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Diversity of benthic macroinvertebrates in Littoral zone of Shahpura Lake, Bhopal, Madhya Pradesh

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Abstract

Water is one of the most critical requirement for survival along with air and land for all the organisms inhabiting on earth. Bhopal, also famous as city of lakes, has been taken as study it has number of lakes serving daily needs of the city. Shahpura lake, along with Upper and Lower lake is the most important lakes of the city serving multipurpose need of the city of drinking, agriculture etc. Healthy interaction between biotic and abiotic factor in aquatic and terrestrial area determines its abundance of the area. Disturbances in any one of the factors leads to disruption of the whole cycle of system and can lead to risk the rate of survival. Therefore, it is important to keep a check on the water physical and chemical health for sustainable development. Likewise, aquatic organisms serves important role in deciding the health of the lakes, as certain organisms act as indictor of pollution or pollution free environment. Today, there are many indices used to assess the health of freshwater systems – and benthic organisms are the foundation for many of them.

Key words: littoral zone, macro benthic invertebrates, diversity index.

Introduction

Aquatic and terrestrial ecosystem are major source of medicine, food, energy, shelter, and raw materials that we use and need in daily lives. Aquatic wildlife is important sources of food, energy, atmospheric oxygen, buffers against new diseases, pests, and predators, and protection

against food shortages and global climate change. Conserving a rich diversity of plants and animals will:

• provide food for the growing human populations;

• add oxygen and reduce ozone and carbon dioxide in our atmosphere; and

• add jobs and promote tourism through the enjoyment of nature.

-Provides medicine for curing diseases.

Benthic communities are the living 'water purifiers'. The diverse group of benthic organisms plays vital roles of cleaning water, processing detritus, and controlling harmful algae blooms. One group of such organisms, the filter-feeders, is composed of a variety of species that specialize in removing particles from the water column.

Freshwater mussels are one of the most imperiled groups of aquatic organisms in streams and rivers because much of their habitat has been altered by dredging, channeling, impoundment, and sedimentation. Mussels also are sensitive to water pollution, the spread of exotic species, and barriers to migration.

Aquatic plants, such as algae, diatoms, and rooted macrophytes, also improve water quality by removing nutrients from the water and making them available for other life forms. In some cases, rooted plants can remove and degrade toxins like mercury or atrazine (a widely used herbicide). Plants also derive energy from the sun, which is then available to fuel the benthic food web in the form of organic matter. Benthic communities break down the organic matter derived from plants and act as digestion systems, such as aquatic macrophytes and the leaves and branches of trees that fall into streams, lakes, and ponds.

The structure and composition of a benthic community is an excellent bio-indicator of pollution and habitat quality (Rosenberg DM, Resh VH (eds). 1993), (Stevenson RJ, Rollins SL. 2006), (Carter JL, Resh VH, Hannaford MJ, Meyers MJ. 2006). Dr. Ruth Patrick championed the cause for biological diversity through the "Patrick Principle." Her theory was that a diversity of species holds the key to understanding environmental problems that affect our world. It provides a foundation for the bio-indicator approach to examine the quality of water and health of ecosystem. Many scientists used benthic organisms to classify and assess stream and river conditions. Today, there are many indices used to assess the health of freshwater systems – and benthic organisms are the foundation for many of them.

Study Area

The Shahpura Lake which was formed in 1974-1975 is chosen for study. Shahpura Lake is also known for fish culture. From 1975 onwards the lake water is being used by fisheries department for fisheries activities. Factors responsible for pollution of Shahpura Lake are: untreated sewage inflow, siltation, excessive growth of aquatic weeds, encroachment, washing and bathing activities, deforestation, soil erosion and removal of oxygenated surface water through waste water (Giri,A. and Saxena, S., 2017).

Four sampling stations were selected in shahpura lake:

- Chunnabhatti (Station I)
- Fishing spot (Station II)
- Mid site (Station III)
- Near park (Station IV)

Material and Method

The samples of water (Surface) were collected from different sites three times a year pre-monsoon (feb to april), monsoon (june to aug) and post-monsoon (oct to dec) season during 2013 to 2015. Before collection of the samples the clean, dried and well labeled samples bottles and high quality of plastic canes with 1 litre capacity were kept ready.

