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Diversity of benthic macroinvertebrates in Gomti river

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Abstract

Benthic macro invertebrates in the Gomti River is an important area of study to understand the health and ecological status of the river ecosystem. Benthic macro invertebrates are organisms that inhabit the bottom of aquatic environments and are visible to the naked eye. They include various groups such as insects, crustaceans, mollusca, and annelids.

Studies on benthic macro invertebrates in the Gomti River can provide valuable information about water quality, habitat conditions, and overall ecosystem health. These organisms are known as bio indicators because their presence, abundance, and diversity reflect the environmental conditions of the river.

By conducting research on benthic macro invertebrates, scientists can assess the impact of pollution, habitat degradation, and other human activities on the Gomti River. These organisms respond differently to changes in water quality and habitat, making them useful indicators of ecological integrity. For example, some species are more tolerant of pollution, while others are highly sensitive and can only survive in clean, healthy water bodies.

Research on benthic macro invertebrates typically involves collecting samples from different sites along the river, identifying and enumerating the organisms, and analyzing their community composition and diversity. This data can be used to assess the ecological health of the Gomti River, identify pollution sources, and guide conservation and management efforts.

Additionally, the presence of specific benthic macroinvertebrate species can indicate the presence or absence of certain pollutants, such as heavy metals or organic contaminants. Therefore, studying these organisms can help in monitoring water quality and identifying areas of concern for pollution control measures.

The research findings on benthic macroinvertebrates in the Gomti River can contribute to the development of effective management strategies, restoration plans, and policies aimed at conserving and improving the river ecosystem. By understanding the composition and

abundance of these organisms, researchers can gain insights into the overall ecological condition of the river and make informed decisions for its sustainable management.

KEY WORDS; *Water quality, Dissolved oxygen, Free CO2, Trichoptera, Benthos*

Introduction

Benthic macro invertebrates are organisms without a backbone that are visible to the naked eye and inhabit the bottom of aquatic ecosystems. They play a crucial role in freshwater environments as indicators of water quality and ecosystem health. The Gomti River, located in northern India, has been a subject of research and monitoring regarding its benthic macroinvertebrate community.

Several studies have been conducted to assess the benthic macroinvertebrates in the Gomti River. These studies typically involve sampling various locations along the river and analyzing the collected samples in the laboratory. The identified macroinvertebrates can be classified into different taxonomic groups, including insects (such as mayflies, stoneflies, caddisflies, and beetles), crustaceans (such as crabs and shrimps), mollusca (such as snails and mussels), and annelids (such as worms).

The presence and abundance of different macroinvertebrate taxa in the Gomti River can provide valuable information about the water quality and ecological conditions of the river. Some species of macroinvertebrates are more tolerant to pollution and can survive in degraded habitats, while others are more sensitive and require cleaner water. By assessing the composition and diversity of macroinvertebrates, researchers can make inferences about the overall health of the Gomti River ecosystem and identify potential sources of pollution or degradation.

Monitoring benthic macroinvertebrates in the Gomti River is important for several reasons:

1 Water quality assessment: Benthic macroinvertebrates serve as bioindicators, reflecting the water quality conditions in the river. Certain species are known to be more sensitive to pollution, and their absence or decline can indicate deteriorating water conditions.

2 Ecosystem health: The presence of a diverse and abundant macroinvertebrate community suggests a healthy and balanced ecosystem. Changes in the macroinvertebrate population can indicate disturbances or imbalances in the river ecosystem.

3 Conservation and management: Studying the benthic macroinvertebrates helps in understanding the ecological requirements of different species. This knowledge can inform

conservation efforts and help develop appropriate management strategies to protect and restore the Gomti River's biodiversity.

4 Long-term monitoring: Regular monitoring of benthic macro invertebrates provides valuable data over time, allowing researchers to identify trends, evaluate the effectiveness of restoration efforts, and make informed decisions regarding the river's management.

