HYDROBIOLOGY OF MAKRODA LAKE (GUNA)WITH SPECIAL REFERENCE OF AQUATIC BIODIVERSITY

A
Thesis

Submitted towards the Requirement for the Award of Degree of

Doctor of Philosophy
in
Zoology

Under the Faculty of Science
By

Surendra Singh Mourya
Enrollment No. 161596406204

Under the Supervision of

Dr. Aliya Aijaz
Head of the Department (Zoology)
Dr. R .P. Richhariya Degree College
Barua Sagar Jhansi (U.P)

Year-2023

P.K. University
NH-27, Village. Thanra (P.O. - DINARA),
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DECLARATION BY THE CANDIDATE (PARA 26-B)

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Date 31/7/23

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Acknowledgement

In the name of the almighty, God the most gracious and merciful with his gracing blessing had led to success be upon this thesis. I would like to dedicate my research work to my parents ***Mr. Parash Ram Mourya*** and **Mrs. *Chhimma Bai Mourya***.

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Dedicated To,

Mother, Father

&

Mourya

Family Members

"List of Abbreviation"

CBD	:	Convention on Biological Diversity
BD	:	Biological Diversity
NBA	:	National Biodiversity Authority
BMC	:	Biodiversity Management Committee
SBB	:	State Biodiversity Boards
BDA	:	Biological Diversity Act
GIS	:	Geographic Information System
TDS	:	Total Dissolved Solid
TSS	:	Total Suspended Solids
DO	:	Dissolved Oxygen
NTU	:	Nephelometric Turbidity Units
EC	:	Electrical Conductivity
COD	:	Chemical Oxygen Demand
BOD	:	Biological Oxygen Demand
SS	:	Suspended Solids

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ABSTRACT

India is one of the twelve mega-biodiversity countries, biological resources have been diminishing at an alarming significantly in the last two decades, biological species can affect the ecosystem functioning. Water body monitoring at regular intervals can gives the understanding of the composition of hydrobiology and its dynamics. Water quality assessment refers to the general processes of assessing the physical, chemical, and biological characteristics of water in relation to normal quality. The bio-monitoring, indicators provides the species, and may represent the biological, chemical, or physical characteristics of the environmental circumstances. The existence, conditions, and quantities of ecological indicators have been used to indicate serious stressors on ecosystems. Phytoplankton's are useful indicators of water quality. The growth of phytoplankton may be greatly influenced by elements such as nutrient availability, energy accessibility, as well as the composition and quantity of zooplankton.

The hydro-biological research is being conducted for the Makroda Reservoir, which is located in the Northwestern portion of the Malwa area in Guna district, which is located in Madhya Pradesh's south Gwalior division. Makroda Reservoir, it divided into three zones for the context of this research. One sample location was identified for each zone, denoted by the letters M1, M2, and M3, respectively. The results of physicochemical analyses of water samples recorded from November 2018 to October 2019. The primary objective of physicochemical water analysis is to determine the condition of the reservoir. The physicochemical parameters are divided into two groups for convenience of presentation: Transparency, temperature, turbidity, and conductivity are

examples of physical parameters in Group I. Group II include chemical parameters. Phytoplankton is the primary producers of an aquatic environment, and they regulate biological production. The fluctuation of phytoplankton with seasonal changes in the water habitats is critical for maintaining water quality and sustained aquaculture. The qualitative and quantitative examination of hydro-biological parameters such as phytoplankton and zooplankton studies of Makroda Reservoir. The study reveals some suggestions for additional research in the Guna district of Madhya Pradesh. The research has also been taken out to understand better overall aquatic life system of the Makroda Reservoir water in order to assess its feasibility for upstream aquaculture. Zooplankton categories such as Rotifera, Cladocera, Copepoda, and Ostracoda. Cladocera, the current examination revealed that after certain treatments, the water from all of the bodies of water under investigation is safe to drink. The majority of metrics found to be within the acceptable range. Few of the exceptions are in the metrics within the WHO and ISI acceptable limits. In terms of quality requirements, the parameters measured are unsatisfactory. According to the current findings, there is a need to investigate the physicochemical state of water in order to determine its quality in the future. Though the water bodies under consideration are not badly contaminated, continuous monitoring in the future is required to protect water quality through correct ways. Expert supervision and corrective procedures are required for long-term repair and conservation of water bodies of Makroda Reservoir in Umri taluka, Guna (M.P).

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Chapter1

Hydro-biological Overview of Makroda Lake,Guna

Introduction

The aquatic ecosystem is the most diversified in the earth. The original life evolved in water, but the first creatures being probably aquatic, having water acting as an exterior and interior environment for organisms. As a result, water is a vital component in the survival of all living species. Biological resources have been diminishing at an alarming significantly in the last two decades as a result of rising damaging anthropogenic factors producing anguish to all biological species and affecting ecosystem functioning. India is one of the twelve mega-biodiversity countries, holding approximately 7-8% of the world's catalogued species. The Himalaya, Indo-Burma, Western Ghats and Sri Lanka, and Sundaland are five of the world's 34 biodiversity hotspots are shown in the figure 1.1. India is biogeographically located in the central part of the Sub - tropical and tropical, Indo-Malayan, and Paleo-Arctic worlds. India is extensive in biodiversity, as evidence suggests that roughly 62 percent of recognized amphibian species are native to India, with majority of them located in the Western Ghats. India ranks ninth in the world for agricultural plant origin and diversity, across over 300 wild ancestors and near relatives of cultivated plants flourishing natively. Similarly, fish variety is abundant, accounting for 57% of all families and 80% of all fishes worldwide. There are 223 endemic freshwater fish species among the 783 species of freshwater fishes belonging to 89 genera and 17 families. Over 91,200 animal and 45,500 plant species have been identified in the country till yet. Among roughly

4,900 identified plant species belonging the 47 families, 141 genera are endemic which then is mainly located in the northeast, northwest Himalayas, Western Ghats, and Andaman and Nicobar Islands. According to the NBFGR database, our nation seems to have an incredible variety of 2,508 indigenous finfishes, including 877 freshwater species, 113 aquatic species, 1,518 marine species, and 291 foreign species, accounting for 7.8 percent of world freshwater fish species diversity. Apart from finfish resources, India's extensive aquatic genetic resources include 2,934

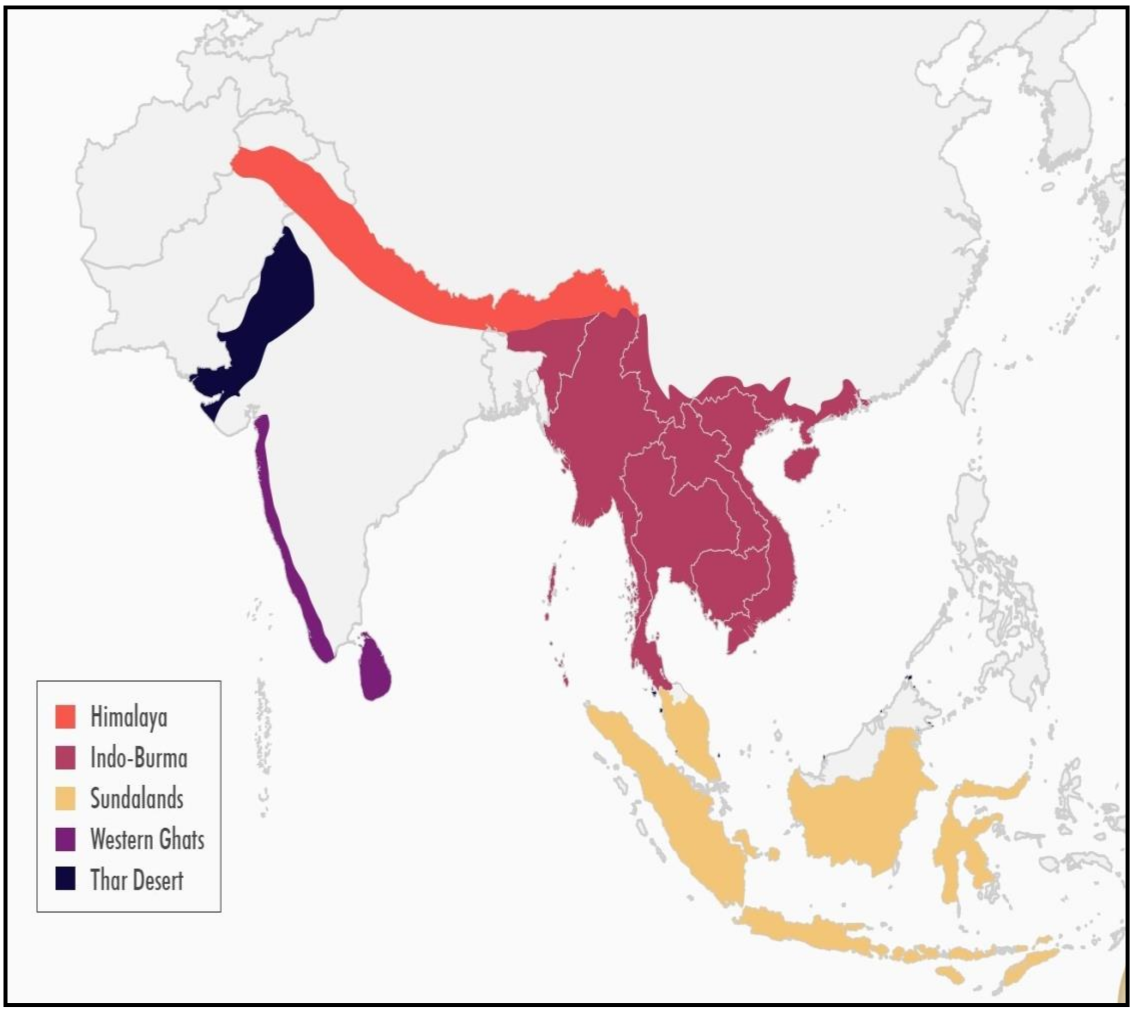


Fig 1.1 Five Hotspot Biodiversity of India (Himalaya, Indo-Burma, Western Ghats and Sri Lanka, and Sundaland)

crustacean species (2,430 marine and 504 freshwater species), about 5,070 molluscs (3,370 marine and freshwater species), 765 echinoderms, 486 jellyfish, and 844 algae species. Lists of floral and faunal biodiversity are gradually being maintained, with several new species discovered from continuous research and survey. About 9,500 plant species are utilized as medicine in traditional health practices, and around 3,900 plant species are used as food, fibre, fodder, insecticides and pesticides, gum, resins, dyes, fragrances, and wood by local and indigenous people. Biological resources are critical for people's economic and social development in countries such as India, where a considerable proportion of the population still relies on local flora and fauna for economic survival and traditional medicinal techniques that exploit biological resources persist. Unfortunately, due to India's increased population, fast economic expansion, and industrialization, biodiversity and ecosystem services are under enormous strain. As a result, natural habitats are being destroyed and fragmented, affecting the environment and occupants as well as the lives of millions of people. Such extraordinary depletion of biological variety at the national and global levels has prompted various international conferences and conventions to express concern about degradation of biological resources. Eventually result inside the planning worldwide summit in 1992 known as "Convention on Biological Diversity (CBD)"

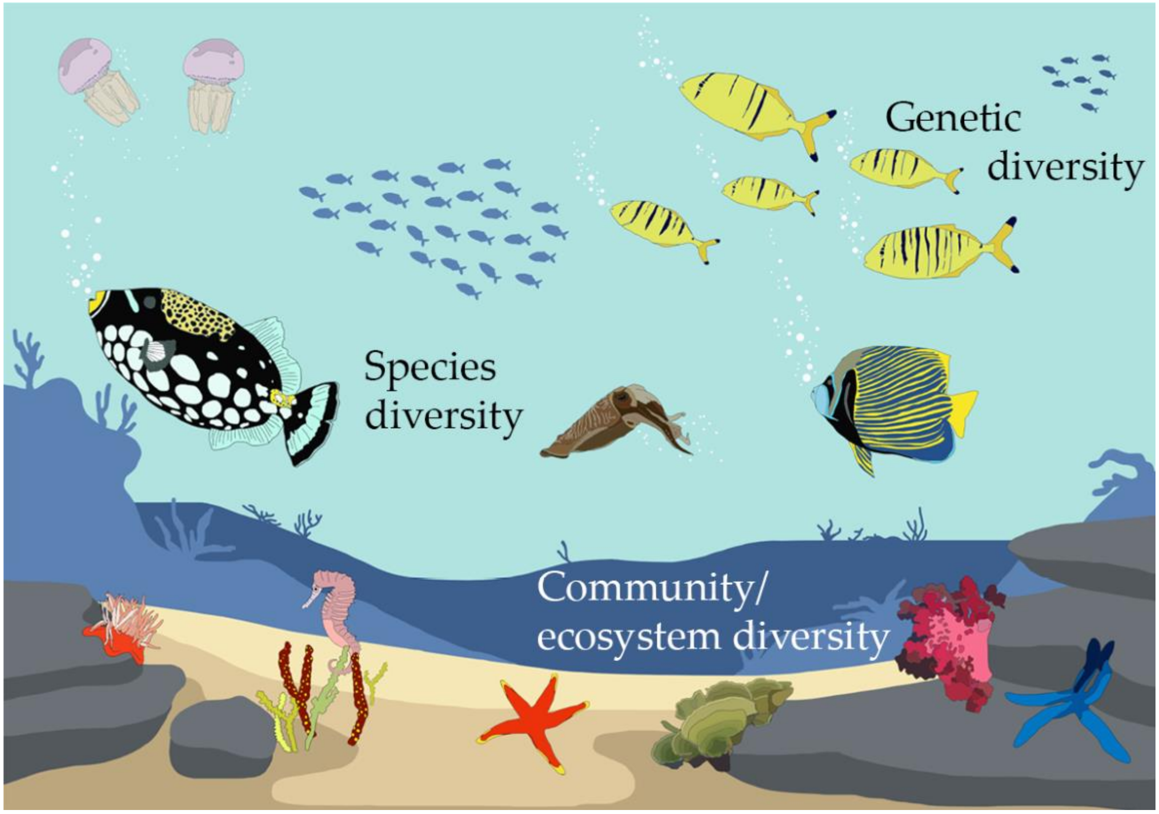
As a result, India established the Biological Diversity (BD) Act in 2002 and notified the BD Rules in 2004. A three-tier regulatory framework has been developed for the execution of the BD Act 2002, with the National Biodiversity Authority (NBA) occupying the apex position, located in Chennai, and constituted by the Central Government of India in 2003 under Section 8(Act). The State Biodiversity Boards (SBB), that are established in 29 states, operate at the state level, whereas the Biodiversity Management Committee (BMC) are constituted at the regional level in accordance with Section 41Act to represent both second and third stages, accordingly. NBA provides recommendations to the Government of India on biodiversity protection, sustainable exploitation, and fair distribution. It also regulates activities and publishes guidelines for biological resource utilization. Similarly, SBB provides biodiversity-related recommendations to state governments. The BMCs are in place to promote the conservation, sustainable use, and documentation of biological diversity, which includes the preservation of habitats, the conservation of land races, folk varieties and cultivars, domesticated stocks and breeds of animals and microorganisms, and the chronicling of biological diversity wisdom. India contributes significantly to the world's biological resources, including 4 of the 34 biodiversity global hotspots, namely the Western Ghats, the North East Region Himalayas, and the Nicobar Islands.

Biodiversity

Biodiversity is classified into three types:

Genetic diversity

Genetic means the features that are given back from parents to children. "Diversity" refers to having a variety of various things. The variety of various genetic features within a species is referred to as genetic diversity. There would be numerous individuals with a wide range of various qualities in a species with significant genetic diversity. The ability of a population to adapt to changing conditions is dependent on genetic variety. When a


Genetic
diversity
Species
diversity
Community/
ecosystem diversity

highly chosen and limited diversity strain, such as fish populations grown for aquaculture, is introduced into a natural population, the population's capacity to respond to changes is reduced.

Species diversity

Species diversity is defined by the number of species in a biological community (species richness), but also by the relative abundance of individuals within that community. The amount of individuals per species is referred to as species abundance, while relative abundance refers to the evenness of distribution of individuals among species in a community. Two communities may have the same number of species but differ in relative abundance. These elements of species diversity react differently to diverse environmental situations. A area with a limited diversity of habitats is often species-poor; nonetheless, the few species that are able to colonise the region may be numerous due to lower competition for resources with other species.Variations in species diversity may give information around a region's past and present environment. The Antarctic continent contains few species because its environment is so unfavorable; however, oceanic islands are species-poor and they are difficult to access or, as in the case of the Lesser Sunda Islands in south-central Indonesia, because organisms don't have enough chance to build them.

Ecosystem diversity

Ecosystem diversity is involved with differences of ecosystems inside a geographic region and their overall influence on human existence as well as the environment. Ecosystem diversity is concerned with the interaction of biotic (biodiversity) and abiotic characteristics (geodiversity). It is the variance in ecosystems present in an area or the variation in ecosystems found around the world. Ecological diversity involves includes terrestrial and aquatic ecological variety. Ecological diversity may also explain for variations inside a biological group's complex, such as the number of diverse habitats, the number of taxonomic groups, and other ecological processes. The variance in habitats such as deserts, forests, grasslands, wetlands, and seas is an example of global ecological diversity. The biggest scale of biodiversity is ecological variety, and within each ecosystem, there is a tremendous quantity of both species and genetic variation.

Aquatic Biological Effective Resource & Development

Environmental threats, both man-made and natural, can have a cascading and interconnected impact on biodiversity, ranging from loss of genetic diversity to population declines and, in extreme cases, species extinction. The effect of such stresses causes a decline in natural populations more than an amount of time, depending upon original population size and magnitude of the threat. Research findings have shown that in the figure 1.2 aquatic biological effective resource & development subsequently increases enormous amount of individuals or species in an aquatic community can adversely affect species richness, ecosystem biomass, a maturity level of first life experience for fishes, or food web dynamics underlining a need to maintain the structure of freshwater ecosystems. The conservation of aquatic biodiversity is crucial because the bulk of genetic resources such as food currently originate from the wild due to the low level of domestic inside the fisheries sector. Aquaculture has quickly developing and

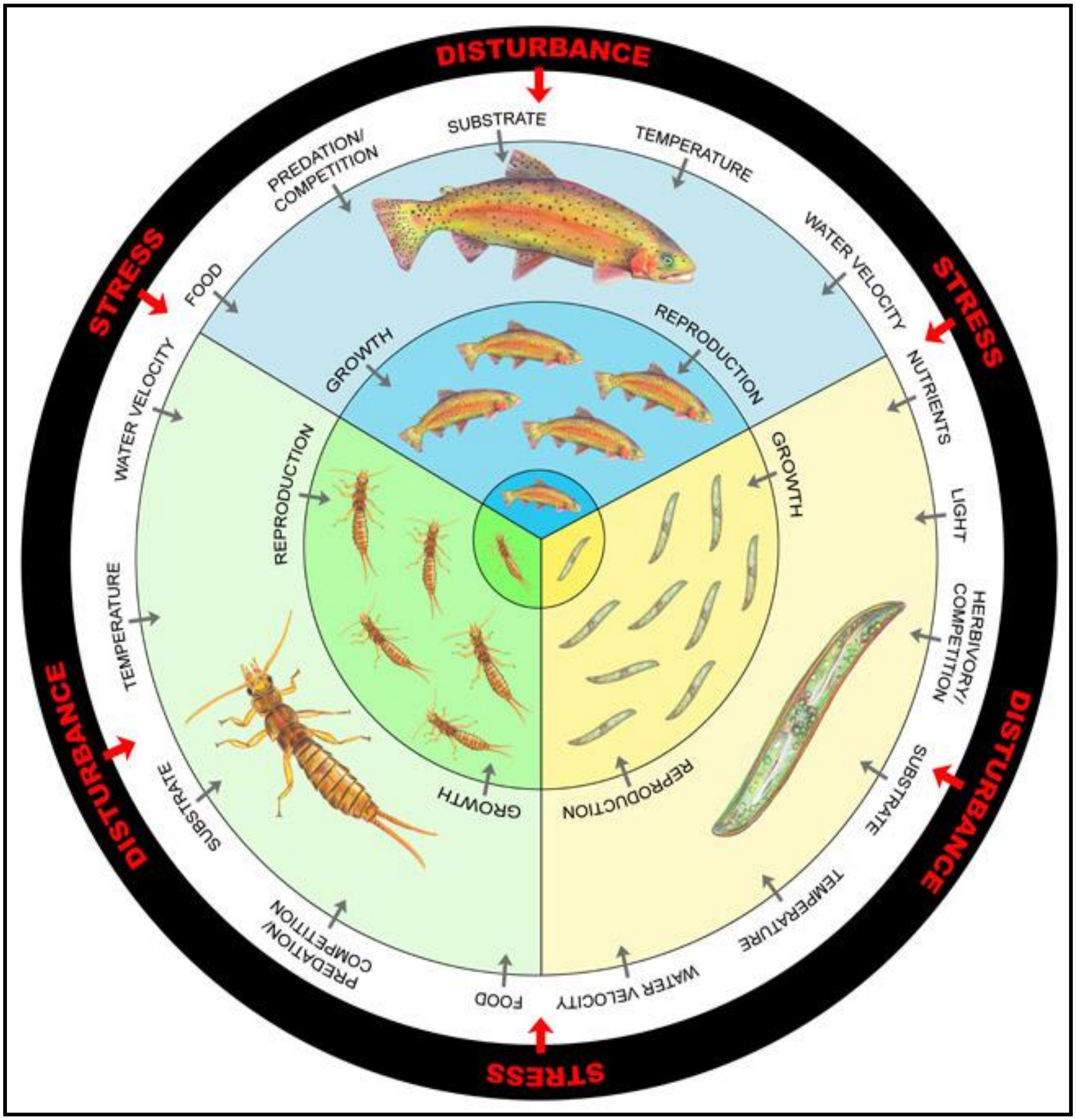


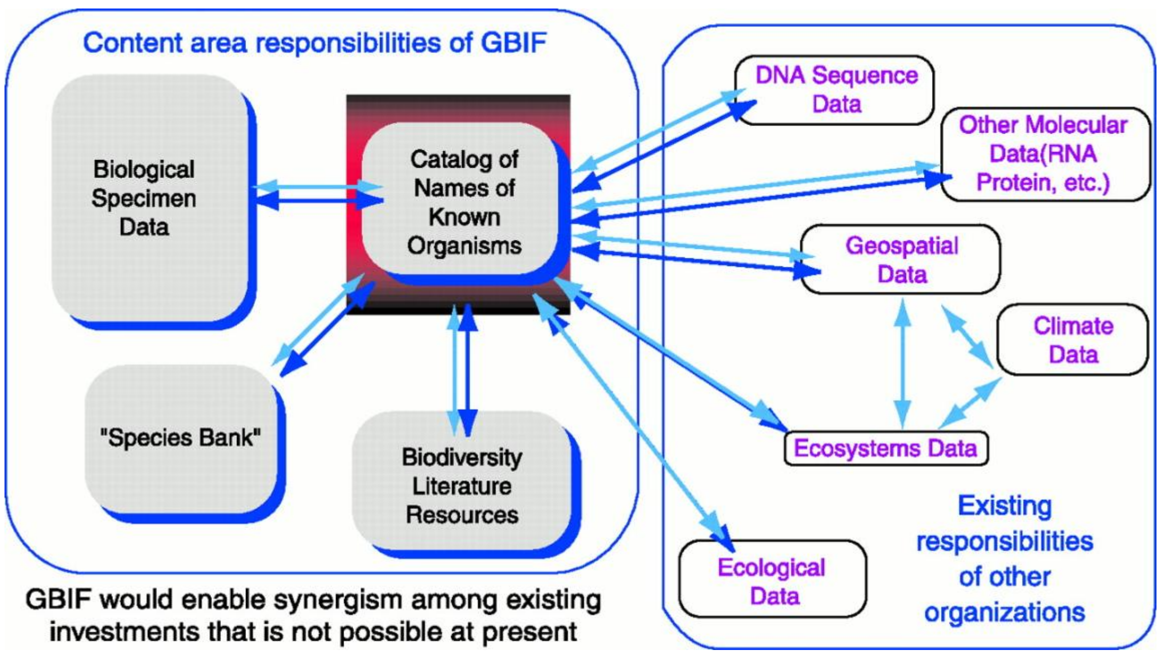
Fig 1.2 Aquatic Biological Effective Resource & Development

accounted for about 50% among all aquatic foods consumed directly by people worldwide. Aquaculture produces 50 percent of the total fish output in India, which is currently 8.0 million metric tonnes. While biodiversity and technologies are playing a big role in this development, they still have to be utilized to the extent that they would be in farmland.

Such distinctions are due to not only the relatively new adaptation with most cultivated aquatic plants, but to the significant number of fished and farmed aquatic species, as well as the diversity of their aquatic environments (from the deep sea to small mountain streams) and production systems in which they have been preserved as well as cultivated. The conservation of India's enormous and diversified fish genetic resources is critical for maintaining ecological and socioeconomic equilibrium. It should also attempt to preserve current biodiversity as well as the evolutionary processes that promote biodiversity. It requires comprehensive approaches to the development of aquaculture and responsible capture fisheries, including the incorporation of knowledge on the biology, status, and habitat of the target species. However the Indian Fisheries Act of 1879 (as amended in 1956) is a fisheries milestone, it has had no meaningful influence on the protection of fish variety. India established the Biological Diversity Act (BDA) in 2002 to protect and optimise the use of its biofuel while preserving control over them. This includes instructions for dealing with a wide variety of concerns with the use of natural sources and information both inside the country and by other countries. Each species seems to have a distinct based on genetic resources, and conservation efforts may focusing on a particular species. To protect a diminishing species, researchers should first understand its ecology, biodiversity, and inter-population biological diversity. Identification of separate stocks at the population level has become a prevalent problem in aquaculture research. The concept for resource may vary, because aquaculture system motives external sources and it could be influenced by political, economic, or biological obligations. Finally, in most animals, the biggest reservoir of genetic variety resides as genetic variations among individuals within a group. This variation is caused by the physical distribution of genes among children during reproduction. The conservation of this genetic diversity is critical, and the loss of this variability is greater in small groups than in big ones. As a result, the objective of maintaining large ecologically healthy natural populations corresponds with the goal of retaining genetic heterogeneity in a population. The various water resources are rich in biological wealth and require good management techniques for long-term exploitation in future years and for posterity. Prospects for aquaculture and their conservation for future strategy must be developed based on past growth and the potential for future expansion, taking into consideration the funding, infrastructure, and trained manpower, as well as the impact of research data monitoring on aquaculture resource can conserve. Maintaining the genetic health of the waterbody resource is equally crucial for scaling up aquaculture output and sustaining natural-water supply. As a result, management requirements must focus on protecting current biodiversity as well as the evolutionary processes that promote biodiversity. One of the most significant hurdles to appropriate usage and defending our interests is the lack of a good database on our aquatic biodiversity. However, due to the massive and dispersed nature of data, the needed collecting and synthesis of data can only be accomplished through broad-based collaborative activities .

