types being researched by Hamilton (1822) and Hora (1938). In fish, it is not uncommon for fecundity to vary from one individual to the next for reasons that include size, age, environmental conditions, food availability, nutrition, and the types being studied. The variations in O. fecundity are probably due to these factors. It's possible that the river's ecosystem is to blame for pabda. Many fish types, such as Mystus cavasius, Ompok bimaculatus, Hilsa ilisha, Mystus bleekeri, and Setipinna phasa, have shown a similar linear relationship between fertility and body mass. Compared to carps, other types of catfish, and other types of air-breathing fish, the O. pabda was shown to have poor fertility in the present study. This research is comparable to that which Khan and Mukhopadhyay (1972) reported. O's ova are this wide. Pabda typically falls in the 0.868 mm range but may go from 0.421 to 0.96 mm. The captive-reared population of this types exhibits differences comparable to those observed by Ezenwa et al., (1986) for other types. These differences are likely due to individual differences in ovulation cycle distance and egg maturation stage.

In the case of Ompok pabda in the Gomati River (2.64), it was found that the obtained growth performance indices (f) were exceptional. This research confirms the presence of G. in addition to G. manminna in Kaptai Lake, as found by Azadi et al. L values derived using the ELEFAN-I and Wetherall Plot methods are roughly in agreement with the experimental findings. Like the case of Ompok malabaricus, the current study found a restricted O. pabda's size range (7.0–20.0 cm) was found in the Gomati River. This can be as a result of various seasonal breeding behaviors that take place in appropriate habitats with advantageous environmental conditions. This might be because pabda only find success when breeding in environments that meet their specific needs. The growth co-efficient and asymptotic distance (L) of O. the pabda in River Gomati were calculated to be 21.0 cm and 1.0 year-1, respectively. Similar results were found by Rajagopal and Davidar (2018) while studying different catfish types. O. has seen a rising pattern of recruiting. This study's estimation of the pabda uncovered evidence of a single peak pulse in ongoing recruitment in the river Gomati. The apex of this pulse was seen in September;however, it was present throughout August and November. Not all fishes had two recruitment peaks, as was shown for some.

Mortality from fishing is proportional to the quantity and kind of gear used. Using Pauly's empirical equation, we calculated a natural death rate. The low fishing mortality observed for O. pabda in River Gomati (0.29 year-1) suggests that The decline in this species' population may be attributed mostly to environmental factors rather than fishing. There is a lack of long-term 'Z' values and reliable catch-and-effort statistics in the tropics, Pauly (1980) proposed that this technique offers a to include into the most popular way of calculating 'M'. It is generally agreed that an exploitation rate of E = 0.50 is best for maintaining a sustainable fishery. In this case, the calculated exploitation rate for O is 0.13. The fact that the pabda was below desirable levels indicates that fishing pressure is having little effect on the population of this types. Since an optimal yield is achieved when F = M, as stated by Gulland (1971), the stock is often regarded to be overfished when E is more than 0.5. This assumption, he said, is based on the work of Gulland, who showed that optimal yield may be achieved when F = M. Fishermen at Bangladesh's Kalpi reservoir compete fiercely for the prized catla catla, according to research by Ahmed et al. (2003).

This research presents the first proof of a growth pattern, population structure, and reproductive biology that are well established for O. pabda in the river Gomati. While this study may not save the highly endangered O. pabda fish, it has provided essential data on the most important features of preservation biology and may be utilized to build a baseline for the types. This information might be useful for future studies comparing biological parameters across Ganga basin water bodies. The aforesaid results allow us to conclude that the riverine population of O. pabda is now being utilized at its maximum potential. The average size of an O. pabda caught in the River Gomati is less than the size at which 50% of fish reach maturity. These results suggest that 12 centimeters in total distance should be the bare minimum for fishing. Fishing using gill nets and drag nets, both of which have very small mesh sizes, should be banned from June to August, when the fish are spawning. It is quite likely that the yield per recruit, and hence the maximum sustainable production, will decrease if the present fishing level is significantly altered. The stock might be in danger if this pattern continues for a while.
According to the value of for the perfect fish stays constant at 3.0 throughout its lifespan. Beverton and Holt (1957) found that values other than three are relatively infrequent in adult fish.

