CHAPTER-1
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Life began in water and is sustained by water. No wonder life revolves round water. Water covers about three quarters of the earth surface either as oceans or fresh water and forms the hydrosphere. Water is essential to all life. First life was originated in water. Water is nature’s free gift to all the leaving organisms. Most of the biochemical reactions which occur during metabolism and growth of living cells, involve the medium of water. It is estimated that more than two third of human body is constituted of water and so also the area of globe. Water is required for the satisfactory physiological performance of physiological reactions as a circulatory fluid, as a carrier of assimilated food and the removal of waste products.

Fresh water represents a very small part of the total water on the earth. fresh water has become a critical natural resource due to number of reasons. The increasing demand of fresh water in all the sectors like drinking, agriculture, aquaculture and industrial. India receives about 1400-1800 mm of rainfall annually. It is estimated that 85% of water is used for agriculture, 10% for industry and 5% for domestic use and analysis conducted in 1982 revealed that about 70% of all the available water in our country is polluted (Chandrasekhar, 1997; Andhale, 2008).

After the time of industrial and green revolution, the discharge of untreated effluents from industries and agricultural wastes which enters in environment, disturbs biological balance with the growth of technology, two groups of substances in particular have lasting effect on the natural balance in aquatic systems; “Nutrient” which promote unrestricted biological growth and in turn oxygen depletion and sparingly degradable synthetic chemicals and other
waste substances which often constitute adverse effect on aquatic ecosystem. It was estimated that industrial and domestic wastewater adds up to a million different pollutants into natural water. Substances such as polycyclic aromatics, pesticides, radioactive substances and trace metals directly endanger to human life (Kodarkar, 1995).

Water the unique component of nature has played an important role in the evolution of life from molecules to man. Since time immemorable the great human civilizations have developed, evolved and flourished around water resources. For any nation its aquatic ecosystems; lakes, rivers and coastline are national wealth and constant efforts are made to exploit them for the benefit of its population. In the last part of 19th century freshwater has become a critical natural resource due to a number of reasons, important being and consequent increasing demand of fresh water in all the sectors of human activity like drinking, agriculture, aquaculture and industrial. Judicious exploitation and sustainable use will determine standards of life and livelihood of population in developed, developing and underdeveloped countries. In this context in 2010 billion people lack access to adequate sanitary facilities and billion don’t get clean drinking water. Further, water borne, carried and transmitted disease account for 80% morbidity in the developing world and kill 10 million annually of the available freshwater, 85% is used by agriculture, 10% by industry and 5% for drinking purpose (Chandrasekhar, 1997).

By definition a dam is created due to depression on land in which water from all around accumulates. Reservoirs on the otherhand, are man- made impoundments created by damming a lotic system, a stream, or river. All over the water, huge reservoirs are constructed mainly to meet irrigational needs. In India after independence impounding major rivers created massive reservoirs. Historically, the importance of water management was well understood by rulers in South India and the result is innumerable impoundments dot the landscape.

Limnologically speaking a water body is highly influenced by its catchments geology, magnitude of precipitation and anthropogenic influence. No doubt, the system has capacity to off set alteration in limited range and maintains the ecological balance. Nevertheless, in the case of impoundment self-regulatory capacity is low. Particularly when a system is enriched due to domestic and industrial waste the damage is irreversible (Malathi, 1999).
The problem of aquatic pollution is aggravated by direct discharge of domestic sewage into the water bodies. Indian cities have been growing at a faster rate over the past few decades. This trend of urbanizations is a direct result of the progressing economic growth through industrialization. All the urban centers are facing typical environmental problems like lack of sanitation, treatment and safe disposal of waters. 57% population in class I and 88% in class II cities are unsewaged and sewage linked eutrophication of water resources is the major environmental issue today. Eutrophication a consequence of nutrient enrichment mainly from sewage exhibits characteristic manifestations like deterioration in water quality, reduction in biodiversity, breeding of vectors, foul smells and fish kills. (Kodarkar, 1995).

Dams are the major part of freshwater resources. Globally more than 3 times the freshwater in rivers is available in the dams, which have multiple uses, such source of water for drinking, fishing, agriculture and aquaculture, conservation areas of biodiversity, recreation and tourism. When compared to rivers, the situation with respect to dams is not very different, particularly water bodies in the urban environment are subjected to all types of degradative process like heavy siltation, pollution from untreated sewage and industrial effluents and surface run off from areas on which urban solid and industrial waste is dumped. While siltation and encroachment effectively reduced morphometry, nutrient enrichment which leads to eutrophication with its characteristics manifestations like algal blooms and wild growth of aquatic weeds, foul smells, vector breeding, loss of diversity, groundwater pollution and fish kills (Chandrasekhar and Kodarkar, 1994).

Recently conservation science has focused all on the preservation of hotspots in the biorich tropical evergreen forest. However, during the recent past it has become increasingly overt that species loss is occurring at a more rapid rate in several other specialized ecosystems whose coverage is a smaller. One of the most important such vital ecosystems which are rapidly declining are wetlands. They have been drained and converted into other forms of land use for the last several centuries. These relict patches of wetlands with their specialized micro and macro flora and fauna are of great long term significance for human development. In most cases residual wetland habitats in Maharashtra are not natural wetlands but are formed in man made, aquatic holdings. These vary from
small Pazar tanks to large irrigation and hide power dam. Some of the larger in size but several are small and scattered through agricultural landscapes. All these are now increasingly important due to changes in surrounding land use. These changes have gone through several phases. In the initial period these impoundments built from the pesewa period onwards were used by small village settlements and was surrounded by agricultural lands. (Inland Wetlands of India, 2006).

Due to high land values and population pressure whenever the water level recedes either in summer due to inadequate rains in monsoon, peripheral zones of a lake are prone to unauthorized encroachment in the prevailing socio-political climate. Construction of housing colonies, surroundings and construction on bed are some of the example of the destructive process. In the name of beautification large zones of dams are redamed for laying parks, flyovers, recreational areas (Malathi, 1999).

