GENERAL CONSIDERATION

Wetlands are one of ecosystems having potentials for high productivity and nutrient recycling that provides various resources to diverse groups of organisms (Odum, 1971; Tiner, 1984; Weller, 1988). This makes the wetland, second best productive ecosystem in the world (Ramchandra, 2002). This dynamic ecosystem has always drawn attention of ecologist. In recent years emphasis has been given to conserve them irrespective of their sizes (Kushlan, 1986).

Over the years the dependency of human being on the wetland is increasing. With the evolution of new technologies many of these wetlands are rapidly losing their biodiversity. This gave rise to realization for need of conservation of these ecosystems and evolution of many conservation and management programmes. In order to consider the conservation and management of any ecosystem, it is vital to study its biodiversity. One such programme is Asian Mid Winter Waterfowl Census, initiated by Wetland International in mid 1980s. In semi arid zone of Central Gujarat this census was initiated regularly during mid 1990s. The monsoon is irregular and unpredictable here. To overcome the shortage of water, for domestic use as well as for irrigation, several water bodies were constructed by His Highness Shrimant Maharaja Sir Sayajirao Gaekwad III of erstwhile State of Baroda. Considering shallow parts of these waterbodies as wetlands, some of these and few others, are regularly visited for Asian Mid- Winter waterfowl census in Vadodara. Out of these wetlands, two irrigation reservoirs, Wadhwana Irrigation

Reservoir (WIR), Timbi Irrigation Reservoir (TIR) two ponds Masar Village Pond (MVP) and Harni Village Pond (HVP), under varied anthropogenic pressures were considered for the present study.

Among various organisms inhabiting wetlands, birds are the prominent species. Due to their ability to fly away and avoid unfavourable conditions, birds are considered as important indicators of health of an ecosystem. Survey of bird populations was carried out at the four water bodies in two years from 2005 to 2007 (Chapter I). As the birds are dependent on other organisms especially macroinvertebrates like mollusc, for their calcium needs, the density and species richness of mollusc were also studied simultaneously (Chapter II). In a wetland ecosystem the plankton are at the base of trophic levels. Hence, their diversity and density with their seasonal variations *etc.* are also considered (Chapter III). The Primary productivity of a wetland depends on the water chemistry of the wetland which includes the physical aggregate parameters and inorganic nonmetallic parameters. Hence, the fluctuations in water chemistry are also considered (Chapter IV). Twice in a month surveys were carried out at all the wetlands to collect the data and the data was pooled into 4 seasons each of 3 months for of as per Indian climate.

The Ist chapter deals with variations in water bird (waterfowls) populations over the four seasons which are considered as Species richness, Species diversity and density. The species richness and density increase with the arrival of migratory populations of birds during winter at the four wetlands and declines during

monsoon when migratory species are absent. Monsoon is the period when the resident species are busy in nesting activities and as food is abundant every where their visits to the wetland are infrequent. This further resulted in the decline of population of birds. The group wise categorization of birds on the basis of feeding habits has made it convenient to analyze and understand their distribution. The Group 1 includes Moorhens, Coots, Cormorants, Jacanas and Grebes: the Group 2 all the ducks resident as well as migratory species; the Group 3 Waders and the Group 4 Terns and Kingfishers. Depending on the size of wetland, macrophytes present and influence of anthropogenic pressures, dominance of each group is different in every wetland. Group 1 birds were dominant at the wetlands that have higher proportion of macrophytes (TIR and HVP) while Group 2 dominated at the undisturbed village pond (MVP) throughout the year. At TIR Group 1 dominated during major part of the year, whereas group 3 waders including Egrets and Storks dominated the area during monsoon. At WIR, which is the largest wetland studied, different groups were dominating the area during different seasons. Here, Group 1 dominated during summer and postmonsoon, Group 1 and 3 during monsoon and Group 1and 2 during winter. The population of Group 4, being smallest, inspite of increase during winter was always in minority at all the wetlands studied throughout the year. This indicates that depending on availability of micro habitat different groups of birds inhabit the four wetlands studied.

As far as species richness is considered, Group 3 waders which includes more species of birds dominated all the four wetlands studied throughout the year. It

was observed that as the species richness was high the diversity was also high but birds were unevenly distributed. The correlation of the bird density with the biotic as well as abiotic factors in the wetlands of semi arid zone of Gujarat indicates that the wetland ecosystems are not governed by a single factor but as whole it is maintained by the interdependency of various factors.

Looking at the molluscan density it was observed that the density of molluscs was high during postmonsoon at all the wetlands. The difference in the species composition of the mollusc indicated the characteristics of the wetland.

Bellamya bengalensis, the most widely distributed and well acclimatized species in semi arid zone is abundant at all the wetlands. This could be because of changing habitat at WIR from seasonal to perennial. The euryhaline species (*Thiara granifera*) has been found only at MVP which gets slightly brackish during part of the year probably due to its proximity to Mahi river estuary. The species *Indoplanorbis exustus* that is known to harbour the parasitic pathogens is observed only at HVP which is facing the anthropogenic pressure due to sewage input (Plate XII). *Lymnaea auricularia* that prefers flow in water currents are found only at WIR and TIR. WIR and TIR are known to receive the water from Narmada canals and release the same for irrigation through distributing canals creating a partial lotic ecosystem.

