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Diversity, Richness, Evenness and Dominance Index Fishes in Ami River Water, Gorakhpur, Uttar Pradesh, India

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Abstract

The Ami River's fish diversity was investigated using monthly samples collected from January 2020 to August 2021. The local community, industry, and fisheries all use the river's water. The findings of the current inquiry show that there are 8 fish species that are members of 6 orders, 5 families, and 8 genera. In all sites where species were collected, the family Cyprinidae (42%), one order cypriniformes was the most prevalent 3 genera and each genera have one species Catla catla, Labeo rohita, and Chela atpar. Second most prevalent family-siluride (21%), order-siluriformes have two genera they have two genera each genera have one species Wallago attu and Ompaok bimaculatus. Although they were present, the number of order- siluiformes and family-Sisoridae (6%,), species-Bagarius bagarius, have lowest distribution, Clariidae (16%) order-siluriformes- Clariaus batracus, and Channidae (15%), order-anabntiformes, Channa punctatus, was quite low at all sites. Richness range 0.20 to 0.73, abundance range between 0.25 to 0.6, evenness range 0.01 to 0.02, Shannon-Weiner index (H′) range 0.01 to 0.14, Simpson index of dominance (D), range 0.01 to 0.02, Simpson index of diversity (1-D), range 0.005 to 0.06, and Simpson ′s reciprocal index (1/D), range 0.01 to 0.08. Reported data of all the three sites are also indicate low diversity, richness, and evenness of fish's diversity as it classifies as low diversity. The dominance index also indicates low category in Ami River.

Keywords

Diversity, Richness, Simpson Index, dominance, Shannon-Weiner Index, Ami

1. Introduction

Many studies have shown that the physico-chemical characteristics of water as well as spatial and environmental factors play a role in the extinction of local freshwater fish species (Gilliam, et. al., (2011), Tripathi et.al. (2015), Gebrekiros (2016). Millions of people worldwide suffer from hunger and malnutrition, and fish serve as a nutrient-rich food source and a way to help people overcome these challenges. In other words, they swim in the rivers, lakes, and wetlands that make up less than 3% of the water on Earth. Roughly half of all fish species reside in fresh water. One-third of the world's freshwater fish species were thought to be in danger of extinction in 2021, according to a coalition of conservation organizations, because of contaminated water. Since water is one of the most vital natural resources on the planet, we cannot conceive life as we know it without it.

Water is one of the five components that go into creating an animal's body (Srivastava and Singh (2014) India has been endowed with a wide variety of natural resources, including forests, lakes, rivers, oceans, and glaciers. Freshwater habitats, which include bogs, ponds, lakes, rivers, and streams, are among the most crucial natural systems for human health, food production, and economic development. They also offer a suitable habitat for all living things, including fish. The presence of fish is a reliable sign of freshwater bodies. The variety of fish and other invertebrate species dictates the fresh water quality of a pond, lake, or Taal (Balian et. al 2010). Sant Kabir Nagar district, one of the 75 districts of Uttar Pradesh in Northern India, with a total area of 1,646 km2 and a population of 1,715,183 as per the 2011 census, which is the most recent available roughly equivalent to the size of the US state of Nebraska or the Gambia. The district has a density of 1,041 inhabitants per square kilometers (2,700/sq mi). For the ten-year period 2010–2021, its population grew at a rate of 20.71%. Gorakhpur is to the east, Basti is to the west, Siddharth Nagar is to the north, and Ambedkar Nagar is to the south of the district. The River Ami, also known as Gaon ki Ganga, is the lifeblood of Sant Kabir Nagar and originates in Sikahara Tal, Siddharthnagar. Sant Kabir Nagar, Basti, Siddharthnagar, and Gorakhpur are all located along this river. It travels 152 kilometers before joining the River Rapti close to the village of Sohgaura in the tehsil Bansgaon of the district of Gorakhpur. A large population. The water quality of the Ami River, the diversity of flora and fauna that it supports, and the growing pace of Sant Kabir Nagar are all negatively impacted by industry, which also negatively impacts human life around the Ami River. The majority of the rivers, lakes, and surface waters in our nation are polluted as a result of industries, untreated sewage, and solid wastes. Every, almost 40 million liters of wastewater are discharged into rivers and other water bodies, because they tend to live close to India's major water bodies, the weaker segments of society are the class most severely affected by water pollution. The World Bank research claims that these pollutant emissions in the upstream areas slow down economic development in the downstream areas, which slows the growth of GDP in these areas and lowers the growth of the country's overall GDP. The GDP is lost by almost half.