Construction activities in the catchment area are the major cause of siltation. Similarly immersion of idols made up of clay, and plaster of paris add tones of silt into the dam.

Man is responsible for accelerating the phenomenon of eutrophication, which is associated with nutrient enrichment, threatens the survival of an aquatic ecosystem. The chief sources of nutrients (nitrates, phosphates) are untreated domestic sewage and detergents. Effluents from fertilizers and chemical industries also add phosphate to the water body. Nutrient enrichment directly affects the water quality and leads to a number of consequences indicative of imbalance in an ecosystem. The main symptom of nutrient enrichment is the growth of algal blooms (Chandrasakher and Kodarkar, 1994).

Aquatic weed also referred to as macrophytes constitute an important component of aquatic food chain/web and it’s diversity reflects the limnological status of an ecosystem. Some seed species are bio-indicators of aquatic pollution. Macrophytic growths in a eutrophic water body provide ideal sites for breeding of vectors like mosquites, snails, files and cyclopoids. Excessive nutrient enrichment leads to anaerobic conditions indicated by low DO and high BOD. These condition set in microbial process producing foul smelling gases like hydrogen sulphide, methane and ammonia. Mass mortality of fishes is one of the dramatic manifestations of high degree of pollution. Balanced ecosystem
maintains fairly constant trophic status and biodiversity. The imbalance as a result of pollution once sets in; tolerant and fast breeding and hardy ones replace sensitive species. Mass mortality of sensitive species is an indicator of ecological imbalance and environment degradation.

In an aquatic ecosystem, physico-chemical environment has profound influence on its biotic components. It controls diversity, biomass and spatial distribution of biotic communities in time and space. The physical and chemical parameters exert their influence both individually and collectively and their interaction produces abiotic environment which ultimately conditions the origin, development and finally succession of communities. Hydrogen, oxygen, carbon, nitrogen, calcium and phosphorus are the elements present in greatest quantity in both soil and water as they required in larger concentrations than the other elements and most of the studies have been focused on carbon, nitrogen and phosphorus (Kodarkar, 1995). Phosphates and sulphate occur on the bottom sediments and in biological sludges, which are precipitated in organic forms and incorporated into organic components where as chlorides are dissolved in water. Each ecosystem has its characteristics, abiotic features and their thorough understanding is essential for its effective management.

Among the environmental parameters, water temperature is one of the most important factors having profound influence on biotic communities; particularly planktonic communities, which are the base of the energy cycles, are prone to temperature influence (Atiya Khanum and Zafar, 1983).

In India, the conditions are hot from March- May, hot-wet from June-September and cool-wet in October- January. In tropical countries, there may be direct relationship between the duration of sunshine and temperature. Many studies showed that sunshine hours and temperature influences the solubility of gases in water, particularly that of carbon dioxide and oxygen. Long hours of sunshine enable the phytoplankton and other population of the dam to carry on photosynthesis for a longer duration. This helps in the utilization of CO$_2$ of water. This CO$_2$ is utilized during photosynthesis by blue green algae, which are abundant in the water boy during summer season (Verma et. al., 1987).

The dam sustains algal blooms throughout the year (Atiya Khanum and Zafar, 1983). Among toxic blue green blooming species, *microcystis aeruginosa* and *Melosira granulata* are the most dominant. Particularly in summer thick
scums of algae are found drifting towards shore by wind action. Nutrient enrichment and favorable environmental conditions are sighted as main reason for the algal bloom phenomenon (Kodarkar et. al., 1991). Progressive eutrophication led to extensive proliferation of the water hyacinth. Now the dam surface is covered by the hyacinth and algal blooms.

Extensive work on different aspects of limnology has been carried out in different regions of India by a number of workers (Saha et. al., 1985, Patil, 1973). Pantha et. al.,(1979) have studied trophic status of two Kumaun lakes in Assam, Chourasia. Adoni (1985) have worked on zooplankton dynamics in a shallow eutrophic lake. On the basis of their studies on three fresh water ponds at three levels of trophication, Sennayya and Zafar (1981) have proposed that waters with low DO, nitrogen and phosphorus support intermittent blooms of Euglena and Nitzschia. A study of the hydrobiology and fisheries of the Saroornagar Lake was made by Kodarkar et. al., (1994) with special reference to conservation. Various physico-chemical factors in relation with plankton were discussed.

Kulkarni et. al., (1995) have shown that high concentration of nitrate in winter, which is an essential governing factor for the growth of phytoplankton. Siddiqui and Rama Rao (1991) have stated that changes in the ambient and surface water temperature, PH, ammonia and nitrogen during summer increase the chances of fish mortality in Lake Hussainsagar, Hyderabad. Kodarkar, (1995) has summarized the reasons for fish kills in Hussainsagar as high temperature and resultant thermal shock, anaerobia due to low dissolved oxygen and level of toxic ammonia and algal blooms and clogging of gills.

Phytoplanktons are tiny single-celled plants. Like higher plants, phytoplankton requires light to live and reproduce. (Campbell and Reece, 2005). Therefore, the largest concentrations occur near the surface. The amount of nutrients in the water is a major determinant to the abundance of these plants. According to Welch, (1952) no single abiotic or biotic factor has so many profound direct and indirect influences which can be fixed nature, but there is inherent variation at different times of the day and during different seasons of a year and even latitude to latitude.

Plankton and water chemistry of Montreal river lake stream system was studied by Cushing, (1964) at Saskatchewan. The relationship between dissolved ions and related aquatic environmental parameters are important to nutrients and
has long recognized their action on the biological activities of the ponds has been discussed by Hutchinson, (1967). According to Reynold et. al., (1991) pH considered to be the most important factor particularly in the case of green algae.

Buergi et. al., (1986) have observed that an increase in nutrients in explosive development of small algae and herbivores zooplankton. Further there was collapse of several algal communities as consequences of the grazing habit of the zooplankton resulting in a clean water period. Anderson, (1981) in his study on oxygen and nitrate in reed swamp sediment found that oxygen uptake inversely proportional to the nitrogen content of the sediment. Gokovskaja, (1987) suggested that temperature and food are the important factors influencing the development rate of plankton. In recent years number of studies on macro invertebrate dynamics which includes diversity, density and seasonal variations in three main groups of invertebrates undertaken by number of workers in North and South America and in Europe.

