AVIFAUNAL DIVERSITY AND ECOLOGY OF WETLANDS IN SEMI-ARID ZONE OF CENTRAL GUJARAT WITH REFERENCE TO THEIR CONSERVATION AND CATEGORIZATION

(CONCISE SUMMARY)

SONAL L. DESHKAR

Division of Avian Biology,
Department of Zoology, Faculty of Science,
The Maharaja Sayajiroa University of Baroda,
Vadodara-390002,
India

Ph.D. THESIS **JULY 2008**

CONCISE SUMMARY

Out of various ecosystems of this Biosphere, wetland forms one of the important ecosystems. Wetlands, the transitional zone between land and water, support diverse form of life. As it is a complex ecosystem it has always been tricky for the ecologist to define and classify it. The best accepted definition for the wetland was proposed by IUCN (International Union for Conservation of Nature and Natural Resources 1971). IUCN defines it as "*Wetlands are the areas of marsh, fen, peat land of water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water; the depth of which at low tide does not exceed six meters*". Wetlands are considered as the second most productive ecosystem (Ramchandra *et al.*, 2002). This significant ecosystem gained importance as an independent ecosystem recently (Kingsolver, 1989; Dunson and Travis, 1991). With the natural wetlands the artificial wetlands have also gained the importance in recent years.

Rain is the major source of water in the semi arid zone of central Gujarat. As the rainfall here is irregular, need for water is fulfilled by the development of water reserviours. This has resulted into the construction of small/ large water reserviours satisfying the human requirements. In addition to this the role of wetlands in maintaining hydrology, Biogeochemistry and supporting Biodiversity is recognized. Hence recently a need for conservation of wetland has been felt. For the conservation of any ecosystem the biodiversity of that area and the factors

affecting it should be known. In present study four wetlands in Semi arid zone of Gujarat were selected to study their biodiversity with seasonal changes. The study also includes abiotic parameters that influence the water chemistry of wetlands. The wetlands selected for present study are Wadhwana Irrigation Reservoir (WIR), Timbi Irrigation Reservoir (TIR), Masar Village Pond (MVP) and Harni Village Pond (HVP).

Wetlands support a wide range of biodiversity starting from the unicellular plankton to complex mammals. Because of their significant ability to fly away from any obnoxious situations birds have gained the importance as indicators of health of any ecosystem (Urfi *et al.*, 2005). Thus, in a wetland ecosystem waterfowls are the indicators of its health. During present study from February 2005 to May 2007, 61 species of birds were noted at WIR, 53 at MVP, 56 at TIR and 31 at HVP. Density and diversity of the waterfowls as discussed in Chapter I vary seasonally. The density varies highly significantly (***) and species richness significantly (*). Both the density and the species richness were higher at all the wetlands during winter due to the migratory birds visiting the area. Among the four groups studied different patterns of distribution were noted depending upon the Narmada inundation, geographic position, urban proximity and anthropogenic pressure. The larger wetlands like WIR and TIR that are inundated frequently with Narmada water show seasonal difference in the dominance of the density of birds group. Here it is observed that during summer Group 1, which includes the divers and Marsh birds like cormorants, Grebes, Moorhens and Coots; dominate the area

as this is the season when the migratory birds are almost absent. In recent years due to Narmada inundation these to reservoirs have become perennial. During monsoon these wetlands are dominated by Group 3 birds- the wader. Waders are known to prefer shallow water. But during monsoon when the reservoir were filled with water three species of Egrets (Cattle-, Little-, and Intermediate-) and Asian Openbill stork *(Anastomus oscitans)* are observed around ploughed irrigation fields in large numbers. As the birds of other group are busy with the breeding activities and plenty of food is available everywhere, their visits to the wetland are infrequent. However, postmonsoon is the period when Group 1 birds with their youngones started appearing at the wetlands and at three study areas (WIR, TIR and HVP) this group was dominating. At MVP Group 2 birds dominated during postmonsoon. During winter WIR is dominated by Group 2 (ducks) while TIR is dominated by Group 1. With the arrival of migratory population of birds the density of the ducks increased at WIR. However at TIR, congregation of the migratory population of Coots is high thereby increasing their dominance. At MVP the Group 2 dominated the wetland with high density during winter and at HVP because of emergent vegetation Group 1 dominated the area. With reference to the species richness Group 3, being the largest group, dominated all the wetlands throughout the year.