Biodiversity Databases

Data compilation on a geographic information system (GIS) platform would allow large amounts of data to be processed and meaningful judgments to be made . Using contemporary remote sensing and GIS tools, information on ecosystems harbouring endangered fish species may be quickly gathered and successfully exploited . Aquatic areas that have been harmed or have lost or degraded habitat can be recovered by using management strategies such as establishing riparian buffer zones and restoring natural flow patterns and discharge regimes. Several wetland habitat restoration programmes are being implemented around the country. However, because to the enormous and dispersed nature of data, the needed collecting and synthesis of data can only be accomplished through broad-based collaborative activities. Data compilation on a geographic information system (GIS) platform would allow huge amounts of data to be processed and meaningful conclusions to be drawn from them. Using contemporary remote sensing and GIS tools, information on ecosystems harbouring endangered fish species may be quickly gathered and successfully exploited. Aquatic areas that have been harmed or have lost or degraded habitat can be recovered by using management strategies such as establishing riparian buffer zones and restoring natural flow patterns and discharge regimes. Several wetland habitat restoration programmes are being implemented around the country. Rivers and streams, regardless of their state, are frequently left unprotected since they frequently flow through more than one political authority, making conservation and resource management difficult to implement. To address this, the development of local watershed bodies consisting of various stakeholders will be an alternative. Because there is no technique for routine cryopreservation of gametes and embryos of many aquatic species, the most practical way to save endangered fish is to



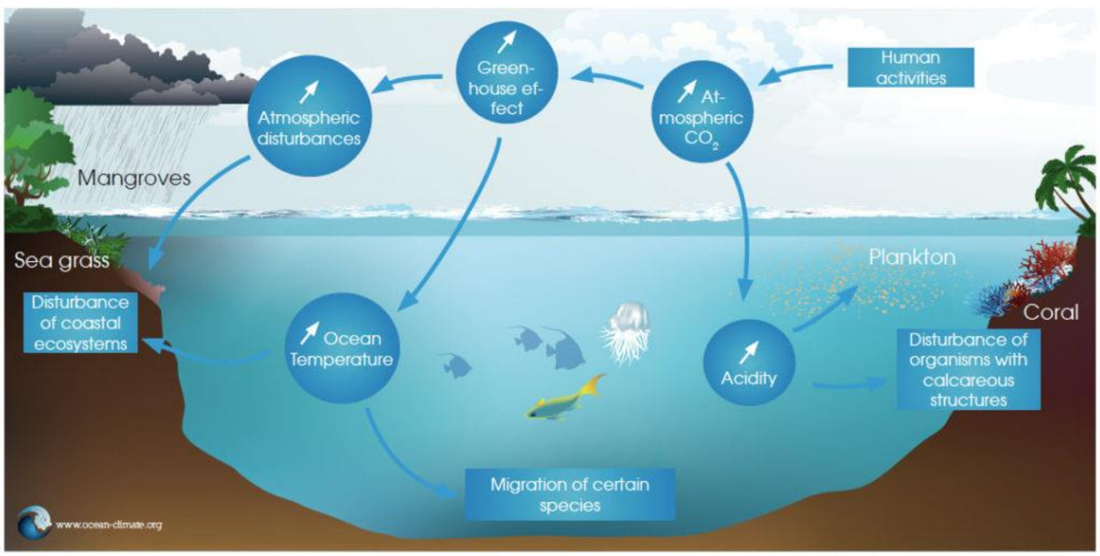
keep them in in situ gene banks. Species-specific recovery programmes, as well as broad-area in situ conservation programmes involving local communities, NGOs, and other organisations, may allow us to keep threatened species from being extinct due of anthropogenic disturbances. Indigenous and local communities organisations can play an important role in recognising and preserving aquatic biodiversity. Local rivers and lakes often retain valuable traditional knowledge for conservation, like the range, abundance, and condition of their biodiversity. entire communities can become engaged in genetic sciences that are required to improved animal care. Engagement in survey initiatives promotes linkages between communities, scientists, and managers, and offers doors to valuable science in both directions. Conservation efforts of embryos in live germplasm (LGBs), as well as gene banking of zooplankton germ cells and ovum, as well as advanced molecular techniques such as primordial germ cell/spermatogonial stem cell transplantation, will not only help to preserve biodiversity, but will also yield biotechnological benefits. The main issues with aquatic LGBs are the limits on the number of individuals that can be maintained for each species, the different environmental requirements of different species, the difficulties in propagating individuals while maintaining genetic diversity, as well as the increased price of these holding cells. The preservation of aquatic species in aquatic protected areas can aid in overcoming these issues, since complete populations of species can be "banked" together in a cost-effective manner. Advances in molecular biology, as well as the resulting potential of transforming fundamental taxonomic research based on genotypic features, have contributed to the shift in the framework of knowledge generation. DNA barcoding is a beneficial tool for this aim that has given taxonomy a "elegance" and attracted young entrepreneurs.

FISH-BOL (http://www.fishbol.org) and SHARK-BOL (http://www.sharkbol.org) are two global efforts that are presently barcoding species. However, trustworthy barcodes for much other economically significant aquatic taxonomy have yet to be created, necessitating the deliberate, collaborative efforts of molecular biologists and conventional taxonomists to provide correct baseline data. Identification of species-specific single nucleotide polymorphisms (SNPs) that really can contribute to the development of DNA chip technology for much faster and accurate identification of many species and hybrids, as well as detection of fish product adulteration, are additional researchable areas in DNA barcoding. By identifying the genes associated with quantitative trait loci, DNA microarray technology may also greatly aid in the molecular selective breeding of fish. We will be able to protect biodiversity and genetic improvement programmes by using modern DNA tools to describe our native fish populations and created breeds. The new branch of genetics known as 'population genomics' (where population and functional genomics finally converge) is becoming a popular method for identifying the architecture of genes controlling various commercially important traits, and it is expected to play a significant role in prospective specific livestock and aquaculture programmes. The most recent biotechnological disease diagnostic tests must be significantly more sensitive, cost effective, and simple to apply in the field without the need of complex laboratory instruments. The protection of the country's fish variety and aquatic resources need concerted efforts that integrate capture, cultural fisheries, and environmental programmes employing cutting-edge technical advancements. Genetic tools appear to be a promising way for boosting aquaculture output and food security of the nation, as well as minimising fishing load on natural resources in the future. To achieve the stated goals of improving fish habitat and biodiversity protection, environmental regulations with stringent enforcement mechanisms must be adopted. Despite rising interest in public perceptions and public engagement in environmental decision-making, more study on understanding biodiversity concepts is needed to better understand public attitudes toward biodiversity and engage the public in conservation initiatives.

Importance of Water

Water is a valuable natural resource that sustains all life on the globe as well as our Earth, and it circulates in a continuous cycle known as the hydrologic cycle. It is consistently dispersed in time and space and has a distinct feature. It is impossible to substitute, tough to contaminate, and expensive to carry, and it is a really unique gift from nature to life. Water, as a natural resource, requires special care due to the numerous advantages and issues caused by its excesses, scarcity, and decline in quality. Water is also one of the most controllable natural resources since it can be diverted, transported, stored, and recycled. All of these features contribute to water's enormous benefit to humanity. The quantity of water is a fundamental aspect of the world. Water covers more than 71% of the earth's surface. On a worldwide scale, the total amount of accessible water is 1600 million cubic kilometres. The hydrological cycle transports massive amounts of water across the world. However, because 97.5 percent of all water on Earth is salty, most of the world's water has human potential. The majority of the remaining 2.5 percent of fresh water is deep and frozen in Antartica and Greenland as continental ice, with just approximately 0.26 percent floating in rivers, lakes, soils, and shallow aquifers that may be readily exploited. The world's freshwater resources are deteriorating at an alarming rate. Lakes, in instance, account for less than 0.07 percent of the world's freshwater supply. India contains 17,370 lakes spanning a total area of 3,153,366 hectares, including 56 big (1,140,268 hectare), 180 medium (527,541 hectare), and 19,134 tiny (1,485,557 hectare) lakes, at least 100 of which have been submitted to scientific investigations. There are a total of 1869 bm3 of water resources available, with surface water accounting for 690 bm3 and ground water accounting for 432 bm3. The current per capita existing water resource is 1122 bm3 and 2050 bm3, respectively, and is expected to fall to 748 bm3 in the future. According to the World Water Assessment Programme, the quality of water supplied to everyone is expected to decline by 30% over the next 20 years (WWDR, 2020). Water shortage is a barrier to the ongoing preservation of aquatic ecosystems. The rising industry, urbanization, fast population expansion, indiscriminate use of fertilizers and pesticides, and a less aware attitude toward the environment pose a danger to all fresh water ecosystems. The discharge of urban, industrial, and agricultural wastes has increased the volume of numerous chemicals that enter drinking water, significantly altering their physicochemical properties. While industrialization and agricultural expansion are vital for economic progress, it also is necessary to preserve freshwater resources. Development should be both individuals and eco friendly. Development will be threatened until humans protect the structure, function, and variety of the world's natural systems over which mankind live. In many regions where food scarcity affects human existence, it is a shortage of water that limits food production. In India, per capita surface water availability was 2309 and 1902 m3 in 1991 and 2001, respectively, and is expected to fall to 1401 and 1191 m3 by 2025 and 2050, respectively. It is also anticipated that by 2025, two-thirds of the world's population would confront

water scarcity. As a result, there is a need for efficient planning, development, and management of the country's most valuable asset, namely water, in order to raise the living conditions of millions of people, particularly in rural areas. Water, as a scarce and community-shared resource, has already been a source of contention; continual monitoring of their environmental systems is essential for appropriate management. Historically, when towns were sparsely populated, water was capable of self-purification by metabolising waste; but, due to a massive rise in pollution, water's self-purification ability has declined, resulting in significant other problems. Water resource restoration, conservation, and management need a greater knowledge of what defines a healthy environment. Monitoring and evaluation, using water quality measurement techniques, give fundamental information on the state of our water bodies, their exact type, as well as the source and quantities of contaminants.



Investigation of Aquatic System

The physicochemical characteristics dictate the quality of lake water, whereas the productivity of the freshwater ecosystem affects the overall health of the system, as measured by fish growth. The dynamics of aquatic ecosystems physicochemical components govern it. The algal community, as a major component of aquatic plants, exhibits dramatic changes in response to changes in physicochemical properties, whereas the rotifer community structure is likely shaped by a variety of environmental factors. Many studies have examined physicochemical conditions and seasonal fluctuations in zooplankton, demonstrating that changes in physicochemical factors lead to changes in plankton density, which results in change in faunal variety.

The number and variety of species in an aquatic habitat are determined by the availability and quality of water. Water is an essential component of all life on Earth, and it completely controls the chemical composition of all species. Water's prevalence throughout biota as the fulcrum of biochemical metabolism resulted in its distinct physical and chemical features. Limnology, or the study of freshwater habitat, is the study of the functional relationships and productivity of freshwater biotic communities as they are impacted by the dynamics of physical, chemical, and biotic environmental elements. It is a freshwater ecosystem or aquatic ecology science that includes

multidisciplinary studies such as hydrobiology, hydrophysics, and geology. Hydrobiology, the study of life and living processes in water, is a subfield of limnology, the study of inland waterways. It is not a separate field, but a branch of biology concerned with the life of creatures in water. The clarification of basic environmental

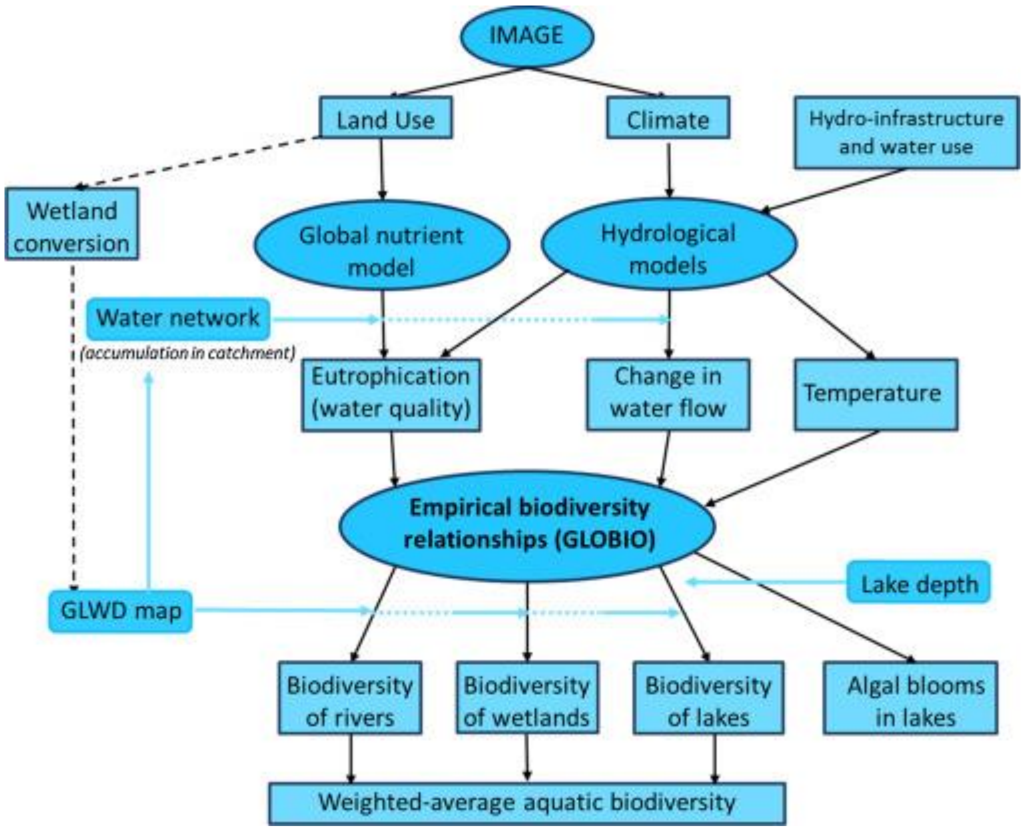
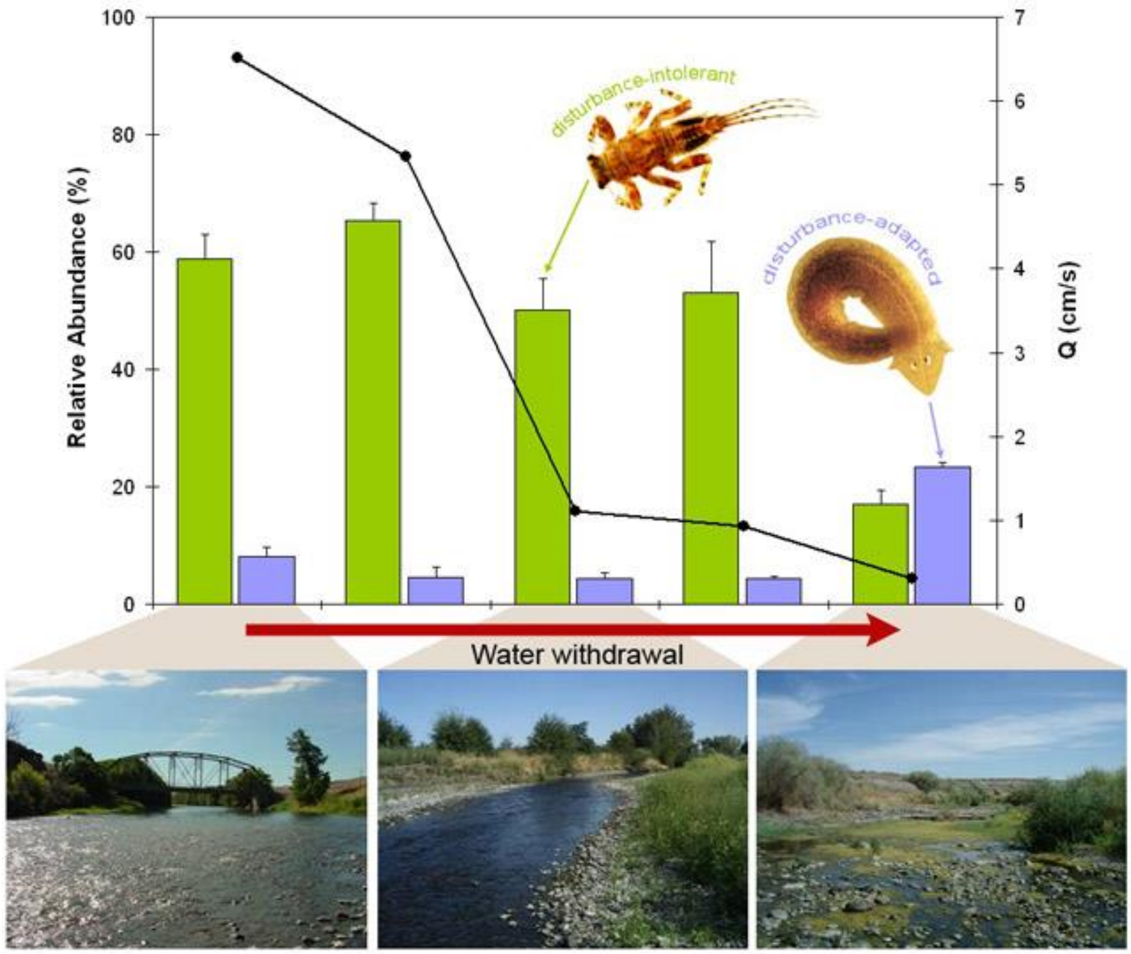


IMAGE
Land Use
Climate
Hydro-infrastructure and water use
Wetland conversion
Global nutrient model
Hydrological models
Water network
(accumulation in catchment)
Eutrophication (water quality)
Change in water flow
Temperature
Empirical biodiversity relationships (GLOBIO)
Lake depth
GLWD map
Biodiversity of rivers
Biodiversity of wetlands
Biodiversity of lakes
Algal blooms in lakes
Weighted-average aquatic biodiversity

Function of the ecosystem in lakes that are vital for water quality management is one of the goals of modern limnology research. The quality of water influences the species composition, quantity, productivity, and physiological conditions of indigenous populations of aquatic creatures (APHA, 1985); hence, the character and health of aquatic communities are expressions of water quality. The world's fresh water systems are deteriorating at an alarming rate, which has a significant impact on biodiversity. Natural phenomena such as dust storms, runoff and mineral weathering, as well as Phosphorus and Nitrogen intake from household water, all contribute to gradual eutrophication. As the human population grows, so does the need for food, land conversion, and fertiliser, all of which contribute to the quicker depletion of freshwater supplies. Furthermore, the discharge of urban, industrial, and agricultural wastes has increased the quantity of numerous chemicals that enter receiving water, significantly affecting their physicochemical properties. Over period, nations have controlled there own point micronutrients, such like municipal and industrial discharges, as well as replaced non-point micronutrients, like run-off from agricultural or urban land, as the driver of eutrophication-a globally known issue of groundwater pollution in many regions-with land - based sources. The original flora and fauna changes like a consequence of eutrophication, and the ecosystem's behaviour become unpredictable. Additionally, excess fertilizers or manure application creates nutrient buildup in the soil. These nutrient-rich soils are swept into lakes, in which some disintegrate or stimulate phytoplankton and aquatic plant development. Changes in the aquatic environment, along with anthropogenic pollution, are raising concerns and necessitate monitoring. Monitoring the quality of surface water using hydro-biological indicators is one of the primary environmental concerns since it allows for immediate evaluation of the health of ecosystems subjected to harmful human factors. Pollutants that enter lakes, streams, rivers, seas, and other bodies of water are dissolved in water, suspended in life, or deposited on the bed. Any system can endure contaminants up to a certain point, after which the water quality deteriorates, damaging the aquatic system. When biological data is connected with physical and chemical factors, a greater knowledge of the impacts of pollution is achieved. Biological indicators, on the other hand, give direct proof of contamination, whereas physical and chemical data provide indirect evidence. Because they appear to be heavily impacted by climatic influences, plankton has been employed as an indicator to study and understand changes in the ecosystem. Utilizing ecological analysis to assess the quality of an aquatic system is just a moment strategy. Water body bio-monitoring at regular intervals also aids in understanding the composition of biota, its dynamics, and the consequences for tropic structure, and vice versa. Water quality assessment refers to the general processes of assessing the physical, chemical, and biological characteristics of water in relation to normal quality, human consequences, and planned applications, particularly those that may affect human health and the health of the aquatic environment itself (UNEP, 1996).

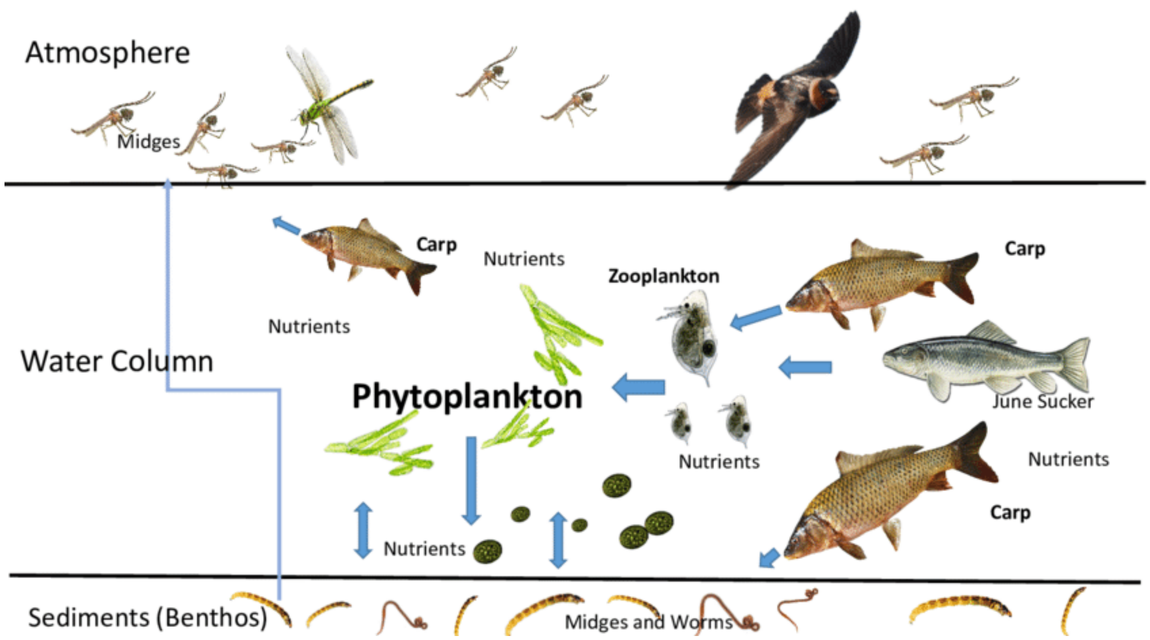
Biological approaches for measuring water quality include collecting, counting, and identifying aquatic species (APHA, 1985). In biomonitoring, indicators, indicator species, or indicator communities are used. They may represent biological, chemical, or physical characteristics of the environmental circumstances. The existence, conditions, and quantities of ecological indicators have been used to indicate serious stressors on ecosystems. The amount of different species of fish, insects, plankton, amphibians, and plants—the bioindicators—determines the ecosystem's quality or state (EPA, 1976). The presence or absence of a certain indicator, indicator species, or indicator community reveals the water body's environmental parameters. Because of their short turnover time and sensitivity to environmental challenges, phytoplanktons are useful indicators of water quality. The survey of phytoplankton therefore aids in determining the tropic state and the level of organic pollution in the environment. Phytoplankton is the foundation of an ecosystem's nutrient cycle. They serve a crucial role in maintaining the balance between living creatures and abiotic forces since they are primary producers. They are influenced by physical, chemical, and biological variables, making them an important tool in monitoring programmes. Several experts have emphasized that algal populations as a whole serve as trustworthy indicators of contamination as a result of this. Many lakes and lakes in India have been examined for water quality evaluation and fisheries



Relative Abundance (%)
Q (cm/s)
disturbance-intolerant
disturbance-adapted
Water withdrawal

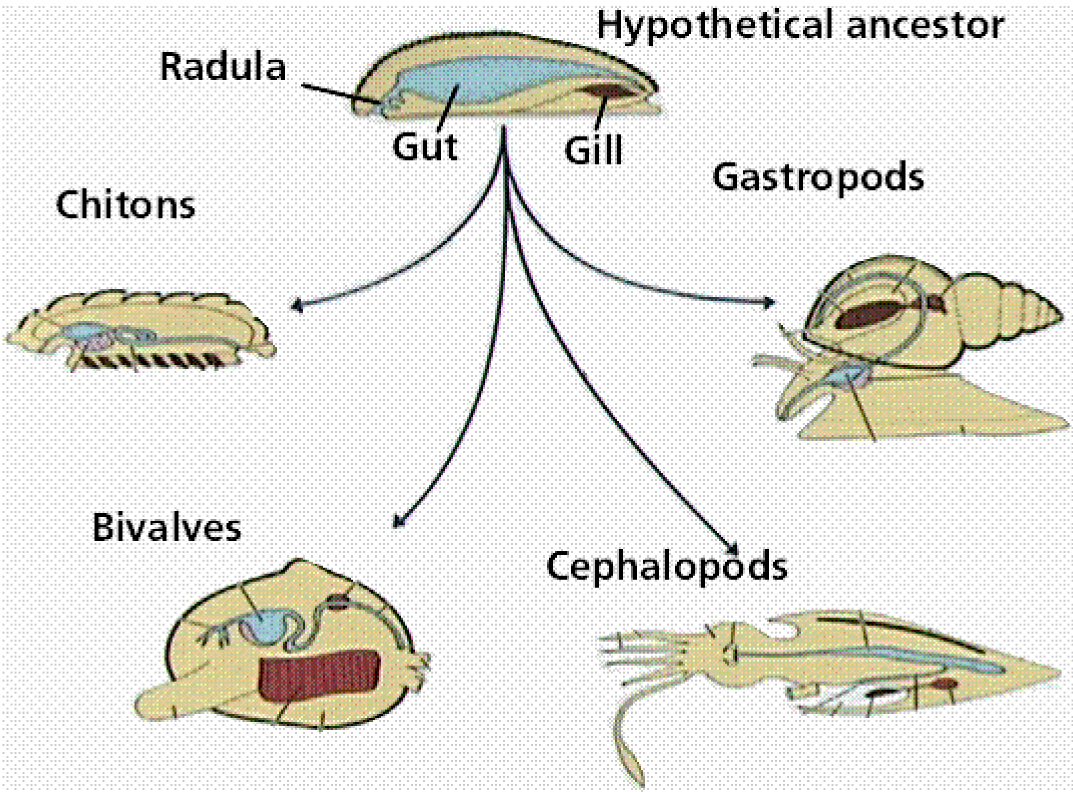
development. However, there are numerous aquatic habitats that have yet to be discovered. Several studies on phytoplankton variety in ponds, reservoirs, and bodies of water have been undertaken in India, illustrating the significance of this type of investigation. It has been shown that the organization of phytoplankton communities in lakes is determined by the interaction that exists between the physical, chemical, and biological characteristics present in the water body. The growth of phytoplankton may be greatly influenced by elements such as nutrient availability, energy accessibility, as well as the composition and quantity of zooplankton.