Water depth, shoreline slope, and exposure to winds are important measures for shoreline-dwelling lake fauna. Discharge and its associated variables are important measurements for stream fauna (Newbury and Gaboury, 1993). Primary productivity measurements (usually the concentration of chlorophyll-a) are generally useful in both lentic and lotic habitats (Turner et. al., 1991). However, the collection, processing, and determination of chlorophyll-a concentrations is labour-intensive, time-consuming, and requires specialized equipment.

In addition to pH, dissolved oxygen, and total suspended solids, measurements of temperature, conductivity, alkalinity, total phosphorus, nitrate, and major ions should be considered. Some of these variables can be measured by portable field instruments (e.g. pH, dissolved oxygen, conductivity), whereas others may require laboratory analysis (e.g. total phosphorus, nitrate, major ions). Details of the chemical analysis of fresh water are discussed by Stainton et. al., (1977).

Seasonal variability of community structure and productivity is high because many species of benthic macroinvertebrates have annual (or shorter) life cycles, which culminate in an adult phase during the open-water period. Thus, the presence of mature larvae, pupae, or adults may be short-lived and easily missed if seasonal development rates differ from year to year. It is best to sample either
just after ice-out in the spring when late-stage larval forms are present but have not yet begun their final maturation, or in late fall after most species have mated and the immatures have had a chance to develop throughout the summer in preparation for over-wintering.

Phytoplanktons are typically microscopic single-celled organisms called algae. Zooplanktons are small organisms that eat the phytoplankton and which in turn do other animals eat; thus Phytoplankton and Zooplankton are a basic foundation of life.

There does not seem to be any correlation between zooplankton occurrence and salinity or temperature when comparing numbers of zooplankton, mainly rotifers. However, rotifer abundance increases with decreasing seasonal salinity. Johnson and Allen (2005) have shown that huge concentrations of rotifers can appear and disappear within a few days.

A food web is a complex and diverse series of food chains where many different species of plants and animals interact by producing food, consuming organic materials, and recycling wastes (Jacobson, 2005). Primary producers like phytoplankton, algae, and sea grasses are eaten by small animals and fish, which in turn become meals for larger fish and animals (Jacobson, 2005). The cycle then continues with larger and bigger creatures.

Primary production in aquatic systems is almost entirely the province of microscopic algae that are collectively called phytoplankton (Harding, et. al., 1987). Phytoplanktons are tiny single-celled plant organisms that form the root of the aquatic food web (Casey, 2005). These single cells or small chains of cells form a variety of taxonomic groups occupy the lighted upper areas of oceans, seas, and estuaries and use light energy to assimilate inorganic carbon by photosynthesis (Harding, et. al., 1987). Species composition of phytoplankton communities are regulated by environmental variables, including light, temperature, and nutrients (Boynton et. al., 1982). Pigments, such as Chlorophyll $a$, use sunlight to produce carbohydrates, a prime part of a phytoplankton’s diet, during the process of photosynthesis. As a result, chlorophyll $a$ is a necessary element for the plankton’s survival. Without it the tiny plants would not be able to generate their own food, resulting in death. This could have devastating results since it would throw the entire food chain out of order. Phytoplanktons are consumed by small animals, the zooplankton, that are themselves consumed by
other animals; thus they are a basic foundation of life in the estuary (Lippson and Lippson, 1997). This means that if there were no phytoplankton, there would be a major decline in other numerous species as well.

Benthic macro invertebrate species are differentially sensitive to many biotic and abiotic factors in their environment. Consequently, macroinvertebrates community structure has commonly been used as an indicator of the condition of an aquatic system (Rosenberg and Resh, 1993). Biotic index systems have been developed which give numerical scores to specific indicator organisms at a particular taxonomic level (Armitage et al., 1983). Such organisms have specific requirements in terms of physical and chemical conditions. Changes in presence/absence, numbers, morphology, physiology or behavior of these organisms can indicate that the physical and chemical conditions are outside preferred limits, presence of numerous families of highly tolerant organisms usually indicate poor water quality.

Soil is one of the most significant ecological factors, which is developed by weathering of the rocks present in the nature and differentiated into different horizons having various heights and different characters. The soil is defined as the complete physiological system providing water, mineral salts, and nutrients dissolved oxygen to the plants. The soil is a natural medium for the plant growth and supplies the required nutrient material for their growth. The soil may remain fertile when it contains adequate amounts of all essential elements in the form of which is readily available to plants. The soil consists of the five major components viz-mineral matter, organic matter, humus, water and microorganisms.

An accumulation of metal occurs at all levels in the food chain, including the phytoplankton (Bently et al., 1977; Button and Hostler, 1977). Heavy metal pollution causes disorder in the aquatic ecosystem with deleterious effect on associated organisms. Amongst the heavy metals, mercury and cadmium uptake via food chain is more significant than direct uptake from water and sediments (Markich, 2002).

There has been little effort to appreciate the biodiversity value of this aquatic ecosystem through a large scale study that explores the nature of this ecosystem. The existing biodiversity value through a common protocol is a comparative assessment of these areas in terms of their biodiversity value which
can be used for better management of such wetland areas. Documentation of biodiversity can be done through various organizations, the most efficient managers who are now sensitive to the needs of biodiversity conservation. (Inland Wetlands of India 2006).

