CHAPTER 1.

INTRODUCTION

Accelerating rates of biodiversity loss and the signing of International agreements, such as the Convention on Biological Diversity and Agenda 21, have called for the world's biodiversity to be inventoried and monitored. Yet to date, so few organisms have been collected and named and their distributions recorded as the scale of the task is mammoth.

Biodiversity inventorying is the surveying, sorting, cataloguing, quantifying and mapping of entities such as genes, individuals, populations, species, habitats, biotopes, ecosystems and landscapes or their components and the synthesis of the resulting information for the analysis of patterns and processes. Biodiversity inventories with monitoring provide the essential information for biological sciences like systematics and population biology, ecology, for applied sciences such as biotechnology, soil science, agriculture, forestry and fisheries sciences and conservation and environmental sciences. This information is essential for identifying the key issues for policy and management goals, for assessing priorities, for conservation, for land use, for environmental impact assessment and also for making policy as well as creating awareness among general public.

Monitoring consists of repeated inventorying over time and space and hence is useful in measuring the change. It consists of intermittent (regular or irregular) surveillance to ascertain the extent of compliance with a predetermined standard or degree of deviation from an expected norm. Monitoring is usually goal oriented and designated to reveal changes in one particular parameter or several parameters (Goldsmith, 1991). Repeated at intervals (mostly regular) monitoring provides a baseline for interpreting changes in the future. Thus, monitoring of biological diversity aims to develop a strategic framework for predicting the behavior of key variables in order to improve management, increase management options and provide an early warning of change in the system. To support Articles 8, 9 and 10 of the Convention on Biological Biodiversity the identification and monitoring of biological diversity is essential (Glowka *et al*., 1994). These articales considers the *in situ* and *ex situ* conservation and sustainable use of various components.

Knowledge of the presence and abundance of organisms in a given area, from local to regional to global scales is crucial for its preservation, management and utilization as national as well as global biotic resources. Inventorying tells us about existence of biodiversity and to some extent, what are their relationships. Among various habitats, monitoring of the protected areas is crucial for the continual updating of information while, monitoring human utilized area is crucial to determine use of resources.

Representatives of 190 countries at the 2002 Johannesburg World Summit on Sustainable Development committed themselves to "--- achieving by 2010 a significant reduction of current rate of biodiversity loss at the global, regional, national and local level" (UNEP 2004). By adopting the 2010 target, governments have explicitly recognized the value of biodiversity. However, the time has come to find out how far we have reached in achieving the goal.

The undertaking has put forward a great challenge for conservation scientists. So far only a fraction of the earth's biological diversity has been identified and just a rudimentary understanding has been reached about how biological, geophysical and geochemical processes interact to contribute to human well being. How can we present our knowledge in ways that are useful to decision makers and in time to contribute to achieving the 2010 target is a mamoth challenge. The 2010 target of Biodiversity conservation (UNEP, 2004) can only catalyze effective conservation, if systems are in place to tell governments and individuals about the consequences of their actions.

The most effective and efficient mechanism for conserving biodiversity is to prevent the destruction or degradation of various habitats. For conserving the diversity of landscapes and ecosystems, the only alternative is to conserve individual species, populations and genes in their own habitat may that be an aquatic or a terrestrial one.

Aquatic ecosystems that include rivers and streams, ponds and lakes, oceans and bays and swamps and marshes with their associated animals are the most productive ecosystems. They are divided into lentic and lotic ecosystems based on the difference in the water residence time and the flow velocity in addition to direct use as water source. The aquatic ecosystems provide human being with numerous benefits. The human civilization is centered around water. However, the industrialization, coupled with intensive agriculture in early 1980's to meet the growing demand of ever

increasing populations has led to the over exploitation of these valuable resources and has threatened its very existence. To conserve these valuable resources from further deterioration there is great need for its regular monitoring. A comprehensive biomonitoring process, involving both physicochemical and biological approaches, gives the exact status of this ecosystem. Biomonitoring of water bodies also help to understand the composition of biota and its dynamics.

