General Introduction
1. General Introduction

1.1. Inland fisheries resources: production and potential 2
1.2. What is a floodplain lake? 2-3
1.3. Eco-biological importance of floodplain lakes 3-4
1.4. Floodplain lakes in India 4-6
1.5. Problems of sustainable fisheries in floodplain lakes of India. 6
1.6. Objectives 9
1.7. Division of the thesis 10
1. General Introduction

1.1. Inland fisheries resources: production and potential

India is endowed with plentiful of natural inland fisheries resources in the form of rivers, estuaries, ponds, tanks, lakes, reservoirs, floodplain lakes, swamps and many other such water bodies, which are noted for their heterogeneity in composition and productive potential. The present production of fish in India is about 6.9 million tonne of which 3.8 million tonne is contributed by the inland fisheries sector (URL-1). The production could be increased to many folds had all fisheries resources exploited to its full potential. Unfortunately, many of the inland freshwater bodies particularly the floodplain lakes, swamps and derelict waters kept largely under exploited (Jhingran, 1990) and a large gap remained between actual production and potential of these resources.

Floodplain lakes in India constitute an important fisheries resource particularly in the states of Assam, West Bengal and Bihar. But the average production of fish from the floodplain lakes in India remained poor at 100-300 kg/ha/yr only, while it was observed that proper scientific management of these water bodies could result in a production of as high as 1000-1800kg/ha/yr (Das, 2002). There are several reasons behind the under exploitation of the floodplain lakes which need to be addressed in order to utilize the production potential of these water bodies.

1.2. What is a floodplain lake?

A floodplain is a flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding. It tends to develop on the lower and less steep sections of rivers. Two types of river channels are found in floodplains: meandering and braided. Meandering rivers consist of a single main channel that bends and loops. In some cases, the channel is so winding that the length along the channel is several times the straight-line distance along the river valley. Braided rivers have numerous distinct channels that repeatedly divide and then merge again downstream. While a meandering channel occupies only a small part of its floodplain at any one time, a braided river occupies much of its floodplains.

Floods play a central role in creating and shaping floodplains. During a flood, the flow of a river is both deeper and faster, allowing it to carry more sediment. As flood recedes, the depth and the speed of the river diminish and the river deposits some
of its load of sediment. Since floodplains are constructed of the material being carried by the river, they are composed of relatively fine sediment. Most floodplains are thus composed of sand, silt, and clay; but floodplains of gravel occur where the water flows especially fast.

A braided river reworks the sediment in its floodplain very frequently as the various individual channels continually shift position. In meandering rivers, the water on the outside of the bend speeds up, while the water on the inside of the bend slows down. Consequently, material is eroded from the outside of the bends where the flow is a little faster and deposited along the inside of bends where the flow is slower. Sediment is thus eroded on the outside of bends and on the downhill side of traverses and deposited on the inside bends and on the uphill side of traverses. Over times, it causes the meander loops to migrate downstream. If the movement of one meander loop overruns the next one downstream, then a meander cut-off or chute is formed. This causes the course of the channel to be shortened as the two meander loops join. The abandoned meander loop is gradually isolated as sediment is deposited at each end by the water flow in the main channel. This process eventually leads to the creation of an ox-bow lake.

Many interrelated factors determine the form taken by river channels and it is not precisely understood why some river channels have a meandering pattern and others are braided. Meandering channels are more common where the floodplain sediments are sand, silt, and clay. Braided channels are more common where the floodplain sediment is mostly gravel or where there is an increase in channel steepness. A braided pattern also tends to be favored if the amount of water flowing in the river is highly variable or if the banks are easily eroded and can provide abundant sediment to the channel. In India, particularly in Assam, West Bengal and Bihar the floodplain lakes are formed from river meanders.

1.3. Eco-biological importance of floodplain lakes

Floodplain lakes are an important component of global environmental security and resilience because of their high compensatory potential to mitigate environmental change, their capacity of water retention, food production, CO₂ sequestration, production of bio-fuels and their capacity to support wide variety of flora and fauna (Anonymous, 2008). Floodplain lakes are integral part of river basins and are dynamic
water bodies with high potential of river purification and regulation of exchanges of nutrients between land and water maintained by the pulse-regulated hydrology of running waters. In agricultural river valley landscapes, floodplain oxbow lakes function as very effective biochemical filters contributing to sediment trapping, nutrient removal and river pollution prevention. They maintain stability in low land ecosystem providing effective floodwater retention mechanism. The floodplain lakes present diverse ecological conditions, from lotic to lentic water and from deep lakes having summer thermoclines to shallow swamps and have high potential of fish and allied agricultural production. They support a rich variety of biotic communities in the form of fish, zooplankton, phytoplankton, macrophytes, benthos, insects and other associated fauna (Vass, 2006). Thus floodplain lakes are highly productive and large scale commercial capture fisheries are practiced in many of them. They play important roles in rural economy and livelihoods of the people living adjacent to it (URL-2). In India many floodplain lakes also provide unique habitat for both indigenous and migratory birds (Barua et al., 2000; Gogoi, 2007).