The species diversity (H') at both the irrigation reserviour showed insignificant variations while that at village pond showed significant (HVP) or significantly significant (MVP) variations. The evenness showed no significant variations at

any of the wetland. It has also been observed that when the species richness is high the diversity index (H') of the birds is high and hence the evenness (E) is low.

Different abiotic factors are correlated with bird density at different wetlands. This indicates that no single common abiotic predictor is responsible for the variations in the fluctuating diversity and the density of the birds across the seasons in the wetlands of semi arid zone of central Gujarat (details in chapter IV). The bird density was positively correlated with Carbondioxide (at WIR and MVP), TSS (at WIR and TIR), Hydroxyl alkalinity (at TIR), Plankton (at MVP) and Temperature (at MVP and HVP) and was negatively correlated with Dissolved Oxygen (at MVP and HVP), water cover (MVP) and Phosphates (HVP).

In any ecosystem the trophic cascade plays an important role. In the hierarchy of trophic cascade the macroinvertebrates (e.g. Mollusc) form a crucial link between the organisms of lower and higher trophic levels thereby maintaining the flow of organic matter in an ecosystem (Hart and Newman 1995; Ramchandra *et al.*, 2002; Murkin and Kadlec, 1986). The molluscs are the important source of calcium and proteins for the birds (Mccann, 1939; Ankney *et al.*, 1980; Stanczykowska *et al.*, 1990; Perrins, 1996). Chapter II describes the molluscan density and the diversity over the four seasons of all the four wetlands studied. The wetlands that show variations in the water level and not in the water cover *i.e.* WIR (which receives the water the form of Narmada inundation) and HVP (which receives water in the form of sewage) support almost uniform density of the mollusc resulting in no significant variations. However significant seasonal variations were observed at

TIR and MVP which dries up partially during summer. Partial drying is reported to increase the productivity of a wetland. The maximum mollusc density is noted during postmonsoon and minimum during winter at all the four wetlands studied. The postmonsoon is the season when precipitation of water stops resulting in stabilizing the water level. The mollusc come out increasing their density. During postmonsoon the density of macrophytes that shelter the mollusc also increases.

All together seven species of mollusc belonging to six families have been noted. The species that dominated at all the four wetlands was *Bellamya bengalensis* whereas the second dominant species varied according to the uniqueness of each wetland. The species like *Lamellae consobrinus, Pila globosa and Lymnaea auricularia* were found exclusively at the irrigation reservoirs that have different water chemistry compared to village ponds. The hydrologic conditions were different at the four wetlands studied. At WIR and TIR the inflow of water is extended in the form of Namada inundation and being an irrigation dam outflow continues till early summer. MVP is probably having the underwater tidal influence which makes the wetland partially brackish from end of winter and summer. *Thiara granifer,* the species that is more tolerant towards the brackish water was second dominating species at MVP. Other species were not frequently present at this wetland. Another important observation is noted for HVP, the wetland having maximum anthropogenic pressure among the four study sites. Here more resistant species like the *Indoplanorbis exustus* that harbours

pathogenic parasite (Subba Rao, 1989) and serves as an important carrier of pathogen was observed.

In the present study, at the wetlands that showed minimum change in water cover (WIR and HVP), molluscan density was not correlated with any abiotic factors. Whereas, at the wetlands that face partial drying (TIR and MVP) the Bicarbonate (negatively at TIR) and Hydroxyl alkalinity (positively at HVP) were correlated.

The trophic structure of a community depends on the basis of the biomass availability, which in turn is dependent on the available resources and primary productivity (Vakkilainen *et al.*, 2004). Being at the base of an aquatic ecosystem, the Plankton communities present an important element of biota in a ponds (Soininen *et al.*, 2007). The phytoplankton are the primary producers and the zooplankton are the primary consumers of an aquatic ecosystem and hence the plankton community is considered (Chapter III) in the present study. About 22 species of plankton were noted during present study. The plankton observed were categorized into three main types *i.e.* the Crustaceans, Rotifers and the Phytoplankton. At three wetlands (WIR, TIR and HVP) the plankton density showed significant variations, while at MVP it was highly significant. Radical hydrologic conditions, occur at MVP. During summer it dries up partially which probably augments the underground influence of high tides in Mahi River Estuary that is 15-20kms. away and has one of the highest tidal fluctuations in the World. In addition, during present study the heavy monsoon washed away the boundaries

of MVP removing fresh water in both the years. Hence resulting in variations in the plankton density at MVP.

