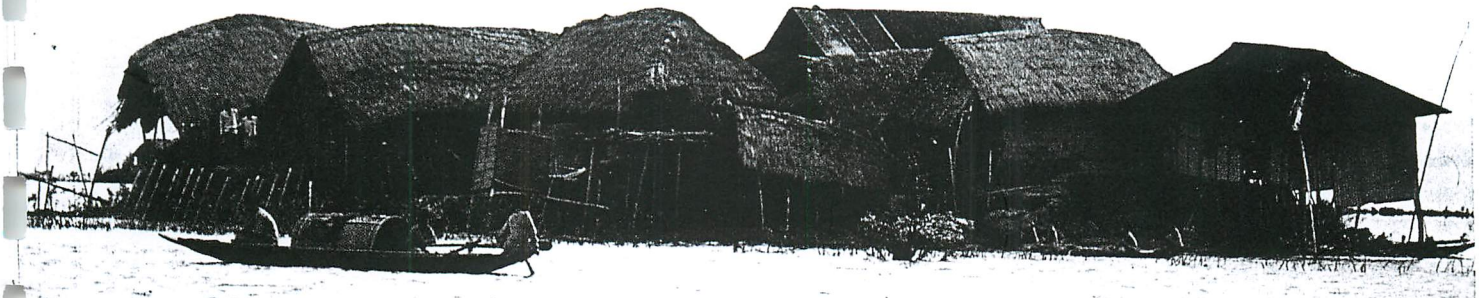
Government of the People's Republic of Bangladesh
Bangladesh Water Development Board
Flood Plan Coordination Organisation

FLOOD ACTION PLAN

NORTHEAST REGIONAL WATER MANAGEMENT PROJECT (FAP 6)

SPECIALIST STUDY
WETLAND RESOURCES
Final Report

October 1995



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in association with

Engineering and Planning Consultants Ltd.
Bangladesh Engineering and Technological Services
Institute For Development Education and Action
Nature Conservation Movement

Canadian International Development Agency

COVER PHOTO: A typical village in the deeply flooded area of the Northeast Region. The earthen village platform is created to keep the houses above water during the flood season which lasts for five to seven months of the year. The platform is threatened by erosion from wave action; bamboo fencing is used as bank protection but often proves ineffective. The single *hijal* tree in front of the village is all that remains of the past lowland forest. The houses on the platform are squeezed together leaving no space for courtyards, gardens or livestock. Water surrounding the platform is used as a source of drinking water and for waste disposal by the hanging latrines. Life in these crowded villages can become very stressful especially for the women, because of the isolation during the flood season. The only form of transport from the village is by small country boats seen in the picture. The Northeast Regional Water Management Plan aims to improve the quality of life for these people.

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ACRONYMS AND ABBREVIATIONS

AWB	Asian Wetland Bureau
BCAS	Bangladesh Centre for Advanced Studies
BCIC	Bangladesh Chemical Industries Corporation
BNH	Bangladesh National Herbarium
BWDB	Bangladesh Water Development Board
CIDA	Canadian International Development Agency
DC	District Commissioner
DEPC	Department of Environment Pollution Control
DOE	Department of Environment
DPHE	Department of Public Health Engineering
EIA	Environmental Impact Assessment
FAP	Flood Action Plan
FCID	Flood control, drainage, irrigation
FEAVDEP	Flood- and Erosion-Affected Villages Development Project
FMP	Forestry Master Plan
FPCO	Flood Plan Coordination Organisation
GEF	Global Environment Fund
IUCN	International Union for the Conservation of Nature
IWRB	International Waterfowl and Wetland Research Bureau
LGED	Local Government Engineering Department
MAB	Man and Biosphere Programme (UNEP)
MIWDFC	Ministry of Irrigation, Water Development, and Flood Control
MMP	NERP Monthly Wetland Monitoring Programme
MOEF	Ministry of Environment and Forests
MOL	Ministry of Land
MPO	Master Plan Organisation
NACOM	Nature Conservation Movement
NCS	National Conservation Strategy
NEMAP	National Environment Management Action Plan
NEMREC	Northeast Regional Environment Management, Research, and Education Centre
NEMREP	Northeast Regional Environment Management, Research, and Education Project
NERP	Northeast Regional Project
NGO	Non-Governmental Organisation
NHC	Northwest Hydraulic Consultants
ODA	Overseas Development Agency (UK)
SAARC	South Asian Association for Regional Cooperation
SPARRSO	Space Research and Remote Sensing Organisation
SLI	Shawinigan-Lavalin Inc.
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
WARPO	Water Resource Planning Organisation
WWF	Worldwide Fund for Nature (formerly World Wildlife Fund)