It is important to note that specific research findings related to the benthic macro invertebrates in the Gomti River may vary depending on the scope and objectives of individual studies. Therefore, it is recommended to consult recent scientific literature, reports, or academic databases for more specific and up-to-date information on research conducted on benthic macro invertebrates in the Gomti River

Water quality management system based on physical and chemical parameters is not sufficient to assess the quality status in terms of the "health of a water body". Over the years, it has been realized that the inclusion of biological parameter will enhance the quality evaluation in cost-effective manner. Among all the biotic components, benthic macro-invertebrate communities have been considered as the most suitable biological parameter to assess the health of surface water bodies. In Germany, bio-monitoring has been practicing for almost 100 years, for effective water quality assessment. The maps drawn based on bio-monitoring have proved as a powerful tool; for preparation of action plan for control of pollution and for improvement of water quality of rivers. Biological monitoring provides an effective, easy to understand, less time consuming and cost-effective method to determine cumulative impact of pollution in surface waters in India. Use of benthic macro-invertebrates for bio-monitoring is based upon community effects and the most frequent response of a community which is expressed in terms of Saprobic score and Diversity score for determination of biological water quality using Biological Water Quality Criteria. Bio-mapping of Gomti river will help in evaluation of the performance of action plan to control industrial and domestic pollution contributed to RiverGomti river .

The water parameters of a river like the Gomti can vary significantly based on various factors such as season, location, human activities, and environmental conditions. Here are some of the key water parameters that can exhibit variation in the River Gomti:

1. **pH (acidity/alkalinity):** pH levels can fluctuate due to factors like rainfall, agricultural runoff, and industrial discharges. Higher levels of pollutants can lower the pH, making the water more acidic.

2. **Dissolved Oxygen (DO):** DO levels are crucial for aquatic life. They can vary due to temperature, flow rate, and pollution. Warm water holds less dissolved oxygen, and pollution can deplete oxygen levels.
3. **Temperature:** Seasonal changes can cause variations in water temperature. Urbanization, industrial discharges, and deforestation can also impact water temperature.
4. **Turbidity:** Turbidity refers to the clarity of the water and is influenced by sediment runoff, erosion, and human activities near the riverbanks.
5. **Nutrient Levels (Nitrogen and Phosphorus):** Agricultural runoff, sewage, and industrial discharges can lead to increased levels of nutrients in the water, causing issues like eutrophication.
6. **Total Suspended Solids (TSS):** TSS levels can fluctuate due to erosion, construction activities, and agricultural runoff.
7. **Bacterial Contamination:** The presence of bacteria such as E. coli can vary due to agricultural runoff, sewage discharges, and animal waste.
8. **Heavy Metals:** Industrial discharges and urban runoff can introduce heavy metals like mercury, lead, and cadmium into the water, leading to variations in their concentrations.
9. **Flow Rate:** Seasonal variations in rainfall and human interventions like dam construction can lead to changes in the river's flow rate, affecting its overall dynamics.
10. **Biotic Diversity:** Variations in water quality parameters can impact the diversity of aquatic organisms, such as fish, insects, and algae, in the river ecosystem.
11. **Sediment Load:** Erosion, deforestation, and construction activities can influence the amount of sediment carried by the river, affecting water clarity and aquatic habitats.
12. **Toxic Substances:** The presence of pollutants like pesticides, industrial chemicals, and pharmaceuticals can vary based on agricultural practices, industrial discharges, and urban runoff.

These parameters can be influenced by both natural processes and human activities. Monitoring and managing these variations are crucial to maintaining a healthy river ecosystem and ensuring the well-being of communities that depend on the river for various purposes. Local environmental agencies and organizations often conduct regular water quality assessments to track these variations and take appropriate actions if needed.The water parameters of a river like the Gomti can vary significantly based on various factors such as season, location, human activities, and environmental conditions.