Water quality factors cause significant seasonal fluctuations, as well as quantitative and qualitative variances in phytoplankton populations. Zooplankton, the other type of plankton, is likewise affected by changes in abiotic and biotic factors. Zooplankton are the principal consumers of every aquatic environment and play an important role in the movement of food from the primary to secondary levels as well as the conservation of detritus matter into consumable animal food. Their habitat traits, location in the food chain, and biological characteristics make them good model organisms that flourish in the aquatic environment and may be used to test broad ecological hypotheses. As a result, the research of Zooplankton is also being conducted in this higher altitudinal lake in the mid Satpura range of North West Maharashtra. The study of freshwater fauna, particularly zooplankton, in a specific region plays an important role in the preservation and maintenance of ecological balance due to the effect of different extrinsic and intrinsic variables. Organisms in water bodies can be found at different depths, determining their own niches in each sort of biological setting. The density of zooplankton is determined by the presence of phytoplankton, organic matter, nutrients, and physicochemical factors. Zooplankton species have a wide geographical range; studying their composition, abundance, and seasonal fluctuation serves in aquaculture planning and management. Phytoplankton and Zooplankton can also be used as indicators of water quality, including pollution. They are useful bio-indicators due to their short life cycles and fast responsiveness to environmental changes. In India, zooplankton groups have been studied in a variety of lakes, lakes, and shallow water bodies. The majority of these research concentrate on the interaction between zooplankton and water quality, particularly eutrophication and organic pollutants. Environmental influences have been explored not just in fresh water systems, but also in a shallow eutrophic, man-made hyposaline lake. Various researchers study the link between nitrogen, total phosphorus, and zooplankton density, as well as eutrophication and ecological state, to determine the nutrient status of lakes. The biodiversity of plankton, variety as well as seasonal patterns of zooplankton, physico-chemical conditions and the occurrence of seasonal variations, zooplankton-phytoplankton connections through shallow subtropical lakes instead of temperate lakes, as well as the effects of altitude on hydrology, productivity, and species richness are also studied to compare and contrast the dynamics of phytoplankton, zooplankton, and nutrients. But, the fundamental study is needed and thus is essential only at regional scale. They occur prevalent in shallow parts of lakes, but just a few species are common in open water. Because of the importance of zooplankton in both natural and contaminated environments, it is vital to investigate the density, diversity, and species



richness for zooplankton in every aquatic ecosystem in relation to the environmental conditions. The significant series of researches covering a wide range of ecosystems including creatures indicate that species diversity for diverse vertebrates varies significantly with ecosystem productivity and habitat heterogenicity. Another major type of biota in an aquatic habitat is molluscs. They are extremely old, with the earliest fossils dating back to the Cambrian epoch some 600 million years ago. Molluscs are a structurally diverse collection of soft-bodied creatures that have colonised every imaginable environment, from deep waters to higher altitudes (4500 m).

A two major Mollusk groups, Gastropoda and Bivalvia, are spread into freshwater, with the earlier possibly approaching ground. Overall, these two groups comprise up 98 % of all known live molluscan species. Mollusks have also effectively adapted to a variety of ecological variables. They play a key role in the generation of biomass. They are the earliest living organisms that have hard shells, which may have attracted early man. Man and mollusks have been associated since prehistoric times, as indicated by their remains in Mohenjodaro, Harappa, and other locations. Aside from the aesthetic attractiveness of their shells, man consume the soft portions of molluscs, particularly Bivalvia, while Gastropods are taken in huge quantities from water bodies for sale to shrimp fisheries as prawn feed. This has had a negative influence on the duck and bird populations, which rely on mollusks for sustenance. Some mollusks are employed as possible sources of biological compounds used in the creation of medications, while others are required for the production of commercially important items such as pearls and raw materials for the shell craft sector. Marine molluscs assist fisheries in various nations; however, freshwater molluscs have received less attention due to their dismal colours. However, they are



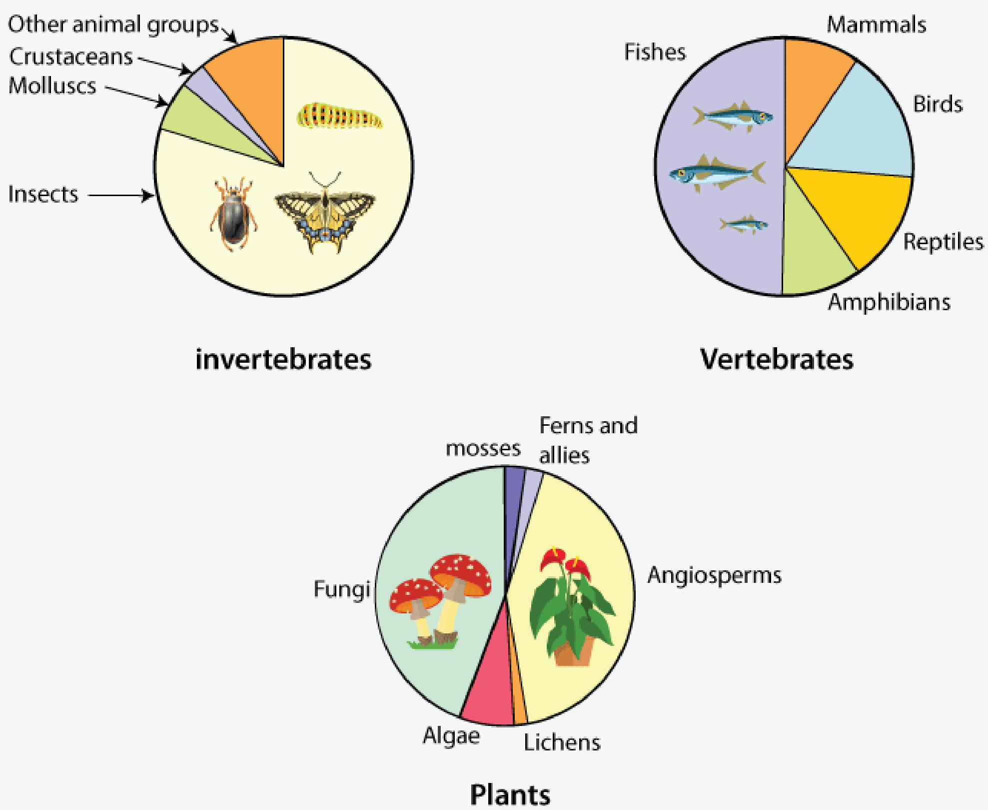
recognised to play an important role in public and veterinary health. Because certain fresh water snails act as intermediate hosts for various trematode parasites that carry illnesses in animals and humans, their involvement has been studied. Certain mollusks have also been observed clogging the filtered water pipe systems and water inlets of coastal thermal power facilities.

Freshwater and Aquatic Diversity

Freshwater gastropod diversity is low when compared to terrestrial or marine mollusc diversity. Because they are extremely susceptible to environmental changes, current and future global changes will endanger their variety. Wetlands are shallow bodies of water that are regarded to be one of the most productive systems in the world (IUCN, 1990). The birds serve as simple, obvious, and low-cost indicators of such a system. The impact of wetland features on bird population and species composition is a topic of aesthetic, economic, and scientific interest, and hence the focus of current study efforts. Wetlands that vary in quantity, size, and quality due to either short-term or long-term changes might be expected to vary in their ability to attract water birds and impact their abundance and variety. Many bird watchers have recorded the quantity and diversity of different species in a marsh. Many variables are known to impact local population estimates, and the difficulty is exacerbated when dealing with long-distance migration. Population size and density are used to determine whether or not a species has good or bad habitat. Bird populations are regarded as sensitive indicators of pollution in both terrestrial and aquatic habitats. Ornithologists play an important role in resolving environmental concerns and bringing conservation to the public's attention since birds capture the interest of a huge segment of the population. Wild birds are more or less always visible, but migratory birds, particularly those in the lake area, appear to be severely impacted by climate changes and direct human effect. As environmental factors reach their tolerance limits particular species, the range of birds shifts. A study on bird species distribution seems essential because it can be linked with field use including the value of location conservation importance.

As a result, it is critical to design a management strategy to secure the system and to use it as a baseline against any future modifications. Climate change is modifying the structure and function of ecosystems all around the world, and this is now widely understood. Despite their great biological variety, many birds share key life-history features that have made them useful for assessing the effects of climate change. They are extensively spread and extremely mobile, their yearly cycles are based on seasonal phonological signals, and their generation time is relatively short. Thus, knowing the factors that influence bird spatial distribution is critical not only for theoretical science, but also for practical elements such as conservation and wildlife management planning. Since the Ramsar Convention came into force in 1972, the debate over environmental protection has progressed. The protection of biological variety is becoming increasingly important. The aquatic environment is the world's most diversified ecosystem. The earliest life appeared in water, and the first creatures were likewise aquatic, with water serving as both an exterior and interior environment for organisms. As a result, water is the most important component in the survival of all living species. Water is a valuable natural resource that is essential for the survival of all life on Earth, and it circulates in a continuous cycle known as the hydrologic cycle. It is equally dispersed in time and space and occupies a singular location, the planet. It is impossible to substitute, tough to

REPRESENTATION OF GLOBAL BIODIVERSITY



depollute, and expensive to convey, and it is a really unique gift from nature to life. Water quality has deteriorated as a result of its excesses, shortages, and quality deterioration as a result of its numerous advantages and issues. Water is also one of the most controllable natural resources since it can be diverted, transported, stored, and recycled.

Madhya Pradesh Biodiversity

Madhya Pradesh is located on the physical expressway that connects the Western Ghats and the North East, one of the country's biodiversity hotspots, and is one of the greatest reservoirs of biological variety in the country. Madhya Pradesh has a lot of wooded areas. Over 30 percent of the state or over 95,000 square kilometres, is wooded, accounting for 12 percent of the national total. There are nine national parks, 25 wildlife sanctuaries, two biosphere reserves, and five tiger reserves in the woods. The woods also provide habitat for a diverse range of fauna, including key tree species such as teak, sal, saja, and tendu, as well as wildlife such as tiger, bison, and wild boar. 20 percent of the indigenous population in the region lives in the woods and relies on them for a living, notably from non-forest timber products such as fruits, seeds, medicinal plants, gums, and resins. Considering enhanced wildfire monitoring as well as other Official efforts to maintain the forests, they are under substantial stress as a result of strong local reliance on fuelwood, livestock overgrazing, unsustainable extraction of forest products, and unregulated conversion of forest to agricultural fields. According to an evaluation of the impact of climate change on forest ecosystems in Madhya Pradesh, around 23% of the state's wooded land might be affected in the short term, while over 50% could be affected in the long run. Madhya Pradesh's forest composition and distribution are projected to change as a result of climate change. This might have a significant impact on forest biodiversity and the availability of forest resources such as fuelwood, fodder, and non-timber forest products, all of which are crucial to local populations' lives. Furthermore, climate change may cause greater migration and conflicts between forest residents and wild animals over acceptable habitats as the animals seek water and more hospitable surroundings. Warmer temperatures as well as an increase of weather events renders aquatic species increasingly sensitive towards exotic plant and animal species owing to resource shortages and increased struggle. Dry seasons periods over forested regions might lead to additional more severe forest fires. Drought and fire may weaken forests, increased susceptibility for insect and pathogen infestation. Higher temperatures and subsequent dry periods may exacerbate desertification in western Madhya Pradesh, resulting in biodiversity losses and a negative impact on the region's economy. The state's habitats include plateaus, ravines, mountains, valleys, riparian zones, and flat plains. Tiger state has one of the highest faunal and floral richness, with four primary forest types, nine National Parks, and 25 Wildlife Sanctuaries. These woods, which have over 5000 plant types, provide home for 500 bird species and 180 fish species, thousand of rice varieties,wide range of minor millets, indigenous cattle, poultry landraces, and the agro-biodiversity of Kadaknath. The biological variety of the state, which is home to six tribes with different customs, practises, and civilizations, maintains livelihoods and guarantees food security for two-fifths of the state's 66 million people. Indigenous health systems, nourished by a wealth of traditional knowledge weaved around over 1000 medicinal plants, contribute greatly to rural health security. A plethora of customs, rituals, festivals, and traditional knowledge have a substantial impact on the long-term viability of biodiverse resources. Such biodiversity richness gives one-of-a-kind chances to improve people's lives and boost biotechnological advances for food and livelihood security.

The hydro-biological research is being conducted for the Makroda Lake, which is located in the Northwestern portion of the Malwa area in Guna district, which is located in Madhya Pradesh's south Gwalior division. Makroda Lake is a medium-sized project located around 25 kilometres from the Guna District headquarters and approximately 255 kilometres from Bhopal. It is built over the Negri River, a tributary of the Parvati River. It is located at latitude 24o43'30"N and longitude 77o16'00"E. The Makroda Lake is accessible by all-weather motorable road from NH-46, the nearest railway station is Guna Railway Station, and Bhopal Airport is around 199 kilometres away. It is located in the Chambal Betwa Basin and supplies water for irrigation and water delivery in the local community. In the figure 1. Shown the synoptic view of Makroda Lake. Villagers and fishermen also utilise the water for pisciculture. As a result, studying the molluscan diversity of Makroda Lake was critical. The variety of freshwater mollusks is also a strong indicator of the quality of Makroda reservoir water. As a result, in addition to phytoplankton, the current study investigates the species richness, density, variety, and abundance of zooplankton in a higher altitudinal lake called "Makroda Lake" in North West Madhya Pradesh. Thiara and Indoplanorbis are two genera that survive in a somewhat contaminated environment. As a result, including mollusks to create critical baseline data for an evaluated water body such as Makroda Lake is important. As a result, the current study focuses on the ecology of a Makroda Lake, Guna at a higher altitude in Western Satpura. As a result, the current research of biotic and abiotic parameters is intended to provide a comprehensive assessment of the state of "Makroda Lake" that can aid in not only management but also sustainable usage in the form of creating ecotourism.

Chapter 2

Literature Review

Introduction

The word "biodiversity" became a part of the research strategy in various nations, as well as humanitarian groups and projects, potentially arise in the Rio Summit 1992 as well as the approval of the Biological diversity.Biological diversity is diverse and unique, and it is fundamental for biosphere, along with its countless species and habitat. It is the foundation of human life and livelihood. While the world's total number of species is believed to be between 10 and 30 million, only approximately two million have been recognised. This vast variety, which has been preserved as a valued asset for millions of years, has been a vital source of ecosystem goods and services. The variety of species and ecosystems that make up the world's freshwater, tidal, and marine zones, as well as their interconnections, are referred to as aquatic biodiversity.The world is currently suffering a one issue throughout its morphology of contaminants. Pollution became a worldwide issue as a consequence of enhanced urbanisation, industry, as well as the development impulse of humanity. Pollution of fresh water ecosystems is becoming an increasingly serious issue across the world. India comprises 4 of the world's 34 biodiversity, such as the Western Ghats, the North East Region Himalayas, and the Nicobar Islands, that significantly contribute to the world's biodiversity. As per the statistics, the country seems to have a rich diversity of 2,508 indigenous 877 freshwater species, 113 brackishwater species, 1,518 marine species, and 291 foreign species, accounting for 7.8 percent of world finfish variety. Apart from fishes resources, India's abundant aquatic genetic resources include 2,934 crustacean species (2,430 marine and 504 freshwater species), about 5,070 molluscs (3,370 marine and 1,700 freshwater species), 765 echinoderms, 486 sponges, and 844 seaweed species. Over the recent decade, so many more as 59 new freshwater shrimp have been discovered in the Indian EEZ's North East, Western Ghats, and deepwater zones. Much more biodiversity have been expected to be found in the watersheds of Western Ghats, the North East, and other unexplored places, suggesting an emphasis to investigation of such area. Limnology is the study of the physical, chemical, and biological traits and characteristics of fresh water lentic and lotic behaviours. F. A. Forel (1841–1922), a Swiss professor, is regarded as the father of limnology. The twentieth century is regarded as the canonical time of Limnological studies and several relevant Limnological research have been conducted following literature have been reviewed during the inception of this research work. Following are the past research work which are used in the form of literature review.

P. Sabhapandit and A.K. Mishra, 2011, Inside this research, 34 samples were collected from various sources such as dug wells, bore wells, hand pumps, and ponds. The results showed that chloride and nitrate concentrations in all of the sources were below the allowable level, however ponds had a high concentration. Sulphate, salt, and zinc concentrations were quite high in dug and bore wells, whereas calcium and chromium concentrations were below acceptable limits. In terms of the parameters evaluated, the overall study found that 11 samples were suitable for drinking.

Bansod, M.A 2014, Ghotnimbala lake of Chandrapur spread over a large area and the water of this lake degraded day by day 18 Rotifers species from 14 genera were found during the study period and seasonal changes, change in Rotifers diversity and density observed which is at a high level in summer and at a low level in monsoon Summer saw

17 species, winter had 15 species, and the monsoon season saw the fewest, with just 8 species recorded. Details on the taxonomy of Rotifers and their relationship to surface water pollution

Sitre, Shahsikant 2014, The world's aquatic ecosystems encompass a large area, and the creatures that live in them are influenced by its physicochemical properties. The presence and quantity of zooplankton are determined by productivity, which is regulated by abiotic environmental conditions and the availability of nutrients in the water body.

Pandey 2000, The chemical composition and cyanobacterial diversity of a tropical fresh water reservoir, Udai Sagar Lake in Udaipur, Rajasthan, were studied. The lake's four substations were sampled at monthly intervals. 22 of the 46 species identified were N2-fixing (both heterocystous and unicellular diazotrophs). The nutritional level of ambient water influenced both species diversity and individual species dominance. The decline in cyanobacterial diversity, particularly in regions receiving urban-industrial effluents, has long-term ecological ramifications.

C.G.Montana's (2011), In the 2001-2007, monthly studies of local fisheries were done at five major landing points on the Ganges in Bhagalpur, India. The capture was dominated by fish of various sizes with largely periodic-type life-history tactics, including many catfishes and carps. During the research, the average yearly yield (total mean monthly catch in units of biomass) was very varied but trended downward. The use of analytical coordination indicated relationships among collection diversity and hydrological phases.

Overall yields in this stretch of the Ganges tended to be highest when the annual flood pulse was prolonged for a longer period of time.

Manoharan, D. (2016), Correlation analysis was performed among the physical, chemical, and nutrient characteristics of three freshwater temple ponds at Thirupparankundram, near Madurai, for the observation of monthly variations in 15 surface water parameters from September 2009 to August 2012. A variety of correlations were discovered between the various physical, chemical, and nutritional characteristics. This link between physical, chemical, and nutritional characteristics was discovered to be altered by seasonal and altitudinal fluctuations.

Veerendra Babu (2018), The previous research seems to be on the ecological studies of Alisagar lake in the Nizamabad District of Telangana. Water samples were collected over a two-year period (June 2014 to May 2016) to analyse water quality. Throughout the examination, the lake water was alkaline. Throughout the experiment, high concentrations of dissolved oxygen, carbonates, and low concentrations of chlorides, bicarbonates, total hardness, and organic matter were measured. In the lake, four types of phytoplankton were discovered. Diatoms were the most diverse and prominent of the four groupings, followed by Chlorophyceae. Diatom development was aided by low temperatures, high dissolved oxygen, and silica levels. Diatom growth was highest in the winter and lowest in the summer and wet season. Temperature, bicarbonates, nitrates, phosphates, and organic matter were all shown to be strongly attributable to Chlorophyceae.

Murkute, Vaishali Babanrao (2016), The three freshwater ponds, Kalikar, Lendra, and Barai, are located in three separate regions of Bramhapuri town and have varying trophic statuses. The current work looks at the variety of macrophytes in three separate ponds. The research was carried out over a period of 24 months, from June 2005 to May 2007, during several rent seasons. According to the study, a total of 24 species of macrophytes were recorded from the littoral and sublittoral zones of the ponds, and the species are categorized as free floating, submerged, marginal, and emergence.

E.Sedamkar(2003), The physico-chemical characteristics, with specific reference to phytoplanktons, were tested in two standing fresh waterbodies of Gulbarga, one of which is the Jagat tank, which is located in the heart of Gulbarga city and is extensively contaminated by municipal sewage input and has become eutrophic. Because it is close to Pala settlement, the Pala tank is less contaminated and mesotrophic. From July 1996 to June 1998, researchers evaluated numerous physicochemical characteristics and their interactions with phytoplanktonic groupings. The results show that high levels of temperature, pH, total alkalinity, oxygen, chloride, nitrate, phosphate, total hardness, total dissolved solids, and biochemical oxygen demand have an effect on the growth of phytoplanktonic groups in the Jagat tank. Due to a lack of nutrients, production in the mesotrophic Pala tank was quite poor. Correlations and inter-correlations between physicochemical factors and phytoplanktonic groupings were also established.

Mani Rahasya Mishra (2011), The current study focuses on the water quality of Rani Lake in Rewa, Madhya Pradesh, India, in order to analyze the effects of human activities.

Over a two-year period (January 2008 to December 2009), water samples were taken monthly from the lake's six sampling locations for examination of various physicochemical properties. The results showed that electrical conductivity (422mg/l), turbidity (34.9 mg/l), total dissolved solids (674.25 mg/l), total hardness (175.58 mg/l), alkalinity (215.16 mg/l), chlorides (81.62 mg/l), biological oxygen demand (15.47 mg/l), chemical oxygen demand (55.74 mg/l), phosphate (3.35 mg/l), and nitrate (1.46 mg/l) The investigation found that the water had a low Dissolved Oxygen level compared to the permitted criteria, and that it was alkaline and hard. The water quality metrics varied seasonally. The studies clearly indicate that such a reservoir was contaminated and eutrophic as a result of sewage flow as well as other human activities.

Rita Páez (2001), research on the limnological aspects of Tulé Reservoir, a large and shallow reservoir in western Venezuela. This reservoir has a poor water transparency and is polymictic. Nitrogen levels were high, but phytoplankton production was low. The low orthophosphate concentrations over the majority of the sample time, as well as the frequent mixing and resuspension of sediments, may explain the phytoplankton productivity results. The Colony-forming Units/ml of heterotrophic bacteria ranged between 1651.67 to 4365.00. The crustacean zooplankton community's diversity composition was comparable to those of other neotropical eutrophic reservoirs.

Manthan Tailor (2013), Two ponds in Vadodara City, Gujarat, were chosen for research of the chemical qualities of their water in this study. Human dwellings bordered both ponds roughly evenly. Mahadev Pond had a man-made barrier, but Bapod Pond had a natural limit with an inward slope. Dissolved Oxygen, pH, Chloride, Total Hardness, Phosphate, and Nitrate were the chemical parameters chosen for analysis. The dissolved oxygen content of the waters in both ponds was determined to be enough to maintain healthy aquatic life forms. The findings revealed that the pH of the water in both ponds was alkaline throughout the research period and was identical in both ponds. Dissolved Oxygen, pH, and Total Hardness were nearly same in both ponds. In the case of chloride, nitrate, and phosphorus, the Bapod Pond, which has a natural limit, had a far higher concentration than the Mahadev Pond. The investigation also revealed that the created perimeter of Mahadev Pond was beneficial in limiting the entry of water soluble ions carried by runoff from adjacent regions. The greater amounts of Chloride, Phosphate, and Nitrate can be linked to the natural border, which allows uncontrolled sewage input from neighbouring living things.

Onkar Singh Brraich (2019), The current study investigates the variety, quantity, and composition of zooplankton in the Ropar wetland. From October 2015 to September 2017, a total of 17 taxa of zooplankton population were recorded and classified into 5 distinct categories, namely Protozoa, Rotifera, Cladocera, Copepoda, and Ostracoda, at all locations. Protozoa and Rotifera were the most numerous groupings, each with six genera. Summer season had the largest density of zooplankton at all sites and the lowest diversity during monsoon season. The diversity indices were found to be highest in the two stations when compared with other stations, indicating that the wetland is moderately polluted because the Shannon-W eaver diversity index for zooplankton is more than two in various seasons. This indicates that this wetland receives contamination from a variety of sources but has a modest impact. The association of zooplankton population with several physicochemical parameters was also evaluated, which revealed a negative correlation with dissolved oxygen (DO) and free CO_2 at all locations, as well as total dissolved solids (TDS).

Sitaram Raut, Kakasaheb (2011), This research examines the water quality of Ravivar Peth Lake in Beed District, Marathwada Region, India. Physicochemical properties were researched and assessed from January to December of 2004. Seasonal fluctuations in the Ravivar Peth Lake were detected at three separate sample locations. These investigations looked at conductivity, pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Nitrate, Sulphate, and Phosphate. The findings revealed that the state of this lake in different seasons showed changes in physico-chemical parameters as well as the lake's pollution status.

Ani Chijioke(2016), The water qualities of three rivers (Asu, Ebonyi and Cross) were evaluated for these physicochemical parameters: transparency, flow rate, depth, temperature, conductivity, total dissolved solid (TDS), pH, dissolved oxygen (DO), phosphate (PO_4^-) and nitrate (NO_3^-) for 12 months (August 2014 – July 2015). The results showed variations in the water quality parameters among the rivers. Temperature, conductivity and TDS were highest in Asu River with mean values of 30.23 ^{0}C, 88 µS/cm and 42.58 mg/L, respectively. The mean values of pH varied from 7.0 to 6.56 with the highest value (7.0) recorded in Ebonyi River and the lowest value (6.56) recorded in Mid-cross River. The mean value of DO was highest (5.8 m/Ll) in Mid-cross River and lowest (4.9 mg/L) in Asu River.

Chijioke, Ani (2016), For a 12-month period (August 2014 – July 2015), the water qualities of three rivers (Asu, Ebonyi, and Cross) were analysed for the following physicochemical parameters: transparency, flow rate, depth, temperature, conductivity, total dissolved solid (TDS), pH, dissolved oxygen (DO), phosphate (PO4-), and nitrate (NO3 -). The results revealed differences in the water quality indicators between the rivers. The Asu River has the highest mean temperature, conductivity, and TDS readings, with mean values of 30.23 0C, 88 S/cm, and 42.58 mg/L, respectively. The mean pH values ranged from 7.0 to 6.56, with the highest (7.0) reported in the Ebonyi River and the lowest (6.56) recorded in the Mid-cross River. The mean value of DO in the Mid-cross River was the greatest (5.8 m/Ll) and the lowest (4.9 mg/L) in the Asu River. The Asu River had the lowest mean values of transparency, flow rate, and depth, while the Mid-cross River had the greatest mean value of transparency (0.5 m), and the Ebonyi River had the highest mean value of flow rate (1.48 m). Variations in nutrient mean values in water revealed that PO4 - (0.28 mg/L) and N03 - (0.40 mg/L) were the greatest in Asu River. The Ebonyi River had the lowest PO4- value (0.17 mg/L), whereas the Mid-Cross River had the highest NO3- value. Temperature, DO, Flow rate, and PO4- variations were not substantially different (P > 0.05), although conductivity, TDS, and transparency were (P 0.05). Most of the reported water parameters are within the acceptable range of regulatory criteria for rivers.

A.C. Nzeagwu (2017), Between February 2015 and January 2016, the physicochemical characteristics of three fish ponds at Michael Okpara University of Agriculture, Umudike, were examined to determine their suitability for optimal fish productivity. The following values were obtained: water temperature (24.1 - 34.0 oC), depth (52.0 - 115.0 cm), transparency (30.4 - 38.2 cm), pH (6.3 - 10.8), conductivity (44.0 – 190.0 S/cm), Total Dissolved Solids (35.1 - 98.0 mg/l), Dissolved Oxygen (3.7 - 5.1 mg/l), Biochemical Oxygen Demand (1.3 - 2.8 mg/l), nitrate (1 Except for pH, all of the phyisco-chemical parameters examined were within the NESREA permissible range. Previous research revealed that the depth (water level) was insufficient. Except for pH and depth, the water quality variables examined in the fish ponds were found to be appropriate for optimal fish productivity (water level).

Sudhir Bhandarkar (2017), this species is categorised as Least Concerned, however it is declining at an alarming rate. The Gondia district, which borders Chhattisgarh, is densely forested and home to a variety of flora and animals. According to the studies that were conducted, the populations have substantially fallen. The current study may be the first record of an Indian flying fox in Baghnadi (Chhattisgarh), near Gondia in eastern Maharashtra. The observation revealed that the roosting place is secure and that no unusual threats were discovered.