The samples of sediments were collected from the surface of lakes from all the stations between 9am -5pm by using Peterson grabe mud sampler. The collected samples were sieved through 0.5 mm sieve (Ankar and Elmgreen, 1976) and the materials which retained on sieve were collected. Benthic organisms from the retained mud were sorted out with the help of forcep and brush and were preserved in narrow mouthed plastic bottle which contained 70% alcohol as preservative (Adoni, 1985). Some fauna which were attached from rocks, stones and macrophytes were also collected. All macro faunal organisms were identified to species level with the help of available key and manuals Needham and Needham, 1962 and Pennak (1989) under the Metzer light microscope. The population of organisms were counted species wise i.e., no of individuals of a species per sample and were expressed as number / m2. In twenty four months study period, thrice sampling were done.

Observation

A diversity index is a mathematical measure of species diversity present in a community. Diversity indices provide more information not only about community composition than simply species richness, i.e., the number of species present but they also take the relative abundances of different species into consideration. Another index that is commonly used to characterize species diversity in a community is A) A mathematical measure of species diversity in a given community is termed as diversity index.

B) Based on the species richness (the number of species present) and species abundance (the number of individuals per species).

C) The more species, the more diverse the area.

D) However, there are two types of indices, dominance indices and information statistic indices.

E) The equations for the two indices are:

Shannon Index (H) = - ∑ pi ln pi

Simpson Index (D) = 1/ ∑pi^2

The Shannon index is an information statistic index, which means it assumes all species that are represented in a sample and they are randomly sampled. In the Shannon index, **p** is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), **ln** is the natural log, Σ is the sum of the calculations, and **s** is the number of species. The value of Shannon diversity index for real community typically falls between 0 to 1. The lower value indicates more diversity, while index value 1 means all groups have same frequency.

The Simpson index is a dominance index because it gives more weight to common or dominant species. In this case, a few rare species with only a few representatives will not affect the diversity. In the Simpson index, **p** is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), Σ is still the sum of the calculations, and **s** is the number of species. With higher value indicates high dominance in the area.

Shannon diversity index (H). Like Simpson’s index, Shannon's index accounts for both abundance and evenness of the species present

Table 1: Macrobenthic diversity of station I during year 2013-14 and 2014-15

Station I	Pre Monsoon		Monsoon		Post Monsoon	
Macrobenthos	**2013-14**	**2014-15**	**2013-14**	**2014-15**	**2013-14**	**2014-15**
Annelida	**3**	**1**	**1**	**1**	**1**	**2**
Tubificidae	3	1	1	1	1	2
Arthropoda	**40**	**30**	**30**	**24**	**32**	**22**
Aeshinidae	2	2	1	0	2	1
Belostomatidae	1	2	2	2	1	2
Caenagrinidae	1	2	1	0	2	1
Chironomidae	4	2	2	1	1	1
Cordulegastridae	3	3	2	2	2	0
Corixidae	5	3	1	1	3	3
Dytiscidae	4	1	3	2	3	1
Ephemerellidae	3	0	3	2	2	1
Gerridae	1	2	1	3	1	2
Gomphidae	3	1	2	1	2	1
Hydrophilidae	1	3	2	1	4	1
Libellulidae	0	2	1	2	1	2
Naucoridae	2	1	0	1	2	0
Nepidae	1	1	0	0	2	1
Notonectidae	5	2	5	2	2	3
Palaemonidae	2	2	2	2	2	2

Tipulidae	2	1	2	2	0	0
Mollusca	**4**	**28**	**29**	**19**	**24**	**22**
Ampullarioidae	0	4	6	5	4	6
Hydrobiidae	0	1	1	2	1	2
Lymeidae	1	6	3	3	3	1
Orthalicidae	1	0	2	0	2	2
Physidae	0	1	1	1	1	1
Thiaridae	0	6	8	3	4	4
Unionoidae	1	3	1	1	3	2
Viviparidae	1	7	7	4	6	4
Grand Total	**47**	**59**	**60**	**44**	**57**	**46**