MPO Land Classification

F0	Land inundated to < 0.3m
F1	Land inundated between 0.3m and 0.9m
F2	Land inundated between 0.9m to 1.8m
F3	Land inundated more than 1.8m on which deepwater aman can be grown
F4	Land inundated more than 1.8m on which deepwater aman cannot be grown

< 9 months

> 9 months

(Perennial)

NERP DOCUMENTS

The Northeast Regional Water Management Plan is comprised of various documents prepared by the NERP study team including specialist studies, the outcome of a series of public seminars held in the region, and pre-feasibility studies of the various initiatives. A complete set of the Northeast Regional Water Management Plan Documents consists of the following:

Northeast Regional Water Management Plan

Main Report
Appendix: Initial Environmental Evaluation

Specialist Studies

Participatory Development and the Role of NGOs
Population Characteristics and the State of Human Development
Fisheries Specialist Study
Wetland Resources Specialist Study
Agriculture in the Northeast Region
Ground Water Resources of the Northeast Region
Surface Water Resources of the Northeast Region
Regional Water Resources Development Status
River Sedimentation and Morphology
Study on Urbanization in the Northeast Region
Local Initiatives and People's Participation in the Management of Water Resources
Water Transport Study

Public Participation Documentation

Proceedings of the Moulvibazar Seminar
Proceedings of the Sylhet Seminar
Proceedings of the Sunamganj Seminar
Proceedings of the Sherpur Seminar
Proceedings of the Kishoreganj Seminar
Proceedings of the Narsingdi Seminar
Proceedings of the Habiganj Seminar
Proceedings of the Netrokona Seminar
Proceedings of the Sylhet Fisheries Seminar

Pre-feasibility Studies

Jadukata/Rakti River Improvement Project
Baulai Dredging
Mrigi River Drainage Improvement Project
Kalni-Kushiyara River Improvement Project
Fisheries Management Programme
Fisheries Engineering Measures
Northeast Region Environmental Management, Research, and Education Project (NEMREP)
Habiganj-Khowai Area Development
Flood & Erosion Affected villages development project (FEAVDP)
Pond Aquaculture
Applied Research for Improved Farming Systems
Manu River Improvement Project
Narayanganj-Narsingdi Project
Narsingdi District Development Project
Upper Kangsha River Basin Development
Upper Surma-Kushiyara Project
Surma Right Bank Project
Kushiyara-Bijna Inter-Basin Development Project
Dharmapasha-Rui Beel Project
Updakhali River Project
Sarigoyain-Piyain Basin Development

GLOSSARY OF TERMS

English Terms

Biodiversity — Variability among living organisms from all sources including *inter alia* terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part; diversity within species, between species and of ecosystems (Convention on Biodiversity, 1992).

Ecosystem — Dynamic complex in which plant, animal and microorganism communities and their non-living environment interact as a functional unit (Convention on Biodiversity, 1992).

Emergent vegetation — Rooted aquatic plants standing in water with vegetation above the water surface.

Law — Main tools by which policies are implemented.

Legislation — The aggregation of laws enacted by legislative authorities of a country over time, plus common and customary laws that have accumulated respectively through judicial or traditional practice.

Mother fishery — Used by local fishermen to refer to sites characterized by densely concentrated, diverse, high-quality fish habitats (deep river scour holes, called duars, clear tributary streams, deep beels, sediment-free khals) and supportive flora (swamp forest, reed swamp, floodplain grasslands). Five mother fisheries have been identified in the region (see *Fisheries Specialist Study*).

Policy — Principles that govern action toward given ends. A statement of agreed-upon courses to be adopted and followed.

Wildlife — Most generally, organisms living in a natural state. The legal definition in Bangladesh restricts it to (Bangladesh Wildlife (Preservation) (Amendment) Act 1974) vertebrate species, other than humans, fish, and usually domesticated animal species, and including the eggs of birds and reptiles.

Wetland — An area of land saturated with or submerged under water. Legal definitions can vary from country to country. The term is not defined in any domestic legislation in Bangladesh. Rec. C.4.7 of the Conference of the Contracting Parties to the Ramsar Convention identifies 36 broad types, 26 of which are natural or semi-natural and 10 man-made.