Shinde, V.D. (2007), Flouride is a trace element that humans require in minute amounts. Study had been carried out to determine the fluoride concentration of ground water. 30 ground water samples from the Hingoli area were collected. Fluoride concentrations in drinking water from hand pumps range from 0.2 mg/L to 2.3 mg/L in the Hingoli district. The fluoride concentration of several hand pumps drinking water in the Hingoli region is documented in this research, as well as its effect on school-aged children and individuals of various ages.

S.P. Chavan (2006), Lotic and lentic ecosystem, Yeladari Siddheshwar, Vishnupuri (Shankar Sagar), Niwli, Majalgaon are local and global irrigation reservoirs, Icthyo-biodiversity are plentiful in the existing aquatic resources. Among many critically endangered and unusual aquatic organisms in Marathwada, Mastacembalus armatus has a high market value as a nutritious fish, so it is removed from its natural habitat without regard for its breeding season, catch size, mesh size of the net, breeding habit, or fecundity.

N Busch, Wolf-Dieter (2011), To identify aquatic habitat and assess habitat deterioration in Lake Ontario, a habitat categorization system was utilized. Data on anthropogenic biological, chemical, and physical alterations were scattered, spotty, and fragmented. The Delphi method was used to assess the degree of functional habitat damage in 29 habitats. The severity of the ecological damage and its persistence were the criterion for the impairments. Each habitat's functional degradation was averaged and multiplied by the estimated areal share of that habitat in the ecosystem. The ecological health of Lake Ontario has deteriorated by 58%. Anthropogenic pressures from biological, chemical, and physical sources were approximately equally responsible for the impairments.

Suthers, Iain (2006), During February 1993, zooplankton size and larval fish assemblages were examined across sites and the free stream of Cato Reef' island wake in the south Coral Sea. There was no difference in total abundance or larval fish variety between the lee side and the wake. Myctophids and gonostomatids dominated the capture (85%), with reef-associated taxonomic contributing for 2% of the total. There were approximately 25% less reef fish larvae in the wake than in the free stream. The majority of the ichthyoplankton (58 families) were linked with the thermocline (ca. 50 m depth) during the day and night. The study discovered that steeper slopes of the normalized biomass size spectrum were substantially connected with a greater abundance of larval myctophids and gonostomatids, probably due to fish seeking fertile regions and upper elimination of large zooplankton.

Cózar, Andrés (2003), The biomass anomalies in the plankton size spectra of two subtropical shallow lakes were measured by assuming the size spectrum's classical observed generalities. The allocation of spectral abnormalities was influenced by three major functional size ranges during a seasonal cycle: microbial food web, nanoplankton–microplankton autotrophs, and herbivorous microorganisms. Inspite of normal spectrum undulation caused by self-organization (well-defined trophic positions, limnetic–benthic interaction), biomass inconsistencies were an indicative of the major interactions disrupting the steady state. The mechanisms that caused the abnormalities worked together at the ecological and micro level.

Chapter3

Study Area, Material and Method

Study Area

The hydro-biological research is being conducted for the Makroda Reservoir, which is located in the Northwestern portion of the Malwa area in Guna district, which is located in Madhya Pradesh's south Gwalior division. Makroda Reservoir is located around 25 kilometres from the Guna District headquarters and approximately 255 kilometres from Bhopal. It is built over the Negri River, a tributary of the Parvati River. It is located at latitude 24º43'30''N and longitude 77º16'00''E. The Makroda Reservoir is accessible by all-weather motorable road from NH-46, the nearest railway station is Guna Railway Station, and Bhopal Airport is around 199 kilometres away. It is located in the Chambal Betwa Basin and serves water for irrigation and water supply in the local community. Figure 3.1 illustrates a synoptic overview of Makroda Reservoir. Farmers and fishermen also utilized the water for pisciculture. The fundamental information about Makroda Reservoir is needed for hydro-biological investigations, and data is collected in accordance with study criteria even while keeping archives to ensure reliable future studies.

Basic data of Makroda Reservoir

Salient features

A. HYDROLOGY

a. Catchment area : 174.77 km2

b. Mean annual rainfall : 1054.46 mm

c. Maximum annual rainfall : 1687.57 mm

d. Minimum annual rainfall : 376.93 mm

e. Maximum flood discharge : 2554 cumec (Revised) 598.41 cumec (Original)

B. RESERVOIR

a. Gross storage capacity at FRL : 46.57 Mm3

b. Dead storage at DSL : 5.61 Mm3

c. Live storage capacity : 40.96 Mm3

d. FRL : 459.33 m

e. MWL : 461.16 m (Original) 462.12 m (Revised)

f. LSL/DSL/ MDDL : 461.18 m

g. Area of submergence at FRL : 8.47 km2

h. Top level of Dam : 462.99 m (original) 463.99 m with 1 m parapet wall (Revised)

C. MAIN DAM

a) Type : Earthen Dam

b) Total length of dam : 1551.40 m

c) Maximum height of Main dam : 25.48 m above River bed level (with out parapet wall Height)

d) Top width : 5 m

D. SPILLWAY

a. Type : Ungated Flush Bar spillway.

b. Location : Right Flank of Subsidary Dam

c. Length of spillway : 182.88 m

d. Crest elevation of spillway : 459.33 m

E. IRRIGATION OUTLET

Outlet for Feeder Channel (On right bank of river and left side of subsidiary dam)

a. Location : Subsidiary Dam

b. Number and Size : 2 no vents of size 1.83 m (width) x 1.83 m (height)

c. Invert level : 450.18 m

d. Outlet Discharge : 12.74 cumec

F. GATES & HOISTS OF IRRIGATION

Outlet for Feeder Channel

a. Location: Subsidiary Dam

b. size : 1 no gate with size of 4.00 m (width) x 2.00 m (height)

c. Sill Level: 450.18 m

d. operation arrangement : Manually M. S. Rod Type (Vertical Lift)

e. Maximum vertical lift of the gate: 2.00 m

Head Sluice LBC

a. Location: RD 127 m

b. size : 1 no gate with size of 1.20 m (width) x 1.83 m (height)

c. Sill Level: 357.83 m

d. operation arrangement : Manually M. S. Rod Type

e. Maximum vertical lift of the gate : 1.83 m

G. DISTRIBUTION SYSTEM

a. Total length of Feeder Channel: 16 Km

b. Sill level of head regulator: 450.18 m

c. Bed Width of Canal at head : 5.0 m

d. Bed level of Canal at head: 450.18 m

3.2 Methodology & Material

3.2.1 Sampling and Water Quality Monitoring

Makroda Reservoir was divided into three zones for the context of this research. One sample location were identified for each zone, denoted by the letters M1, M2, and

M3, respectively. The sample locations were chosen to cover as much of the Reservoir as conceivable. Reservoir's physicochemical qualities are vital in the movement of materials and the development of microorganisms in water. As a result, physico-chemical evaluation of water is the most important component of establishing the quality of lentic water habitats for optimal utilisation to human and other animal intake, agricultural purposes, and plants. From November 2018 to October 2019, the findings of physicochemical studies of water samples were documented for a year. The primary objective of physicochemical water analysis is to determine the condition of the reservoir. Water samples were collected monthly in the morning hours from three separate sampling locations for physicochemical investigations from November 2018 to October 2019. The samples were collected in clean 5 gallon plastic cans. The pH, temperature, and humidity were measured on the spot, and rainfall data were obtained from the M.P. Water Resources Department, while other parameters were calculated in the laboratory. The physicochemical parameters are divided into two groups for convenience of presentation: Transparency, temperature, turbidity, and conductivity are examples of physical parameters in Group I. Group II includes chemical parameters such as pH, Dissolved Oxygen, Alkalinity, Hardness, Chlorides, Phosphate, Nitrates, COD, BOD, Sulphate, Nitrites, Calcium, Magnesium, and Ammonia.

Physical Properties

Colour – Refill the fitted Nessler cylinder to the 50 mL mark with water and compare the colour of the samples against guidelines. Consider staring vertically downward through the cylinder towards a white surface angled at such an angle that light is reflected upwards through the liquid column. If the turbidity has not been cleared, the colour should be reported as 'apparent colour.' If the colour exceeds 70 units, dilute the sample with distilled water until it is within the standard range. Remove turbidity from the sample by centrifuging it until the supernatant liquid is clear. To ensure that turbidity has been eliminated, compare the centrifuged sample to distilled water. Compare the sample to the standards if it is apparent.

Color units should be calculated as follows.

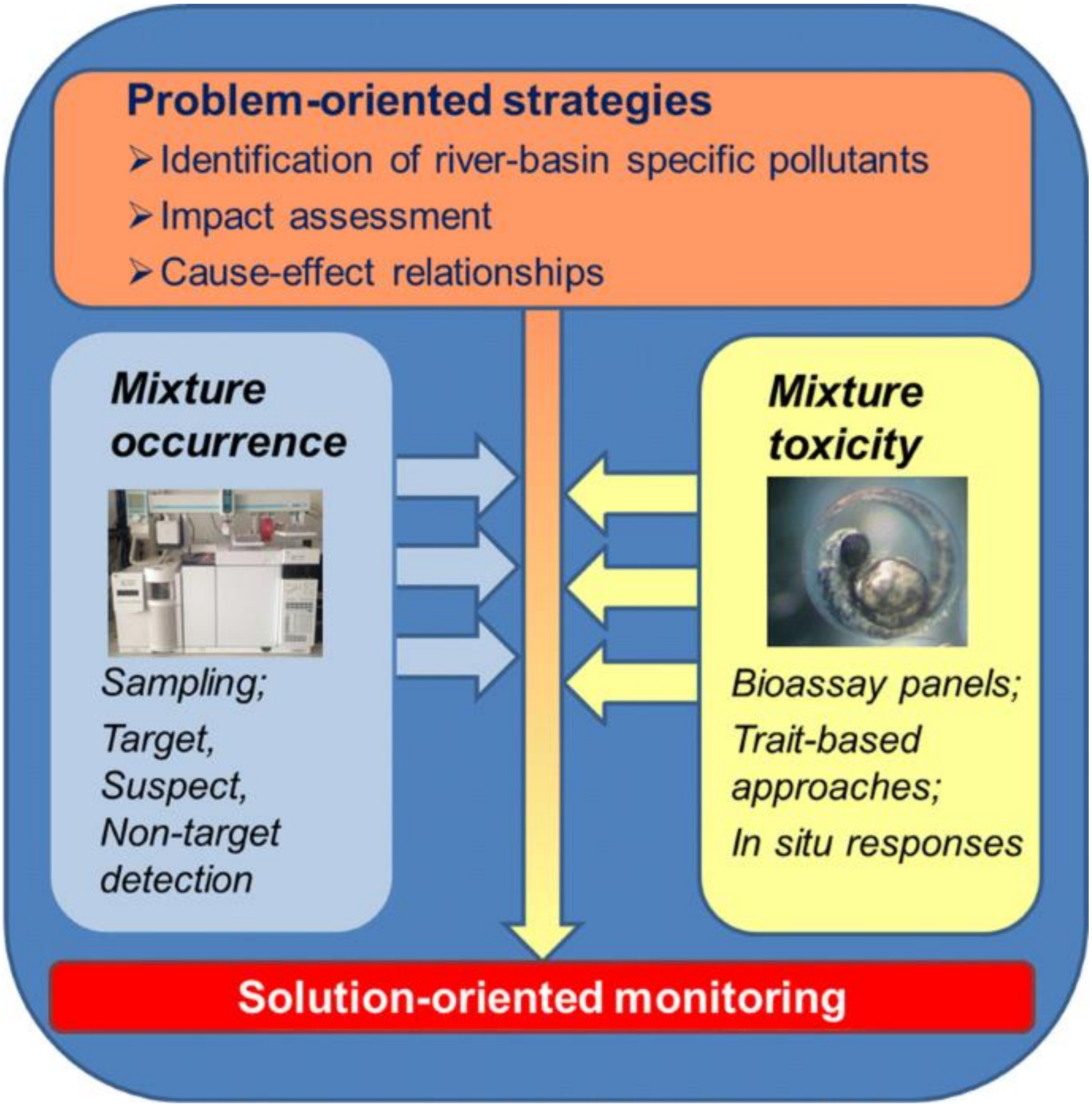
Color units/Hazen Units = V/50A

Where A= Estimated color of diluted sample, V= Volume in ml of sample taken for dilution.

Water transparency – It defines the depth in which sunlight can enter into the water and hence the depth in which the plants may grow. Turbidity is measured in depth with standard measure of water transparency. It is measured with an Indicator disc, a round white (or black and white) plate that is dropped into the water until it is no longer visible.

Turbidity - Turbidity is the lowering in transparency caused by the presence of particulate matter in the water, such as clay or silt, organic materials, plankton, or other tiny microbes. Light is dispersed and absorbed as a result of this, light transmitted in straight lines through the entire sample. The measurements are in nephelometric turbidity units (NTU). The approach is suitable to drinking, surface, and saline waters with turbidities ranging from 0 to 40 NTU. Dilution of the sample might result in higher values. The nephelometric technique compares the intensity of light dispersed by the sample under certain conditions to the intensity of light.

Water conductivity- Pure water is not an excellent good conductor of electricity. Normal distilled water has a conductivity of roughly 10 x 10-6 W-1*m-1 (20 dS/m) when in equilibrium with carbon dioxide in the air. Because electrical current is carried by ions in solution, conductivity rises as ion concentration increases. As a result, conductivity rises as ionic species dissolve in water. Water is a substance's where conductivity is described as "the capacity or power to conduct or convey heat, electricity, or sound." Its SI units are Siemens per metre [S/m], while its US customary units are millimhos per centimetre [mmho/cm]. Its symbol is either k or s.



Electrical Conductivity and TDS- Total Dissolved Solids, or TDS, is a measure of the total ions in solution. EC is a measure of a solution's ionic activity in termsability to transfer current. TDS and EC are relatively equivalent in dilute solution. The TDS of a water sample may be determined using the following equation based on the measured EC value:

TDS (mg/l) = 0.5 x EC (dS/m or mmho/cm) or = 0.5 * 1000 x EC (mS/cm)

The above equation can also verified the suitability of water chemical analyses but it does not apply on waste water.

The proximity of the solution ions to each other depresses their activity and hence their capacity to transfer current as the solution gets more concentrated (TDS > 1000 mg/l, EC > 2000 ms/cm), despite the fact that the physical quantity of dissolved solids is unaffected. At high TDS levels, the TDS/EC ratio rises, and the relationship tends to TDS = 0.9 x EC. The above-mentioned connection should not be employed in these instances, and each sample should be classified independently. For agricultural and irrigation water, the values for EC and TDS are connected and may be translated with an accuracy of around 10% using the following equation:

TDS (mg/l) = 640 x EC (ds/m or mmho/cm).

Chemical Properties

pH- The pH of water indicates how acidic or basic it is. The scale runs from 0 to 14, with 7 being neutral. A pH less than 7 implies acidity, whereas a pH greater than 7 suggests baseness. The pH of water is an extremely essential indicator of water quality. The pH of water indicates how acidic or basic it is. The scale runs from 0 to

14, with 7 being neutral. A pH less than 7 implies acidity, whereas a pH greater than 7 suggests baseness. The pH of water is really a measure of the relative number of free hydrogen and hydroxyl ions. Water with a higher concentration of free hydrogen ions is acidic, whereas water with a higher concentration of free hydroxyl ions is basic. Because chemicals in water may influence pH, pH is a significant indication of chemically changing water. pH is expressed in "logarithmic units." Each value reflects a 10-fold increase or decrease in the acidity/basicity of the water. Water with a pH of 5 is ten times as acidic as water with a pH of 6. The solubility and biological availability of chemical components are determined by the pH of water.

Dissolved Oxygen- Another typical test is dissolved oxygen (DO), which is a measure of how much oxygen is dissolved in the water - DO may tell us a lot about the quality of the water. Although water molecules include one oxygen atom, this oxygen is insufficient for aquatic species living in natural waterways. Water really dissolves a little quantity of oxygen, up to roughly ten molecules of oxygen per million of water. Oxygen enters a stream mostly from the atmosphere, but also via groundwater discharge in locations where groundwater discharge into streams accounts for a significant fraction of stream-flow. This dissolved oxygen is breathed in by fish and zooplankton and is required for survival. Cold water has the ability to store more dissolved oxygen than warm water. When the water temperature is low in the winter and early spring, the dissolved oxygen content is high. When the water temperature is high in the summer and fall, the dissolved-oxygen content is frequently lower. Because dissolved oxygen in surface water is utilised by all types of aquatic life, it is commonly used to assess the "health" of Reservoirs and streams. The atmosphere and groundwater discharge both contribute to the entry of oxygen into a stream.

Alkalinity- A water buffering capacity can measure the water body's ability to neutralize acids and bases and so maintain a relatively steady pH level. Alkalinity is a feature of water that is reliant on the presence of specific compounds in the water, such as bicarbonates, carbonates, and hydroxides. In simpler terms, water with a high alkalinity would see less of a change in its own acidity when acidic water is added into the water body, such as acid rain or an acid spill. Alkalinity can be beneficial to a Reservoir's health and well-being. The ecology and species that live in the Reservoir developed in slow-changing water bodies. Water bodies were not vulnerable to chemical spills or acid rain prior to the arrival of humans. The pH and aquatic features of a Reservoir most likely did not alter significantly over the short period, which suited the Reservoir's fish perfectly. The alkalinity of a surface water body, such as a Reservoir, is mostly derived from the rocks and ground surrounding the Reservoir. Precipitation falls in the Reservoir's catchment, and the majority of the water entering the Reservoir is runoff from the terrain.

If the terrain contains rocks like limestone, runoff picks up compounds like calcium carbonate ($CaCO_3$), which elevates the pH and alkalinity of the water. Reservoirs will have a lower alkalinity in locations where the geology contains a lot of granite, for example. However, a pond in the suburbs, even in a granite-heavy location, may have significant alkalinity due to runoff from residences. To determine alkalinity, take a water sample and add acid to it while monitoring the pH of the water as the acid is added. After taking an initial pH reading of the water, little quantities of acid are added in increments, the water is agitated, and the pH is measured again. Initially, the acid added will be neutralized by water-soluble molecules such as bicarbonates. The bicarbonates are depleted when additional acid is introduced and neutralized by the acid. Any acid added to the water beyond this point will drop the pH linearly, and the scientist will be able to detect this reflection point by watching a line chart of the quantity of acid supplied to the water and the consequent pH. The point at which the change in pH line becomes linear is used to calculate the alkalinity of the water.

Total Hardness- Water hardness is defined scientifically as the quantity of dissolved calcium and magnesium in water. In layman's terms, water hardness can be detected when your hands remain greasy after washing with soap and water, or when your drinking glasses at home become less than crystal clear. Calcium and magnesium compounds, as well as a variety of other metals, create hardness. Waters with calcium carbonate concentrations of 0 to 60 mg/L (milligrammes per litre) are classed as soft; 61 to 120 mg/L as moderately hard; 121 to 180 mg/L as hard; and greater than 180 mg/L as quite hard. Water hardness is a concern for groundwater systems because when water moves through soil and rock, it dissolves small amounts of naturally existing minerals and transports them into the groundwater supply.

Chloride- Chloride is a natural component found in most freshwater waters. This is most usually observed as a constituent with saltwater (sodium chloride) or, in such circumstances, in association with potassium or calcium. Chlorides are abundant in nature as sodium (NaCl), potassium (KCl), and calcium salts ($CaCl_2$). The chloride anion's taste threshold in water is affected by the accompanying cation. Sodium chloride and calcium chloride taste thresholds in water are in the 200–300 mg/litre range. Coffee's flavour is influenced by water with a chloride content of 400 mg/litre as sodium chloride or 530 mg/litre as calcium chloride. Caustic soda, chlorine, sodium chlorite, and sodium hypochlorite are all manufactured using sodium chloride. Fertilizers are manufactured using potassium chloride. Silver nitrate titration with chromate indicator, mercury(II) nitrate titration with diphenylcarbazone indicator, potentiometric titration with silver nitrate, automated iron(III) mercury(II) thiocyanate colorimetry, chloride ion-selective electrode, silver colorimetry, and ion chromatography are all suitable analytical techniques for chloride in water. The detection limits for colorimetry range from 50 g/litre to 5 mg/litre for titration.

Free Carbon dioxide – The concept "free carbon dioxide" means the carbon dioxide which is present in the environment. It may be found in water as a dissolved gas. Surface water typically contains less than 10 ppm of free carbon dioxide, although certain ground fluids may contain more. Carbon dioxide dissolves in water. CO_2 gas (CO) is present in the air at a concentration of 0.03 percent by volume and 0.05 percent by weight. Mostly all natural waters include some carbon dioxide that they acquire in a variety of ways. Rain absorbs some of this gas because it falls through air. If rainwater that is moderately acidic enters to soil, it will absorb additional amounts of carbon dioxide if it flows across decaying flora. At the same time, carbonic acid is formed from carbon dioxide. When the water travels through limestone formations, the carbonic acid in the water reacts with the limestone to generate soluble calcium bicarbonate. Carbonic acid is largely neutralised during this procedure. However, no similar reaction occurs when water travels through rock formations such as granite. The carbonic acid remains unneutralized. It remains as carbonic acid until it is pulled to the surface, that can cause deterioration if still not neutralised. The most basic method for removing carbonic acid is to run the water through a tank filled with limestone particles.

Phosphate- Phosphorus is a necessary ingredient for plant growth, but it often in water can accelerate eutrophication (a decrease in dissolved oxygen in water bodies caused by an increase in mineral and organic nutrients). Phosphates are compounds that include the element phosphorous and have an impact on water quality by producing excessive algal growth. Phosphates in water nourish algae, which grow uncontrollably in aquatic environments, causing imbalances that kill other living forms and generate hazardous poisons. Phosphorus is a critical element required for plant and animal growth, and in Reservoir ecosystems it is the growth-limiting nutrient. It also serves as the backbone of the Kreb's Cycle and DNA. Phosphorus is frequently limited in well-oxygenated Reservoir waters, and low levels of phosphorus limit the productivity of freshwater systems. Phosphates are not hazardous to humans or animals unless they are present in extremely high concentrations.

Nitrates- Nitrate and nitrite are nitrogen cycle ions that occur naturally. For oxygenated environments, stable form of linked nitrogen is the nitrate ion ($NO3-$).

Although it is chemically inert, microbial activity can reduce its effectiveness. The nitrite ion contains nitrogen in a very unstable oxidation state (NO_2^-). Chemical and biological activities can further degrade or oxidize nitrite to become nitrate (ICAIR Life Systems, Inc., 1987). Nitrate is mostly used in inorganic fertilizers. It is also employed as an oxidizing agent and in the manufacture of explosives, and refined potassium nitrate is used in the creation of glass. Sodium nitrite is a food preservative that is normally found in processed meat. Nitrate is occasionally added to meals to act as a nitrite reservoir. Nitrates occur naturally in plants and are an important nutrient for them. Endogenous nitrate and nitrite formation occurs in animals, including humans. Nitrate is released in saliva, It is converted to nitrite by oral micro-flora. As a result of agricultural operations and waste water treatment, as well as the Nitrogenous waste oxidation in human and animal excreta, including septic tanks Rhizobium bacteria are also capable to generate nitrite Chemically in distribution pipes during nitrate-containing and oxygen-depleted drinking water stagnation in galvanised steel pipes, or if chloramination is used to provide a residual disinfectant and the process is not well regulated. Surface water nitrate concentrations are typically low (0–18 mg/l), but can reach dangerously high levels due to agricultural runoff, garbage dump runoff, or contamination with human or animal faeces.

COD- The Chemical Oxygen Demand (COD) is a measure of the quality of water and wastewater. The COD test is frequently used to measure the performance of water treatment plants. This test is based on the fact that in acidic circumstances, a powerful oxidizing agent may completely oxidize practically any organic substance to carbon dioxide. The quantity of oxygen used to chemically oxidize organic water pollutants to inorganic end products is referred to as the COD. Under acidic circumstances, the COD is frequently measured using a strong oxidant. The sample is treated with a known excess quantity of the oxidant. After the oxidation process is complete, the concentration of organics in the sample is estimated by measuring the quantity of oxidant left in the solution. Titration with an indicator solution is frequently used for this. COD is measured in milligrammes per litre of solution and represents the mass of oxygen used per litre of solution. The COD exam only takes about 2-3 hours.

BOD-The quantity of oxygen required by bacteria and other microorganisms when decomposing organic materials under oxygenated conditions is known to as Biochemical Oxygen Demand (BOD). Small quantities of oxygen, in the form of dissolved oxygen, can be found in a typical Reservoir or stream. Dissolved oxygen is an essential component of natural water bodies, sustaining aquatic life and the aesthetic qualities of streams and Reservoirs. The biochemical oxygen demand is a measurement of the breakdown of organic materials in water. Biological oxygen demand is simply a measure of how much oxygen is required to remove waste organic matter from water during the breakdown process by aerobic bacteria. Leaf and woody debris, dead plants and animals, animal manure, effluents from pulp and paper mills, wastewater treatment facilities, feedlots, and food-processing industries, failed septic systems and urban storm water runoff are all sources of biological oxygen demand. Phosphate pollution from American houses is one of the most major nutrients impacting BOD in aquatic systems, particularly in recent years. There are number authorized techniques for calculating biological oxygen demand. This approach examines the difference in dissolved oxygen from a sample over the course of five days. The initial DO concentration of a given volume of sample is recorded, and after a five-day incubation period at 20°C, the sample is withdrawn from the incubator and the final DO content is determined. The BOD value is again calculated using the depletion and sample size. DO measurements are typically expressed in parts per million (ppm). High BOD levels imply that more oxygen is required, indicating poor water quality. Low BOD levels indicate that less oxygen has been taken from water, implying that the water is typically purer.

Sulphur- Sulfates are the mixture of sulphur and oxygen that occur naturally in some soil and rock formations that include groundwater. Over time, the mineral dissolves and is discharged into groundwater. Sulfate minerals, like other minerals, can produce scale building in water pipes and may be linked with a bitter taste in water, which can have a laxative impact on people and young cattle. Sulfate can make it tough to clean garments. Hydrogen sulphide gas is naturally present in certain groundwater. It is generated by organic stuff dissolving subsurface deposits, such as decaying plant debris. Deep or shallow wells can penetrate surface water by springs, but the water quickly evaporates into the atmosphere. Hydrogen sulphide is frequently found in wells dug in shale or sandstone, or near coal, peat, or oil resources. Sulfur-reducing bacteria, which use sulphur as an energy source, are the principal producers of hydrogen sulphide. These bacteria use a chemical reaction to convert natural sulphates in water to hydrogen sulphide. Deep wells, plumbing systems, water softeners, and water heaters are examples of oxygen-deficient settings where sulfur-reducing bacteria thrive. The US Environmental Protection Agency regulates the quality of water delivered by public water systems (EPA). Sulfate is categorized under the Secondary Maximum Contaminant Level guidelines, which are focused on aesthetic considerations such as water taste, odour, and discoloration rather than health impacts. The sulphate standard in drinking water is 250 milligrammes per litre (mg/l), sometimes known as 250 parts per million (ppm).