The purpose of this methodology is to lay down uniform and reliable method for sampling and analysis of benthic macro-invertebrates for biomonitoring of fresh water bodies. This method of bio-monitoring is based on saprobic and diversity score analysis for benthic macro-invertebrates of fresh water bodies. Benthic macro-invertebrates are considered as most

suitable biological parameter for water quality evaluation. This prescribes the methods of sampling and analysis of benthic macro-invertebrates of fresh water bodies. This method is applicable for bio-monitoring of all fresh water bodies for water quality evaluation.

Sampling Methods Different methods of sampling for biota may be adapted depending upon nature of water bodies:

- Methods that extract and separate the organisms from their habitat (which at the same time will be disturbed)
- Methods that remove an undisturbed part of the habitat from which the organisms are then extracted.
- Various artificial experimental designs like; artificial substratum from which the biota are collected

Rough Estimation of Substratum Composition (%)

An arbitrary assumption is made on river bed substratum type by selecting roughly one kilometer river stretch having almost uniform ecological conditions at sampling location on possibly both the river banks. The substratum of water body may be composed of boulders with size of >256 mm, cobbles 255-64 mm, pebbles 63 – 16 mm, gravel 15 – 2 mm, sand 0.0625 mm, silt 0.002 mm and clay

Sampling Devices

Benthic macro-invertebrate fauna in water bodies are normally collected by adopting a variety of techniques for bio-monitoring. For determination of saprobity indicated by benthic fauna, it is sufficient to sample qualitatively. But, for the diversity evaluation of benthic biological community, it requires a more or less quantitative methodology. To obtain such evaluations, wide ranges of sampling devices are used depending upon the nature of substratum of a water body.

Sampling Frequency

For allowing spatial and temporal comparison of the biota, all biological samples of a water body at different locations must be taken in the same season to minimize seasonal variations resulting from life cycle changes and annual hydrological variations. There is marked variation in biotic composition due to intermittent release of water from dams and barrages. Hence, the period followed by such releases should be avoided, if possible. The sampling should be done on monthly basis, covering biologically active period of the year (October-May), excluding monsoon and post monsoon periods for bio-monitoring on natural

substratum. The sampling frequency may be continued throughout the year at locations, where bio-monitoring is carried out through artificial substratum.

MATERIAL AND METHODS

1. SITE OF STUDY

We have studied the availability of benthic macro-invertebrates at Gomti River stream in Pilibhit

Gomat Taal, also known as Fulhar Jheel, is where Site 1 is located. There are stairs there that down to the river. These stairs are protected from the river's water during the rainy season. Humans utilize these ghats for things like bathing, cleaning clothes, and other similar activities.

Site 2: A second location is situated eight to ten kilometers from the Gomat Tal of the river. Because it is deeper than site 1 and lacks stairs, this site has not been altered to a great extent.

location 3: Between 18 and 20 kilometers separate the third location from the Gahaee River. Where can I go on an adventure and enjoy a picnic? is beautiful and teeming with birds? Here is the rest area for the irrigation department.

2. WATER PARAMETERS

Different parameters of the atmosphere may affect the habitat and diversity of benthic macro invertebrates. We have checked the different parameters such as temperature, color, odour, taste, longitude, latitude, pH, CO_2, and O_2 of water. Various standard methods were used to check the effect of these parameters on the habitat of benthic macro invertebrates.

AVAILBLITY OF DISSOLVED O_2 AND CO_2

Submerge the BOD sample bottle in running water and fill it with water. Then Remove the sample bottle from the water. Turn the bottle upside down to check and avoid the formation of air bubbles. Further, add 2ml Manganese sulfate ($MnSO_4$). Then add 2ml alkali-iodide-azide (KOH+KI) with the help of a measuring pipette, placed the cap, discard the extra sample and mix gently. In the next step Add 2ml sulphuric acid (H_2SO_4) and shake BOD gently. Take 100 ml sample from the solution of BOD bottle and place in a conical flask, add few drops of starch that act as an indicator. As a result, a violet blue colour is obtained. Titrate the sample with sodium thio-sulphate in a pipette, until the transparent colour is obtained. Repeat the above procedure twice and use the given formula to check the availability of dissolved oxygen in the water.