Indian wetlands have not been comprehensively surveyed. There are, varying estimates of the total extent of wetland resources in the country. Recent estimates of the total area of wetlands in India are presented as:

<table>
<thead>
<tr>
<th>Area of wetlands in India</th>
<th>Figures in million ha.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area under paddy cultivation</td>
<td>40.9</td>
</tr>
<tr>
<td>Area suitable for fish culture</td>
<td>3.6</td>
</tr>
<tr>
<td>a. freshwater</td>
<td>1.6</td>
</tr>
<tr>
<td>b. brackish water</td>
<td>2.0</td>
</tr>
<tr>
<td>area under capture fisheries</td>
<td>2.9</td>
</tr>
<tr>
<td>mangroves government of India 1991</td>
<td>0.4</td>
</tr>
<tr>
<td>estuaries</td>
<td>3.9</td>
</tr>
<tr>
<td>Backwaters</td>
<td>3.5</td>
</tr>
<tr>
<td>Man mad impoundments</td>
<td>3.0</td>
</tr>
<tr>
<td>Rivers, including main tributaries</td>
<td>28,000 km</td>
</tr>
<tr>
<td>Canals and irrigation channels</td>
<td>1,13,000 km</td>
</tr>
<tr>
<td><strong>Total area of wetlands excluding rivers</strong></td>
<td><strong>58.20</strong></td>
</tr>
</tbody>
</table>

Wetland destruction and degradation have been major causes for the progressive loss of the rich biological diversity associated with these habitats. Over exploitation of wetland resources, hunting, and poaching are more direct threats. A number of animal and plant species dependent on the Indian wetlands are currently threatened.

Although a considerable amount of wetland research has been undertaken in India, the great majority of the information has come from a small number of well known sites, such as keoladeo, Ghana, Point calimere, Chilika lake, and the Sunderaban or from specific regions, such as Gujarat and Ladakh. (Hussain and Varshney, 2006)

Several wetland ecosystems, viz. Dal, Wular, Renuka Rewalbai, Pichola Fatechsagar, sukhna, Bhoj Sagar, Chilika, Kolleru, Lokta, Sasthamkotta, and Kodaikanal, have been investigated in detail especially the physico chemical characteristics of water, sediment composition, flora, fauna, weed infestation, pollution, hydrology and other limnological parameters. For providing scientific and technological inputs, which could be utilized directly for conservation and
management of the 16 identified wetlands in the country, the ministry of environment and forests has identified node research institution such as Manipur university for Loktak lake, and Utkal university for Chilika lake in the concerned states. These research institution works in collaboration with the concerned state Government to provide solutions to the problems confronting the wetlands. The priority areas have been identified under the wetlands programme survey and mapping of wetland resources in the country, using remote sensing technology application of Geographical information system (GIS) and mathematical modeling in selected wetlands, evolving wetlands evaluation techniques to facilitate quick appraisal of the health of specific wetland ecosystems and also environmental impacts of developmental projects and other human activities on the ecosystem, control of prolific growth of some exotic species, and weed management, siltation control and fisheries development. Recently the ministry of environment and forests has helped in setting up the Salim Ali centre for ornithology at Coimbatore for conducting applied research and for creating a data bank on Indian ornithology.

The Indian wildlife (Protection) Act, 1972 was enacted to provide special legal protection to wildlife on a unified national basis. It contains provisions for the establishment of national parks and sanctuaries by state governments for the purpose of protecting, propagating, and developing wildlife therein or its environment and includes powers for stringent punishment if these provisions are infringed. Hunting of all animals and the destruction of flora is prohibited, except in special circumstances when the state government can approve the granting of a permit. The complete ban on all cattle grazing and fishing in national parks indicates a higher level of protection than in wildlife sanctuaries where grazing and fishing may be either regulated, controlled or prohibited the act has been adopted by all the states and union territories with the exception of Jammu and Kashmir, which has a separate legislation enforced since 1978.

The wildlife Protection Act was amended for the fourth time in 1991 in order to extend protection to wildlife and intensify punishment for violations. This amendment has provisions for non government organizations and individuals non official to report matters of violation of the act directly to the court after notification. Hunting of all wildlife specified in schedules II III and IV of the 1972 act is prohibited. These include all wetland dependent species of
birds and animals. Commercial fishing and exploitation of wildlife flora and fauna is banned in all wildlife sanctuaries and national parks. The amended act extends protection to plant species for the first time. A part from the amendment to the wildlife protection act, India has also amended its export policy in 1991 bringing a total ban on export of birds.

Legislative measures have been instituted to stop the hunting of waterfowl outside protected areas. Illegal trapping of waterfowl by villages in the states continues, but this may be stopped once the government has taken more adequate measures to rehabilitate the trappers.

Over 20 legislation regulate India’s environment those especially relevant to wetlands include the Water Prevention and Control of Pollution Act, 1974 and the Water Prevention and Control of Pollution cess Act, 1978. Individual states have, in some cases, developed their own conservation legislation in addition to adopting the national policies. The level of conservation interest varies greatly between the states as each state and union territory authority is responsible for conservation within its area of jurisdiction. The Indian fisheries act, enacted in 1897 delegated power to the state governments to develop rules laws for the development and conservation of fisheries in the inland and territorial water of the respective states. Several states subsequently formulated their own marine and inland fisheries regulating acts & rules. However, fishing and fisheries beyond the territorial water are in the union list.

In June 1981, India became a party to the Bonn convention on the conservation of migratory species of wild animals and in 1984, negotiated a bilateral convention on migratory birds with the erstwhile USSR. Under the world heritage convention, of which India became a signatory in 1972, Keoladeo Ghana National Park, the Sunderban, Manas National Park and Kaziranga National Park have been designated world heritage sites.

In 1982, the Ministry of Environment produced a working document entitled National wildlife action plan which envisaged the establishment of a representative network of protected areas. Seven Biosphere Reserve in the Nilgris, Nanda Devi, Great Nicobar, Gulf of Mannar, Manas, Sunderban, and Nokerk (Meghalaya) have so far been established by the Ministry of Environment and Forests, Government of India. (Inland Wetlands of India, 2006).