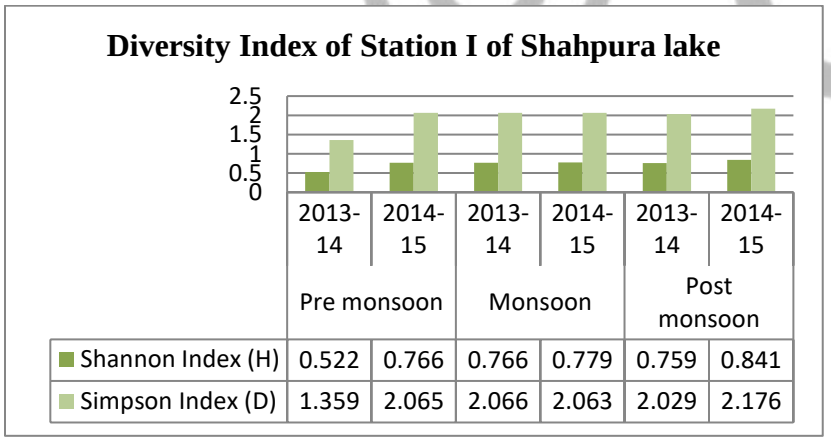


Table 2: Macrobenthic diversity of station II during year 2013-14 and 2014-15

Station II	Pre Monsoon		Monsoon		Post Monsoon	
Macrobenthos	**2013-14**	**2014-15**	**2013-14**	**2014-15**	**2013-14**	**2014-15**
Annelida	**2**	**1**	**2**	**3**	**1**	**2**
Tubificidae	2	1	2	3	1	2
Arthropoda	**46**	**13**	**27**	**16**	**13**	**12**
Aeshinidae	2	2	1	0	0	1
Belostomatidae	2	1	1	2	0	1
Caenagrinidae	2	0	1	0	2	1
Chironomidae	2	0	1	0	0	0
Cordulegastridae	3	2	0	2	1	0
Corixidae	3	1	3	1	1	2
Dytiscidae	4	0	3	1	1	1
Ephemerellidae	3	0	2	2	1	1
Gerridae	1	1	0	1	0	0
Gomphidae	4	1	1	0	0	0
Hydrophilidae	2	1	2	1	2	1
Libellulidae	2	2	1	1	1	1
Naucoridae	3	0	0	1	1	0
Nepidae	2	1	1	0	0	1
Notonectidae	7	1	6	1	2	1
Palaemonidae	2	0	2	2	1	1

Tipulidae	2	0	2	1	0	0
Mollusca	**3**	**18**	**35**	**15**	**16**	**16**
Ampullarioidae	0	3	6	3	3	4
Hydrobiidae	0	1	1	2	2	0
Lymeidae	1	3	5	3	1	2
Orthalicidae	0	1	2	0	1	0
Physidae	0	1	2	0	1	1
Thiaridae	1	3	8	3	2	2
Unionoidae	0	1	1	1	1	1
Viviparidae	1	5	10	3	5	6
Grand Total	**51**	**32**	**64**	**34**	**30**	**30**