All the wetlands studied are located in the semi arid zone of India. Hence, evaporation of water results in concentration of Plankton thereby increasing the plankton density. The density of the plankton is lowest during postmonsoon at both the irrigation reservoirs and during monsoon at both the village ponds. During monsoon and postmonsoon the water levels are high. Thus, because of dilution the density was low during this time.

The Crustacea is the major group consisting maximum individuals in the planktonic form. Thus, as far as species richness is considered, the Crustaceans dominated all the areas while the Rotifers dominated only during monsoon that too only at MVP. The rotifers prefer more lotic conditions (Baranyi *et al.*, 2002). Due to the overflowing of the village pond a temporary lotic condition favoured by rotifers was developed. The Rotifers were absent during winter at WIR and HVP.

All organisms and their communities are directly/ indirectly affected by the physical characteristics (abiotic factors) of their environment (Gillis *et al.*, 2008). Hence, the study of interactions between biotic and abiotic factors is needed to understand community structure of an ecosystem (Dunson and Travis, 1991). The seasonality/succession and hydrology are also major factors affecting the biota (Hussain, 1995). The physical and chemical properties of freshwater body are characterized by the climatic, geochemical, geomorphological conditions and

pollution levels prevailing in the drainage basin and the underlying aquifer (Ramchandra *et al.*, 2002). This determine the condition of water (Anonymous, 2003). The physical aggregate parameters which include Temperature, Water Cover, Solids, Acidity, Alkalinity, Salinity, Hardness and the inorganic non metallic components the Dissolved Oxygen, Carnondioxide, Chloride, Nitrate, Nitrite and Phosphate are considered in present study. The significance of each of the parameter is discussed in detail in Chapter IV. The seasonal fluctuations in the parameters are observed at all the wetlands studied. These are either because of the season, the geographic location (MVP), the anthropogenic stress (HVP) or the inundation of water from major river (in the case of WIR and TIR). In the semi arid zone of Central Gujarat the pronounced climatic changes influence the physical aggregate parameters. Further, the location of the wetland also influences variations in the abiotic parameters like the Chlorides, Salinity and Hardness, which is evident at MVP. The difference in the water Temperature is noted with reference to the location of wetland to urban limits. The wetlands (TIR and HVP) located in surroundings; with the high temperature belt prevailing the city, have higher water temperatures, than those wetlands in rural area (WIR and MVP). The two irrigation reserviours WIR and TIR also show variations depending on water inundation from the Narmada river.

The data collected in the present study is expected to help in identification of fully/ partially protected areas and their conservation and management programmes. All the wetlands studied support wide range of biodiversity. Though the conservation

activities are observed all over the world, these are mainly confined to the larger water bodies. However, the present study emphasizes the importance of smaller wetlands for conservation. WIR has already been declared as Nationally Important Wetland around the time when this study was initiated and it is satisfying the criteria for the Important Bird Area- IBA as well as some of the criteria for the Ramsar Site. The inundation of water from Narmada has turned the wetland perennial and hence the waterfowl, especially the ducks population has increased both in terms of species richness and density (Padate *et al*, 2008). The summer population of the Comb duck (*Sarkidornis melanotos*) at WIR exceed its 1% global population of the world. Further, 1 % population of Glossy Ibis, Ruff, Black tailed Godwit, Grey lag Goose are also recorded at WIR during winter. In addition, Brahmini duck Painted stork, Spoonbill *etc.* also utilizes the pond in large number (few short of 1 % global population). These are some of the important observations that can help in declaring WIR as a Ramsar Site. Further, with mutual coordination of irrigation department and local village communities WIR can be developed as a unique conservation area in the semi arid zone of central Gujarat. TIR is another wetland which has the potentials to be developed and declared as Nationally important wetland. It can be developed as a reference wetland for the routine studies and also an educational and ecotourism center.