1.4. Floodplain lakes in India

The floodplain lakes are common feature of the Indian landscape, especially along the Ganga and Brahmaputra river systems. Total area of wetlands in India (excluding rivers) is estimated to be 58,286,000 ha (URL-3; Ramchandra et al., 2002), out of which a little over 2, 00,000 ha is covered by the floodplain lakes (Sugunan, 1995; Shina, 1998). However, the floodplain lakes are restricted mostly to the eastern and northeastern states of the country with West Bengal, an eastern state, sharing approximately 42,000 ha area from about 150 floodplain lakes (Anonymous, 2000; Bhaumik et al., 2003; ICAR, 2006). Most of the floodplain lakes in India are cut-offs from the river meanders and are of basically two types: open and closed (Sinha, 1993). Open one retains its connection with the river course, at least during the monsoon months, offering scope for auto stocking, while the closed one is completely cut off from the river course. The open floodplain lakes serve as natural breeding ground for many riverine and estuarine fish (Payne, 1986; Jha, 1989; Maltby, 1991; CIFRI, 2000) and play a vital role in the recruitment of fish population of the riverine and estuarine ecosystem (Maltby, 1991; CIFRI, 2000).

In West Bengal, the floodplain lakes are commonly known as beels or baurs or jheel, (Khan, 2002) while these water bodies are called as “mauns”, “chaurs” and dhar
in Bihar, “pats” in Manipur and “beel” in Arunachal Pradesh, Assam, Meghalaya and Tripura (Vass, 2006). In West Bengal, the floodplain lakes are abundant in the districts of Nadia, Murshidabad, North 24 Parganas and Hoogly (Sinha, 1993). The floodplain lakes of the North 24 Parganas district of West Bengal are called as “baur”, most of which are open floodplain lakes with seasonal or perennial connection with the river.

The present study was conducted on two floodplain lakes in the Bongaon subdivision of the North 24 Parganas district. The river Ichamati and its branches form a large complex of floodplain lakes in the Bongaon subdivision of North 24 Parganas district (Das and Nandi, 2004). Most of these floodplain lakes (baurs) are open with a seasonal or perennial connection with the river Ichamati and are fed with tidal ingress of saline water from the Bay of Bengal. Thus a varying degree of brackish water condition exists in these baurs for a considerable period of the year. The baurs serve as vital spawning ground for Indian major carp and many small fishes. The easily accessible shallow areas of these baurs provide ground for spawning and space and food for rearing larvae of the spawning fish. Many brackish water species of fish migrate from the Ichamati river into the baurs during breeding season and exploit the rich nutrient resources of these water bodies for spawning. As a result, many brackish water species, which are not found in other freshwater floodplain lakes of the state, are found in these water bodies (Mondal and Kaviraj, 2009). Detailed biology and recruitment pattern of many of these brackish water species are not completely known. These baurs are also rich in zooplankton, phytoplankton and macro-invertebrate species apart from being ideal habitat for many species of amphibia and birds (Khan, 2002). As a result, a biologically sensitive ecosystem exists in most of the baurs of the Bongaon subdivision.

The floodplain lakes of Ichamati river basin are also extensively used for culture of Indian and exotic carps. From a study of six baurs in Bongaon region it was revealed that Indian major carps are stocked annually in these baurs, stocking rate ranging from 2561 to 19600 kg depending upon size of the baur (Mondal et al, 2006). This study revealed that maximum yield per unit area was obtained from Gopalganj baur (901.9 kg/h) during 2000-01 while Dumur baur yielded only 648 kg/h. This yield was far below the average yield expected from a baur (Kumar, 1999). Indian major carps raised in pens, installed in two floodplain lakes of Assam, with supplementary feeds exhibited production from 1780 to 2106 kg/h (Gorai et al., 2006). Although fishing is the main economic activity in the floodplain lakes, a wide range of other activities like irrigation,
agriculture, jute retting, duck rearing, navigation and washing are closely linked to these water bodies, making them a lifeline of rural West Bengal (Plate 1.1; URL-2). Traditionally, these different activities have been carried out in harmony for long period until conflicts that appeared in recent years between agriculture and fisheries. Agriculturists would like to reclaim and convert as much lake area as possible into agricultural fields particularly during dry season, while aquaculturists would prefer to exploit entire water bodies for production of fish.