$$\text{Do } (mgl^{-1}) = \frac{(\text{ml x n}) \text{ thiosulfate x } 1000}{\text{Vol. of the sample (100ml)}}$$

To check the availability of CO_2 in water, we were taking 100 ml of the water sample and Add 4-5 drops of phenolphthalein indicator in sample. The colour change to pink is an indication of free CO_2 absence in sample. If, the sample remains colourless, then titrate it with 0.05 N, NaOH. Check the availability of free CO_2 in water by the following calculation.

$$\text{Free } CO_2 \text{ as mg/l} = \frac{R \times N \times 1000 \times \text{Eq. Wt.}}{\text{volume of } CO_2}$$

3. COLLECTION OF BENTHOS

To collect the benthic macro-invertebrates fit the survey square in the bottom of a river. Wash the stones of square covered area properly. Remove survey square from the river gently. Collected all the macro-invertebrates from a net catcher in sample collection bottles and Preserve in 4 % formalin solution for further investigation. Net catcher is another technique used to catch benthos.

4. IDENTIFICATION OF BENTHOS

All the collected specimen were studied and visualised by the help of Stereo Microscope OLYMPUS SZ40

RESULTS

The latitude and longitude of the sampling site were 30.37805339 and 78.48035417 respectively. The temperature of lotic river water was not fixed and cooler than standing water, color was light transparent green, normal odour, sweet taste of water with pH 5.5.

Availability of Dissolved oxygen :

The recorded DO for three samples viz A, B and C at different concentration (8.0 ml, 8.1ml, 8.2ml) of sodium thiosulfate is 2mg/ml, 2.025mg/ml and 2.05mg/ml respectively as shown in fig 1. The calculated average dissolved oxygen was 2.025mg/ml.

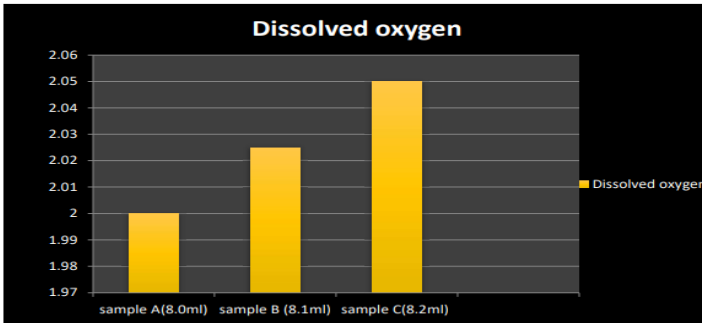

Fig 1. Concentration of Dissolved oxygen in sample A, B and C

Availability of Free CO_2

Available CO_2 in water was 1.76mg/ml. Comparative analysis of available CO_2 and O_2 has shown that the availability of oxygen is higher than carbon dioxide. This is provided favourable condition for the survival of benthic fauna