In the semi arid zone of India, the wetlands that are studied were mainly constructed to satisfy the human requirements and hence human dependency can not be ignored. At MVP the water is not potable but it is utilized for various

domestic purposes. However, the people of Masar village are aware of the conservation needs as well as the different kinds of birds visiting the area. Hence, with the participation of the local community, this wetland can be developed as a community reserviour. The HVP is situated in the city limits and hence the dependency of the human being has now been slowly converted in to the heavy anthropogenic pressures. A decade ago Padate *et al.* (1996) reported many migratory species of birds visiting this area. However, because of the urban pressures the wetland has lost majority of its area along with its biodiversity. Further, the residential and commercial areas are coming up just few feet away from the wetland boundaries. If this wetland is developed as a recreation zone, the quality of water can be improved and the public view can change. This kind of wetlands instead of getting filled up and loosing a habitat, can become an acceptable social venue.

This work can serve as a baseline information to carry out further investigations on the wetlands of semi arid zone of Gujarat. Besides it can serve as secondary data for future studies providing better understanding of changes in wetland ecosystem. The conservation and management can become effortless if these wetlands are recognized. These wetlands need recognition from the various authorities to get momentum for development and its conservation which can benefit the society and provide good habitats for various plants as well as animals.

The highlights of present study are:

- ❖ The wetlands of semi arid zone of Central Gujarat are important habitats for the migratory as well as resident species of birds.
- ❖ Apart from the larger irrigation reserviours, the smaller village ponds also play significant role as wetlands in supporting biodiversity.
- ❖ The seasonal variations in the bird density with reference to migratory and breeding period are noted.
- ❖ The mollusc density though not directly correlated with bird density is important indicator of the health of a wetland. Different mollusc species were noted depending on the type of wetland. The dominant species was *Bellamya bengalensis.*
- ❖ Among Plankton, the Crustaceans are dominant in the terms of density at all the wetlands. Rotifers dominated the wetland when partial lotic conditions were developed.
- ❖ Wadhwana irrigation reserviour has a positive influence of Narmada River water inundation as far as bird populations are concerned.
- ❖ Timbi irrigation reserviour needs to be properly maintained as it has an important wetland near to urban limits.
- ❖ Masar village pond is having the influence of the high tidal fluctuations of the Gulf of Khambhat through Mahi River estuary through the underground water table. This wetland becomes brackish during winter and summer and hence is ecologically unique.

- ❖ Harni village pond is under high anthropogenic pressures, and shows decline in its bird diversity over the years.
- ❖ Each wetland being ecologically important can be conserved by designating/ developing them as follows: WIR can be declared as the Important Bird area (It is having all the potentials to be declared as Internationally important wetland too). TIR can be declared as the educational and ecotourism site. MVP can be categorized as community reserviour and HVP can retrieve its aesthetic value if it is protected and developed as recreation area.

References:

Anonymous 2003. *A Manual on Water and Wastewater Analysis.* One Day Training Programme conducted by Gujarat Pollution Control Board (GPCB) Gandhinagar Gujarat India.

Ankney, D., Davison, C. and ScottSource, D. M. 1980. Changes in Nutrient Reserves and Diet of Breeding Brown-Headed Cowbirds. *The Auk*, **97** (4): 684-696.

Baranyi, C., Hein, T., Holarek, C., Keckeis, S. and Schiemer, F. 2002. Zooplankton biomass and community structure in a Danube River Floodplain system: effects of hydrology. *Freshwater Biology*, **47:** 473-482.

Boere, G.C., Galbraith, C.A. and Stroud, D.A. (eds.). 2006. *Waterbirds around the world.* The Stationery Office, Edinburgh, U.K. 960 pp.

Dunson, W. and Travis, J. 1991.The Role of Abiotic Factors in Community Organization.*The American Naturalist*, **138** (5): 1067-1091.

Gillis, P. L., Mitchell, R. J., Schwalba, A. N., McNicholsa, K. N., Mackiea, G. L., Woodb, C. M. and Ackermana, J. D. 2008. Sensitivity of the glochidia (larvae) of freshwater mussels to copper: Assessing the effect of water hardness and dissolved organic carbon on the sensitivity of endangered species. *Aquatic Toxicology,* (in press) doi:10.1016/j.aquatox. 2008.04.003.

Green, A. J. 1996. Analyses of globally threatened Anatidae in relation to threats, distribution, migration pattern and habitat use. *Consrev. Biol.*, **10**:1435-1445.