Wetland values — All valued products and services derived from wetlands, such as food, fodder, fuel, medicines, flood storage, water purification, and so on.

Bangla Terms

Beel	Permanent shallow lake.
Duar	Deep river scour hole, important as refuge for fish.
Haor	River backswamp.
Kanda	Ridges that are higher than the haor basin but lower than homestead land.
Khal	Small drainage channel.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Introduction

The Northeast Region of Bangladesh (Figure 1) contains numerous large semi-natural wetlands and small fragments of natural and human-modified upland forest. This document focuses on selected biodiversity elements of these landscapes. This information is part of the total information base generated for the NERP regional water resources planning exercise. Other NERP reports – in hydrology/hydrogeology, fisheries, river morphology and sedimentation, social anthropology, and so on – document other characteristics of the region.

Scope of study and methodology

The information presented here is based on (1) *wetland field studies* conducted throughout the region during the period December 1991 to May 1993 a naturalist team including a wetland specialist, ornithologists, botanists, and wildlife biologists; (2) *village-level participatory studies* conducted in villages at three of the key wetland sites and near threatened habitat fragments from January to March 1994 by a team of social anthropology field workers; and (3) *upland forest visits* during early 1994 by the naturalist team.

The *wetland field studies* opened with a regional wetland appraisal and ornithology survey at the height of the waterfowl migration season, and included three aerial surveys. Based on these observations, a programme of ornithological, floral, and wildlife studies was designed and carried out at selected sites over the next year.

The *village-level participatory studies* were designed as a follow-on investigation, to learn from local people their perceptions of the history and current status of wetland resources, in particular remaining threatened habitat fragments; how these landscape elements were and are managed and utilized; what benefits they previously and currently provide(d); and what measures could be taken to secure their survival and continued local benefits.

The *upland forest visits* were undertaken to round out NERP's understanding of regional biodiversity, and to draw attention to the small but highly biodiverse fragments of tropical forest remaining in the region. Uplands account for but a small fraction of the study effort; results are presented in Annex E.

Historical perspective

In its original form, the haor basin of northeast Bangladesh would have consisted of a rich mosaic of permanent and seasonal lakes and ponds with abundant aquatic vegetation, surrounded by vast areas of swampy ground with tall reeds and seasonally flooded grasslands. Swamp forest, dominated by *Barringtonia acutangula* hijal, *Pongamia pinnata* koroch, and other flood-tolerant tree species, would have covered the river levees, and provided a secure refuge for terrestrial wildlife during the monsoon floods. On higher ground, this would have given way to scrub jungle and dense stands of bamboo.

Wildlife would have been abundant – Marsh Crocodile, Otter, Rhinoceros, Wild Buffalo, and Swamp Deer grazing in the marshes; Asian Elephant, Gaur, Sambar Deer, Hog Deer, and Wild Boar roaming the forests and grasslands; and Tigers and Leopards, and smaller cats and other types of predators hunting their preferred habitats.

Birds would have been everywhere – teeming flocks of migrant ducks and herons, egrets, storks, ibises, whistling-ducks, comb ducks, pygmy geese and many more species. During the breeding season, there would have been huge mixed colonies of cormorants, herons, and storks in the patches of forest, while the marshes would have rung with the bugling calls of Sarus Cranes.

Many millennia ago, humans would have begun visiting and later inhabiting the region, initially fully dependent on hunting animals and gathering plants. Later, domesticated herds and cultivated crops would have taken on increasing importance, introduced through local innovation, and by traders, travelers, and new settlers.

Today, although most of the permanent water bodies have survived, all the other major natural ecosystems have almost completely disappeared. Vast areas of the seasonally flooded plains have been converted to rice monoculture, while areas less suitable for rice are now heavily grazed by domestic livestock or cultivated for wheat and other crops. The swamp forests have been reduced to a few small patches, often no more than ten or twenty widely scattered and now very old trees, while all land above the level of the monsoon floods has been utilized for permanent settlement and homestead forests. The swamp forests, scrub jungle, bamboo thickets, and dense stands of reeds have almost entirely disappeared.