Calcium- Studies have generally found hard water to have positive effects on the health of its drinkers. Several studies have reported that calcium and magnesium in drinking water have a dose-dependent protective effect when it comes to cardiovascular disease. Because of its buffering properties, calcium is a significant factor of water harness; it is employed as a pH stabilizer. Calcium occurs naturally in water; saltwater has roughly 400 ppm calcium. The natural presence of calcium in the earth's crust is one of the primary causes for its abundance in water. Rivers typically contain 1-2 ppm calcium, but in lime regions, calcium concentrations can reach 100 ppm. Calcium also improves the flavour of water. Water containing calcium carbonate at concentrations less than 60 mg/l is termed soft, 60–120 mg/l moderately hard, 120–180 mg/l hard, more than 180 mg/l very hard.

Potassium: The potassium content of freshwater is approximately 400 ppm. It accumulates but also, like a byproduct, mostly ends up into sediment. Potassium levels in rivers are typically about 2-3 ppm. This variance is mostly due to high potassium content in ocean basalts. Granite with a high calcium content can hold 2 to 3 % potassium. This element is mostly prevalent in water as K+ (aq) ions. 40K is a radioactive potassium isotope that occurs naturally. The natural concentration of seawater is around 4.5. 10-5 g/L. Potassium is found in a variety of minerals and can be dissolved by weathering processes. Potassium is found in several clay minerals. It eventually winds up in saltwater due to natural processes, where it mostly settles in sediments.Because of its high reactive power, elementary potassium is isolated from potassium chloride but has few applications. It is used in alloys as well as organic synthesis. Potassium is a dietary requirement for almost all organisms save a few bacteria since it is essential for nerve activity.Potassium is essential for plant development yet frequently hinders it. Before it dissolves in water, potassium from dead plant and animal material is frequently linked to clay minerals in soils. As a result, it is readily absorbed by plants once more. Ploughing may interfere with this natural process. As a result, potassium fertilisers are frequently widely used in agriculture soils. Plants contain around 2% potassium (dry mass) on average, although concentrations can range from 0.1% to 6.8%. Mosquito larvae have 0.5 to 0.6 percent potassium, while insects contain 0.6 to 0.9 percent potassium (dry mass). Because of their strong osmotic activity, potassium salts have the potential to damage plant cells.

Magnesium:- Magnesium is found in freshwater in concentrations of roughly 1300 ppm. It is the second most abundant cation found in oceans after sodium. Rivers have about 4 ppm of magnesium, marine algae have 6000-20,000 ppm, and oysters have 1200 ppm. The magnesium content in Dutch drinking water ranges between 1 and 5 milligrammes per litre. Water hardness is caused by magnesium and other alkali earth elements. Water with a high concentration of alkali earth ions is referred to as hard water, whereas water with a low concentration of these ions is referred to as soft water. Magnesium gets carried away from rocks and eventually ends up in water. Magnesium serves various functions, and as a result, it may wind up in water in a variety of ways. Magnesium may be found not just in seawater, but in rivers and rainwater, leading it to disseminate organically throughout the ecosystem. The human body has roughly 25 g of magnesium, 60 percent of which is found in the bones and 40 percent in muscles and other tissue. It is a nutritional element which is one of the micro components important for membrane function, nerve stimulant transmission, muscular contraction, protein building, and DNA replication in humans. Magnesium is found in numerous enzymes. Magnesium and calcium frequently conduct similar activities in the human body and are thus antagonistic.

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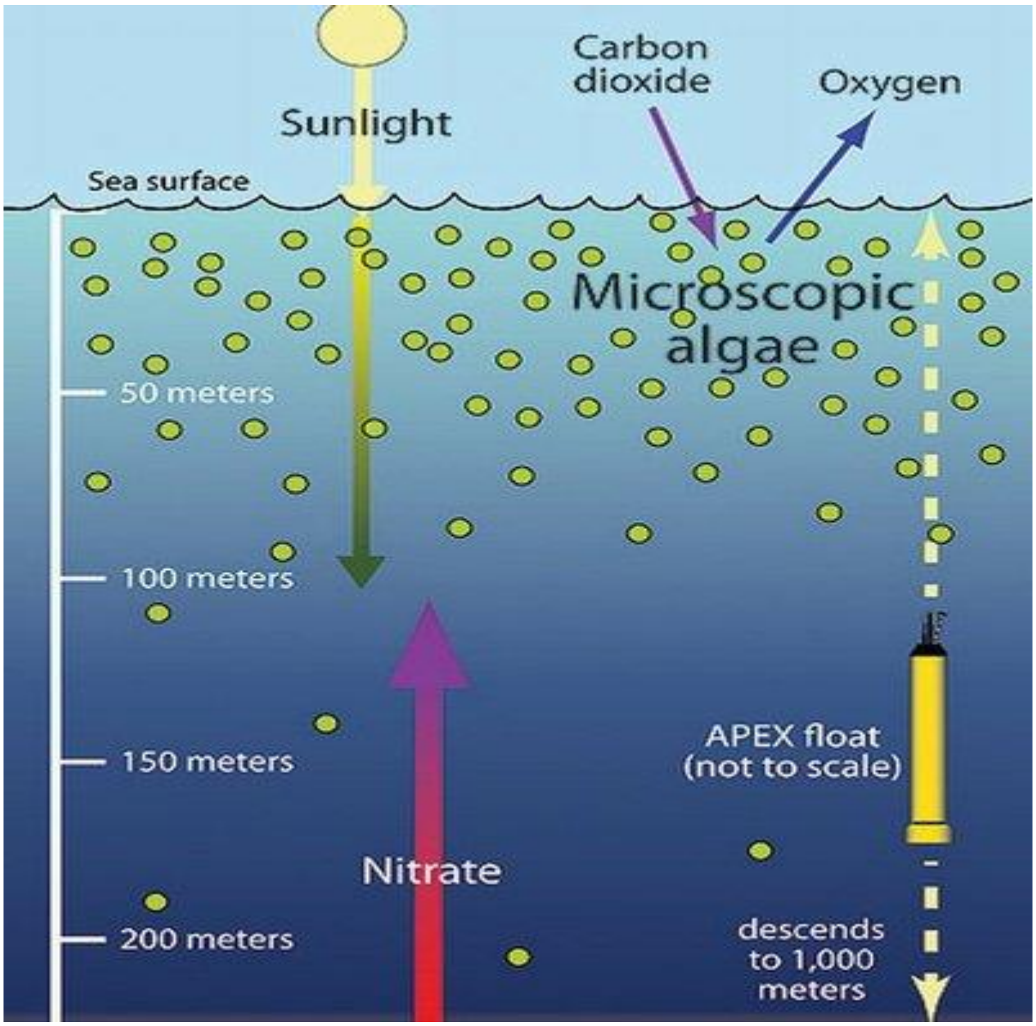
Ammonia- Water containing ammonia isn't really hazardous for humans, but it really is harmful to aquatic organisms. Unlike other forms of nitrogen, which can affect aquatic ecosystems indirectly by raising nutrient levels and encouraging algal growth in a process known as eutrophication, ammonia has direct harmful effects on aquatic environments. Ammonia is a colourless, smelly gaseous hydrogen-nitrogen chemical that is extremely soluble in water. It is a physiologically active chemical present in most bodies of water as a byproduct of the regular biological breakdown of nitrogenous organic materials. It may also infiltrate ground and surface waters as a result of the discharge of industrial process wastes including ammonia and fertilizers.

For more than 70 years, municipal treatment systems have employed ammonia to extend the efficiency of disinfection chlorine supplied to drinking water.

Biological Properties

Phytoplankton - Phytoplankton are microscopic organisms that live in aquatic environments, both salty and fresh. The term is derived from the Greek terms phyto (plant) and plankton (made to wander or drift). Some phytoplankton is bacterium, some is protist, and the majority is single-celled plants. Cyanobacteria, silica-encased diatoms, dinoflagellates, green algae, and chalk-coated coccolithophores are examples of frequent types. Phytoplankton, like land plants, contain chlorophyll to catch sunlight and employ photosynthesis to convert it into chemical energy. They expel oxygen while consuming carbon dioxide. Although all phytoplankton photosynthesize, some obtain excess energy by consuming other species. The abundance of carbon dioxide, sunshine, and nutrients is critical for phytoplankton development. Phytoplankton, like terrestrial plants, require different amounts of nutrients such as nitrate, phosphate, silicate, and calcium depending on the species. Many phytoplankton may absorb nitrogen and flourish in environments with low nitrate concentrations. They also need trace amounts of iron, which inhibits phytoplankton development in wide regions of the ocean due to reduced iron concentrations. Several elements that impact phytoplankton development rates include water temperature and salinity, water depth, wind, and the types of parasites that feed on phytoplankton. Whenever the conditions become adequate, phytoplankton concentrations can increase, a process known as a bloom. Blooms in the water can cover hundreds of square kilometres and can be seen in satellite photographs. A bloom can endure for many weeks, yet individual phytoplankton has a life span of only a few days. Phytoplankton are the major producers of the aquatic food chain, feeding everything including microscopic, animal-like zooplankton to inter whales. Small fish and invertebrates feed just on plant-like organisms, which are eventually consumed by large mammals. Phytoplankton is sometimes a sign of impending death or disease. Some phytoplankton species generate potent biotoxins, which are responsible for "red tides" or toxic algal blooms. Toxic blooms may harm marine creatures as well as people who consume polluted food. Phytoplankton also contributes to mass death in numerous ways. Dead phytoplankton settle to the ocean or Reservoir floor after a large bloom. The bacteria that breakdown phytoplankton reduce the oxygen in the water, smothering animal life and causing a dead zone. Phytoplankton are microscopic plankton that can photosynthesise but are found in oceans, seas, and rivers. They are an essential element of aquatic ecosystems. Phytoplankton can vary in size and form, and because they are photosynthesizing autotrophic animals, they exist on sunlight-exposed environments. Although every species are microscopic, phytoplankton may be seen in sufficient quantities as colourful patterns on the surface of bodies of water and where two currents combine due to the presence of chlorophyll. Since the Paleozoic Era, phytoplankton have been critical in managing carbon dioxide and oxygen levels in the Earth's atmosphere. However, phytoplankton are believed to be responsible for up to 85 % of the oxygen in the atmosphere. To survive, phytoplankton depend mostly on elements present in aquatic environments and Vitamin B. The presence of iron, phosphate, silicic acid, and nitrate is essential for aquatic conditions to maintain phytoplankton. Indeed, when certain macronutrients are deficient, there is a corresponding lack of phytoplankton. Because the term phytoplankton refers to a wide range of different photosynthesizing aquatic microorganisms (over 5000 species have been identified), various species are found in different environments; the most commonly studied genera are given below:



Coccolithophorids

Coccolithophorids are a kind of phytoplankton that has distinctive calcium carbonate plates known as coccoliths shown below in figure. Although this phytoplankton is an important microfossil, it is also a generator of dimethyl sulphide, which is regarded to be a possible mechanism for regulating climate change. It is believed that by increasing the quantity of these phytoplankton, the increased amount of dimethyl sulphide will be oxidised, resulting in sulphur dioxide and sulphate aerosols. These particles will act as cloud seed nuclei, increasing cloud coverage and sunlight reflection.

Cyanobacteria

Cyanobacteria are extremely tiny phytoplankton that live in less turbulent seas and may grow in conditions with few nutrients shown below in figure. Cyanobacterial species are incredibly varied and have been demonstrated to be particularly adaptable to changes in aquatic environments, displacing many other types of phytoplankton if water temperatures change or nutrients are scarce.

Diatoms

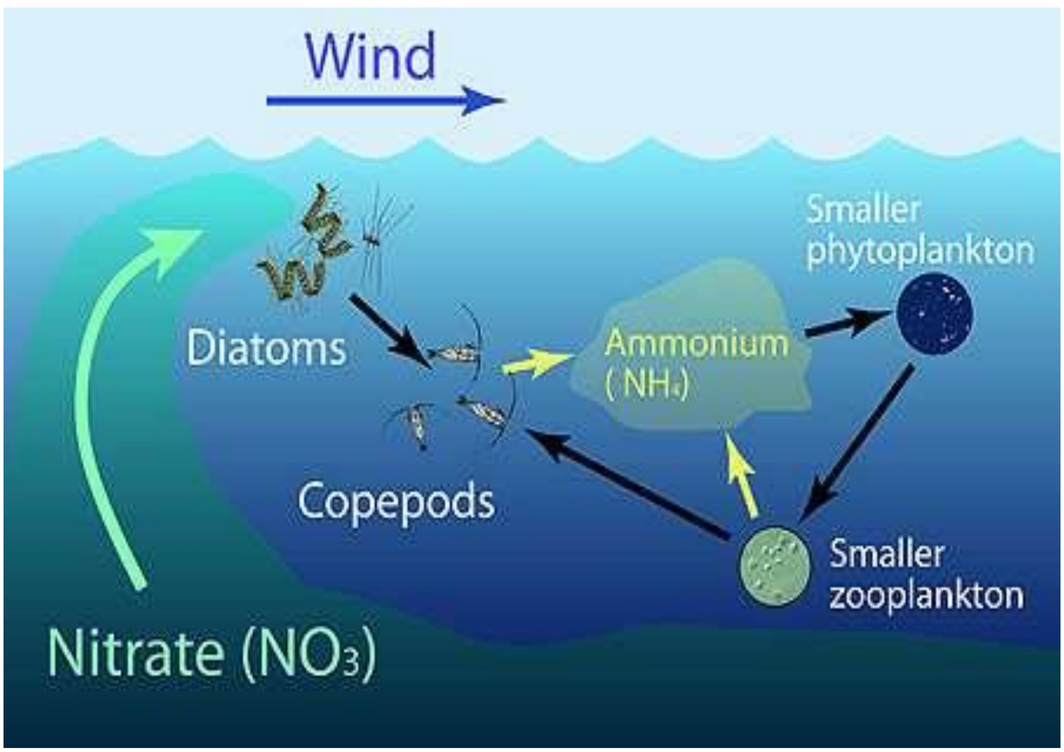
Diatoms are a kind of phytoplankton that, while being minute, reproduces quickly. Diatoms, which have a "bloom-and-bust" life cycle, can be used to assess water quality shown below in figure. Diatoms proliferate fast when nutrients reach the ocean's sunlit surfaces. This growth stops when the nutrients (i.e., silicon) are exhausted. Diatoms also make up a significant amount of the organic matter present in big bodies of water's silt.

Dinoflagellates

Dinoflagellates are a kind of phytoplankton that is commonly found in coral reef ecosystems and serves as a key food source for many organisms. Dinoflagellates are known to generate toxic algal blooms with a distinctive red hue, known as "red tide" (shown below). Such blooms are known to infect seafood, causing food poisoning in people if swallowed.

Zooplankton

Zooplanktons are heterotrophic plankton that varies in size from tiny creatures to giant species like jellyfish. Zooplankton may be found in enormous bodies of water such as the oceans and freshwater systems. Zooplanktons are creatures that drift and are an essential component of the food chain. There are two types of zooplankton. Temporary plankton comprises of planktonic eggs and larvae of benthos and nekton members; permanent plankton consists of all creatures that survive their whole life cycles in a floating form. While zooplanktons are frequently gathered by pulling fine-mesh nets across the water, this approach does not capture all species. Other creatures are too tiny to be caught in nets, while others can detect and avoid nets, and some species are too frail to withstand net collection and further processing in synthetic additives. Direct studies of zooplankton utilising diving, ROVs, or underwater have substantially advanced our understanding of vulnerable and/or quickly species.



Rotifers

Rotifers are a tiny (100 m to 30 mm) species of primarily aquatic animals named after the corona, a revolving, wheel-like structure covered with cilia at their proximal end are shown in the figure. Rotifers have three body parts: a head (which houses the corona), a trunk (which houses the organs), and a foot. Rotifers are normally free-swimming, planktonic animals, but their toes or foot extensions may release a sticky fluid that forms a holdfast to assist them attach to surfaces. Sensory organs in the shape of a bilobed brain and tiny eyespots near the corona are found in the head. Although their classification is still being disputed, current approach divides the rotifers into three groups: Bdelloidea, Monogononta, and Seisonidea. However, the group's categorization is continuously being revised as new phylogenetic evidence becomes available. The "spiny headed worms" that are now in the phylum Acanthocephala could be included into to this family in the past.

Cladocerans

Cladocerans have a high survival rate in aquatic sediments because their shells are made of chitin, a white semi-transparent sticky material. According to fossil evidence, the cladocerans' greatest evolutionary growth happened around 250 million years ago, during the late Paleozoic or early Mesozoic era. The classification of cladocerans, on the other hand, is still debatable. Most scientists acknowledge four suborders, ten to fifteen families, around 80 genera, and over 400 species.

Cladocerans are small invertebrates that resemble flat rounds. The majority range in size from 0.008 to 0.1 in (0.2–3 mm), while one species, Leptodora kindtii, can grow to be as long as 0.7 in (18 mm). Their bodies are not visibly segmented like those of other crustaceans, but three components may be distinguished: the head, the thorax, and the abdomen. The dome-shaped head has enormous complex eyes and five pairs of appendages. Among the appendages are two pairs of antennae: a tiny pair for sensory purposes and a bigger pair for swimming. The remaining three pairs of appendages are used to secure food. Although eight species are found in coastal environments, the majority of cladocerans are limited to freshwater settings. Cladocerans can be found in abundance in Reservoirs, ponds, slow-moving streams, and rivers. Some cladocerans are benthic (found on the bottom of a Reservoir, sea, or ocean), whereas others dwell on sediment or in vegetation almost everywhere there is water, including swamps, puddles, ditches, and ground water. On a daily basis, cladocerans travel up and down the water column. They often emerge at night and move to deeper depths during the day, although most humans do not identify cladocerans, they are critical for maintaining services that humans appreciate in many aquatic habitats. Cladocerans, in particular, are an important link in the food chain that allows aquatic ecosystems to maintain key fish species.

Copepods

Copepods are microscopic crustaceans that range in size from 0.2mm to around 20 cm depending on the species. They are found in both natural and man-made aquatic settings. According to research, the subclass contains the most multicellular creatures of any group on the planet. Over 12,500 species have been described so far in the category. They may be found in a variety of aquatic habitats (from freshwater to saltwater), where they can thrive as free-living creatures, symbionts, or parasites. Copepods are classified as planktonic or benthic depending on where they are located. They may be found in freshwater, estuaries, coastal lagoons, and cave habitats, and their distribution and abundance are heavily influenced by salinity, biotic and abiotic variables, temperature, and the quality/quantity of food supplies. Copepods have been found to play a significant part in the food chain in groundwater as well as a range of other ecosystems. They are widely employed as indicators of changing environmental circumstances while also giving information about historical conditions because to their affinity for specific environments and susceptibility to anthropogenic disruptions. Copepods are also classified as benthic or planktonic.

Ostracods

The most complex species studied in the field of micropalaeontology are ostracods. They are Metazoa and are members of the Phylum Arthropoda (as trilobites) and the Class Crustacea (as lobsters and crabs). The bilateral symmetry of the body shape of Ostracods is a key differentiating trait that they share with other arthropods. The paired body parts are encased in a dorsally hinged carapace made of low magnesium calcite, which is widely seen in the fossil record. Today, they may be found in practically every aquatic setting, including hot springs, caverns, within the water table, semi-terrestrial areas, and both fresh and salt water. The Ostracoda are classified into five Orders: the living Podocopida and Myodocopida, as well as the extinct Phosphatocopida, Leperditicopida, and Palaeocopida. The slightly flattened body, undifferentiated head, seven or fewer thoracic limbs, and bivalved, perforate shell lacking growth lines distinguish Ostracoda from other Crustacea. In many situations, differences in appendages and other soft components further classify live ostracods. Although extraordinarily well preserved fossil ostracods with soft parts intact have been discovered, they are extremely rare, and hence the morphological traits (see below) of the carapace have become crucial in fossil ostracod categorization. In general, freshwater ostracods have smooth, thin, poorly calcified simple bean-shaped carapaces. They eat a variety of foods, including diatoms, bacteria, and debris.

Fishes

The phrase fish refers to a broad range of species from various biological groups. It means a type of life rather than a taxonomic classification. Fish, being members of the phylum Chordata, share several characteristics with other species. Gill slits, a notochord, or skeletal supporting rod, a dorsal hollow nerve cord, and a tail are all present at some stage throughout the life cycle. Fishes are classified into five groups, each as unique as the four groups of recognized air-breathing creatures (amphibians, reptiles, birds, and mammals). Freshwater fish comprise for one-fourth of all vertebrates on the planet and provide essential products and services, yet they are increasingly threatened by human activity. A new measure, Cumulative Change in Biodiversity Facets, shows significant changes in biodiversity in more than half of the world's rivers, spanning more than 40% of the world's continental area and more than 37% of the world's river length, but only 14% of the world's surface. Rivers nowadays are increasingly similar to one another, with more fish species, more diversified morphologies, and longer evolutionary histories. Changes in biodiversity were mostly caused by river fragmentation and non-native species in subtropical rivers, where the impact has been greatest. Freshwater habitats are among the most significantly impacted by human activities. Pollution, habitat loss and degradation, draining wetlands, river fragmentation, and poor land management are all major threats to biodiversity. Fish biodiversity may and can function as an indication of ecological health. As a result of these influences, freshwater biodiversity is threatened and has diminished in many locations. Fishes are good markers of aquatic biodiversity changes because their tremendous diversity reflects a wide range of environmental variables. Fish also have a significant influence on the distribution and quantity of other creatures in the waterways in which they live. Fish play a significant part in nutrient cycles because they store a substantial amount of ecosystem nutrients in their tissues, transport nutrients farther than other aquatic species, and excrete nutrients in dissolved forms that primary producers may utilise. Aquatic environments are the most biodiverse food sources utilised by humans. Crustaceans, mollusks, reptiles, amphibians, and finfish are examples of vascular plants and algae, as well as animals such as crustaceans, mollusks, reptiles, amphibians, and finfish. Freshwater habitats encompass just around 1% of the earth's surface yet support over 40% of the world's freshwater fish species. Brackishwater is home to almost 2000 different types of fish. The insectivorous areas have the most fish biodiversity, while the tropical and subtropical floodplain rivers and wetlands have the greatest levels of biodiversity. Rice fields are a major source of biodiversity, supporting approximately 200 species of fish, insects, crustaceans, mollusks, reptiles, amphibians, and plants (in addition to rice).

Several freshwater species are valuable to the aquaculture industry as supplies of embryos for hatching and early life cycle stages (e.g., eggs, larvae) for ongrowth. Non-native aquatic organisms can considerably add to upstream fisheries and aquaculture productivity and profitability.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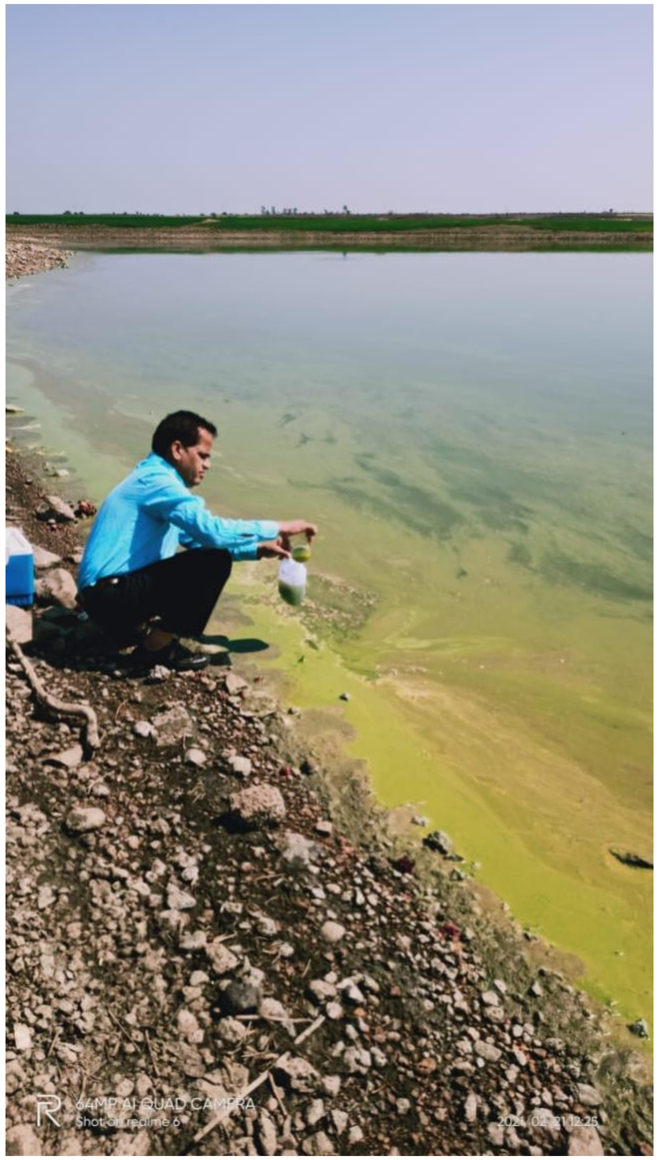
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Chapter 4

Qualitative and Quantitative Estimation of Hydro-biological Parameters of Makroda Lake

4.1 Introduction

The quality of life is strongly bound to the condition of the environment. The physicochemical conditions govern the biological components of a freshwater environment []. Fresh water is one of humanity's most fundamental requirements and is essential to all kinds of life. It lives in lentic and lotic environments. All lentic habitats, such as lakes, ponds, and lakes, are critical because they are supplied with a plethora of other natural resources. Understanding the physicochemical parameters controlling the ecological dynamics of the aquatic system is critical for limnological investigations. Each element plays a specific role in the system, but the overall impact is the consequence of the interplay of multiple factors. The physiochemical characteristics of a fresh water body are influenced by the meteorological, geochemical, geomorphological, and pollution conditions in the drainage basin and underlying aquifer []. Monitoring surface water quality using hydrobiological metrics is one of the most important environmental concerns since it allows for immediate evaluation of the status of aquatic ecosystems subjected to harmful human causes. Physical properties identify the properties of water that interact to the physical senses, touch, taste, odour, and temperature; chemical parameters relate to solvent capabilities such as Total dissolved solids, Alkalinity, Hardness, Chlorides, Metals, and nutrients; and biological parameters measure the density and diversity of various biota. Though the physico-chemical method to monitoring water pollution is the most prevalent and there is plenty of data available on these aspects, it should not give all the data needed at the local level, therefore evaluation of quality of water of all water sources gets necessary. Phytoplankton are vital ingredients of freshwaters, contributing considerably to the succession and dynamics of zooplankton and fish. The community structure, dominance, and seasonality of phytoplankton in tropical wetlands are very varied and depend on nutritional status, water level, underlying substrate morphometry, and other regional characteristics []. Phytoplankton is the primary producers of an aquatic environment, and they regulate biological production. The fluctuation of phytoplankton with seasonal changes in the water habitats is critical for maintaining water quality and sustained aquaculture. The effectiveness of phytoplankton estimating and productivity is heavily reliant on the adoption of proper technique, which includes sample collection, fixation, preservation, analysis, and data calculation. The qualitative and quantitative measurement of hydro-biological parameters, as well as their relationship to environmental conditions, has become a requirement for fish production. The quality and quantity of planktons varies according to depth, place, time, and season of collection, which are all affected by biological and climatic variables. The work in this chapter is primarily concerned with the qualitative and quantitative examination of hydrobiological parameters such as phytoplankton and zooplankton studies of Makroda Reservoir. The study reveals some suggestions for additional research in the Guna district of Madhya Pradesh. The research has also been taken out to understand better overall aquatic life system of the Makroda Reservoir water in order to assess its feasibility for upstream aquaculture.