Conclusion

There was clear seasonal difference in the values of Ompok pabda's deterioration parameter b, which varied from 2.81 to 3.32 and had a r2 value that was more than 0.90. The value of b during pre-monsoon times was 3.08 (around approximately 3), which indicated isometric growth. On the other hand, the value of 'b' during monsoon and post-monsoon periods was somewhat variable, which indicated allometric growth. The typical value of the Fulton's condition factor, denoted by the letter O. pabda at the pre-monsoon, monsoon, and post-monsoon times were separately 0.75, 0.71, and 0.62, O. respectively. pabda amid seasons. The fact that the value of K is greater just before the rainy season begins suggests that the fish are in healthy condition.
The types O. The pabda began reaching maturity in March, and between April and May, most of the fish were in the second stage of maturation. Most of the females had ripe ovaries (stage III and IV) and most of the males had mature testis throughout the months of July and August. In September and October, the V stage was reached, at which point the partially and totally expended ovaries were found. First maturity stages (the distance at which 50% of fishes attains maturity) were 12.9 centimetres and 13.9 centimetres, respectively, in males and females of both sexes. The greatest undeveloped female was 17.8 cm L in distance, while the smallest adult female measured 12.5 cm L. The mean GSI of the fish tends to grow as the fish achieves maturity; however, it begins to decrease after spawning and reaches its lowest point during the resting phase of the life cycle. The range of possible GSI values for females was 0.5 to 8.3, whereas the range for males was 0.1 to 1.8. The GSI was often found to be lower in men than it was in females. Fish measuring 11.5-20.0 cm in distance and weighing 18-38.0 g had a mean fecundity of 4330 799 eggs, with a range of 4360 to 5986 eggs. Egg production ranged from 10128 to 30838 per 100 g of body weight, with a mean of 20228 5053. The fish's reproductive success was influenced by both its size and its weight. This study found that from April to September, the average diameter of ova ranged from 0.42 mm to 0.96 mm, with a mean value of 0.868 mm. This diameter variation was consistent over the whole investigation.

Over the course of a year, the population's distance frequency distribution showed that there were no more than three distinct age groups, with respective mean values of 16.5 cm, 12.7 cm, and 9.6 cm TL. The fact that the populace had been tracked over the course of a year lent credence to this theory. Larger samples made up a significant share of the whole, with the 20-centimeter-and-up August category being the most numerous. The period of recruitment was from July to November, and the average distance of the recruits showed a range of 10.5 to 13.7 centimeters. Seasonal comparisons showed that smaller individuals were more prevalent after the monsoon and throughout the winter. Differences between the dry and wet seasons were found to be substantial when researchers compared the population structure of O. pabda ($p < 0.0001$).

The maximum distance that was seen for an Ompok pabda was 20.00 centimetres, and the maximum distance that was anticipated for it was 19.55 centimetres (95% confidence range = 17.81-21.29 centimetres), respectively. The calculated value for the total mortality coefficient, Z, was 2.22 years-1 with a 95% confidence interval that ranged O. pabda has a determined age range of 19.27–23.72 years-1 when utilizing the distance–to–catch–curve method. The results exhibited that the natural mortality rate (M) was 1.92 years per unit of time, whereas the fishing mortality rate (F) was 0.29 years per unit of time.Considering these findings, an exploitation level (E) equal to 0.13 was determined to be appropriate for the O. pabda fisheries in the river Gomati, which seemed to be much lower than the anticipated level of exploitation that would provide optimal results (E=0.50). For O. pabda, it was discovered that recruiting happens once a year between the months of August and November. The development of O. Studies conducted on paba in captivity using various kinds of feeds (artificial and real feed) revealed substantial differences between the two forms of food. According to the percentage of O. types that survive and their development, O. It has been proposed that live feed is an appropriate diet for the culture of this types when it is kept in captivity; pabda in captive conditions. The artificial feed is not suitable as a preferred diet for O since it results in poorer growth and survival rates than natural feed does. pabda.

In this work, we noticed a considerable structure of fish community within a comprehensive and complicated dataset, and we isolated key environmental factors like depth, flow, dissolved oxygen, and substrate. These aspects of the ecosystem were discovered to be the most influential factor for calculating fish populations. This study's findings include specific recommendations for channel habitats, down to the granularity of depth, silt, and current speed. River channel habitats are crucial to the survival of threatened fish types and should be considered during conservation efforts. Furthermore, our results suggest that conservation and management operations, as well as attempts to restore the fish habitat, might benefit from considering the relevance on the endangered fishes of the effects of regional environmental factors. Management activities must take into consideration the local scale habitat needs and related connection with the assemblage of fish.

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