A bird has been described as feathered bipeds a bird have feathers, and they are the only animals which have them. Nevertheless, when people think of birds, they usually think first of their flying ability as all birds have wings. Birds are vertebrate warm blooded animals i.e. whose temperature remains more or less constant and independent of the surrounding temperature. To assist in maintaining a constant temperature, the body of a bird is covered with non-conducting feathers, its chief characteristic which in details of structure and arrangement reflect the mode of life of the group to which a bird belongs. The body temperature of birds is higher than most of the mammals. Assisted by their non conducting covering of feathers birds are able to withstand great extremes of climate. As long as they can procure a sufficiency of food supply, or fuel for the system, it makes little material difference to them whether the surrounding temperature is over on the burning desert sands or below zero in the icy frozen north. Their rate of metabolism is higher than that of mammals. They lack sweat glands. The extra heat generated by their extreme activity which would under torrid climatic conditions result in overheating and death, is eliminated through the lungs and air sacs as fast as it is produced.

Birds live in all parts of the world, from the Polar regions to the tropics. They are found in forests, deserts, and cities, grasslands, farmlands, on mountaintops, and islands and even in caves. Distinct adaptive features of the birds enable them to survive in a particular kind of habitat. Ducks, gulls, and certain other birds always live near water. Most such birds can swim. Some birds especially those in the tropics, stay in the same general area throughout their life. Even in the Arctic and the Antarctic regions, some hardy birds like penguins stay there throughout the year. However, many birds of cold regions migrate each year to warm areas, to avoid the winter, when food is hard to find. In spring, they fly home again to nest.
There are about 9932 species of birds all over the world, containing about 13% of world's birds, India ranks among diversity rich nations of the world, as a Mega diversity country along with 11 other countries.

All birds hatch from eggs. In most species of birds, the female lays eggs in a nest built by her or her mate, or by both of them. Majority of birds have one mate at a time, with which they raise one or two sets of young each year. Some birds keep the same mate for life; others choose a new mate every year. Most young birds remain in the nest for several weeks or months after hatching. Their parents feed and protect them until they can care for themselves. Most birds leave their parents when they are a few months old.

Birds have always fascinated people. Their marvelous flying ability makes them appear to be the animals with ultimate freedom. Many birds have gorgeous colors or sing sweet songs. The charms of birds have inspired poets, painters and composers. Certain birds also serve as symbols. People have long regarded the owl as a symbol of wisdom and the dove as a symbol of peace. The eagle has long represented political and military might. Birds have also played a role in the development of the airplanes. Inventors have built successful planes only after they patterned wings based on the shape of a bird's wings. (Parvish Panday and Daniel, 2005).

Two hundred million years ago, at a time when insects were the only flying animals, a small lizard-like creature gave up scuttling between the trees in which it lived, and instead took to gliding. It did this on small flaps of skin that acted like parachutes, and from this humble beginning, giant winged reptiles called pterosaurs gradually evolved. But membranous wings had their disadvantages. They were difficult to fold up when on the ground, and if they became torn, the chances of the creature being able to fly again were very small. Evolutions answer to these problems was the feather. In 1861 one of the world's most famous fossil animals archaeopteryx, was discovered. Although this creature lived over 150 million years ago, when the pterosaurs were still in their heyday, the fossil show that this crow-sized animal was thickly feathered. Unfortunately, nothing is known about the immediate descendants of archaeopteryx. What is certain is that when the pterosaurs were mysteriously swept away with the dinosaurs there followed a huge increase in bird species. In short, birds may reasonably be considered to be extremely modified reptiles, and
according to the widely accepted classification of the great scientist, T. H. Huxley, the two classes together form the division of vertebrates termed Sauropsida. (Parvish Pandya and J.C. Daniel, 2005)

The five archaeopteryx fossils found in Germany in 1861 all came from an area which was once flooded by a sea. When the animals died, their bodies were rapidly covered by silt which was so fine that if preserved not only the outlines of bones, but also those of feathers. In this fossil, the bird-like wings and legs are clearly visible, as are the reptilian teeth and tail. It is thought likely that archaeopteryx evolved from small dinosaurs that ran upright instead of walking on all fours. (Parvish Pandya and Daniel, 2005).

Birds have figured prominently in works of art and literature from prehistoric times. They are among the most colorful forms of life, have a wide and usually pleasing assortment of vocal performances, and their fascinating habits have intrigued and challenged man for centuries. Birds have played an important role in education in the preschool instruction of children and in adult education as well. In ancient civilization, birds were symbols often raised to the rank of deities. The bird god, Garuda was the reincarnation of lord Vishnu and is worshiped by the Hindus.

The role of birds, or of other animal forms, in the complex web of life is impossible to evaluate accurately. The great economic value of birds in the suppressing of destructive insects and other pests has long been realized. A few decades ago, it was popular to attempt to place a monetary value on the services of birds or to predict how long mankind could survive without them; one naturalist even calculated that a single summer without birds would be sufficient to eliminate all life before Christmas. As flower pollinators and seed dispersers a large number of birds of diverse families and species are responsible for cross fertilization of flowers, many of them possessing special adaptation in the structure and mechanism of their tongue and bill for the purpose of extracting honey from the base of the flower tube. (Reena and Abhijit, 2005). In the dissemination of seed and the distribution of plant life, birds play a predominant part. Thrushes, bulbuls, crows, ducks and pigeons appear to play a major role in seed dispersal. A black headed oriole has been observed swallowing 77 berries in the course of 3 minutes. The seeds pass through the bird’s intestines unaffected by the digestive juices, and out with the waste matter in due course they
germinate rapidly under favorable conditions and establish them. Many wild plants, trees, shrubs, and vines, mostly highly desirable from the wildlife standpoint, are planted by birds, but of course, some undesirable species are also distributed. The spread of lantana weed over the Indian subcontinent in the last hundred and fifty years or so is chiefly due to frugivorous birds, particularly bulbuls. Loranthus, a tree parasite is entirely bird propagated plat, chiefly by flowerpeckers. The growth of pupil on buildings and as strangler of palm and other trees is the result of birds feeding on its fruits and broadcasting the seeds. One unusual means of commercializing in the planting activities of birds is to collect the seedlings for nurseries.