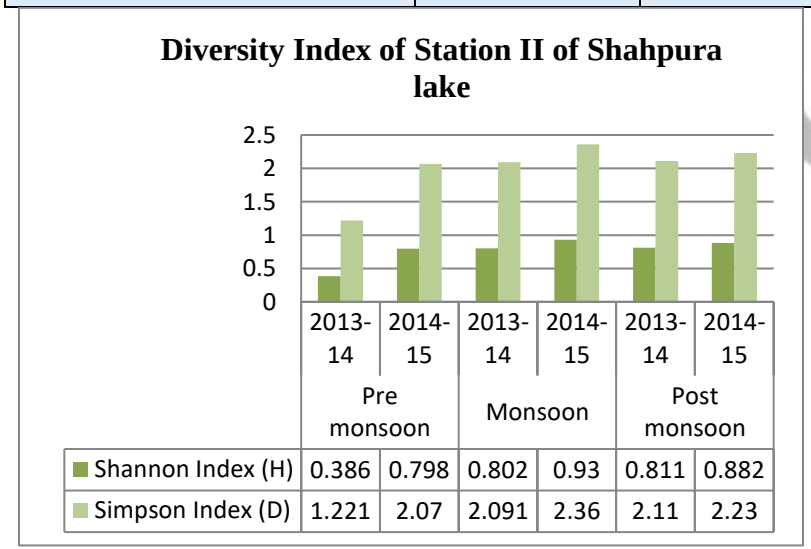


Table 3: Macrobenthic diversity of station III during year 2013-14 and 2014-15

Station III	Pre Monsoon		Monsoon		Post Monsoon	
Macrobenthos	**2013-14**	**2014-15**	**2013-14**	**2014-15**	**2013-14**	**2014-15**
Annelida	**3**	**2**	**2**	**3**	**2**	**1**
Tubificidae	3	2	2	3	2	1
Arthropoda	**49**	**23**	**30**	**27**	**25**	**20**
Aeshinidae	2	2	2	1	2	1
Belostomatidae	2	1	2	3	1	1
Caenagrinidae	1	1	2	1	2	2
Chironomidae	3	1	1	0	0	0
Cordulegastridae	3	3	2	3	0	1
Corixidae	4	2	3	1	1	2
Dytiscidae	4	1	2	3	2	2
Ephemerellidae	3	1	3	2	1	1
Gerridae	1	2	0	2	0	2
Gomphidae	3	2	0	0	2	0
Hydrophilidae	3	2	1	2	3	2
Libellulidae	2	1	2	1	1	2
Naucoridae	3	0	1	2	1	1
Nepidae	3	1	1	1	2	1
Notonectidae	6	1	5	2	5	2
Palaemonidae	3	2	1	2	2	0

Tipulidae	3	0	2	1	0	0
Mollusca	**5**	**24**	**32**	**20**	**27**	**21**
Ampullarioidae	0	3	5	5	3	6
Hydrobiidae	0	1	2	2	2	1
Lymeidae	1	5	5	3	3	2
Orthalicidae	0	1	2	2	2	1
Physidae	1	0	1	1	1	1
Thiaridae	0	4	7	3	5	1
Unionoidae	1	2	1	1	4	1
Viviparidae	2	8	9	3	7	8
Grand Total	**57**	**49**	**64**	**50**	**54**	**42**