2. Material and Methods

Sant Kabir Nagar, a district in eastern Uttar Pradesh that is 120 metres above mean sea level, receives rainwater during the monsoon through connecting tributaries, natural drains, and artificial Nalas on both banks. Rainy season has seen the highest flow rates, and lowest flow during the summer. Three locations along the river Ami were used for the study: Site-1, Satnariya Nala for Industrial Drain Basti, Site-2, and Nagar Panchyat Maghar Nala for Domestic Drain Sant Kabir Nagar, and Site-3, Sarya Drain for Merging Point of Water in Gorakhpur, which is significantly deeper and longer than Site-1 and Site-2.

2.1 Analysis and Gathering of Data

Throughout the study period, Fish sampling took place from 9:00 AM to 5:00 PM using cast nets, fish samples from all three sampling sites were gathered with the assistance of local fishermen using a variety of nets, including gill nets, cast nets, and dragnets. Prior to preservation, photographs were taken because formalin fades the colour of fish on preservation for a long time. In order to fix the fish brought to the labs, one part of a concentrated formalin solution was diluted in several jars according to the species' size. Talwar and Jhingran carried out the identification.

Using various indices, including the Shannon-Weiner index (H), Simpson Dominance index (D), and Simpson index of diversity (1- D), the analysis of fish species diversity was carried out. Simpson (1949).

2.1.1 Shannon – Weiner index

Diversity Index

Diversity index (H') states the circumstances of the organism's population mathematically to analyze the number of individuals in each growth step or genus in a habitat community. The most commonly used diversity index is the Shannon-Weiner index (1963) and Odum (1971).

$$H' = -\sum_{i=1}^{s} Pi \text{ in } Pi$$

Where, **H'** = Shannon – Weiner index,

The Shannon-Weiner index (H), which considers both the total number of species and the abundance of each species, was used to calculate species diversity.

Pi=n/N,

ni= stands for the number of members of each species in the sample.

N=stands for the total number of samples across all species.

The diversity index criteria are as follows:

H' ≤ 1 = Low diversity

1 < H'≤ 3 = Moderate diversity

H '≥ 3 = high diversity

The total number of species present across all sites was used to compute the abundance of the fish population. The variety of fish species in three separate locations served as a simple proxy for estimating species richness. Both primary (direct observation and interactions with local fisherman) and secondary sources were used to gather information on the dangers that the fish species faced.

2.1.2 Evenness Index

The evenness index (E) describes the number of individuals between species in a fish community. The more evenly distributed individuals between species, the more balanced the ecosystem will be. The formula used is [5]:

$$E = \frac{H'}{Hmarks}$$

Where E = Evenness index, H_ = Diversity index, Hmax = ln S, S = Number of species found

The evenness index value ranges from 0-1. Furthermore, the evenness index based on Kreb, (1989), is categorized as follows:

0 < E ≤ 0.5 = Depressed community

0.5 <E ≤ 0.75 = Unstable community

0.75 <E ≤ 1 = Stable community

2.1.3 Simpson's Indexes of Diversity

It serves as a diversity indicator. It is frequently done in ecology to estimate how diverse an environment is. It considers both the total number of species present and their relative abundance species.

2.1.4 Simpson's index of dominance

D=∑ ni (ni-1) / N (N-1)

Where

Ni= is the overall population size of a certain species.

N= is the total population of all species.

Diversity Index for Simpson's= 1- D

Simpson's index value ranges from 0.00-10. Furthermore, the Simpson's index is categorized as follows:

0.0	Absence of diversity
0.01-0.40	Low Diversity
0.41-0.60	Moderate Diversity
0.60-0.80	Moderately High Diversity
0.81-0.99	High Diversity
1.00	Absolute (Perfect) Diversity

3. Result

The diversity of fishes is mostly influenced by abiotic factors, including the kind of habitat, age of the water body, mean depth, and fluctuations in water level, among others. The physico-chemical characteristics of the collecting centre are also useful in assessing the variety of fishes in a given area certain area. 8 fish species from 5 families were observed overall throughout the study period. Cyprinidae members are the most prevalent family among the species that have been collected, compared to other families. Sisoridae species are also found on sites 2 and 3, however they are absent from site 1. Because of the environment and the type of water at each of the three sit Sisoridae species are also found on sites 2 and 3, however they are absent from site 1. Because of the environment and the type of water at each of the three sites, the distribution of fishes varies. Ami displays Weiner – Shannon Site-1 has an index (H) of 1.38, followed by Site-2 at 1.99, and Site-3 at 2.05. The Simpson's Dominance Index (D) value is 0.2 at site 1, 0.13 at site 2, and 0.11 at site 3, with site 1 having the highest value. In this index, 0 stands for limitless variety the distribution of fishes varies. y. The larger value of D demonstrates reduced diversity. The value of this index likewise runs from 0 to 1, but the bigger the value, the more diverse the sample. Simpson's index of diversity (1-D) for sites 1 and 2 in our study is 0.8, 0.87, 0.93, and 0.89 respectively (Table 2). Lists (Table-2) the biodiversity status, abundance, and richness. In contrast to site 1, sites 2 and 3 have higher levels of richness during the inquiry period and respectively (figure-1). The most numerous families of the gathered species was the Cyprinidae family, followed by the Claridae family, which had the second-highest

abundance, and the Sisoridae family, which had the lowest abundance. Compared to sites 1 and 2, site 3 has a higher abundance (Table-1). In 8 different fish species, the assemblage composition showed that the family Cyprinidae was the most prevalent with 42% of the species followed by Siluridae with 21%, and the lowest species belonged to the Sisoridae family (pie chart-1).