4.2 Methods & Methodology

Physiochemical Analysis

The present assessment might take place in the Bhamori tehsil of the Guna district. During November 2018 to October 2019, samples were taken from a reservoir of water in the morning between 9.00 and 11.00 a.m. on the first week of each month for a period of one year, from November 2018 to October 2019. The samples were gathered to be analysed physically, chemically, and biologically. The following measures were adopted during sample collection: black coloured plastic cans (polythene containers) with a capacity of 2 litres were utilised for sample collection. The cans were properly cleansed with both tap and distilled water before being dried. The containers are carefully closed after the material was collected. Besides physiochemical analysis now for sample collection, a bottle with a volume of 300 mL has been employed. During sampling, every effort has been made to avoid air bubbles. At the sites, characteristics such as air temperature, water temperature, pH, and transparency are immediately recorded. While the remaining physical, chemical, and biological parameters were analysed in the research lab using conventional scientific techniques provided by various organizations and scientists such as APHA 1985, Trivedy and Goel 1984, IAAB Hyderabad 1998, and others. As an integrated sample, a 5-meter hosepipe has been used, then for a 1-meter depth sample, a 1-meter hosepipe is being used. Each sample is put into a 10-litre plastic bucket before even being separated as micro inorganic, algal identification, and chlorophyll–α samples. Each sample is put into a 10-litre plastic bucket before even being separated as micro inorganic, algal identification, and chlorophyll–α samples. Suspended solids (SS), ammonia (NH_4), nitrate and nitrite (NO_2 + NO_3), ortho-phosphorus (PO_4^-), sulphate (SO_4), silica (Si), and total alkalinity have all been measured (TAL). Additional variables, such as total Kjeldahl nitrogen (KN) and total phosphorus, have been determined using the same macro inorganic sample digestion procedures. The total nitrogen concentration is the sum of ammonia, nitrate, and nitrite concentrations. To prepare the chlorophyll-α sample, filter 500ml of the sample with a 45m whatman filter paper. The chlorophyll-α is then extracted and measured in a 10ml ethanol solution. The research laboratories use a spectrophotometer to test chlorophyll-α concentrations. The samples taken from the reservoir site at Makroda, Guna.

Hydro-biological Analysis

Phytoplankton samples were collected in a 1-litre plastic container and placed in an ice-filled cooler box for analysis. Sample preparation include placing a 10ml sample into a counting chamber and allowing it to settle overnight or for at least 6 hours. An inverted optical microscope is used for identification, as well as the findings have been displayed as a proportion of the value algae group. For the planktonic investigation, 50 litres of surface water were filtered through a plankton net constructed of bolting silk fabric no. 20. Extreme care was taken to ensure that the water had not been disturbed during the sample selection. The phytoplankton samples are kept in lugol's solution. The samples subsequently transported to the laboratory for qualitative and quantitative examination. Phytoplankton obtained characterized by conventional procedures advocated by scientists. The Sedgwick rafter cell has been used for quantitative research. The sample has been extensively stirred in order to uniformly disseminate the microbes. 1 ml of material being transferred to the cell to use a pipette. The cover slip was perfectly positioned, with no air bubbles. After allowing the planktons to settle for a while, they were counted under a microscope. Many of the planktons inside this cell have been counted by shaking it container vertically and horizontally during the whole space. The Sedgwick rafter cell formula for analysing the sample

$$\text{Cells/L} = (\text{Cells counted/Slide volume}) \times (1/\text{Concentration factor}) \times (1000/\text{L})$$

Zooplankton studies have been done from November 2018 to October 2019 to investigate seasonal fluctuations in zooplankton diversity. The seem to have been equally qualitative and quantitative assessments performed. Every in month, samples taken between the hours of 9.00 a.m. and 11.00 a.m. 50 litres of surface water have been filtered through a plankton net constructed of bolting silk fabric no. 20 for collect samples. Exceptional result shows that the water never was disturbed during the sample operations. The collected samples were preserved in formalin once at concentration approximately 4%. For the variety of zooplankton, a water sample from the surface layer was filtered through a nylon net with a mesh size of 25 mm. A 100-liter sample of water was filtered through a nylon cloth with a mesh size of 25 mm to determine the density of zooplankton. The fish species was gathered with the assistance of local fishermen and a visit to a fish mart. The well-labeled neatly packed samples have being delivered to the lab for further examination. The samples were transported to the laboratory for qualitative and quantitative examination.

Microscopic inspection of preserved zooplankton samples obtained with a conical net dragged vertically through a water column is used in the procedure. A stereoscopic microscope is used to analyse microcrustacea in four layered aliquots. A compound microscope is used to investigate Rotifera in two equal volume sub-samples. The Sedgwick rafter cell was used for quantitative research. The sample was thoroughly stirred in order to uniformly disseminate the microbes. One millilitre of material was transferred to the cell using a pipette. The cover slip was perfectly positioned, with no air bubbles.

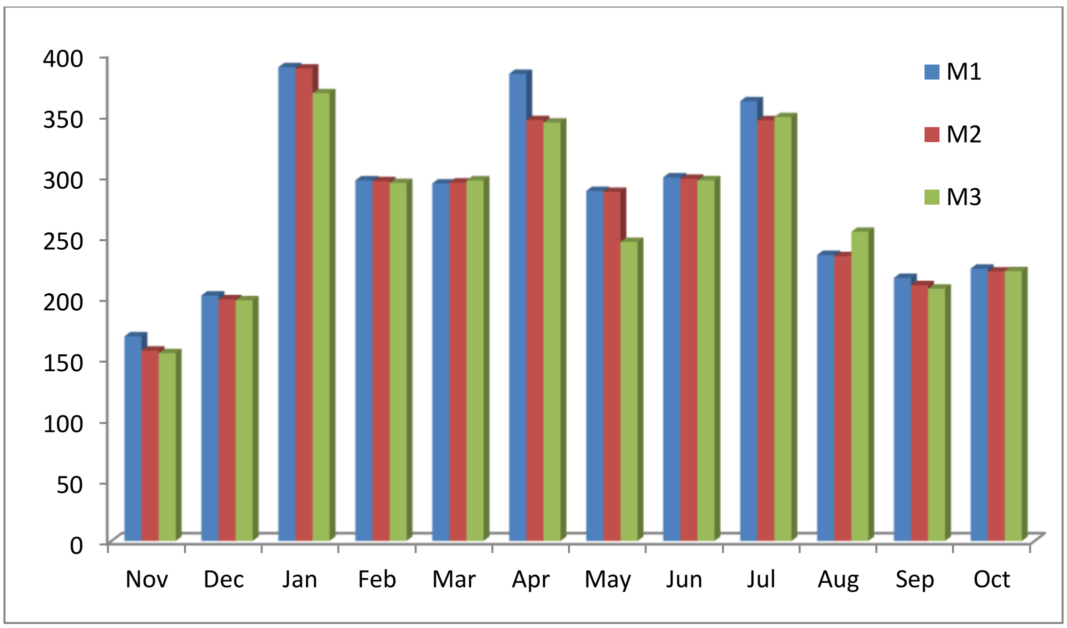

Fig:-4.1 Annual variations of Chlorophyceae *(no./lit) (average value of three stations) of water at selected stations of Makroda Lake, Guna Nov2018-Oct 2019*

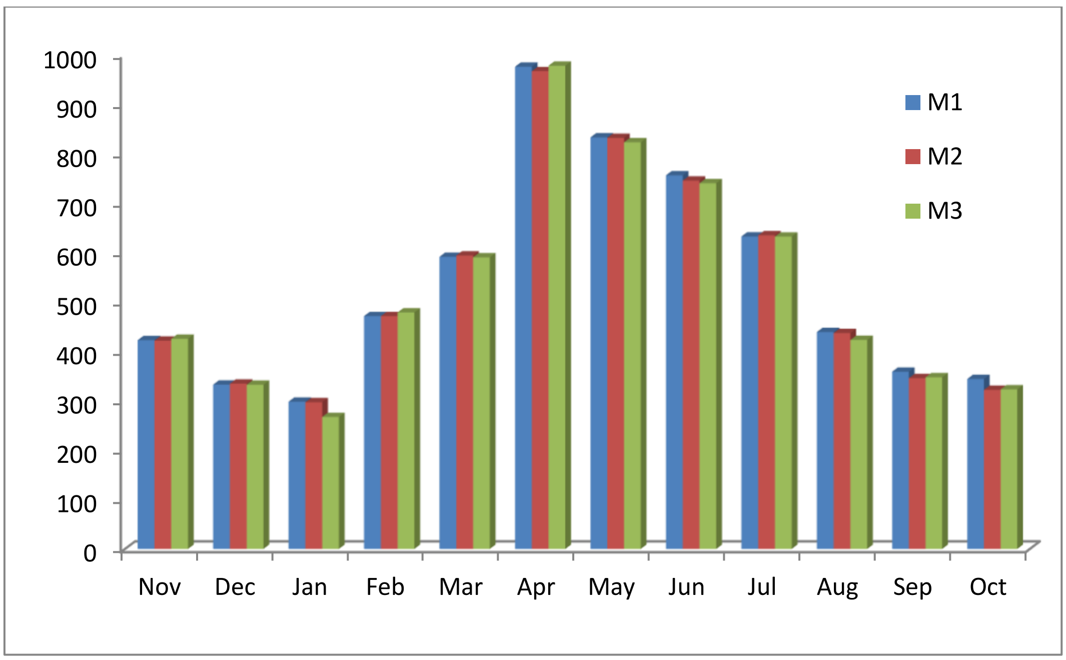

Fig:-4.2 Annual variations of Bacillariophyceae *(no./lit) (average value of three stations) of water at selected stations of Makroda Lake, Guna Nov2018-Oct 2019*

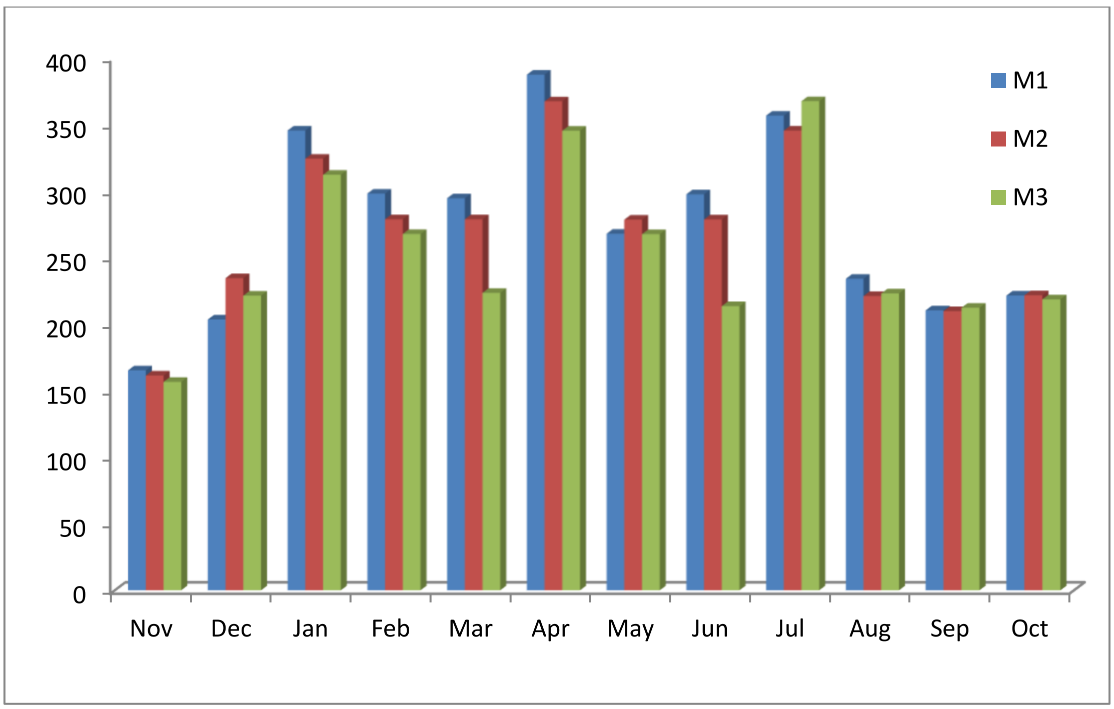

Fig:-4.3 Annual variations of Cyanophyceae *(no./lit) (average value of three stations) of water at selected stations of Makroda Lake, Guna Nov2018-Oct 2019*

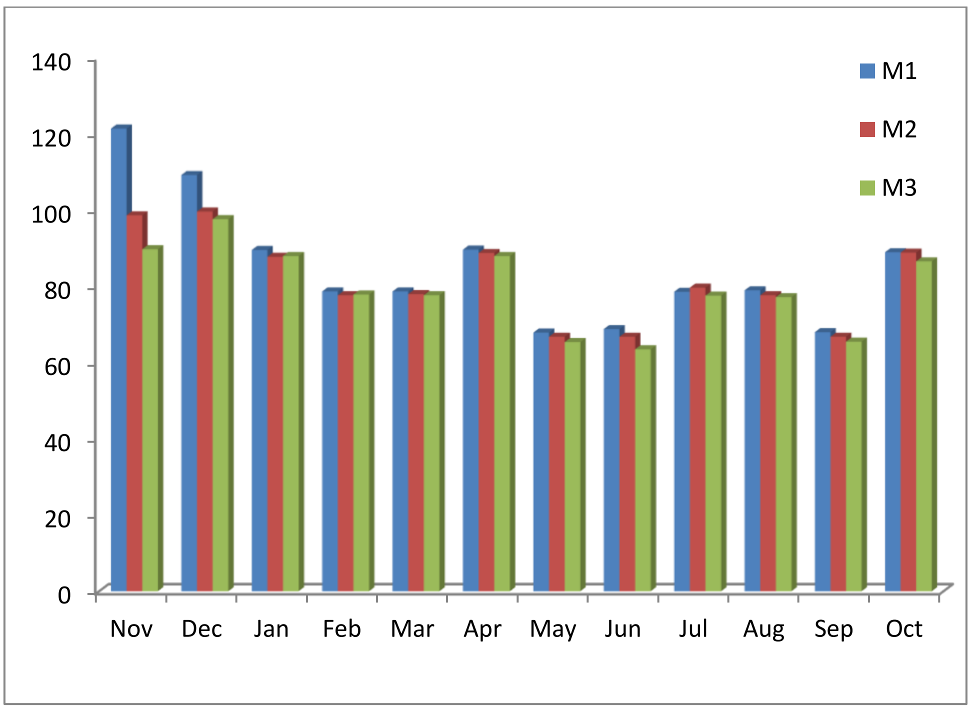

Fig:-4.4 Annual variations Dinophyceae *(no./lit) (average value of three stations) of water at selected stations of Makroda Lake, Guna Nov2018-Oct 2019*

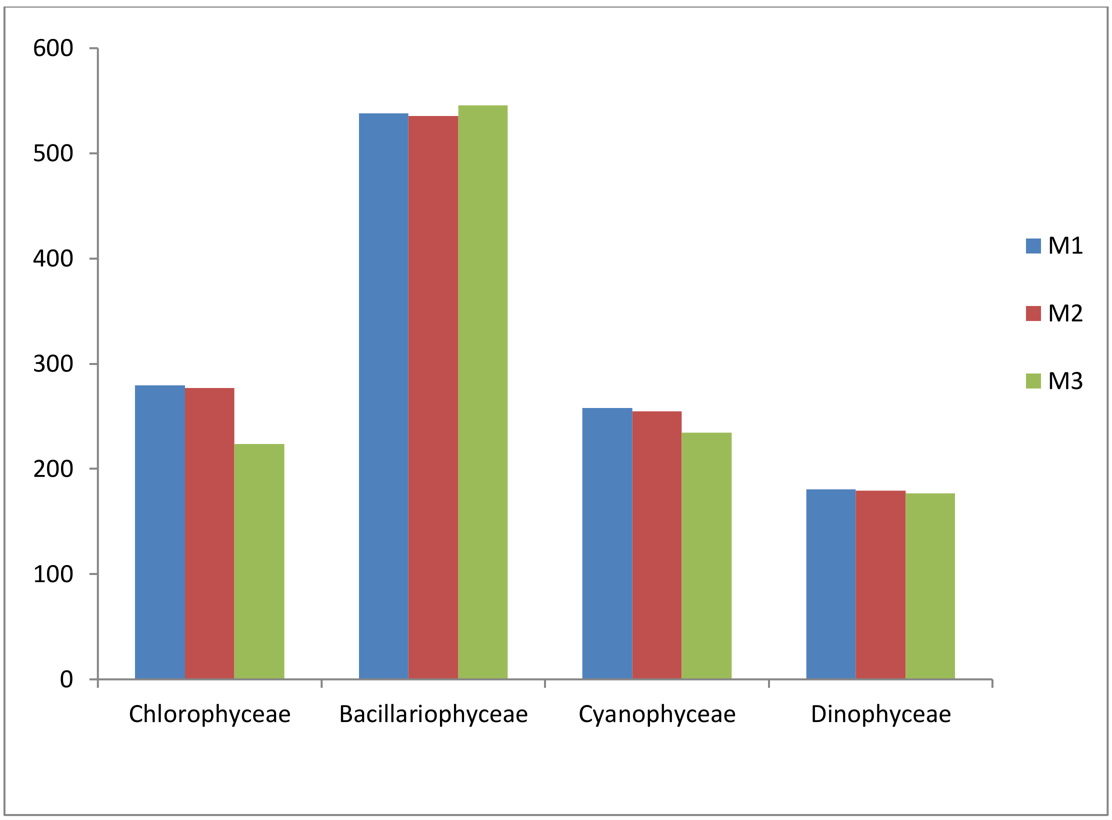

Fig 4.5 Annual variations in phytoplanktons (no./lit) (average value of three stations) of water of Makroda Lake, Guna Nov2018-Oct 2019

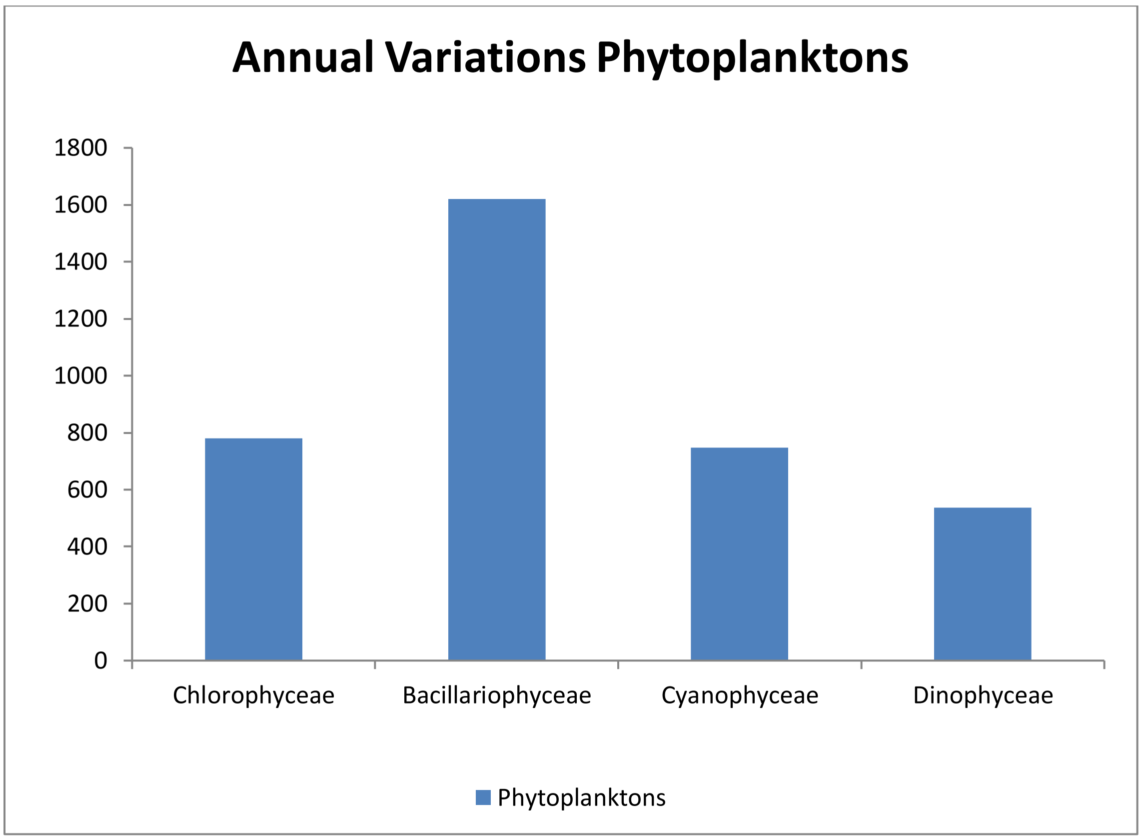

Fig:-4.6 Annual variations in phytoplanktons (no./lit) (average value of three stations) of water of Makroda Lake, Guna Nov2018-Oct 2019

