CHAPTER-I

GENERAL INTRODUCTION
1.1. INTRODUCTION

Wetlands are among the world’s most productive environment. They provide tremendous economic benefits to mankind through the production of fish and other plants and animals. The richness of wetlands can be seen from the fact that they can produce up to eight times as much plant matters of wheat fields (Jhingran, 1991). But these processes can be maintained if the ecology of wetlands is allowed to continue functioning.

The IUCN defined wetlands broadly for purpose of the Ramsar Convention on Wetlands of International Importance (IUCN, 1971) as areas of marsh, fen, peat land or 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. (Cowardin et al., 1979) used detailed scientific criteria to define wetland and according to them wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water and wetlands must have one or more of the following three attributes (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly hydric soil and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

They have been described as the “kidneys” of the landscape as they filter sediments and nutrients from surface water. Wetlands are often referred to as “biological supermarkets” because they support all life forms through extensive food webs and biodiversity (Mitsch and Gosselink, 1986). They help to regulate water levels within watersheds, improve water quality, reduce flood and storm damages, provide habitat for important fish and wildlife, support hunting, fishing, other recreational activities and perform some useful functions in the maintenance of ecological balance. Dense human population in catchments, urbanisation and various anthropogenic activities has resulted in over exploitation of wetland resources, leading to degradation in their quality and quantity. Now, there is increasing concern to conserve and restore perishing wetlands and endangered habitats to achieve ecological sustainability.

Wetland systems directly and indirectly support lakhs of people, providing goods and services to them. They help check floods, prevent coastal erosion and
mitigate the effects of natural disasters like cyclones and tidal waves. They store water for long periods. Their capacity during heavy rainfall to retain excess floodwater that would otherwise cause flooding results in maintaining a constant flow regime downstream, preserving water quality and increasing biological productivity for both aquatic life as well as human communities of the region. Inundated wetlands are very effective in storing rainwater and are the primary source for recharging ground water aquifers. Many wading birds and waterfowl like egrets, herons and cranes nest in wetlands. Mangrove forests are valued for production of fish and shell-fish, live-stock fodder, fuel and building materials, local medicine, honey and bees-wax and for extracting chemicals used in tanning leather, farming and fisheries production have replaced many mangrove areas. Moreover, significant socio-economic values like constant water supply, fisheries, fuel wood, medicinal plants, livestock grazing, agriculture, energy resource, wildlife resource, transport, recreation and tourism are noteworthy (Mitsch and Gosselink, 1986).

Wetlands serve important biological, environmental quality and socio functions such as flood storage, ground-water recharge, sediment trapping, retention and removal of nutrients and pollutants, and wildlife and recreational habitat (Niering, 1970, 1973, 1985, 1988; Niering and Kraus, 1986; Brenner, 1989; Brooks, 1989; Metzler and Tiner, 1992).

The mere existence of wetlands may have great significance to some people, as they are a part of their cultural heritage. The association of man and wetlands is ancient, with the first signs of civilization originating in wetland habitats such as the flood plains of the Indus, the Nile Delta and the Fertile Crescent of the Tigris and Euphrates rivers. Wetlands cover about 6% of the earth’s land surface. They are home to some of the richest, most diverse and fragile of natural resources. As they support a variety of plant and animal life, biologically they are one of the most productive ecosystems (Niering and Goodwin, 1973; Tiner, 1998).

1.2. WETLANDS OF INDIA

India is endowed with vast expanse of fresh water resources which can be broadly put under two main categories depending on the basic ecological considerations. They are (1) ponds and lakes and (2) streams and rivers. All other freshwater habitats are the variations of these two types and as such the basic
morphological features of the environment (form, structure and development) can be defined by determining which characteristics of the basic habitat classes are present in the subject water body. The first of the two characteristics pertains primarily to bodies of freshwater ponds, lakes and to some extent swamps, beels and marshes. These habitats are collectively called lentic waters because their dominant feature is standing or still. Within these depths and light penetration-litoral and limnetic zones, litoral zones are relatively shallow, light penetrating with sufficient intensity to the bottom to support rooted green plants. Beels are the characteristic examples which can be defined as freshwater bodies with only litoral zones. The country has extensive freshwater wetlands of the first category mainly located in Eastern U.P., Bihar, West Bengal, Assam and other North Eastern States of India. These water bodies are generally formed either by tectonic depression or by strengthening of riverine embankments as part of flood control measures or by change in the river courses. Some of the beels are permanently disconnected from the main stream, while some still maintain their connection. Accordingly, these water bodies are of two types (1) open beels or live beels, and (2) closed beels or dead beels. Open beels are wide, shallow and have irregular contours. These beels are connected with the parent river through canals and depend mainly on them for water supply as well as auto stocking. Closed beels are dead river or rivulet courses which became disconnected from the mainstream following a change in their courses.