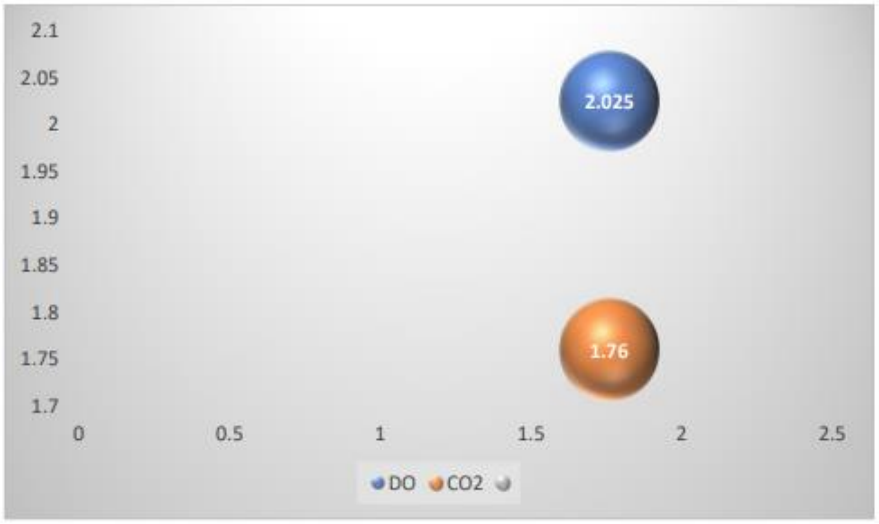

Fig 2: Comparative analysis of available dissolved oxygen and carbon dioxide in lotic water

Captured Macro-Invertebrates

The total 19 benthic macro-invertebrates belong to 4 orders of insect with 1 unidentified species of benthic fauna were captured from the sampling site of Gomti river area and calculated as follows:

BENTHOS CAPTURED	NO OF ORGANISM
COLEOPTERAN	3
EPHEMEROPTERA	2
TRICHOPTERA	12
LEPIDOPTERA	1
UN-IDENTIFIED	1

Table 1.- total collected number of macro invertebrates

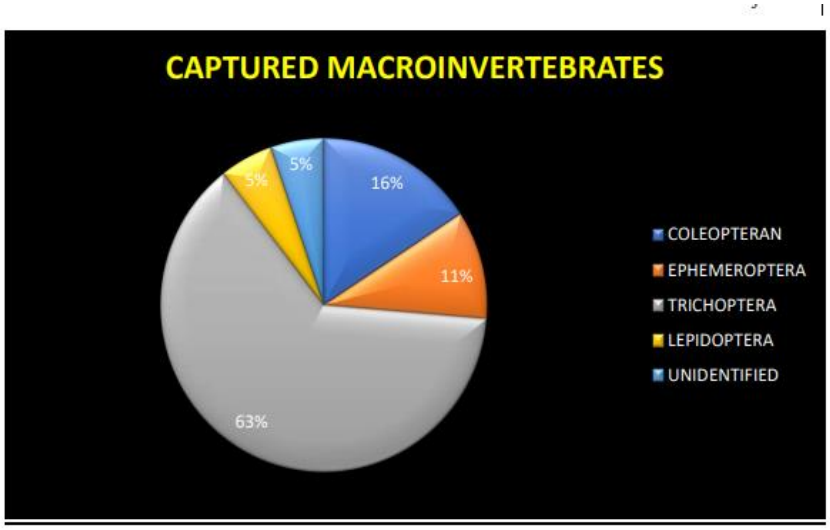

Fig 3.Percentage occurrence of total captured macro invertebrates

The captured benthos contains the majority of Trichoptera (63%), 16% Coleopteran 11% of the total is Ephemeroptera, 5 % Lepidoptera, and 5% unidentified population as shown in fig 3. Apart from that, we were found some developmental or larval stages of Trichoptera in collected macro-invertebrates.

DISSCUSION

The present investigation was carried out to check the seasonal variation of benthic macroinvertebrates survives in Gomti river area of Pilibhit district. Usually, during the month of November, the temperature is very low in the Pilibhit region of the UP, in that case, there is a maximum probability to found benthic fauna on upstream sites and midstream regions. We have found 4 orders of benthic fauna and 1 unidentified species on the selected site of study. The collected genus psephenus of order Coleoptera has front pair of wings that hardened into wingcases, elytra, hard exoskeleton including the elytra. Beetles (endopterygotes), undergo complete metamorphosis, with a series of conspicuous and relatively abrupt changes in body structure between hatching and becoming adults after a relatively immobile pupal stage. Order Ephemeroptera was identified as genus Heptagenia which is an ancient group of insects that includes dragonflies and damselflies. Their immature stages that are nymphs a living in aquatic freshwater and its presence indicates a clean or unpolluted environment. They have a fully winged subimago stages, which moults into a sexually mature adult. Trichoptera was found in abundance as Hydrosyche. This group of insects was found with aquatic larvae and terrestrial adults. Usually, macro-invertebrates use silk to make protective cases through gravel, twig, sand, bitten-off pieces of plants, or debris. The Trichoptera are sensitive to water pollution so that it can be used as