1.5. Problems of sustainable fisheries in floodplain lakes of India

The floodplain lakes have been supporting a lucrative fishery from time immemorial. But unfortunately, these resources in India have become worst victims of environmental degradation since last two decades. Majority of these water bodies are shrinking due to siltation caused by high fluvial allochthonous charges from the river meanders, discharge of organic debris from human settlements around the lakes, run-offs from agricultural fields, eutrophication and autochthonous production of macrophytic biomass (Das, 2002; Deka et al., 2005). Abundance of macrophyte is a serious threat to almost all floodplain lakes in India (Sinha, 1993; Goswami et al., 1999; Sugunan and Bhattacharjya, 2000). The heavily grown of macrophytes not only occupy the surface area of the lakes but also gradually elevate the bottom through deposition of dead plants.

Vono and Barbosa (2001) observed abundance of macrophyte to influence total fish abundance in natural lakes. Infestation of weeds is a common problem of the bairs of the Bongaon subdivision (Plate 1.2) (Khan, 2002). In addition, indiscriminate jute retting during summer months cause sharp deterioration of water quality, which is a concern for survival of fry and fingerlings of the species that migrate from the river Ichamati and breed in the shallow marginal areas of these bairs (Mondal and Kaviraj, 2008). Seasonal flood and drought in Ichamati River also influence the baur fishery of the Bongaon region. However, the greatest pressure on fin fish biodiversity as well as fishery of state and other bairs of Eastern India is indiscriminating catch of all varieties of fish through out the year (Kar et al., 2006; Mondal et al., 2006). As a result, many species of fish are showing a declining trend or being vanished from some floodplain lakes of West Bengal (Panigrahi et al., 2003). Decline in variety and abundance of fish in the floodplain lakes of India are result of multiple effects of environment and human activities (Deka et al., 2005) each of which should be addressed carefully for development of sustainable fisheries in these water bodies.
Introduction

Fishing by men on boat
Duck rearing

A man removing water for paddy cultivation in the bank of the baur
Pumping of water for irrigation

Plate 1.1. Commercial exploitation of floodplain lakes of Ichamati river basin.
Plate 1.2. Macrophytes occupying surface area of two floodplain lakes of Bongaon Subdivision.
1.6. Objectives

The major objectives of this work were to evaluate the status of finfish biodiversity in two floodplain lakes of the Ichamati river basin under Bongaon Subdivision and to formulate policies on long-term sustainability of these two lakes particularly in respect of fisheries. The objectives included an evaluation of changes in the environmental conditions of these two lakes and its impacts on current and future status of finfish biodiversity of the lakes. As a result, investigations were directed towards determining community structure and diversity indices of fish and physico-chemical parameters of water for three consecutive years and determine the trend in environmental condition and finfish biodiversity status of these lakes. In order to make detailed insight in to the trends in biodiversity, studies were made on detailed biology including recruitment pattern of two selected abundant species for one full year. Since jute retting is a major constraint in the floodplain lakes under study bioassays were made in simulated condition of the lakes to evaluate impact of jute retting on the survival of fry and fingerlings of commercially important species of fish and invertebrates inhibiting the lakes. All these observations were put together to get a holistic picture of environmental situation and finfish biodiversity status of the lakes. Therefore, the objectives of this study could be summarized as follows:

- To prepare an inventory of finfish species inhabiting Gopalnagar and Dumar baur situated in Bongaon Sub-division of the North 24 Parganas district in West Bengal.
- To determine community structure and diversity indices of finfish, their temporal variation and pattern of changes over time in these baurs.
- To determine biology including recruitment pattern of two most abundant finfish species of these lakes.
- To determine environmental conditions of these baurs with special reference to hazards caused by jute retting and identify factors that could influence the biology of the self recruiting species and community structure of finfish in these baurs.
- To predict future status of finfish biodiversity and recommend policies on utilization and management of the baurs for long-term sustainability of fishing operations.
1.7. Division of the thesis

The thesis has been divided into six chapters. "General Introduction" is followed by "Literature review" in the second chapter. The third chapter deals with "Materials and Methods". "Results" have been presented in three different sections under chapter 4. A general discussion on entire work has been included in chapter 5. Literatures cited in the text have been listed under "References" in chapter 6. Original data generated for different physiochemical and finfish biodiversity parameters of the two baurs have been recorded in Appendices (I to III). Publication made out of the work of this thesis has also been appended to the thesis as "Publications".