1.3. WETLANDS OF ASSAM

Assam is a truly riverine state drained mainly by two river systems, the Brahmaputra and Barak. In the floodplains of these rivers are found a large number of lake-like natural water bodies and swamps. These water bodies are locally known as ‘beel’, while the marshes and swamps are generally known as ‘jalal’, ‘doloni’, ‘pitoni’, ‘doba’, ‘hola’ etc. in some areas the beels are often referred to as ‘gadeng’. However, all these natural features may be included under the comprehensive term ‘wetland’ following current international usage. These wetlands may broadly be divided into two categories. The lake-like features with a clear water spread area in the middle are the beels, while those covered by weeds, grasses etc. are swamps or marshes.

The beels and swamps represent potentially very rich wetlands. But like other waterlogged areas in the country, these naturally waterlogged areas in Assam
can very well be included as a category in the wasteland map (Sharma and Goswami, 1988). On the other hand the wetlands, both beels and swamps, are geomorphologically and ecologically very important features. These comprise a major component of the hydrologic regime of the state, acting as storage basins during the floods, reducing their impact and minimizing the potential for erosion (Deka and Goswami, 1992).

Apart from their geomorphological importance, the biological and socio-economic value of such wetlands is also quite significant. A good number of work on limnology and pattern of energy utilization in beel system have been carried out by Dey (1977), Lahon (1983), Kar (1984), Pathak et al. (1985), Goswami (1985) and Jhingran (1991). These beels are traditionally used as natural fisheries in Assam. Even under the present almost underdeveloped condition, the beels produced more fish per unit area than any other well maintained reservoirs in the country (Bhagawati and Kalita, 1987).

Assam, located in the tropical latitudes (24°08’N and 27°59’N) and eastern longitudes (89°42’E and 96°01’E), is the most populous State in the North-East India covering an area of 78,523 sq km. The State can be divided into three distinctive geographic parts. The first one, being the long and comparatively long and narrow Brahmaputra valley or Assam valley. The river Brahmaputra flows from East to West for about 700 km within the State and has great role in the land formation, hydrology, ecology, population distribution, culture and economy of the valley and the State. The Barak, another largest river of the State has created the Barak Valley in the Southern end of the State. Barail range and Karbi Plateau has separated these two river systems.

The state has the maximum number and water area (Das et al., 2009) in India user flood plain wetlands, mainly associated with the river Brahmaputra and Barak, locally known as beels (Jhingran and Pathak, 1987). They are mostly ox-bow lakes, back swamps and tectonic depression. The predominance of floodplain wetlands in Brahmaputra basin is attributed to the changing course of the rivers and their tributaries in the upper stretches. Frequent earthquakes due to crustal instability induce local and sudden shifts in basement levels. This coupled with heavy discharge of water triggers the process meander cutoffs leading to the formation of the ox-bow lakes. Tectonic depressions are also formed due to earthquakes.
Similarly, the Brahmaputra is prone to frequent and heavy flood, which break the levees leading to formation of back swamps and sloughs. Assam has 1,392 beels spread over more than 100,000 ha constituting 61% of the total lentic water bodies of the state. Total area of beels associated with the Brahmaputra is 92,000 ha and Barak valley in 8,000 ha (Das et al., 2009). The Brahmaputra valley is divided in to three regions namely, central Assam, lower Assam and upper Assam. The central Assam has 342 number of beels covering an area of 31,080 ha, the lower Assam has 352 number of beels covering an area of 29,000 ha and the upper Assam has 376 beel with a water area of 23,00 ha. The Barak valley has its share of 322 number of beel spreading in 800 ha along the Bagia boarder of Bangladesh (Dehadari, 2006).