bio indicator. order Lepidoptera order of insects includes lepidopterans like butterflies and moths. Lepidopteran species are characterized by the presence of scales that cover the bodies, wings, and the proboscis. in this study among all the orders Trichoptera tops the list with the highest number of benthic faunas followed by Coleoptera, Ephemeroptera, and Lepidoptera with one unidentified benthic fauna.

Biological Water Quality Criteria (Bwqc) for Evaluation of Water Bodies

Central Pollution Control Board (CPCB) has derived a Biological Water Quality Criteria (BWQC) for evaluation of water bodies. This criteria has been developed from the combination of different ranges of saprobic score with the diversity score of the benthic macro-invertebrate families with respect to water quality. The system has been developed after making a calibration study on the saprobity and diversity score data of benthic macroinvertebrate families, collection from various water bodies used for the biomonitoring through artificial as well as natural substratum. The system can be made applicable for evaluation of all the natural water bodies also. To make reliability of the results, the BMWP score and the diversity score of natural and artificial substratum in water bodies having same water quality can be compared though BWQC. One of the advantages of using BWQC for water quality evaluation is that it can be done by simple scoring of indicator species or their presence and absence can easily indicate the water quality without involving any statistical analysis. The biological responses in an aquatic ecosystem are not independent parameter. They are exposed and influenced by multiple environmental factors. Therefore, the statistical analysis of biological data sometimes leads to incorrect and erroneous conclusions, as far as the morphological and physiological response of a biological system is concerned. The entire range of the saprobity score from 1 to 10 in combination with the range of diversity score from 0 to 1 has been classified into five different classes of water quality to indicate changes in water quality with different grades of pollution level. Abnormal combination of saprobity with diversity range indicates sudden change in environmental conditions, physical disturbances in natural or artificial substratum and abrupt change in water quality due to pollution

Table 2: Criteria for Biological Water Quality Evaluation

Range of Saprobic Score (BMWP)	Range of Diversity Score	Water Quality	Water Quality Class	Indicator Colour
7 and more	0.2 – 1	Clean	A	Blue
6 – 7	0.5 – 1	Slight Pollution	B	Light Blue
3 – 6	0.3 – 0.9	Moderate Pollution	C	Green
2 – 5	0.4 & less	Heavy Pollution	D	Orange
0 – 2	0 – 0.2	Severe Pollution	E	Red

The range of diversity for the benthic animals having highest saprobic value, in class 'A' waters, is very wide because their preference to the water quality is limited only in clean waters. Any adverse environmental conditions to minimum level will eliminate the most sensitive organisms. On the contrary

the range of diversity for the animals having very low saprobic value in class 'C' waters is very narrow where only the abundance of pollutant tolerant animals can thrive and their number increases with a very high load of pollution in a water body. Other bottom fauna that can tolerate moderate pollution loads generally occur in the intermediate zone of class 'C' water body. With this concept, the saprobity and diversity of the benthic macroinvertebrate families have been classified into 5 different classes such as A, B, C, D & E. Different degrees of water quality deterioration are thus indicated in general terms like clean, slight pollution, moderate pollution, heavy pollution and severe pollution. To translate this information on a river map, the water quality classes can also be distinguished by means of colour comparison such as Blue, Light Blue, Green, Orange and Red

BENTHIC : Bottom inhabiting

MACRO : Macroscopic, can be seen through naked eye.