As destroyer of insect pest and weeds the insect eating propensity of birds is one of their best known traits. Most passerine species, which comprise more than half of the birds of the world are predominantly insectivorous, other passerines, even the seed eaters, feed in part on insects, especially during the nesting season. Many non passerines woodpecker, swifts, cuckoos, and most shorebirds are also insectivorous, and others even ducks, herons, hawks and owls, take in some insects. Woodpeckers are highly beneficial to forests in controlling timer pests. Perhaps strongly, though insect species run to a million or more different kinds, most damage is inflicted by a relatively small number less than 10 percent that infest mans crops or other economic products. It is perhaps strange too and singularly fortunate that birds prey primarily on the more harmful, rapidly reproducing, herbivorous kinds. Though few birds feed exclusively on seeds or grains, most items taken are weed seeds or waste grains, and seed eating birds have thus often been cited as farmer’s friend. Of course the actual economic gain to farmers by the reduction of weed seeds is impossible to measure. Many seed eaters included grains in their diet, often only waste grains left in the fields after harvest, but in other cases, extensive damage may be done to growing crops. Instances of strictly seed eating species doing damage are rather unusual. Much of the fruit eaten is from the ground, which may reduce insect infestation. (Reena and Abhijit; 2005).

As destroyers of other vermin the principal function of predatory birds is the suppression of rapidly reproducing herbivores, which theoretically at least would otherwise become so abundant that they would soon de vegetate their range. A birds of prey or raptor is the one which hunts and kills other birds or
animals. True raptors include hawks, kites, kestrels and owls, besides others like shrikes, crow pheasants and crows. From ages, raptors have been looked down as vermin have been stigmatized as destructive to poultry and game and have been relentlessly slaughtered almost everywhere. On the contrary, they are highly beneficial since they destroy an enormous number of rodents like rats, mice and squirrels, thus acting as nature's check on these highly fecund vermin. These predators in fact generally predate upon the sick and weak birds and mammals and thus make the population of their prey a strong and healthy one. It has been demonstrated that predators can in certain instances actually increase the numbers of a particular species on which they prey. Hence, all these birds deserve to be encouraged and conserved and not destroyed at sight, as is often the case. Some raptors were used in sport and falconry, a once flourishing sport. Falcons and paellas fishing eagles need conservation by building artificial nests and placing them near suitable lakes. Planting of big Rees, which are becoming scarce, is also needed for these birds. (Reena and Abhijit, 2005).

Aquatic birds like grebes, cormorants, herons, gulls, and kingfishers have often been accused of causing serious reduction in edible fishes. However, studies have revealed that only a small proportion of their diet consists of commercially important fishes, whereas the rest consist of crayfish, crustaceans and insects and some catfishes, which cause a great damage to the spawn of the economically important fishes. Thus, overall these birds compensate for whatever losses they cause. The fish intake by pelicans white or rosy pelican, spot billed or grey pelican and dalmatian pelican is enormous, but only occasionally is some damage done to commercial fisheries. Cormorants are notorious for their fish intake but mostly the fishes are of low economic value. In fact, they devour the less valuable fishes, which are great menace to the spawn and fry of valuable food fishes. The darter is considered harmful, as 75% of the total bulk of its food, consists of fish and crustaceans. Pond heron or paddy bird also takes a good quantity of fish and crustaceans Egrets are also recorded eating economically important fishes. Large egret feeds a great extent on fish, fish fry and crustacean of commercial value, and is hence regarded as injurious to fishery. Painted stork is also a voracious fish eater. Ospreys are known to take fish and the Indian river tern is an exclusive fish eater. The white breasted kingfisher is known to feed on small fry of commercial fishes and crustaceans from about 74% of the diet of the
pied kingfisher and most of it is of commercial value. West Himalayan pied kingfisher grey heron, Himalayan grey headed fishing eagle and Hodgsons fishing eagle are alleged to cause considerable damage to trout fisheries in Kashmir and Himalayan streams although thorough scientific investigation is needed to substantiate this fact. (Reena and Abhijit, 2005).

As scavengers vultures, crows, kites and other birds are efficient scavengers they speedily and efficiently dispose of animal carcasses, decaying matter, refuse and other offending material that would otherwise putrefy and befoul the environment and provide a breeding palace for disease pathogens and transmitting vectors. These birds thus indirectly prevent epidemics. But larger scavenger birds like vultures and black kites congregate on garbage dumps, where they soar and pose serious threats to aviation safety. In India, the black kite is one of our most useful and efficient scavengers, hovering around slaughterhouses, fish makes and refuse dumps and taking in large amounts of kitchen refuse and garbage. House crows are confirmed commensally of and very useful municipal scavengers taking kitchen scraps, garbage, offal and carrion. The jungle crows also take carrion, garbage and offal, but are less gregarious and sociable. The raven takes carrion, kitchen scraps and refuse. (Reena and Abhijit, 2005).

Undoubtedly mans first interest in birds during prehistoric times was as a food supply. Birds were well established long before man appeared on earth, and the number of flightless forms far more than those which exist today, permitted their easy capture without modern weapon. Today birds and their eggs are still used are indeed often virtually indispensable for food by primitive people in many lands, but most countries do not support indiscriminate hunting. Hence the harvest is now restricted to same species during special seasons, and the birds are taken primarily for sport rather than food. Hunting traditionally been popular among upper classes it has been customary, from early item, to set aside reserves and to guard the game therein for the benefit of the privileged few. Quails, partridges, and other game birds are still netted or shot for eating purposes, and innumerable other species of every description are captured and sold in the bazaars to fanciers and exported, yielding substantial returns to those engaged in the trade.
In the past, birds have served man with a variety of economic products. However plumages have been of widespread use, feathers have been used from time immemorial for arrow making, for quill pens, for headgear, and for ornamental wear. Such practices still prevail among primitive people, but the commercial use of wild bird plumages is now illegal. In South America, the skins of Rheas are still used for rug making and their feathers extensively used for dusters. In the old world, birds of paradise from new guinea were in great demand in the hat shops of Paris, Amsterdam and London. Perhaps the most valuable plume producer now is the ostrich, which fortunately, unlike egrets and many other ornamental types lend itself readily to domestication. Ostrich farms have been a flourishing industry in Africa for nearly a century, bringing in annual revenue of $13500000/ in 1913. (Pandya and Daniel, 2005).