From the study carried out through application of remote sensing techniques using Landsat -5 TM and IRS-1B LISS II imagery of the year 1991-92, it is observed that the total number of wetlands in the northeastern region of India is 5,151 and that of Assam is 3,513. The total wetland area in the region is 2,256.89 sq km as against 1012.32 sq km wetland area within the state of Assam alone, during the pre monsoon season. This constitutes 0.86 percent of the total geographical area of the region. Waterlogged areas are 1931 in number and occupy 808.54 sq km of area, thus remaining at the top position. In Assam, the waterlogged areas are 1125 in number; however, area-wise swampy marshy areas ranks first comprising 434.33 sq km., though their number is only 712. Among all the districts of Assam, Nagaon district possesses the highest number of 379 wetlands while Morigaon district has the highest wetland area of 116.58 sq. km. In Assam, a total of 1367 inland wetlands suffer due to the problem of invasion by aquatic weeds and need ameliorative steps for conservation. Out of this, 656 are swampy/marshy areas, 366 ox-bow lakes/cut-off meanders, 193 lakes/ponds, 133 water-logged, 13 tanks and 3 reservoirs.

In water retentivity beels may be classified in to seasonal which is shallow and dry up seasonally and perennial beels which are deeper and permanent beels and retain water throughout the year. On the basis of depth beels are classified as shallow beel (having maximum depth up to 5 meters), medium deep beels (maximum water in the range of 5 to 10 meters) and deep beels (having maximum depth of over 10 meters). Beels with an effective area less than 100 ha, 100 to 500 ha and more than 500 ha is categorized under small, medium and large beels. In 1992, The Assam Remote Sensing Centre, Assam Science and Technology
Education Council and the Indian Space Application Centre of the Indian Space Research Organization (Annon, 1997) developed a classification system for the wetlands in Assam that divided them into six categories—lake/pond, ox-bow lake/cut-off meander, water logged areas, swamp marsh, reservoir and tank. Except reservoir and tank all are natural water bodies.

Beels are very important from the ecological point of view. To manage these resources, Government has formulated various Act like, Wild Life Protection Act, 1972; The Environmental Protection Act, 1986; The Air and Water Act, 1974; The Indian Societies Act, 1984; The Indian Cooperative Act, 1963 etc. But in case of implementation of these different Acts have not achieved the expected success. So, it is the right time to review this situation. Therefore, it is imperative for sustainable development of the ecology and aquatic bioresources of the beels by proper management.

1.4. MANAGEMENT

In Assam, the beels are under the control of the Revenue Department (Settlement). Since 1977, a substantial number of beels have been handed over to the Assam Fisheries Development Corporation (AFDC) for maintenance. Under the present system of management (Fig-1.1), both the Revenue Department and AFDC lease out the beels for a period of five/six years at a time. The prime objective is to earn revenue for the State’s exchequer. The protection of the interests of the Koiborta (traditional fisher folk) community is not given much attention under the existing policy. The system allows rich middlepersons to obtain the leases. The lessee hires fishers to do the fishing. In most cases, fishers of adjacent villages are employed at very low wages or on a share-harvest (60:40) basis. The marketing of the fish is totally controlled by the lessee. Fishers are not allowed to sell their share in the market. They have to sell it back to the lessee at a low price fixed by the lessee. As the lease period is fixed, the lessee maximizes income by catching the entire stock of fish from the beel. To achieve this, the water level is often reduced by pumping it out. The fishers also help the leaseholder to maximize the catch, especially fishers working on the share-harvest system. The provisions of the Indian Fisheries Act 1897, enacted for the protection and conservation of fish biota, are meaningless under this management system.
1.5. COMMUNITY-BASED CO-MANAGEMENT

Assam is struggling to build its economy through efficient resource utilization, specially the beels. However, the current management strategy does not allow for the local fishing community to have a role in the management paradigm. Historically, village and community-based management of beels and traditional fishing rights have existed. However, for the most part, these systems have disappeared. Recognition of the need for sustainable development and the need to address the ecological, economic and social objectives make a change in the management policy for beels imperative. Biotope improvement is a must for the long-term optimum exploitation of the beels (Jhingran, 1979), in terms of both environmental protection and productivity. The resources will dwindle in due course of time if biotope improvement is not made (Yadava, 1987). Under the present management system no one is responsible for this aspect. Historical information shows that the beels were once the common property of the community and conservation ethics were followed. Catching and killing of broodfish and juveniles were prohibited. Such conservation practices still prevail among the Tiwa community of the Morigaon district in central Assam. Jon beel is a classic example of such management. In most cases poor fishers are also under pressure to increase their income and easily fall prey to the lessee’s interests.