INVERTEBRATES : Aquatic animals without vertebral column

Conclusion

This ipaper iaimed ito iinvestigate ithe idiversity iand iabundance iof ibenthic imacroinvertebrates iin ithe iGomti iRiver, iconsidering itheir isignificance ias iecological iindicators iof iwater iquality. iA ithorough isampling iand ianalysis iwere iconducted ialong idifferent istretches iof ithe iriver ito iassess ithe ihealth iof ithe iecosystem iand iidentify ipotential ienvironmental istressors iaffecting

ithese iorganisms. iThe ifindings iprovide ivaluable iinsights iinto ithe icurrent istate iof ithe iGomti iRiver iand ican iaid iin iformulating ieffective istrategies ifor iits iconservation iand irestoration.

The ipresence iof iBenthic iMacro-invertebrates iin ia ipond, ilakes, irivers ietc. icontributes ito itheir ihabitat iin ia idifferent iway, iby iparticipating iin ia ifood ichain ior iby irepresenting ithe iquality. iThe ipresence iof iTrichoptera iin ia ilarge inumber iin ithe iGomti istream ishows igood iwater iquality ias ithey iare isensitive ito ithe ipollutant. iTheir iabundance idecreases iwith ian iincrease iin ipollutants iin iany iaquatic iecosystem. iThis iworks ihelps iin igenerating ibaseline idata ifor ifuture iresearch iin ithe idiversification iof iBenthic iMacro-invertebrates iand idetermining ithe iwater iquality.

1 iHigh iBiodiversity: iThe istudy irevealed ia isignificant idiversity iof ibenthic imacro iinvertebrates iin ithe iGomti iRiver. iThe ipresence iof ivarious itaxa iindicates ithat ithe iriver ican isupport ia iwide irange iof iecological iniches. iThis idiversity iis iessential ifor ithe ioverall ihealth iand ifunctioning iof ithe iriver iecosystem.

2 iIndicator iof iWater iQuality: iBenthic imacro iinvertebrates iare iknown ito ibe ireliable iindicators iof iwater iquality. iThe ipresence ior iabsence iof icertain isensitive ispecies ican iprovide ivaluable iinformation iabout ithe ipollution ilevels iand iecological ihealth iof ithe iriver. iMonitoring ichanges iin imacroinvertebrate icommunities iover itime ican ihelp iassess ithe ieffectiveness iof iconservation iefforts.

3 iImpact iof iAnthropogenic iActivities: iThe ianalysis ihighlighted ithe inegative iimpact iof ihuman iactivities ion ithe iGomti iRiver's ibenthic imacro iinvertebrate icommunities. iPollution ifrom iindustrial idischarges, iagricultural irunoff, iand idomestic iwaste ihas iled ito ia idecline iin icertain isensitive itaxa iand ian iincrease iin ipollution-tolerant ispecies. iUrgent imeasures iare irequired ito imitigate ithese iimpacts iand irestore ithe inatural ibalance iof ithe iriver iecosystem.

4 iPotential iRestoration iStrategies: iTo iimprove ithe ihealth iof ithe iGomti iRiver, irestoration iefforts ishould ifocus ion ireducing ipollution iand irestoring ithe inatural iflow iof ithe iriver. Implementing proper waste treatment and management practices, along with creating buffer zones to filter runoff, can help enhance water quality and support benthic macro invertebrate diversity.

Long-term Monitoring: Continuous monitoring of benthic macro invertebrates is crucial for assessing the success of restoration initiatives and identifying emerging threats. Long-term data collection can aid in making informed decisions and adapting conservation strategies as the river's ecological dynamics change.

In conclusion, this study demonstrates the significance of benthic macro invertebrates as indicators of water quality and the ecological health of the Gomti River. The findings underscore the urgent need for collaborative efforts from various stakeholders to address

pollution and restore the river's ecosystem. By implementing sustainable management practices and continuous monitoring, it is possible to preserve the Gomti River for future generations and maintain its vital role in supporting biodiversity and local communities.

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