The saliva nest of the so called edible nest swiftset, which breed invest colonies in grottoes on rocky islands off the south Myanmar coast were a source of considerable income to those engaged in the trade and of royalty to that government. These swiftset also breed in the Andaman and Nicobar islands and on certain islets off the Konkan coast but the nest here are of poor quality. The nests are exported to China as an epicurean delicacy, the better quality fetching from Rs. 15 to 30 per kg. (Pandya and Daniel, 2005).

Guano which is really the excrement of sea birds such as Gannets, Cormorants and Pelicans is another product of great commercial value. The fertilizing properties of the phosphoric acid and nitrogen contained in fish were not recognized until Guano became a stimulus to intensive agriculture. The real Guano is found in vast stratified accretions on rainless islands off the coasts of Peru. Although to deposits of like magnitude or value exist within our limits, yet the possibilities of the liquid Guano of colonial nesting water birds have not been seriously exploited in India. The fertilizing properties of the water flowing out of the Vedanthangal Bird Sanctuary was possibly the reason, the breeding bird sanctuary was locally protected. (Salim Ali, 1996).

The major zones of Nathsagar reservoir are littoral and limonitic with sunlight penetrating them and a profounder with no access to sunlight. Three categories of inhabitants are distinct plankton, nekton active swimmers and benthos. Three major trophic levels are conspicuous autotrophs, producers,
phagotrophs consumers and saprotrophs decomposers. The principal sources of energy include the sunlight, land surface runoff and detritus. Sunlight is used by the local photosynthesis in water by sessile periphyton, macrophytes and floating plankters yielding autochthonous materials and hence autochthonous primary production, though in small quantity only. Sunlight used by land plants is available by way of autumnal fallen leaves, flowers; fruits and pollen reaching river water as land wash or air dispersal. The food of terrestrial origin allochthonous material contributes substantially to support the primary productivity. Detritus feeding supports a rich benthos of invertebrates upon which thrives the large proportioned secondary production. It may be pointed out that as compared to other regions of reservoir, the shallow zones has more detritus in bed. These detritus are chiefly plant debris resulting from decomposing of dead organic material, autochthonous as well as allochthonous.

The producer organisms are autographs, mostly phytoplankters and large variety of green plants that manufacture their food through photosynthetic activity utilizing the abiotic elements from the water. Other organisms in the aquatic ecosystem are consumers which utilize the producer as their food. These organisms are phototrophic heterotrophic, macro consumers and micro consumers. Another category of heterotrophic is of those organism’s chiefly bacteria and fungi, which are decomposers of dead organic matter, partly utilizing these as their food, and partly releasing simple products utilizable as food by both autotrophy and consumers heterotrophy. Fish belong to the category of phototrophic heterotrophy of macro consumer type. In this set up, complex patterns of food relationship occurs in which there are repeated stages of one organism eating the other and in turn serving as the food for the third one and so on. Fish population may be classified into several trophic levels depending upon their position in this food chain. There are some fish communities which occupy the second trophic level. These are herbivores, eating the green plants, the getting food energy from the producers. Other fish communities belong to the third trophic level are the carnivorous fish, eating the bivourous fish or other herbivorous animals like zooplankters and other invertebrates. Detritus consuming fish also belong to the thirds trophic level, since these eat insects and their larvae and other arthropods living on detritus. Still other fish communities occupy the fourth trophic level these fishes are dominating the whole habitat.
These are the predatory fish eating carnivorous fish or other carnivorous animals. The transfer of good energy from producers occurs in two or three steps, in the third and fourth trophic levels respectively (Khedkar, 2005).

The trophic relationship between animal communities in any ecosystem is best described as the pyramid of numbers. Smaller organisms are more abundant in number in any ecosystem. Larger the animal, fewer is their number. Smaller animals have a higher and a faster rate of reproduction and so are able to support the larger animals serving as their food. In any given food chain, animals at the base are the most abundant and those at the end of the chain the fewest. There is a progressive decrease in number in the communities placed between the base and the end as we pass through different stages in the food chains, thus, higher the trophic level of an animal in the food chain, fewer is the number in its community. (Khedkar, 2005).

Herbivorous fishes which are nearer the producers in the food chain are represented by greater abundance. Carnivore fishes, supported by herbivore fishes are larger in size but fewer in number than the herbivores fish. Predator fishes of very large size should be fewest, but in this habitat, predator fishes are more in number and dominating all other groups of fishes.

Fish is the popular food of around bird species among the visiting or residing bird species in this habitat. Fish provides high quality proteins, minerals and nutrients to the birds. Birds prefer small sized fishes of about 1 to 10 cm length which are air breathing or surface feeders. (Khedkar, 2005).

Therefore, the evaluation of the fish diversity is very essential so as to judge their abundance, size, habits, dominating groups, etc.

Our ancestors were aware the birds are creatures of great sensitivity and are entirely keeping with the nature. Birds have developed strategies to protect their eggs and off springs from predators and extremities of weather. But they have no strategy to protect them against hazardous chemicals and gaseous pollutants. (Yellappa Raddy, 1993).

Almost all pests in the field were delivered by birds, thus protecting the crops. An in numerable variety of aquatic bird brood exist in our country, among them are herons, ducks, jacana, darters, kindfishers and swiftlets. These species and many more are playing a key ecological role in maintaining ecological equilibrium and play a key role in converting non available form of organic
matter into enzymatic, hormone rich organic matter and enrich aquatic, terrestrial and marine life.