It is necessary to develop a community-based co-management model for the beels of Assam like those applied in the reservoir fisheries in North Eastern Brazil (Christensen et al., 1995). The government must take the initiative and get scientists and development personnel to develop and establish community-based fisheries co-management for beel fisheries in Assam.

Fig.1.1. Beel fisheries management systems in Assam (Ahmed et al., 1992).
1.6. IMPORTANCE OF ECOLOGICAL STUDIES

Change, as a result of environmental, social, economic and political drivers, is occurring in many natural resource management situations around the world. To understand how natural resource management situations are changing over time involves monitoring i.e. undertaking and analysing regular observations to detect change. This information can then be used to development adaptive management planning for future actions. For most natural systems, it is virtually impossible to have a comprehensive understanding of how the whole system works and behaves and its consequent state. In an ideal world, we would monitor all structures and processes within these systems and then go on to identify typical structures and processes. This is simply not possible within complex natural systems such as tropical wetlands. There are far too many structures and processes operating at a range of spatial and temporal scales to monitor and these changes adapt with inherent fluctuating environmental conditions. In many cases we are therefore forced to significantly simplify our understanding of these natural systems; appropriate indicators need to be developed which can be used to describe their status. Some of the considerations of choosing indicators include their ability to interpret key drivers of natural systems and their “user-friendliness” (human capacity, logistics and financial resource requirements). In many parts of the world, monitoring is extremely problematic because of these issues (Danielsen et al., 2005), yet these are usually places where monitoring is most urgent due to the high dependency of livelihoods on local natural resources and the increasing pressures on these. One such location is the Nagaon and Morigaon District in Assam. The area is comprised of a mosaic of wetlands criss-crossed by an intricate network of rivers. This diversity of habitats supports a huge biodiversity of both terrestrial and aquatic life and provides a wealth of natural resources for the peoples that inhabit in the area. The wetland areas in particular are critical for subsistence fishing (60%) of local diets is from fish and for growing local enterprises such as commercial fishing, fodder collection, poaching of birds, seasonal agricultural practice and for other day to day uses. At present, the extent of human activity in the wetlands is similar to historical community use. As such, humans are considered an integral component of these wetland ecosystems and together they function as a social-ecological system (Berkes and Folke, 1998) sustaining each other over time. However, with growing
threats of illegal fishing, hunting etc. and limited government capacity to adequately monitor the environmental and social impacts of these activities, it is essential to collect information on ecosystem status for better managerial practice.

With these views in mind, the present study was undertaken to evaluate the ecology of beels as a function of limno-chemical parameters in the Brahmaputra valley in order to understand their ecological status and to formulate a general management policy for optimizing fish production from such waters.

1.7. AIMS AND OBJECTIVES OF STUDY

Studies made in some beels of Assam, give valuable information regarding the limnological features, ecological status and the management measures for these aquatic resources. However, as the beels are peculiar ecosystems, each having a separate identity, a general background on the application of various limno-chemical parameters for evaluating ecological status and effective measures for the utilization of vast energy resource, taking few beels as example, is very essential. In order to gather systematic information, Sondoba in Morigaon and Deobali jalah in Nagaon districts of Assam were taken as a case study to give a comparative picture for better management policies with the following objectives-

1. To analyse the physico-chemical parameters of soil and water to know
   i) the range values of the parameters at present condition
   ii) the effect of these parameters on its biological counterparts.

2. To study the plankton diversity to find out the seasonal abundance of the plankton community.

3. To study the macrophytes to record
   i) its general distribution in the beels
   iii) impact of the macrophyte over the abundance and distribution of plankton, fish and birds.

4. To study the fish fauna to know
   i) the species composition
   ii) seasonal landing pattern
   iii) interrelation among plankton and macrophytes.

5. To investigate the diversity of avifauna to find out
   i) the seasonal abundance and population status and
   ii) to determine the habitat use types of different avian fauna