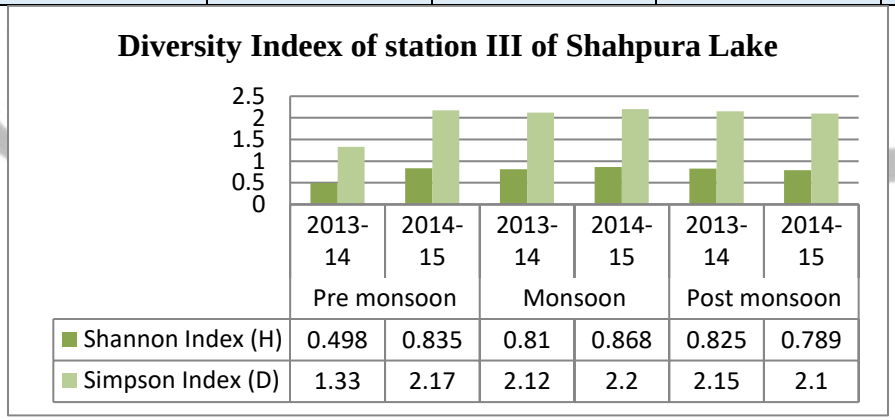
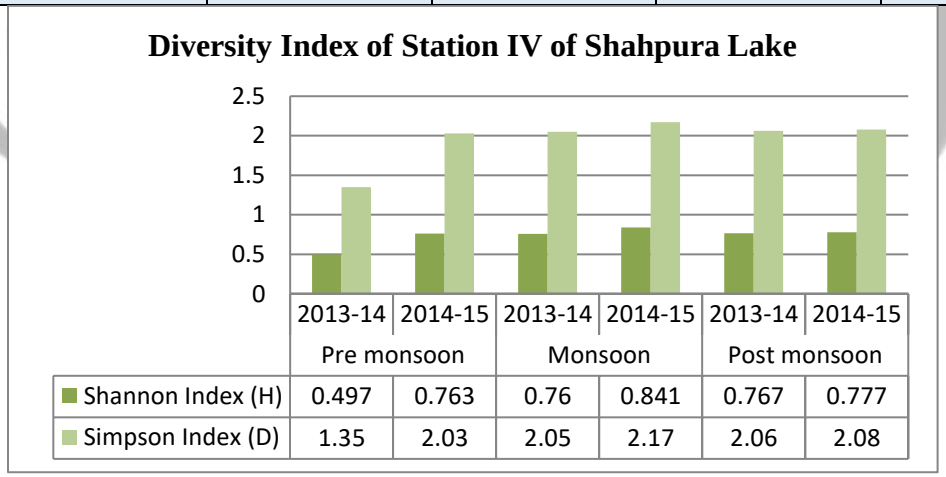


Table 4: Macrobenthic diversity of station IV during year 2013-14 and 2014-15

Station IV	Pre Monsoon		Monsoon		Post Monsoon	
Macrobenthos	**2013-14**	**2014-15**	**2013-14**	**2014-15**	**2013-14**	**2014-15**
Annelida	**2**	**1**	**1**	**2**	**1**	**1**
Tubificidae	2	1	1	2	1	1
Arthropoda	**47**	**21**	**34**	**23**	**27**	**24**
Aeshinidae	3	1	0	1	1	0
Belostomatidae	2	1	2	3	1	2
Caenagrinidae	1	2	3	0	1	2
Chironomidae	2	1	2	1	0	1
Cordulegastridae	4	3	2	1	0	0
Corixidae	5	2	3	3	4	3
Dytiscidae	3	2	2	3	2	1
Ephemerellidae	4	0	4	1	2	0
Gerridae	0	2	1	2	0	3
Gomphidae	3	2	2	1	2	1
Hydrophilidae	2	1	2	2	3	2
Libellulidae	3	1	2	0	1	2
Naucoridae	4	0	1	1	2	1
Nepidae	4	1	0	0	2	2
Notonectidae	4	1	5	1	4	2
Palaemonidae	2	1	2	1	1	1

Tipulidae	1	0	1	2	1	1
Mollusca	**6**	**29**	**30**	**21**	**30**	**25**
Ampullarioidae	0	5	5	6	5	7
Hydrobiidae	0	1	1	1	2	1
Lymeidae	2	5	5	2	3	3
Orthalicidae	0	1	2	2	2	1
Physidae	1	0	1	1	2	1
Thiaridae	1	7	5	4	5	3
Unionoidae	0	3	1	0	4	2
Viviparidae	2	7	10	5	7	7
Grand Total	**55**	**51**	**65**	**46**	**58**	**50**



Conclusion

According to the observation, at all stations, biodiversity was higher during the year 2013-14 and get lowered next year. While biodiversity gradually decreased from pre-monsoon to post monsoon in consecutive years. Station II showed maximum biodiversity among rest stations during pre-monsoon season, station IV showed higher diversity during monsoon season and during post monsoon season station I showed greater diversity in the year 2013-14. While in the year 2014-15, station IV showed greater diversity during pre and post monsoon while station I showed higher diversity. The lake is surrounded by residential area and by a park from another side. The lake is gets input from residential area, which changes the quality of water thus changing its diversity. It's also used fishing and boating. The input of sewage and fishing need to be checked regularly to maintain its diversity and sustainability of lake.

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