Low density of the mollusc was observed during different seasons at different wetlands *i.e.* during winter at WIR, summer at TIR and MVP and Monsoon at HVP. This depends upon characteristics of wetland with reference to the

geochemistry and the hydrology. Molluscs are expected to depend on the calcium carbonate that is available in the form of the bicarbonate salts. However, in the present study no such correlation could be established and no single common best predictor among the four wetlands, could be defined which can be the sole factor responsible for the density of the mollusc.

The Phytoplankton and Zooplankton that are defined as the primary producers and the primary consumers respectively were also showing different pattern of distribution at all the wetlands. The evaporation of water in summer resulted in decline in water cover and hence concentration of plankton increased their density whereas flooding of wetlands during monsoon resulted in the lowest density of the plankton. This causes the dilution of the plankton density. Further, depending on the seasonal variations, difference in the distribution of the plankton was observed. The Crustaceans dominate the plankton density and hence follow the seasonal trend similar to that of total plankton at all the wetlands studied. The Rotifer densities show different trend, with highest density during monsoon at WIR and HVP, during summer at TIR and postmonsoon at MVP. The phytoplankton density is highest during summer as this is the time when maximum sunlight is available and the primary productivity is high.

The Crustaceans dominate in species richness too at all the wetlands except at MVP but only during postmonsoon. During this period Rotifers were dominating. This suggests the difference in the habitat preference of the different groups of plankton depending upon seasonal characteristics of particular wetland.

The density of plankton is correlated negatively with the water cover at WIR and MVP. These are the two wetlands which are having different hydrology compared to TIR and HVP and hence the difference in the correlation of plankton density with water cover.

As the bird have the ability to avoid the unfavourable habitats, the wetlands which have the presence of the birds are often designated as the wetlands with healthy ecosystem. The interrelated correlation of different parameters of water chemistry suggests the physicochemical characteristic of the wetland. Hence, the quality of water is also considered in the present study. Eighteen different physical aggregate parameters, and the non- metallic inorganic constituents of the water have been studied. The changes of these abiotic parameters are mainly because of the climatic changes, the geographic locations (the distance from the urban limits or the distance from the estuarine region), the anthropogenic pressures (nil to heavy) and the hydrology of the individual wetland. The changes in these parameters are described in detail in chapter IV. On the basis of present studies the wetlands can be categorized depending upon conservation and management needs as follows: Wadhwana Irrigation Reservoir (WIR) as an IBA or Ramsar site. WIR has the potentials of supporting more than 20,000 birds during winter and large number of resident birds during summer. Congregation of birds at this wetland during summer is the situation when the dependency of the resident birds can be noted. This was prominent with the highest number of the Comb duck (*Sarkidiornis melanotos*) 800 individuals during the summer of 2007. The number, exceeding

the 1 % global population of (250) Comb duck as per the Ramsar/ IBA Criteria. Further, more than 700 individuals of Lesser Whistling Teal *(Dendrocygna javanica)* have been observed during summer 2008. The reservoir which use to dry up during summer is now almost perennial. This suggests the importance of WIR to the resident birds.

In addition among, the migratory species, Glossy Ibis, Ruff, Black Tailed Godwit and Grey Lag Geese are also recorded during winter at WIR in high numbers which are higher than their 1% global populations. Further, Brahmininy duck, Painted stork and Spoonbill also utilize the pond in large number (few short of 1 % global population). This wetland satisfies the criteria of regularly supporting more than 20,000 birds, the criteria for declaring it as Important Bird Area. The wetland also supports waterfowl based criteria put forward by the Ramsar Convention.

The other reservoir studied, the Timbi Irrigation Reservoir, also supports large number of birds during winter as well as during summer. It has all the potentials to be declared as Nationally Important Wetland. If conserved properly this wetland can be a promising habitat which can be a bliss to biodiversity. The present study proposes that TIR can be developed as education and ecotourism center. TIR is near to the city limits too. Masar village pond, inspite of the domestic dependency, proves to be an Oasis for the water birds. The local community is aware of the bird wealth that the village pond is harbouring. It could be suggested that this wetland should be declared as Community Reservoir. Harni, the smallest

of the wetlands studied, is in the urban limits of Vadodara city and thus experiences the urban pressures. These pressures can not be completely exterminated and hence it can be suggested that the area should be declared as the Recreation Area which will gradually improve the quality of water as well the esthetic value of the wetland.

The present study proves to be a useful source of information regarding the wetlands of the semi arid zone of Central Gujarat, India, and help in the conservation and management of the same.

Future aspects of the study:

The present study indicates the importance of the wetlands in the semi arid zone of Central Gujarat India, the area which frequently faces scarcity of water. The importance of the wetland for the birds and the other factors affecting the bird congregation has been studied in detail. This being one of the pioneer work carried out for the study of avian ecology in the wetlands, of the area thereby opens several new avenues for further studies.

Keeping this work as a source of baseline information, the following studies could be undertaken:

- The study of breeding activities of birds in the area that can add to sustenance of species.
- The inter dependency of the birds on the fishes and other vertebrate fauna.

- Detailed molluscan diversity with reference to wetland ecosystem of Semi Arid Zone of Gujarat.
- The analysis of the physico chemical parameters of the soil and its impact on the mollusc density in detail.
- The study of wetland dependent Arthropods which form food source of birds
- Influence of Narmada inundation on fauna of WIR and TIR with respect to time of inundation.
- Influence of high tide on water quality as well as bird movement at MVP.
- A multidisciplinary work can be undertaken for decreasing the anthropogenic pressures of HVP and converting it into a recreation site. This in long run can help in improving the quality of water and awareness among local people.