Biota-the associated species of any ecosystem have evolved and adapted to that habitat over millions of years. These habitats provide them with food, water, shelter and space essential for their survival. The associated species in an aquatic habitat includes variety of plants and animals; from primary producers- algae to tertiary consumers- large fishes and birds. The intermittently tropic levels are occupied by zooplankton, molluscs, aquatic insects (and their aquatic stages), amphibians and small fishes. The quality of water governs the biota found in it and hence it becomes important to maintain the health of the system. This can be done by water quality assessments that include monitoring and defining condition of water. It provides basis for detecting trends and the information to establishment the cause effect relationships (UNEP, 2004). The water quality assessment programme aims to provide details regarding quality of water relative to human and aquatic ecosystem health to decision makers and public. As the quality of water affects the aquatic community, it is important to understand its composition, abundance, productivity and physiological conditions. In other words, the structure and composition of these aquatic communities act as indicator of quality of water and reflect overall ecological integrity (*i.e*. physical, chemical and biological). The deteriorations in water quality and decline in quantity of clean water has a great bearing on the social, economic and environmental status of a region. This necessitates restoration of degraded ecosystems as a part of conservation and sustainable management of aquatic ecosystems.

To begin the monitoring there is always a need for preliminary survey. A physicochemical approach to monitor water gives the causes and the levels of pollutants if it exists in a water body while a biological approach highlights the impact of pollution, on the aquatic biota, and together they give the overall status of the water body and depict a comprehensive picture enabling effective interpretation and proper decision making.

The use of ecological methods (UNEP, 2004) in biomonitoring of aquatic ecosystem is becoming increasingly important. The condition of water body is deteriorating because of anthropogenic activities. Plankton at the base of aquatic food web and strongly influenced by climatic features, have been used recently as indicators to observe and understand changes in the ecosystems (Beaugarand and Reid 2000). They play important role in maintaining the equilibrium between biotic and abiotic factors. Phytoplankton survey also indicates the trophic status and the level of organic pollution in the ecosystem (Ramchandra *et al*., 2006). Nutrients enrichment due to anthropogenic input in water bodies leads to eutrophication, which is a common phenomenon resulting as algal blooms.

Further, monitoring of a single representative community for *e.g*. Zooplankton, among various communities of aquatic ecosystem, also gives a fair idea of the status of all the communities because of the interrelationships they share in food webs. Therefore, biomonitoring results in directly assessing the status of the entire water body. Zooplankton distribution shows variability due to the abiotic parameters (*e.g*. climatic factors or hydrological parameters: like temperature, salinity, stratification, *etc*.), or biotic parameters (*e.g*. food limitation, predation and competition) or the combination of both (Beyst *et al*., 2001). Zooplankton constitute an important link in food chain as grazers (primary and secondary consumers) and also serve as food for fishes, either directly or indirectly. Therefore, any adverse effect to zooplankton can indicate the effects on the wealth of fish populations too. Hence, an aquatic ecosystem at Toranmal plateau in Western Satpura range located in North Maharashtra was studies over a period of two years to find out its physicochemical status with diversity and density of phytoplankton and zooplankton supported by it.

Terrestrial habitats around aquatic body also support good flora and fauna. Hence terrestrial habitats around Lotus Lake also surveyed for the study of terrestrial fauna like molluscs, insects (butterflies and odonates) and birds.

The Mollusc occupy higher trophic structure compared to plankton. The Molluscs have successfully colonized almost all ecosystems and habitats of the world. Small streams, springs and ground water systems have produced the most species association of freshwater gastropods. Despite their ecological importance in many aquatic ecosystems, understanding of their systematics is discouragingly incomplete. The world's freshwater gastropod fauna faces unprecedented threats from habitat loss

and degradation and introduced fishes and other pests. Unsustainable use of ground water, landscape modification and stock damage are destroying many streams and springs in rural/pastoral areas and pose the most significant threats to the large diversity of narrow range endemic gastropods in springs and ground water. Despite comprising only 25 % of the world's gastropod fauna, freshwater gastropods account for 20 % of recorded molluscs extinctions. However, the status of the great majority of taxa is unknown, a situation that is exacerbated by a lack of experts as well as critical baseline data relating to their distribution, abundance, basic life history, physiology, morphology and diet. Thus, the already considerable magnitude of extinction and high levels of threat indicated by IUCN Red List of Threatened Species (IUCN, 1994) is certainly a significant underestimate.