Table - 1 Showing Distribution of Different Type of Fish Species, Richness and Abundance on The Different Sites of River Aami

Family	Order	Type of Fishes	Site-1	Site-2	Site-3	Richness	Abundance	Over all %
Claridae	Siluiformes	*Clarias batracus*	6	3	6	3	15	16%
Siluride	Siluriformes	*Wallago attu* *Ompaok bimaculatus*	- -	5 6	5 4	2 2	10 10	21%
Cyprinidae	Cypriniformes	*Catla catla* *Labeo rohita* *Chela atpar*	5 4 -	4 10 7	4 4 2	3 3 2	13 18 9	42%
Sisoridae	Siluiformes	*Bagarius bagarius*	-	3	3	2	6	6%
Channidae	Anabantiformes	*Channa punctatus*	5	4	5	3	14	15%

Pie chart 1. Over all distribution of fish families in Ami River

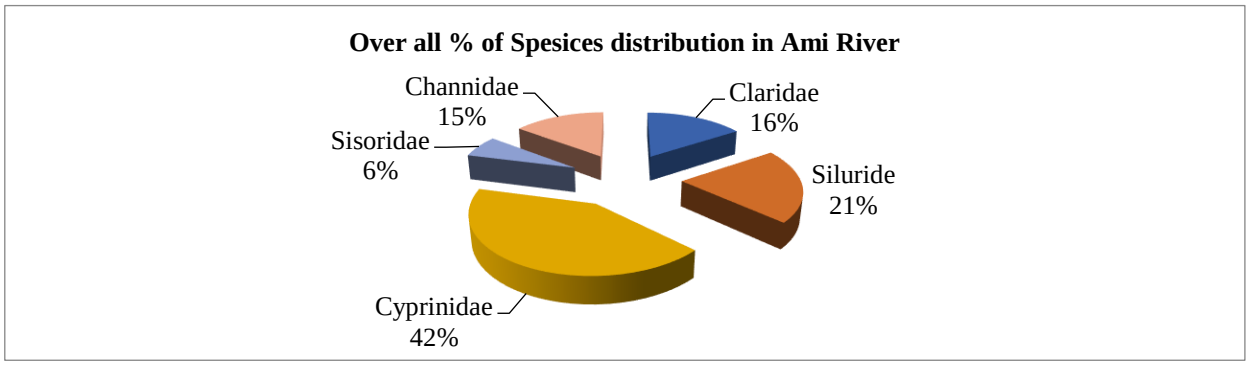

Table-2 Fish species richness, evenness, total no. of individual average population size