In our forest we have 1500 bird species and most of them build their nests on tree tops, hollow trees and earth cavities and on water itself. They reproduce under extremely unpropitious conditions, lakes, tanks, ponds and swampy shares, etc. Where the habitat seems with herons, ducks, ibises, gulls, plovers and moorhens. They also nest in desert areas, again extreme limits of possible survival. Most of them subsist on unbelievable small quantity of liquids. Several species can breed in the area without difficulty and without competing with one another for food. Varieties of birds confine themselves to different levels of forest canopies. The birds need adequate territory and food supply for themselves and their young. Insects, larve, worms, spiders, nuts and fruits, nectar and grains are the major source of food which they get from the forest ecosystem. (Yellappa Raddy, 1993).

One in ten of the world’s birds could be under the sentence of death mostly due to destruction of their habitat and degradation of the environment. It is a known fact that the tropical forest is dwindling at a great speed where the survival of the birds is in great threat. Large numbers of water birds live only near running water natural river system where they need banks lying with vegetation for cover and sites for nest and roosting and abundant aquatic life to provide them with food. Unfortunately in the name of producing energy, large numbers of barricades were built and normal course of running water has been stored, diverted and thereby water birds have been losing their habitat and their survival is in great danger. (Yellappa Raddy, 1993).

The survival of birds is not just a mere culture of ethos, but they play a pivotal role in economy and survival of life, as natural regulators. (Yellappa Raddy, 1993).

A considerable amount of information is available on the flora and fauna of Indian wetlands. Surveys of the resource base of several wetlands across the country and research on the taxonomic aspects of fauna have been undertaken by the zoological survey of India and its research stations the freshwater biological research station Hyderabad, estuarine biological research station, Behrampur, marine biological research station at Madras and Sunderbans field station. The surveys entail study and documentation of the physical feature, water quality,
fauna, flora and the socio economic aspects of wetlands. Among the wetlands sites covered are Chilka lagoon first surveyed in 1916-17 and resurveyed between 1983 and 1989, salt lakes swamp, the peri urban wetlands of Calcutta and wetlands in north and south 24 pargans district West Bengal wetlands, in and around the twin cities of Hyderabad Hussain sagar and Osman sagar among others. The ZSI is now focusing on surveys of those 16 wetlands identified by the ministry of environment & forests for special conservation action National wetlands while surveys of Kabartal, Bihar, Ujni, Astamudi and Chilika, Orissa have been completed, those of Kookeru Andhra Pradesh, Loktak, Manipur and Renuka, Himachal Pradesh are expected to be over by 1994-95. (Hussain and Varshney, 2006).

**Jaikwadi Bird Sanctuary Paithan (Fig. and Map).**

The Jaikwadi Bird sanctuary at Paithan, district Aurangabad is situated at Jaikwadi Dam which was constructed on the upper ridges of river Godavari, this dam was constructed mainly to overcome irrigation and drinking water scarcity in the drought prone area in Marathwada region. In the absence of natural depression in this flat terrain, the compounded water spreads over an area of 54 kms in length and 27 kms in width. This gives a reservoir shallow wetland charter which is known to have very high productivity due to easy penetration of sunlight to the bottom of the reservoir. About 225 species of birds have been recorded both residential and migratory. The water body of Jaikwadi dam has been named as NATH SAGAR because Paithan was residential place of great saint Eknath Mahraj. The Location – Geographical Coordination Longitude – 7500 to 75 – 15 east Latitude – 19 18 13 to 19 93-16 North State - Maharashtra District- Aurangabad & Ahmednagar Tehsil - Paithan , Gangapur, Shevgaon & Newasa. Total area of sanctuary is 341.05 sq. kms. The Government of Maharashtra vides their notification No. WLP/ 1086/27206/CR-39/ (II)/F-5, dated 10th October, 1986 declared the area as a Jaikwadi Bird Sanctuary.

This reservoir supplies water to about 1,50,000 hactors of agriculture land and supplies drinking water to more than 90 villages and cities like Aurangabad, Paithan, Shevgaon, Newasa. As a result this water body has changed the complexioned drought prone Marathwada region. Hence this project has become a life line of Marathwada.
There is a scope for promoting tourism activities in this reservoir if infrastructure like motor launches telescope, camping places and interpretation centers are provided.

Nathsagar has a substantial hydrological and ecological roll in the functioning of Godavari river basin. It recharges water resources in an aquifer that under line and the boundary of Godavari river basin. The total surface area of Nathsagar water body is 339.80 sq. kms. Having typical shallow water character. Nathsagar is a representative example of wetlands community. Character site of shallow wetland Eco-system. It exemplifies a critical stage in ecological and hydrological process. It is an integral part of a unique feature.

The major zones of Nathsagar reservoir are littoral and limonitic with sunlight penetrating them and a profounder with no access to sunlight. Three categories of inhabitants are distinct plankton, nekton (active swimmers) and benthos. Three major trophic levels are conspicuous autotrophs, producers, phagotrophs, consumers and saprotrophs decomposers. The principal sources of energy include the sunlight, land surface runoff and detritus. Sunlight is used by the local photosynthesis in water by sessile periphyton, macrophytes and floating plankters yielding autochthonous materials and hence autochthonous primary production, though in small quantity only. Sunlight used by land plants is available by way of autumnal fallen leaves, flowers; fruits and pollen reaching river water as land wash or air dispersal. The food of terrestrial origin allochthonous material contributes substantially to support the primary productivity. Detritus feeding supports a rich benthos of invertebrates upon which thrives the large proportioned secondary production. It may be pointed out that as compared to other regions of reservoir, the shallow zones has more detritus in bed. These detritus are chiefly plant debris resulting from decomposing of dead organic material, autochthonous as well allochthonous. The debris get mixed with mineral particles and diatoms at the bottom and it is the principal food of a number of benthic invertebrates. Land drainage and surface run off, brings a lot of dissolved organic matter, nutrient salts and finely divided matter upon which feeds the bivalves, snails, annelid worms, chironomids and mayfly insects. The dissolved matter provides food for planktons and bacteria the production and development of plankter in shallow areas show predominance of phytoplankton over zooplankton and of diatoms over other phytoplanktors (Khedkar, 2005).
Location map of Jaikwadi Bird sanctuary
Satellite view showing the catchment area of Jaikwadi Dam (Nath Sagar) at Paithan