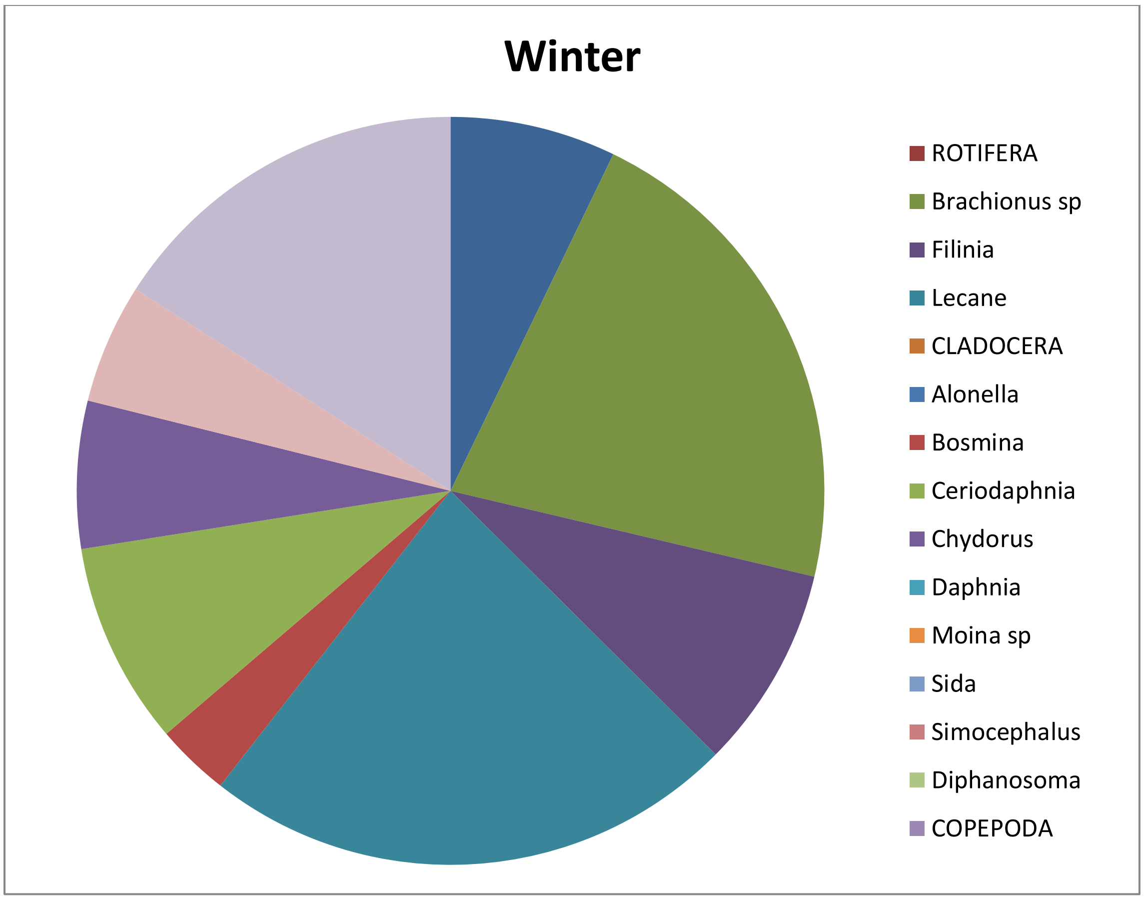

Table 4.7Population dynamics of zooplankton components during

Winter Season

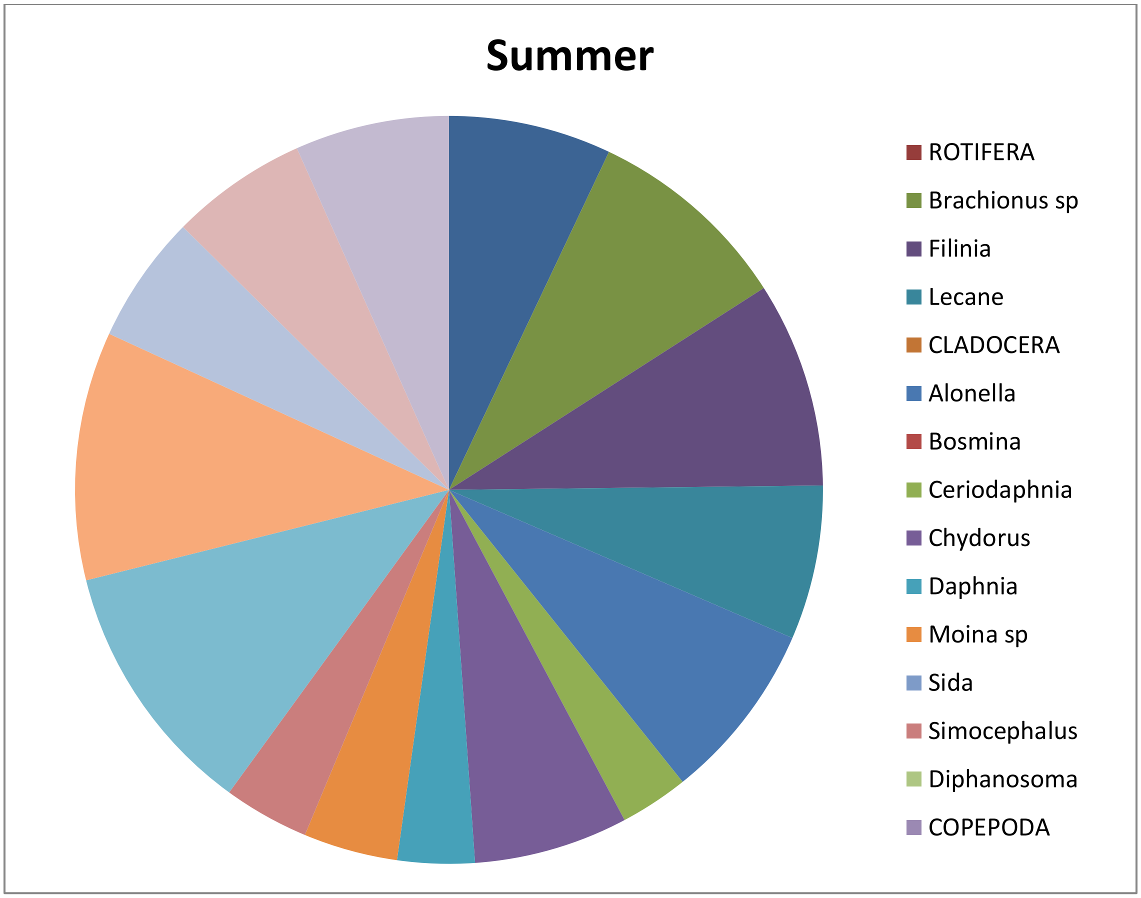

Table 4.8Population dynamics of zooplankton components during Summer Season

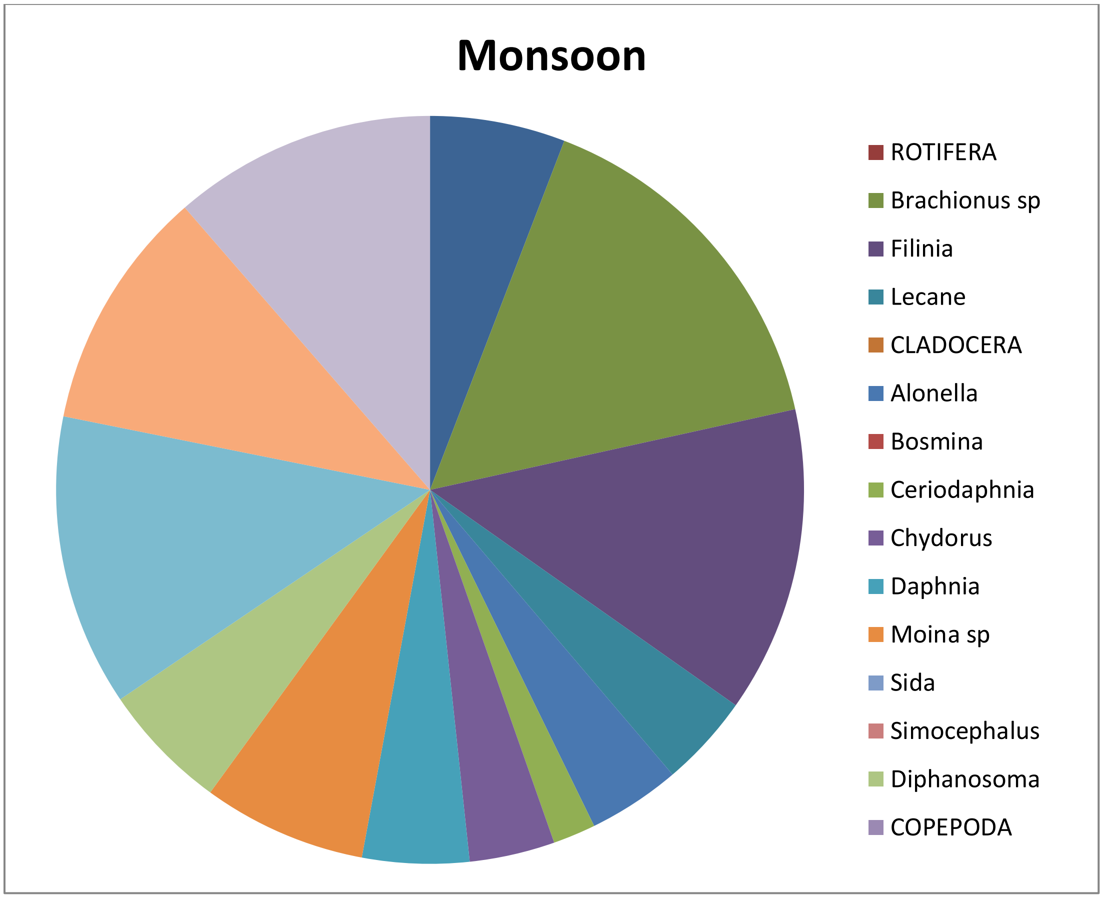

Table 4.9Population dynamics of zooplankton components during

Monsoon Season

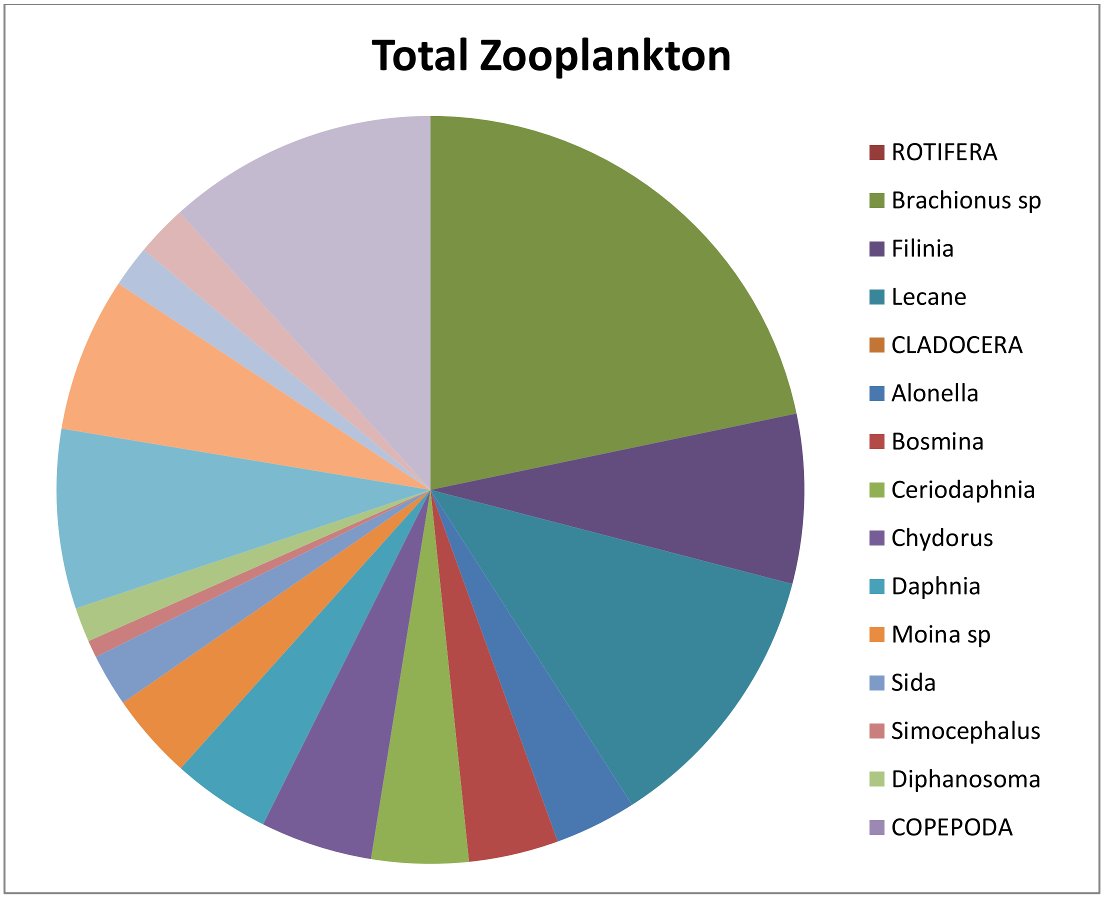

Table 4.10 Total population dynamics of zooplankton components during Nov. 2018 to Oct. 2019

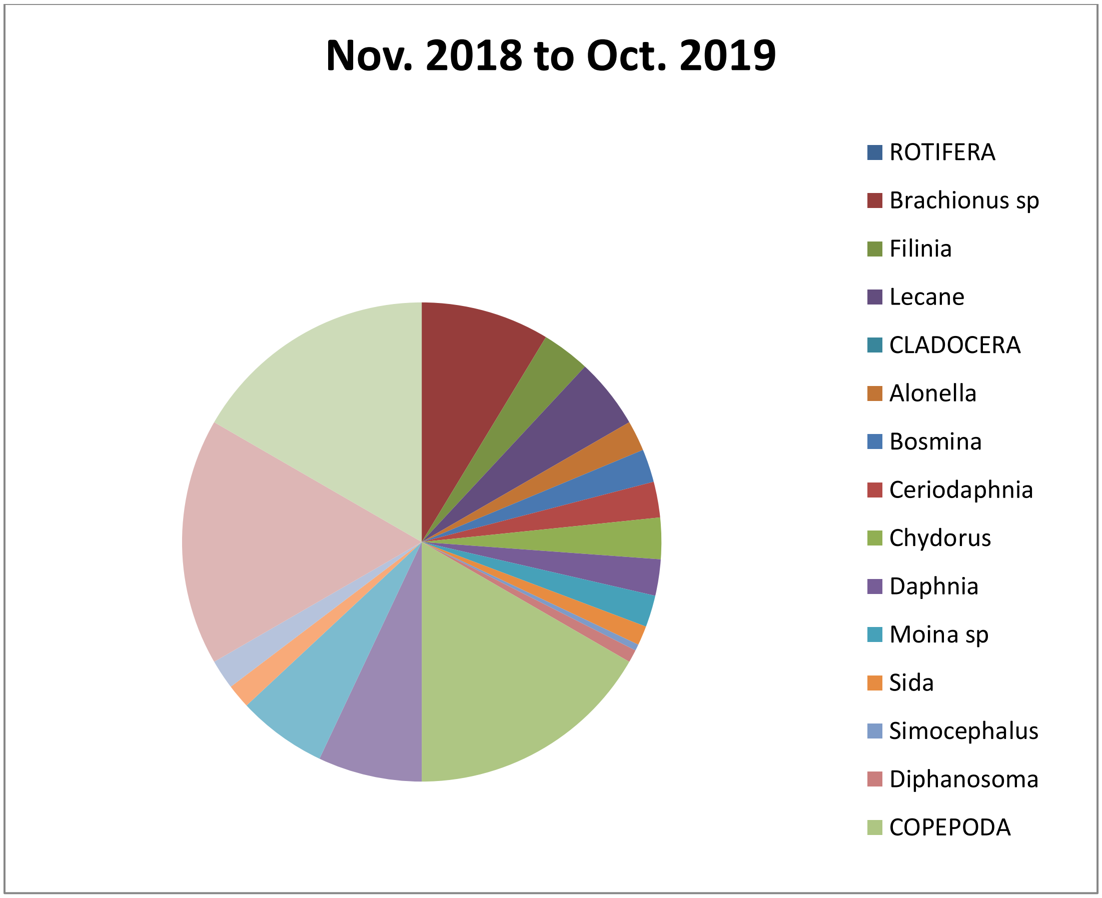

Table 4.11 Genera wise population density of various zooplankton groups with their percentage during Nov. 2018 to Oct. 2019

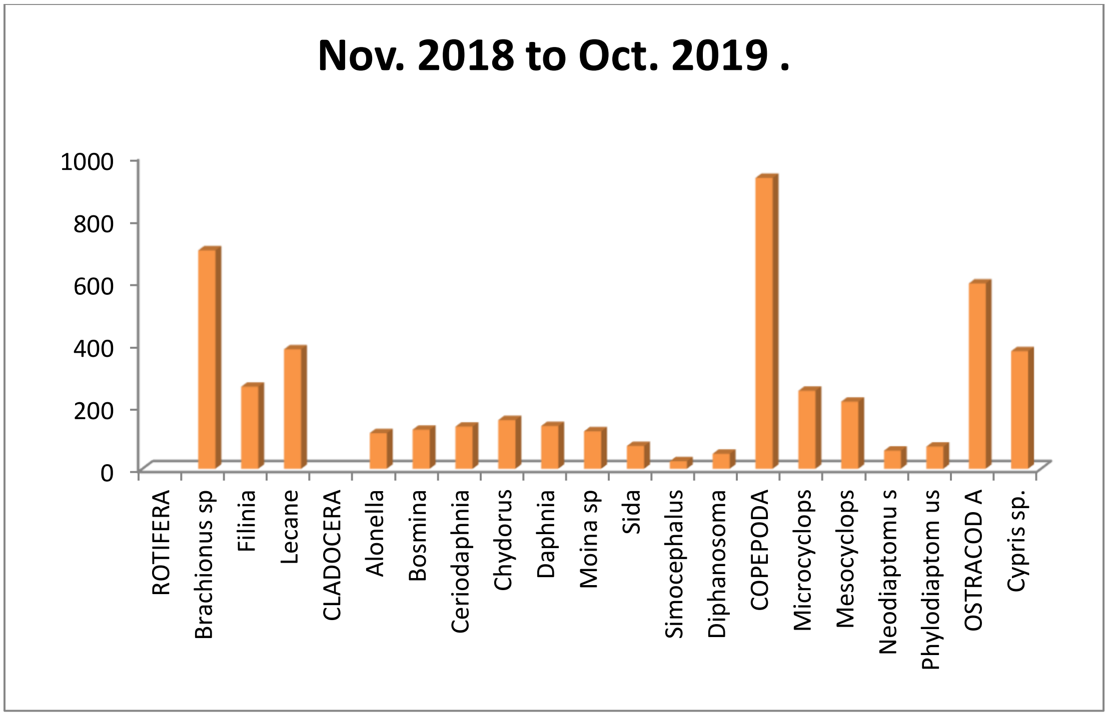

Table 4.12 Total Genera wise population density of various zooplankton groups with their during Nov. 2018 to Oct. 2019

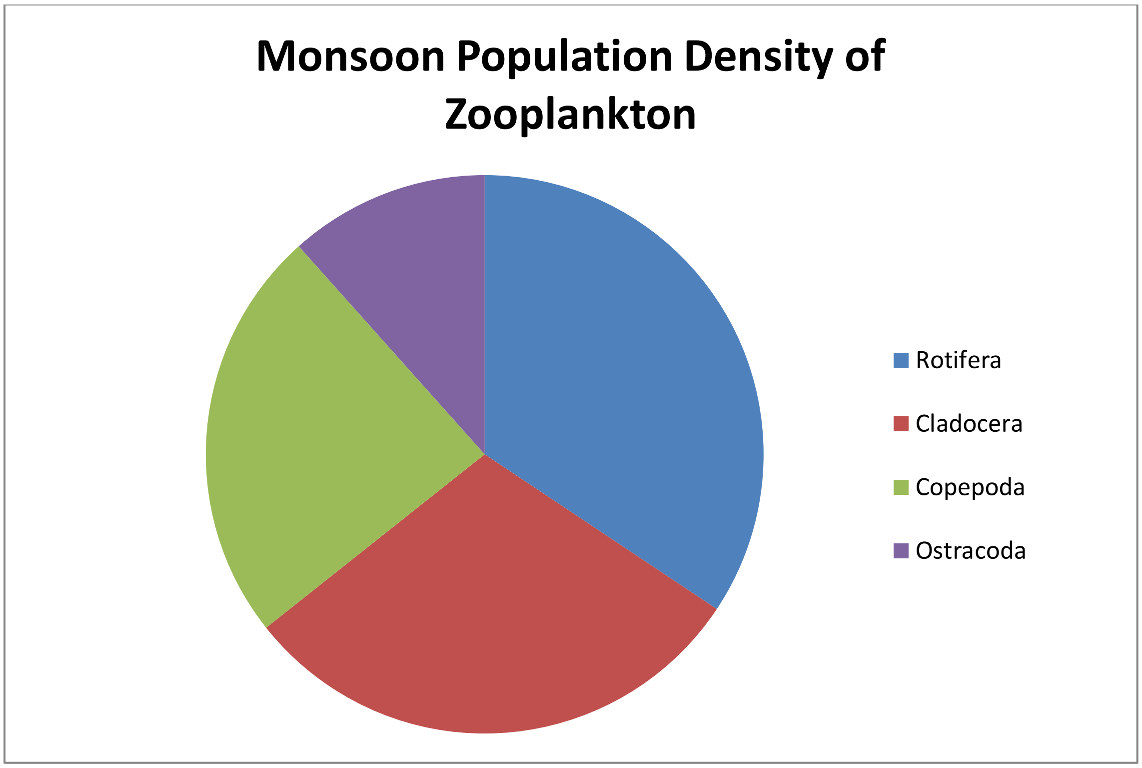

Table 4.13 Group wise seasonal population density (No/L) of Zooplankton during Monsoon

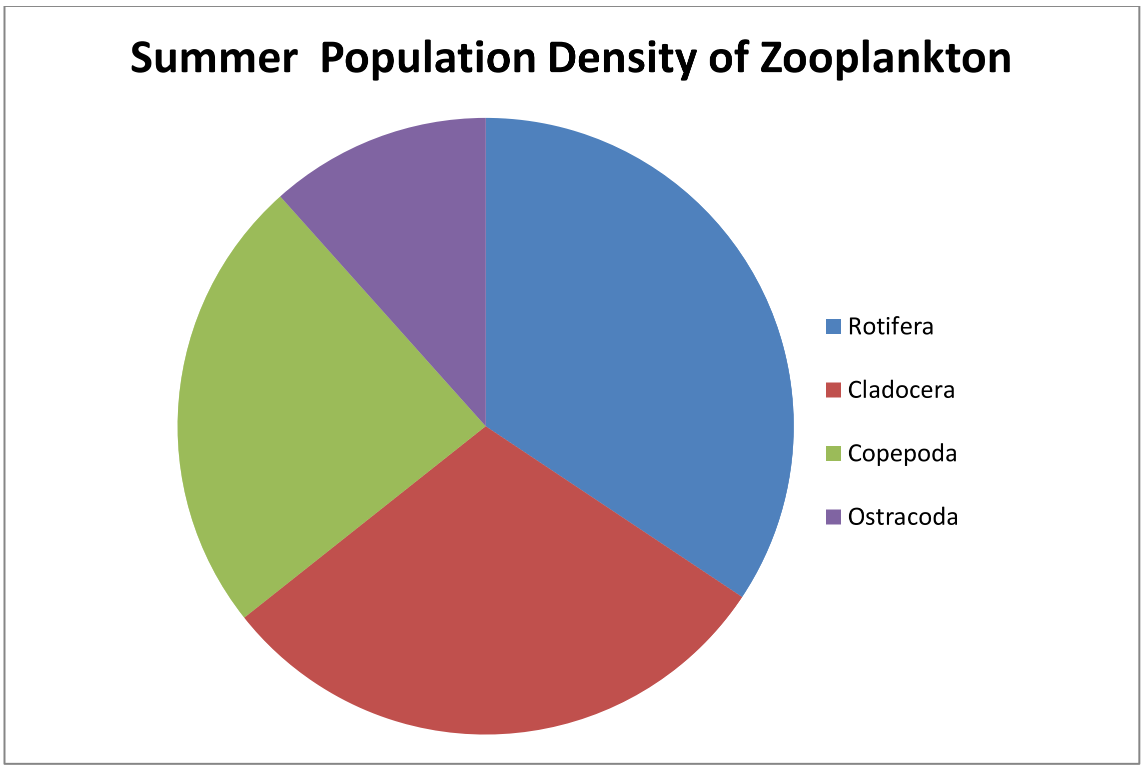

Table 4.14 Group wise seasonal population density (No/L) of Zooplankton during Summer

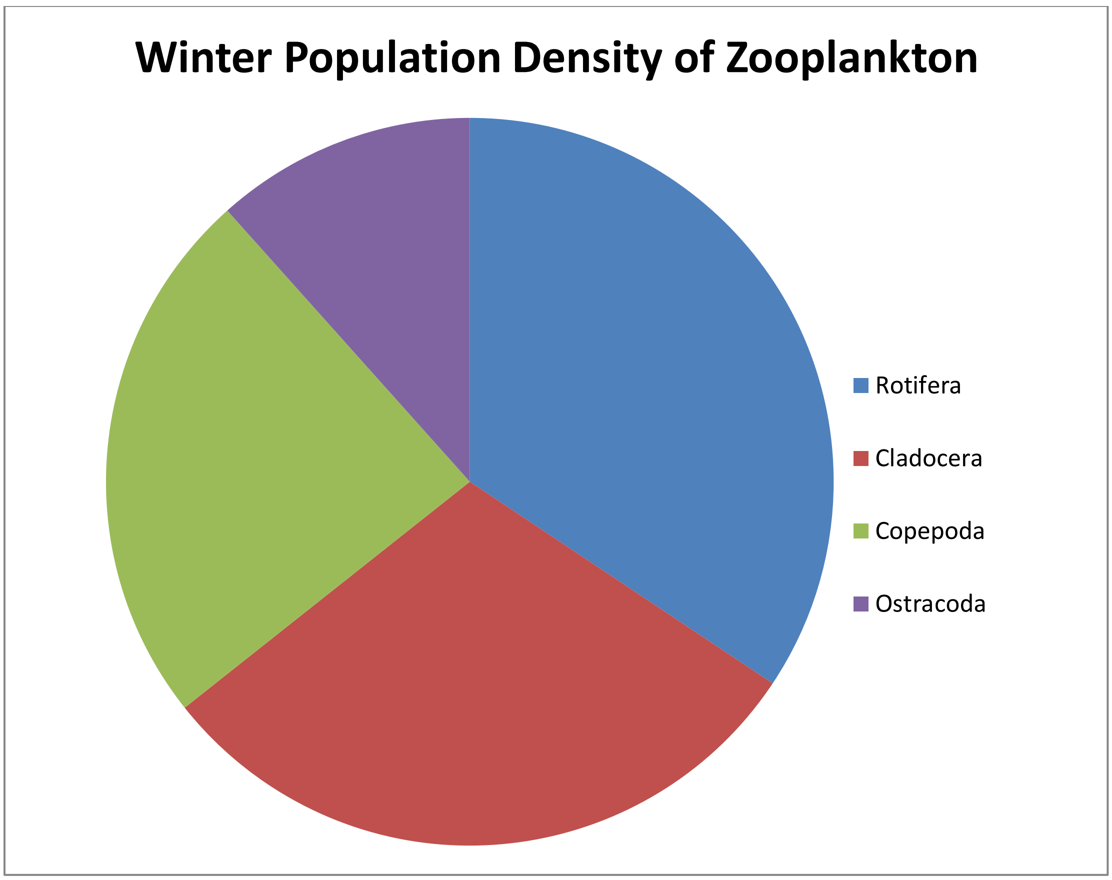

Table 4.15 Group wise seasonal population density (No/L) of Zooplankton during Winter

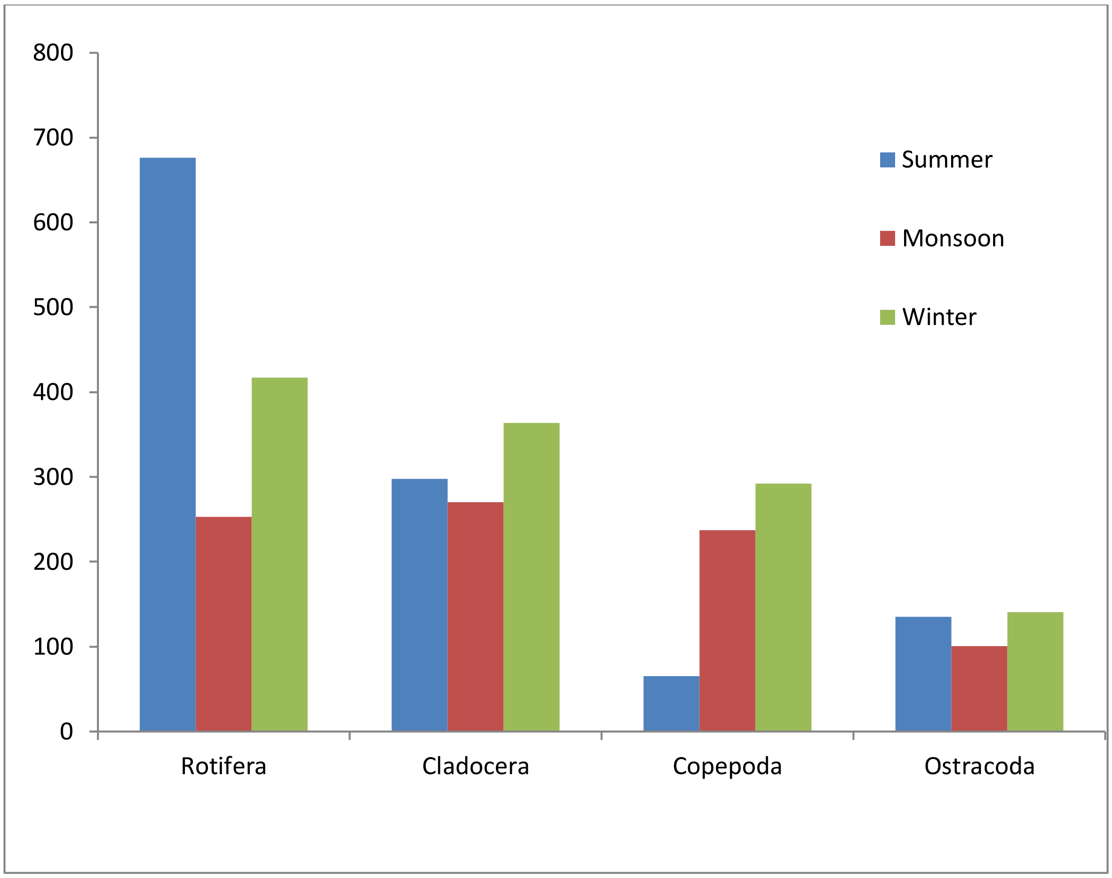

Table 4.16 Total Group wise seasonal population density (No/L) of Zooplankton during Nov. 2018 to Oct. 2019

Results

Physio-chemical Results

The physicochemical parameters were separated into two groups for efficiency of demonstration: Transparency, temperature, turbidity, and conductivity are examples of physical parameters in Group I. Group II includes chemical parameters such as pH, Dissolved Oxygen, Alkalinity, Hardness, Chlorides, Phosphate, Nitrates, COD, BOD, Sulphate, Nitrites, Calcium, Magnesium, and Ammonia. The Makroda Reservoir results are the most significant. Water temperatures were measured the same way at all three locations, with very slight variances in mean values (Table 4.1). They were approximately 18.7°C in the winter and 34.5°C in the summer, with a minimum of 18.7°C in the winter and a high of 34.5°C in the summer, with a minimum of 28°C in the monsoon. Transparent seas enable more light to penetrate, which has far-reaching consequences for all aquatic organisms, including growth, distribution, and behavior. The water is probably transparency ranged from 153 cm to 207 cm. Conductivity is a numerical representation of the capacity to transport electric current, which is affected by conductivity. It is a measure of ionic composition. Makroda Reservoir near Guna, Madhya Pradesh, measured electrical conductivity in the 0.160-0.270 mS/Cm range. Makroda Reservoir's water conductivity ranged between 398 S/cm and 278 S/cm. High conductivity was measured during the summer, that might be associated with increasing chlorides and dissolved solids caused by evaporation of water, leading to higher salt concentrations. Although most aquatic organisms are accustomed to a restricted range of pH and cannot resist rapid changes, pH fluctuation is an essential characteristic in water bodies. The average pH in this research ranged from 6.87 to 7.74. The ideal pH range for drinking water is 7 to 8.5. The results suggest that the water in Makroda Reservoir is safe to drink as well as comes within the standard range. The pH measurements also show that the water at Makroda Reservoir is acceptable for fish production. One of the most essential factors in water quality is dissolved oxygen, which serves as an indicator of the physical and biological activities occurring in the water. The average dissolved oxygen level in Makroda Reservoir ranged from 5.13 to 8.13 mg/lit. The ability to neutralise a strong acid is considered to as alkalinity. It is a measure of the water's capacity to absorb H+ without causing a serious change in pH. The majority of the alkalinity in natural waters is caused by CO. The alkalinity in Makroda Reservoir varied from 54.7 mg/lit to 147.9 mg/lit. Summer has the highest alkalinity in Makroda Reservoir, followed by winter and the lowest during the monsoon season. The hardness of water is defined as the amount of the concentrations of alkaline earth metal cations existing on water, as the capacity of water to dissolve detergent or inhibit leather production. During November 2018 and October 2019, the total hardness of the water ranged from 66.25 mg/l to 135 mg/l. Chloride concentrations in water varied from 11.85 mg/lit to 39.5 mg/lit, indicating contamination with animal and human wastes. Low chlorine levels indicate that the water is not contaminated and is safe to drink. Phosphates are found in trace amounts in natural water. Excess phosphorus in natural water caused by untreated residential sewage and agricultural runoff. These are essential elements for algae development in water. Phosphate is normally a limiting nutrient in the eutrophication process. They are the primary nutrients responsible for the eutrophication process, which ultimately leads to environmental deterioration. During the current examination, it was observed that phosphates ranged from 0.375 to 1.575. It was at its lowest (0.375) in August and its highest point (1.575) in April. The assessment of nitrate is critical because it contributes to assessing the contamination quality of such an aquatic environment. An municipal water system acquires the excess of nitrates from untreated residential sewage, as well as phosphates, which are primarily responsible for the process of reservoir deterioration known as eutrophication. Its concentration in water rises as a result of the addition of home sewage, agricultural runoff, and other factors. Throughout the study period, nitrate concentrations ranged from 0.292 to 0.612.