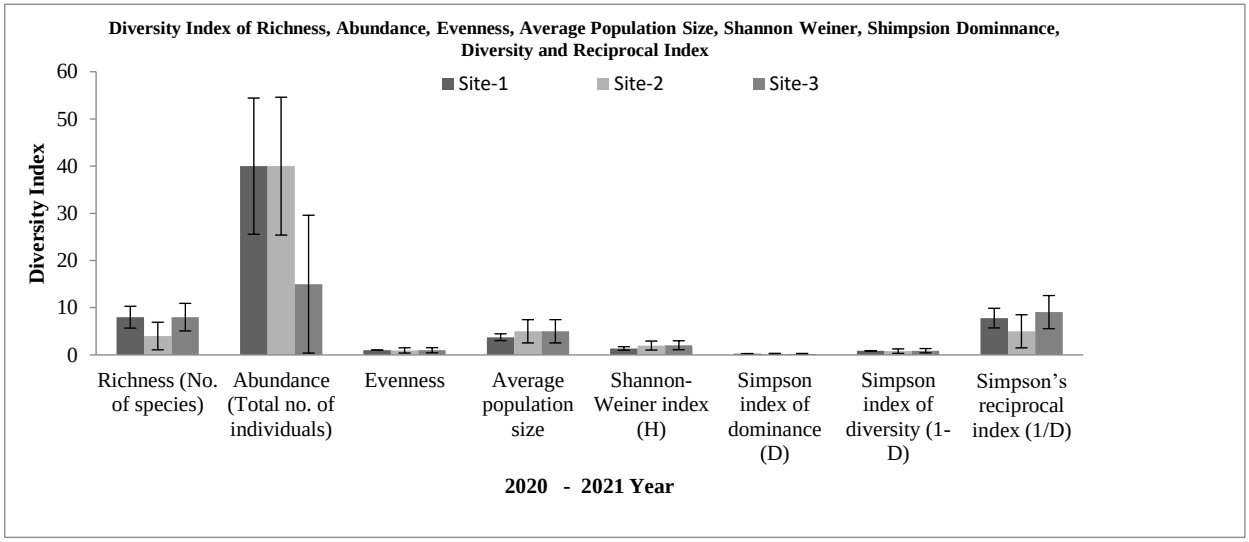

Figure 1. Diversity index on Ami River

Table-2 Fish species richness, evenness, total no. of individual average population size

Diversity index	Site-1	Site-2	Site-3
Richness (No. of species)	8±0.20	4±0.25	8±0.73
Abundance (Total no. of individuals)	40±0.25	40±0.26	15±0.6
Evenness	0.995±0.01	0.955±0.20	0.985±0.02
Average population size	3.75±0.08	5±0.20	5±0.43
Shannon- Weiner index (H)	1.38±0.04	1.99±0.01	2.05±0.14
Simpson index of dominance (D)	0.2±0.02	0.13±0.03	0.11±0.01
Simpson index of diversity (1-D)	0.87±0.005	0.8±0.06	0.89±0.02
Simpson's reciprocal index (1/D)	7.8±0.08	5±0.05	9.07±0.01

4. Discussion

India's fisheries offer a lot of potential to improve the nation's food security. The primary resources for inland fisheries are rivers and lakes, and an awareness of fish flora diversity is crucial for their development and sustainability management. The fish faunal diversity and abundance are primarily represented by the diversity of rivers. The commercial fisheries are supported by the river's wide diversity of fish species. The alteration in the fish assemblage's makeup suggests that the water is changing (Jhingran, 1991), of the world's vertebrate fauna, fish make up close to 50% of the total. One of the key concerns for permitting sustainable use of natural resources is fish variety and conservation. Fish species diversity indicated that there were differences between different locales in the research area (Plates. no. 1). Sites 3 and 2 have the most species (According to the study's findings, the number of fish species in the study area is decreasing as water pollution increases, native species are producing fewer fish, and several species, including Chela atpar, are at risk of extinction in this area.

In site 1 throughout the three seasons, there were Wallago attu, Ompok bimaculatus, and Bagarius bagarus. Due to the rising poverty of local fishermen and the discovery of a sharp loss in fish diversity at the river ami discharge zone (which is contaminated), these consequences have stabilized the socioeconomic sector of the research region.8 species), whereas Site 1 has the fewest species (4 species). There were two diversity indices used in total to measure diversity: the Shannon-Weiner Index and the Simpson Index. Simpson index of diversity and Shannon index (H) for sites 1 and 3 respectively reveal values of 1.38, 1.99, and 2.05 respectively (1-D) during the course of the investigation, 0.8 was found at site 1, 0.87 at site 2, and 0.89 at site 3. As the river Aami can support the most fish species and has a Shannon-Weiner index value over 1, this suggests that it offers superior fish habitat. While the human population is growing quickly and we are depending more and more on aquatic fisheries resources, this inquiry will be utilized as a tool to reduce water pollution and protect the fish species in the Ami River. The variety of aquatic fish may disappear.

If appropriate conservation measures are not put in place, the biodiversity that is determined the biosphere's life support systems, or biodiversity, have intrinsic value, as do the components of those systems, which also have ecological, social, economic, scientific, educational, cultural, and artistic value. Disseminating conservation information is the best strategy for protecting the species.

Providing fishermen with knowledge, instruction, and practises on the threat of extinction and the necessity of the species' survival. Due to the difficulty of reserving or recalling an extinct species, this will go a long way towards protecting and preserving the species (Nsor and Obodai 2016). Fish biologists, aquatic ecologists, and conservationists have a significant role to play in raising public knowledge of and support for the species' protection measures. They have noted the necessity for scientists to raise awareness for the conservation of fish species. This study made clear the importance of public awareness of human and autogenic risks, activities, and harmful behaviors' that may result in the extinction of fish species in the Ami River, as well as the consequences of such extinction and the means by which it may be avoided.

Ompaok bimaculatus

Wallago attu

Bagarius bagarius

Clariaus batracus

Channa punctatus

Catla catla

Chela atpar

Labeo rohita

Plates no. 1. Fishes' distribution in Ami River

5. Conclusion

The findings of the current investigation of the polluted water of the Ami River raised major concerns about the possibility that it could harm fish variety in aquatic environments. To investigate the reduction of fish diversity and biological diversity, several investigations are required repercussions of Aami River pollution for the welfare of residents.

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Conflict of interest

Authors have no conflicts.

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