The potential of freshwater molluscs as indicators is largely unrealized but could be a powerful tool in raising awareness and improving their public image (Seddon, 1998). Their low vagility, adequate size, often large population numbers and the ease of collection and identification can render them a useful and practical tool in biomonitoring programmes (Lee *et al*., 2002). Some freshwater snails are vectors of diseases serving as the intermediate hosts for a number of infections for which human or their livestock are definitive host. The most significant diseases are snail transmitted helminthiases caused by trematodes. In Africa, South East Asia and South America at least 40 million people are infected with liver (*Opisthorchis*) and lung flukes (*Paragonimus*) and over 200 million people with schisostomiasis (Peters and Pasvol, 2001) often resulting in devastating socio-economic consequences. Hence, study of fresh water molluscan diversity becomes essential.

Regrettably, only 2 % of all molluscs species have had their conservation status rigorously assessed, that puts current estimate of threats as a severe underestimate (Seddon, 1998). Nevertheless, it is clear that terrestrial and freshwater molluscs arguably represent the most threatened group of animals effectively requiring a multiplicity of approaches, including research (systematic, ecology, life history, morphology, *etc*.), inventories (distribution, population size and biogeography), mitigation of human impacts and active intervention to promote recovery and also training in taxonomic expertise with enhanced communication and outreach. Hence, the aquatic and Land molluscs of the area are also considered.

The next group considered for the biodiversity study of Toranmal area is odonates.

Odonates: commonly known as damselflies (sub-order: Zygoptera) and dragonflies (sub-order: Anisoptera) they are amphibiotic insects. About 6,000 extant species are distributed all over the world. India is highly diverse with more than 500 known species. Odonata, one of the ancient orders of the class insecta first appeared during the carboniferous era, about 250 million years ago. Earliest consolidated work on the fauna of Indian odonata is by Fraser (1933; 1935; 1936) who published odonata in three volumes in the fauna of British India series. He describes 536 species within Indian region. However, their present status and distribution is inadequately known.

Odonates, being predators both at larval and adult stages play a significant role in the wetland ecosystem as biocontrol agent. However, many species of odonates are intermediate hosts of helminthes parasites of birds especially of poultry and wild ducks and thereby aiding transmission of parasitic diseases (Subramanion, 2005). As species assemblages of dragonflies change with levels of human disturbance their value as indicators of quality of the biotope is now being increasingly recognized. Odonates have been deemed as 'flagship' group of indicators (Oertli *et al*., 2002). They can be specialists with narrow distribution. They respond not only to the quality of the wetland but also to the major landscape changes, especially in the riparian zone. They show amphibious life history, have relatively short generation time, high trophic position and diversity (Corbet, 1993) in these habitats. Though the Indian odonate fauna is well described in terms of adult taxonomy, their ecology is poorly known and the policy of ecological information is a serious lacunae when designing any conservation measure. Hence, while studying biodiversity of Toranmal area odonates are also included.

Another group of insect considered in the present study is Lepidoptera- one of the highly specialized insect orders that includes scale winged insects the butterflies and the moths showing total metamorphosis. Hampson (1996) estimated as many as 89 families and subfamilies of Lepidoptera, while Hamlyn (1969) reported about 1,40,000 species comprising 13,000 butterflies and 1,27,000 moths from the world. Recent estimate of diversity within Lepidoptera from the Indian Sub-region reveals that the group comprises over 15,000 species. Many more species are, however yet to be explored from the remote corners of the plains, the wetlands and the forest covers in different areas of India (Mondal, 1998). In present study only butterflies are considered.