Phytoplankton Result

Phytoplankton Overall During research, 37 genera and 49 species of phytoplankton from four taxonomic assemblages were identified in Makroda Lake: Chlorophyceae, Bacillariophyceae, Cyanophyceae, and Dinophyceae. The density of distinct phytoplankton groups was measured. Annual changes in phytoplanktons (no./lit) (average value of three stations) in Makroda Reservoir, Guna water from November 2018 to October 2019 are presented (Table 4.3). Bacillariophyceae (40.81 to 42.02 percent) > Chlorophyceae (26.94 to 27.82 percent) > Cyanophyceae (19.22 to 20.35 percent) > Dinophyceae (40.81 to 42.02 percent) (8.62 to 8.77 percent). Monthly changes in phytoplanktons (no./lit) (average value of three stations) in Makroda Reservoir, Guna water from November 2018 to October 2019 are presented (Table 4.4). At all three locations, total phytoplankton showed monthly changes at $P \leq 0.0001$. Bacillariophyceae (43.05 to 47.88 percent) > Chlorophyceae (20.83 to 21.10 percent) > Cyanophyceae (18.92 to 20.31 percent) > Dinophyceae (8.0 to 9.72 percent). The density at the three stations decreased in the monsoon to 1917±227.7 ind./L, 2354±299.7 ind./L, and 2475± 311 ind./L at M1, M2, and M3, respectively, and was lowest in the post-monsoon with 1745±91ind./L, 1864±115 ind./L, and 2003±120 ind./L at three stations, respectively, but began increasing in winter with 3099±225 in The overall phytoplankton species richness varied seasonally at all locations. Summer had the highest species richness (37.5±0.4 no. species), followed by M2 and M1 (32.17 ±1.16 and 30.17 ±1.32 species, respectively). The biodiversity decreased in the monsoon and post-monsoon seasons, without a statistical difference between the three stations. In the monsoon, the diversity of species was 25.8±1.1, 28±0.7, and 30±1.3 at M1, M2, and M3, respectively; in the post-monsoon, it must have been 21±0.9, 22.17±1.1, and 24.67±1; while in the winter, that was 19.2±1.8, 20.7 ±0.9 and 22.3 ±1.1. As particular genera were analyzed according to classification, the significant patterns observed.

Cyanophyceae

Cyanophyceae, commonly known as blue green algae, was the third most abundant quantitative component of total phytoplankton, representing for 19.22, 20.35, and 19.45 percent of the total phytoplankton at M1, M2, and M3, respectively. The density of blue green algae at the M1, M2, and M3 was highest in winter, with 760 61.47 ind./L, 864 35.57 ind./L, and 901.7 50.87 ind./L, respectively. Summer density reduced to 512.2 36.24 ind./L, 696 32.26 ind./L, and 626.1 17.02 ind./L at M1, M2, and M3, respectively, while monsoon density decreased to 339 41.38 ind./L, 424.7 36 ind./L, and 415.2 43.58 ind./L at the three stations. After the monsoon, there was a non-significant rise in post-monsoon with 372 33, 433 45, and 484 36/I, respectively. The density of Cyanophyceae varied seasonally with P 0.0001. During the investigation, eight Cyanophyceae genera were found. At the three sites M1, M2, and M3, the mean biennial percentage of Cyanophyceae species richness was 20.3, 19.74, and 18.92 percent, respectively. In the summer, the maximum biodiversity fluctuated between 6.8 0.1 species at M3 and 6.1 0.3 species at M1, while it was 6.5 0.22

at M2. Plant diversity declined in the monsoon to 5 0.3, 5.3 0.2, 5.7 0.2 and at M1, M2, and M3, respectively, and was lowest in the postmonsoon with 3.6 0.2, 3.8 0.3, and 4.2 0.1 species. During the winter, the number of species climbed to 4.6 0.5, 4.8 0.3, and 5 0.3, respectively. Chlorophyceae (Green algae) Chlorophyceae have been the second most commonly quantitative component of overall phytoplankton richness, contributing for 27.82, 27.42, and 26.94 percent of total phytoplankton richness at M1, M2, and M3 stations respectively. Green algae concentrations found highest in winter, with non-significant variations between the three locations, 1154 62 ind./L, 1235 62 ind./L, and 1284 59 ind./L at M1, M2, and M3 stations respectively. Productivity decreased non-significantly in the summer to 753 47 ind./L, 1014 72 ind./L, and 999 58 ind./L, and had been lowest in the monsoon at 456 42 ind./L, 508 62 ind./L, and 531 49 ind./L. Postmonsoon densities climbed to 508 39 ind./L, 503 45.56 ind./L, and 561 49 ind./L at M1, M2, and M3 stations respectively. During the research period in Makroda Reservoir, seven Chlorophyceae genera are recognized. At M1, M2, and M3, the mean biannual percentage species richness was 20.83, 21.02, and 21.1 percent, respectively. Seasonal differences in species richness were detected, with the most species observed in the summer (6.16 0.3, 7 0.3, and 7.6 0.2 at M1, M2, and M3, respectively). The species richness at the three sites decreased in the monsoon (5.5 0.4, 5.8 0.3, and 6.3 0.2, respectively) and was lowest in the post-monsoon (3.5 0.2, 4 0.2, and 4.5 0.2, respectively) and winter (4.8 0.5, 5 0.3, and 5.6 0.2, respectively). Seasonal fluctuations in chlorophyceae density and biodiversity found at all three locations with P 0.0001.

Bacillariophyceae

Bacillariophyceae (Diatoms) were the most frequent species of Whole Phytoplankton richness, with annual percentages ranging from 40.81 to 42.02 % for all three locations. Summer phytoplankton densities of 1783 96 ind./L, 2035 57 ind./L, and 2313 122 ind./L are measured at M1, M2, and M3, respectively. During monsoon, frequencies declined and diversified at the three locations, with 871 122 ind./L, 1069 172 ind./L, and 1167 194 ind./L, respectively. The postmonsoon lowest density is obtained with non-significant variations (516 28 ind./L at M1, 566.3 19.37 ind./L at M2, and 587 37 ind./L at M3). Winter diatom concentrations rose with minor variations across the three sites (1042 100 ind./L at M1, 1054 91.96 ind./L at M2, and 1198 120 ind./L at M3). On Makroda Reservoir, 24 diatom species from 16 genera been discovered. The annual percentage of diatom biodiversity at M1, M2, and M3 reached 43.05, 45.42, and 47.88 %, respectively. Maximum species have been recorded in summer with 15.6 1.2, 16.8 0.9, and 21.0 0.3 at M1, M2 and M3 respectively, that began to decrease in monsoon with 12 0.6, 14 0.5, and 15 0.9 to post-monsoon with 7.3 0.9, 9 0.5, and 10.8 0.9 but were minimum during winter with 6.3 0.7, 7.3 0.6, and 8 0.9 at M1, M2 and M3. Bacillariophyceae density and species richness revealed substantial seasonal variations with P 0.0001 at all stations.

Dinophyceae

Dinophyceae performed badly in Makroda Reservoir, ranking fourth in total phytoplankton density. Their mean annual percentage density ranged between 8.62, 8.74, and 8.77 percent at the three locations M1, M2, and M3. Summer had the highest density of dinophyceae, with 468 29 ind./L, 500 55 ind./L, and 511 28 ind./L. Monsoon and postmonsoon rainfall reduced, despite minor variations across the three locations. During the monsoon and postmonsoon, the density is 197.5 24.41 ind./L, 142.8 4.4 ind./L at M1, 216.8 35.63 ind./L, 162.8 15.95 ind./L at M2, and 258 37 ind./L, 182.5 7.79 ind./L at M3. Minimum densities of dinophyceae are detected in winter at 96 5 ind./L, 159 43 ind./L, and 129 16 ind./L, with seasonal variation at the level P 0.0001. Dinophyceae species richness is minimal in Makroda Reservoir, for only four varieties from different genera identified, bringing it mostly in fourth qualitative approach. The annual percentage of Dihophyceae biodiversity were 9.72, 8.34, and 8% at M1, M2, and M3, respectively. The maximum species diversity of Dinophyceae is reported in the postmonsoon period with 3.66 0.2, 3.3 0.2, and 3.5 0.2 at M1, M2, and M3, respectively, subsequently declined during winter to 2.3 0.2, 2.16 0.1, and 2.3 0.2 and had been minimal in summer with 1.5 0.3, 1.16 0.2, and 1.3 0.2 species exclusively. During the monsoon, it increased dramatically to 1.8 0.1, 2.0 0.2, and 2.0 0.0 at all three stations.

Zooplankton

In the table 4.5-4.11 shows seasonal fluctuations in overall zooplankton density during two years of research. Seasonal fluctuations are considered total zooplankton, which is further separated into four groups: rotifer, cladocera, copepod, and ostracoda. A total of 44 zooplankton species from 26 genera were found in the reservoir's surface water. Nine of these genera belonged to Rotifera (24 species), ten to Cladocera (11 species), four to Copepod (6 species), and three to Ostracoda (3 species) (3 species). Seasonal fluctuations in the species richness of total zooplankton (number of species) include the species richness of the four categories depicted in Figures 4.7 to 4.16. The abundance of total zooplankton has four quantitative components, the abundance of which varies significantly seasonally. Rotifera (35.27 to 36.82 percent) > Cladocera (31.97 to 33.20 percent) > Copepodes (24.53 to 26.17 percent) > Ostracoda (4.9 to 5.5 percent) was the sequence of abundance of several zooplankton groups in decreasing order (Table 4.5 to 4.11). Summer had the highest density of total zooplankton. M3 had a value of (2967 59.7 ind./L), M2 had a value of (2827 59.03 ind./L), and M1 had a value of (2607 56.02 ind./L). The density of total zooplankton reduced during the monsoon to 2607 118 nos./L, 2333 138.4 ind./L, and 2173 133.3 Ind./L at M3, M2, and M1, respectively, and then reduced further in the post-monsoon to 1327 68.05 ind./L, 1567 90.28 ind./L, and 1620 88.09 ind./L at M1, M2, During the winter, density at M1, M2, M3 increased to 1447 137.6 ind./L, 1667 174.9 ind./L, and 1787 187.8 ind./L. At all three locations, total zooplankton density demonstrated substantial seasonal fluctuation at P 0.0001.

Rotifers

When evaluating different categories Rotifera has been the most prevalent of the four zooplankton species, contributing for 36.29 % of the monthly average density . The percentage density of Rotifera at M1, M2, and M3 is 31.97 %, 33.20 %, and 33.14 %, respectively. Summer seemed to have the highest density of rotifers . It was 1158 41 ind./L at M1, while it was substantially higher at M2 and M3 with 1180 77.8 and 1340 53.42 ind./L, respectively. During the monsoon, the density at all stations reduced and fluctuated, with 783 76 ind./L at M1, 973.3 86.82 ind./L at M3, and 900 85.01 ind./L at M2. That after monsoon, rainfall dropped to 395 28 irid./L at M1, 483.3 39.47 ind./L at M2, and 500 59.1 ind./L at M3. In winter, water density is nearly constant at 443.5 63 ind./L at M1, 399 61.97 ind./L at M2, and 491.3 79.11 ind./L at M3 with P 0.0001.

Cladocera

Cladocera are the second most abundant group of zooplankton investigated, contributing for 32.77 percent of the biannual average density. Cladocera percentage densities were 31.97 percent at M1, 33.20 percent at M2, and 33.14 percent at M3. P 0.0001 indicated that there were substantial temporal fluctuations. At the M1, M2, and M3 stations, the maximum density of cladocerans was 742.8 13.63 ind./L, 853.3 24.59 ind./L, and 886.7 12.59 ind./L. Monsoon densities varied from 675 29 ind./L at M1, 713.3 34.9 ind./L at M2, and 826.9 8.43 ind./L at M3. Minimum densities were 459.8 26.17 ind./L, 570 30 ind./L, and 600 34.25 ind./L at M1, M2, and M3, respectively, during the postmonsoon. Winter densities grew substantially at the three locations, reaching 535 50.93 ind./L, 653.3 60.81 ind./L, and 663.3 58.06 ind./L.

Copepoda

Copepoda have been the third quantitative component in total zooplankton dominance. It had an annually average density of 25.55 %. Copepod percentage density ranged from 26.17 percent at M1 to 25.95 percent at M2 and 24.53 percent at M3. Copepoda densities are highest in the summer. This was highest at M2 (660 8.94 ind./L), lowest at M1 (599 14.67 ind./L), and highest at M3 (606.7 21.71 ind./L). It dropped during the monsoon season, with statistically insignificant variances between the three stations: 562.5 3846 at M1, 553.3 31.69 at M2, and 600 46.19 ind./L at M3. Minimum densities were measured in the postmonsoon period, with M1 having 405.8 25.84 ind./L, M2 having 420 24.77, and M3 having 453.3 22.31 copepods/L. Winter have seen a non - significant growth to 407.7 32.42 ind./L, 546.9 51.29 ind./L, and 543.3 50.18 ind./L at M1, M2, and M3, accordingly.

Ostracoda

The density of ostracoda had been very minimal at all three Makroda Lake areas, contributing for the lowest component of overall zooplankton density. Ostracoda had an annual percentage density of 5.29 %. In all three locations, overall percentage density of Ostracoda ranged from 4.90 % to 5.50 % and 5.49 percent, respectively. In contrast to all other zooplankton, the highest concentrations of Ostracoda were seen during the monsoon. In M1, M2, and M3, it must have been 152.2 11.24 ind./L, 166.7 12.29 ind./L, and 206.7 12.29 ind./L, respectively. Post-monsoon densities were 65.17 14.02 ind./L, 93.3 8.43 ind./L, and 66.67 8.43 ind./L at M1, M2, and M3, correspondingly. It must have been smallest in winter for M1 and M2 at 52.83 5.03 ind./L and 73.33 6.66 ind./L, respectively, and highest in monsoon at 86.17 12.29 ind./L for M3. In the summer, the density of Ostracoda increased nearly reaching 106 16 ind./L, 133.8 8.43 ind./L at M1 and M2, and 133.3 28.6 ind./L at M3. Density of Ostracodes showed significant seasonal fluctuations with P 0.0001. Among all the physico-chemical parameters studied at all three stations, rotifer density is positively correlated at the 0.01 level with acidity, alkalinity, atmospheric temperature, chloride, carbon-dioxide, pH, phosphorus, TDS, TS, TSS, and WT and negatively correlated at the same level with WC and DO. It is again favourably linked with Bacillariophyeeae, Cladocera, Dinophyceae, and Ostracoda among biotic factors at the 0.01 level.

Chapter 5

Summary,Conclusions and Recommendations

Introduction

The surface water selected for hydrobiological studies would be in the Guna district's Umri taluka (M.P). Research has been done on the physicochemical and biological assessments, but also their linkages with local biodiversity as well as water quality. For one year, monthly fluctuations in abiotic and biotic variables of the above water bodies are explored. Atmospheric temperature, water temperature, humidity, pH, transparency, conductivity, TDS, dissolved oxygen, free carbon dioxide, total alkalinity, bicarbonates, total hardness, calcium hardness, magnesium hardness, chlorides, phosphates, and nitrates are among the physicochemical factors. A biotic factor is any group of zooplanktons that has been investigated for variety and density through to the species level. The diversity of freshwater fishes also was investigated. Throughout the research, the ambient temperature fluctuated from 16.6 0C to 31.6 0C, while the water temperature ranged from 19.2 0C to 28.5 0C. Temperatures and humidity are found to be greater in the summer and monsoon seasons than the winter. The fact that surface water temperature rises in the summer and falls in the winter implies a near parallel relationship between air and water temperature. In winter, a rise in water temperature causes natural processes to extend out, reducing the solubility of gases such as O_2 and CO_2. The pH of the bodies of water under consideration varied from 8 to 8. 7 pH demonstrated minimal seasonal fluctuations. It was highest in the summer and is related with significant photosynthetic activity in the water. As per existing research, the pH range is favorable for aquatic life, irrigation, and household purposes. Throughout the current investigation, the transparency varied from 52 cm to 140 cm. Overall transparency is highest at all locations between winter season and summer season. It was found to be at the very worst during the monsoon season due to sewage pollution of precipitation from the surrounding region. A high subtropical condition of water bodies is indicated by low transparency levels. Later in the summer, there is less clarity in the water body because it is saturated with more planktons. Electrical conductivity of an existing aquatic environment ranged from 252 Mhos/cm to 321 Mhos/cm. Summer conductivity readings are high, while winter conductivity values are low. Water pollution from sewage, household garbage, and excessive salt concentrations resulted in increased conductivity levels. A rise in conductivity is caused by increasing chlorides and TDS as a result of water evaporation, which results in higher concentration salts. TDS values were highest in summer, followed by monsoon, and lowest in winter in the existing research. TDS parameters were recorded in the summer due to evaporation of water, which increased the concentration of salts, and in the monsoon due to the addition of sewage and household waste, and also the influx of monsoon runoff from the surrounding region. The dissolved oxygen concentration varied from 2.8 mg/lit to 7.6 mg/lit. Throughout the research, at all aquatic bodies under consideration. Maximum DO values are high in winter that may be explained by the water. Minimal DO is found throughout the summer due to the increased consumption of microorganisms in the degradation of organic materials. The free CO2 concentrations in the present research ranged from nil to 11 mg/lit for the three aquatic environment examined. During the winter, CO2 levels were at their highest. A high CO2 level implies that larger organic pollutants, that may be due to fertilizer and inorganic fertilizer inclusion into streams. The lack of CO2 might be linked to that used in photosynthesis. The alkalinity of phenolphthalein ranged from 0 to 15 mg/lit. Throughout the research. It was only documented during the summer months. Throughout the research period, total alkalinity readings ranged from 110 mg/lit to 185 mg/lit. The alkalinity concentrations are usually larger than 110 mg/lit, indicating that the water bodies are substantially contaminated as a result of household effluent as well as fertilizer waste. The concentration of nutrients in water and the drop in water level caused by evaporation keep total alkalinity higher in the summer. During the monsoon, overall alkalinity decreased, which might be attributed to the diluting effect. There was no evidence of hydroxide alkalinity. Large amounts of bicarbonates were found during the summer months, which might be attributed to the release of CO_2 during the breakdown of bottom sediments, resulting in the conversion of impermeable carbonic acid into carbonates. During the summer, carbonate alkalinity was measured. The total hardness ranged from 56 mg/lit to 130 mg/lit. Summer had the highest total hardness, followed by monsoon, while winter had the lowest. The presence of carbonates and bicarbonates may account for the highest hardness levels in the summer. Across the research process, calcium hardness varied from 16.83 mg/lit to 39.27 mg/lit. Its values were found to be highest in the summer and lowest in the winter. Total hardness and calcium revealed a very positive association ship, indicating that total hardness is mostly caused by the presence of calcium salts. Magnesium concentrations were found to be lower than calcium concentrations in all water bodies studied. It also contributes significantly to overall hardness. In the current study, magnesium hardness ranged from 2.92 mg/lit to 10.72 mg/lit. Chloride levels are increased throughout the summer and monsoon seasons. High chloride levels measured in the summer may be responsible to increase organic degradation of animal source or even to water evaporation due to evaporating. Excessive chlorine levels are found in the monsoon as a result of highly polluted household drainage with influx of wastewater from neighboring town. Phosphates and nitrates are measured at trace levels in the present research. Their concentration in drinking water increased as just a consequence both unprocessed household effluent and fertilizer waste interacting. Phosphate levels were somewhat higher during the monsoon.

Phytoplantkton has been the base of an ecosystem's nutrient cycle. Algae perform an essential role in determining the efficiency among biological organisms and abiotic elements because they are main sources. The highest phytoplankton density was reported during the summer, when the water level dropped and the plankton became more concentrated, and the lowest during the post-monsoon, when the water level rebounded and the plankton have become more dispersed. Because of the river's significant rainfall during the monsoon, the water table and consequent water coverage have been at their peak during the post-monsoon. That resulted in a decrease in plankton abundance. During the post-monsoon, the Reservoir was overflowing, as well as the plankton is mostly likely transported along with water. Seasonal fluctuations in overall phytoplankton density and biodiversity are found to be highly significant. The dam is situated in the subtropics, which receive the most photosynthesis during the summer, stimulating the growth of aquatic organisms. 8 of the 49 phytoplankton species observed belonged to the Chlorophyceae, 10 to the Cyanophyceae, 24 to the Bacillariophyceae, and 4 to the Dinophyceae. The Bacillariophyceae were abundant in both qualitative and quantitative terms in Makroda Reservoir. Summer had the highest species richness, while winter had the lowest. Physicochemical conditions have an impact on the phytoplankton population. Temperature, pH, and nutrients are revealed being more influential on phytoplankton. Pollution indicator species have also been identified, but overall numbers remained insignificant. Bacillariophyceae, Cyanophyceae, Chlorophyceae, and Dinophyceae are identified numerically and qualitatively among phytoplankton.

The diversity analysis found 17 genera belonging to zooplankton categories such as Rotifera, Cladocera, Copepoda, and Ostracoda. Cladocera, the most diverse group of zooplanktonic creatures, including nine genera: Alonella, Bosmina, Cerodaphnia, Chydorus, Daphnia, Moina, Sida, Simocephalus, and Diphinosoma. The Rotifera group was represented by three genera: Brachionus, Filinia, and Lecane. Microcyclops, Mesocyclops, Neodiaptomus, and these four genera belonged to Copepoda, although only one genus Cypris belonged to group Ostracoda. The greatest diversity of zooplankton was seen during the winter months. Among Rotifers, Brachionus and Lecane prevailed in all water bodies studied during the research. Copepods Mesocyclops and Microcyclops dominated. Cladocera Chydorus and Ceriodaphnia were found in abundance. Seasonal fluctuation in zooplanktonic organisms observed as a function of physicochemical and biological characteristics. Summer seemed to have the highest component-wise population density of Rotifers. Zooplankton has been most visible in the winter, while Copepods are really visible during the monsoon season. Ostracods were most commonly seen during the winter season. Rotifers have a varied ability to survive in contaminated water, particularly in the summer. Rotifer development would have been aided by higher temperatures, less nutrients, and lower oxygen levels. Rotifer population density grew in the summer but declined drastically during the monsoon season as a result of environmental stress. The high population of Rotifers over the summer may have suggested contamination caused by organic materials from untreated home waste. Pollution is indicated by the presence of Brachionus and Lecane. The highest density of Cladocera was seen during the winter, which might be attributed to ideal temperature conditions and the abundance of food in the form of bacteria. The population of Cladocerans is also influenced by a pH range that is favourable (8 to 8.7). Mesocyclops and Microcyclops in the summer suggest a contaminated water body. A decrease in Copepod count in winter suggests that the water body is unpolluted during this season. The population of Ostracoda is influenced by water temperature and food availability. The fact that the highest number of Cypris was recorded in the winter shows that the water body is not contaminated. In the summer, their lowest count implies bad water quality. Rotifera (41.43 percent) > Cladocera (28.69 percent) Copepoda (18.28 percent) Ostracoda (18.28 percent) was the annual population density of Zooplankton components detected in decreasing order of abundance during 2012-13. (11.6 percent). Rotifers were seen to predominate throughout the summer, accounting for around 57.58 percent and 57.29 percent in 2012-13 and 2013-14, respectively. In the monsoon, the rotifer population was noted to be the lowest (29.38 percent and 18.01 percent, respectively). Cladocera accounts for around 25.38 percent and 28.79 percent of the total Zooplankton population in 2012-13 and 2013-14, respectively. During the winter, the Cladocera population was at its peak. During the monsoon season, the number of Copepods is now at the maximum. During the research period, ostracods accounted for approximately 11.62 percent and 11.34 percent of the total population of zooplankton. Only Cypris, a member of the Ostracoda group, was sighted during the research period. The richness of fish fauna seen during this study is attributable to 13 species from five orders and seven families. The Order Cypriniformes was found to be the most diverse, with seven fish species: L. Rohita, L. calbasu, C. catla, C. mrigala, C. carpio, P. sarana, and P. ticto. W.attu, M. seenghala, and C. batrachus are members of the Order Siluriformes. C. marulius is represented by the order Channiformes, whereas N. notopterus is represented by the order Osteoglossiformes. R. corsula is represented by the order Mugiliformes. The current examination revealed that after certain treatments, the water from all of the bodies of water under investigation was safe to drink. The majority of metrics were found to be within the acceptable range. The pH was within the allowable range, ranging from 8 to 8.7, but it was somewhat higher (8.6 to 8.7). TDS levels were from 110 to 210, which were within the allowable range. In the summer months, DO was found to be somewhat lower than the ISI and WHO allowed level. Total hardness and alkalinity were found to be much lower than the WHO acceptable level. Calcium levels that are considered average. Magnesium and chlorides were likewise within the allowable range. Phosphates and nitrates, both vital nutrients, were found in trace amounts. With a few exceptions, all of the metrics were within the WHO and ISI acceptable limits. In terms of quality requirements, the parameters measured in the summer, such as DO and pH, are unsatisfactory.

Recommendations & Future Scope

According to the current findings, there is a need to investigate the physicochemical state of water in order to determine its quality in the future. Though the water bodies under consideration are not badly contaminated, continuous monitoring in the future is required to protect water quality through correct ways. Expert supervision and corrective procedures are required for long-term repair and conservation of water bodies of Makroda Reservoir in Umri taluka, Guna (M.P). The following recommendations have been made in order to limit the occurrence of heavy pollution.

1. Bathing, cleaning clothing, automobiles, and household animals, among other things, should be avoided.

2. Continued agricultural and home wastewater disposal activities should be rigorously avoided.

3. Adequate water supply schemes must be created for people to avoid unrestricted water consumption.

4 Before consuming the water, preliminary treatments should be undertaken.

5. For water conservation, waste water should be recycled using adequate purification processes.

6. Regular activities of arranging and cleaning dangerous aquatic plants and fauna should be promoted.

7. Communities must be informed about the benefits of conservation as well as its scarcity.

8. Legislative actions should be implemented to limit misuses in order to protect the lake's natural eco-balance.

Photgraphs During Investigation


64MP AI QUAD CAMERA
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2021/02/21 12:24


M.P. GOVT. W.R.D. GUNA
CONTROL ROOM
MAKRODA DAM SITE
INSPECTION BANGLA
64MP AI QUAD CAMERA
2021/02/21 12:24


ग्राम पंचायत मकरावदा
आपका हार्दिक स्वागत करती है
सबका विश्वास
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म.प्र.शासन
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