Hart, R. and Newman, J. 1995. The importance of isolated wetlands to fish and wildlife in Florida. Project report for non game wild life program project NG88-102, Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Hodgson, Y. S. 2005. A trophic cascade synthesis: review of top-down mechanism regulating lake ecosystems. *Bios,* **76**: 3: 137-144.

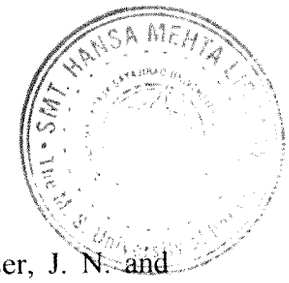
Hussain, S. 1995. Management for migratory waterfowl. In: Gopal B. (compiler) *Hand book of wetland Management,* WWF-India New Delhi, India.

Kingsolver, J. G. 1989. Weather and the population dynamics of insects: integrating physiological and population ecology. *Physiological Zoology*, **62**:314-334.

Klak, G. E. 1937. A Comparative Study of Summer Plankton from Twenty-One Bodies of Water in the Vicinity of Minneapolis and St. Paul, Minnesota. *Transactions of the American Microscopical Society*, **56** (2): 196-202.

McCann, J. 1939. Studies of the Grit Requirements of Certain Upland Game Birds. *The J. Wild. Manag.*, **3**, (1): 31-41.

Murkin, H. R. and Kadlec, J. 1986. Relationship between water fowl and macroinvertebrate densities in Northern Prairie Marsh. *J. Wild. Manag.*, **50** (2) :212-2 17.



Pace, M. L., Bade, D., Cottingham, K. L., Essington, T. E., Houser, J. N. and Schindler, D. E. 2001. Trophic Cascades, nutrients, and lake productivity: whole lake experiments. *Ecological Monographs*, **71**:163–186.

Padate, G., Deshkar, S. and Sapna, S. 2008. The Influence of Narmada water Inundation on the Duck Populations of Wadhwana Irrigation Reserviour. Published in proceedings of 'Taal 2007' the world Lake conference Sengupta, M. and Dalwani R. (eds.) Pp.131-136.

Perrins, C. M. 1996. Eggs, egg formation and the timing of breeding. *IBIS*, **138** (1): 2–15.

Ramchandra, T., Kiran, A., Ahylaya, N. and Deepa, R. S. 2002. Status of wetlands of Banglore. Technical Report 86. available at www.wgbis.ces.iisc.ernet.in/energy/TR86/welcome.html

Soininen, J., Kokocinski, M., Estlander, S., Kotanen, J. and Heino, J. 2007. Neutrality, niches, and determinants of plankton metacommunity structure across boreal wetland ponds. *Ecoscience,* **14** (2): 146-154.

Stanczykowska, A., Zyska, P., Dombrowski, A., Kot, H. and Zyska, E. 1990. The distribution of waterfowl in relation to mollusc populations in the man-made Lake Zegrzynskie. *Hydrobiologia,* **191**: 233-240.

Subba Rao, N.V. 1989. *Handbook: Freshwater molluscs of India.* Zoological Survey of India, Calcutta.

Townsend, C. R., Doledec, S. and Scarsbrook, M. R. 1997. Species traits in relation to temporal and spatial heterogeneity in streams: a test of habitat templet theory. *Freshwater Biology*, **37**: 367-387.

Urfi, A. J., Sen, M., Kalam, A. and Meganathan, T. 2005. Counting birds in India: Methodologies and Trends. *Current Science*, **89** (12): 1997-2003.

Vakkilainen, K., Kairesalo, T., Hietala, J., Balayla, D., Cares, E., Wouter, J. Bund, V., Donk, E., Ferna Ndezalaez, M., Gyllstrom, M, Hansson, L., Miracle, M., Moss, B., Romo, S., Rueda, J. and Stephen, D. 2004. Response of zooplankton to nutrient enrichment and fish in shallow lakes: a pan-European mesocosm experiment. *Freshwater Biology*, **49**: 1619–1632.

Candidate
(Sonal L. Deshkar)

Guiding Teacher
(Dr. Geeta Padate)

Reader in Zoology
Department of Zoology
The Maharaja Sayajirao University
of Baroda, Vadodara-390 002.

T/c Head, Department of Zoology

Head of the Dept. of Zoology
Faculty of Science
The Maharaja Sayajirao University
of Baroda, Vadodara-390 002.