Ecologically, the adult butterflies are useful to plants as pollinators. The caterpillars may be sporadic or random plant feeders or pest which in turn, are important food in a food web. The predation and parasitism are high at all the stages of development of butterflies and only a small proportion survives to adulthood. Butterflies offer good opportunities for studies on population and community ecology (Pollard, 1991). Many species of butterflies are strictly seasonal, preferring only a particular set of habitats. Inspite of this, butterflies have been generally neglected by community ecologists and there are very few studies available on their community structure, population dynamics and the ecoclimatic factors which affect them. Butterflies comprise an ideal group for studying the effects of climatic changes. Being poikilothermic organisms, their life cycle, activity, distribution and abundance are influenced by temperature (Pollard, 1979, Roy and Sparks, 2000). Thus, being good indicators of climatic conditions as well as seasonal and ecological changes they can serve in formulating strategies for conservation, hence included in the present study.

Since time immemorial, man has been adoring butterflies, more for their virtues than vices. The most rewarding pleasure is to observe them flying amidst forests, atop hills and in gardens. Their fabulous patterns, designs and texture together with acting as principal agent in effecting pollination of the flowering plants, exert tremendous influence on mankind all over the globe. Their inclusion in biodiversity study and conservation has been considered encouraging by Gadgil (1996).

Higher in the trophic structure, by virtue of their flying ability and to leave any obnoxious habitat, birds are also good indicators of condition of habitat. Because of their great mobility they have dispersed over every corner of the planet. They have colonized from the arctic tundra to the hottest deserts and also the dense forests all over the continents including the remotest oceanic islands. They have even explored the vastness of the oceans and the human dwelling. Many species of birds are gregarious, teaming in flocks of thousands while others are solitary or move in pairs and in small parties of 5 – 20. Of the 9026 species in the world listed (Saha, 1998) about 437 species and subspecies have been designated as threatened for their survival (King, 1981). Many more are likely to be covered under this category and some are at the risk of extinction unless consorted measures are taken in time for habitat preservation as well as species conservation. Hence, to understand the trophic

structure, bird diversity in Lotus Lake and surrounding forested area up to 10 Km radius from Toranmal village is also considered in the present study.

The Indian subcontinent has 1232 species belonging to 78 families of which India can boast for having 1166 species. In India about 47 species have been designated as threatened, (2 with suspected to be extinct, namely the Mountain Quail and Pink Headed Duck). Forest Owlet has recently been rediscovered by Jathar (2005) in the Toranmal area.

Birds face various degrees of threats and accordingly are categorized as Endangered, Threatened, Vulnerable, Rare and Extinct. Local population of many species, especially in the areas of drastic change of land use pattern, through industrial setup, mining, river valley projects, deforestation for various purpose and other human activities, have subjected various habitats to the adverse impact. These have resulted in dwindling of population of various species resulting in their local extinctions or extirpations (Sodhi *et al*., 2004).

There are ethical, social and economic relations between man and the birds besides other relations. Economic relation is many fold. On one hand birds are friends as well as foes to mankind. Some are beneficial being agent for pollination, germination and dispersal of seeds, as controlling pests like insects, rodents, *etc*., as cleaning agents for the carcasses by scavenging while also as offering flesh and eggs for the table. On the other hand, destroying crop in the field as well as in ponds by devouring seeds and fishes likewise, and by spreading diseases, birds become men's enemy. Besides, in an ecosystem context, birds offer themselves as prey as well as predator species maintaining ecological balance in nature.

The habitat destruction is one of the major threats for decline in bird populations. Despite extremely high species diversity and endemism of existing tropical forests, 16 million hectares of forest is lost annually (Achard *et al*., 2002). The speed of tropical deforestation is unprecedented in evolutionary history (Beaugrand *et al*., 1992). Toranmal area is having dry deciduous forest. Under the pressures of ecotourism it is likely to face deforestation. Hence in the present study avifauna of the Toranmal area is also considered.

It has been predicted that, globally one in eight bird species may become extinct over the next 100 years and 99 % of this extinctions may be owing to the human activities

such as deforestation and hunting (Bird Life International 2000). Ninety three percent of 902 threatened forest birds are found in the tropics (Bird Life International, 2000). Tropical forest birds are particularly sensitive to deforestation (Brook *et al*., 2003). Toranmal may not be any exception. This area has not been explored earlier hence the current study can provide base line data for future studies as well as monitoring.