One result is that wave erosion increasingly affects many villages of the deeply flooded area, as the grasses, reeds, and swampforest trees growing around them are removed. Still today, however, many villagers of the region, especially the poorest, still rely on wetlands for biomass fuel, building material, fodder, and food, and the continuing loss of these potentially renewable resources is a source of hardship to them.

Similarly, the hillocks within the region and foothills areas along its borders were once covered with primary growth tropical forest, a habitat type that here as elsewhere is highly biodiverse. Now, most has been converted to tea plantation, scrub, or monoculture forest plantation. Only one small fragment of primary growth forest survives; a few others though significantly human-modified retain significant biodiversity.

Internationally significant wetland sites

The NERP wetland investigations found nine wetland sites in the region (Figure 2) that meet one or more Ramsar Convention criteria (Tables 2.1a and 2.1b) for international significance. Further study might well show that other regional wetland also qualify. In addition, many other sites would meet one or more of any reasonable set of criteria for national significance (which have not been formulated in Bangladesh as yet).

In order of general importance, the nine key wetland sites are:

1. *Tangua Haor*, perhaps the most natural large wetland remaining in the region. Tangua is the core of the northern haor system, which held 40% of all waterfowl recorded during the February/March 1992 survey. Tangua Haor has also been identified as the single most important major fish production and dispersal centre ("mother fishery" - see Glossary) in the region.

2. *Pasua Beel, Gurmar Haor* is surrounded by the finest stands of natural floodplain vegetation in the region, including a dense stand of *Pongamia pinnata* koroch, large areas of reeds

Phragmites kharka nol, and patches of dense shrubbery. These appear to be the best remaining examples of *Pongamia* forest and tall reed swamp habitat in the region. The site provides secure roosting for huge numbers of cormorants, herons, and egrets (at least 4,600 in late April 1992), supports a number of bird species which are scarce elsewhere in the region, including concentrations of Pallas's Fish Eagle, a globally threatened species, and exhibits a much higher diversity of waterfowl and other wetland birds than any other site investigated, with surveys finding 56% of all regional waterfowl species at this site.

3. *Hakaluki Haor* has been long known as a major wintering area for migratory waterfowl, especially ducks, and is a popular duck-hunting area for sportsmen from Dhaka. Important for wintering migratory shorebirds, and a mother fishery.

4. *Hail Haor* has biodiversity value primarily with regard to its unique status in the region as the largest shallow permanent lake, which supports a very rich and diverse aquatic plant community and a wide variety of resident bird species, several of which are scarce elsewhere in the region.

5. *Kaliajuri Area*, a relatively undisturbed area representative of the deeply flooded zone, has also been identified as a mother fishery. The area has some swamp forest patches, and in the dry season extensive areas of winter grasses, such as *Hematheria protensa* chailla which is rot resistant and widely gathered and used in the construction of homestead erosion protection works.

6. *Companiganj Area* contains the best reed swamp habitat remaining in the region and also has some floodplain grassland, which may be habitat for one or more threatened passerine bird species. It has been identified as mother fishery. Otters and large concentrations of turtles have been observed.

7. *Bara Haor* contains the best floodplain grassland habitat remaining in the region, and some reed swamp and swamp forest areas. Breeding cormorants and breeding herons have been observed. As at Companiganj Area, the floodplain grassland may be habitat for one or more threatened passerine bird species.

8. *Kawadighi Haor* remains very important for a wide variety of waterfowl, despite changes occurring since Manu River Project construction in 1976-83. Shallow beels with large shallow fringes provide attractive habitat for large numbers of shorebirds; and some beels may be important as breeding sites for Whiskered Tern and Black-winged Stilts, species not previously seen breeding in Bangladesh. Prior to Manu River Project, it was a mother fishery. The scope for habitat rehabilitation, and for modified flood control project operation in support of this, are key issues at this site.

9. *Balai Haor* was flagged on the basis of the presence of two threatened bird species, Lesser Adjutant and Pallas's Fish-Eagle; and of large concentrations of mostly resident ducks during periods of flash flooding (32,000 were present in late March 1992). The site is more heavily utilized by humans, habitats are more degraded, and conditions in general are less unique than at the first eight sites mentioned above. Further study will be necessary to determine if it would more properly be classified as a nationally significant site.

Wetland habitat types and regional status

Nine wetland vegetation types or habitats were identified. From lower to higher elevation these are submerged (about 20 macrophyte species), free-floating (20), rooted floating (15), sedges/meadows (35), floodplain grassland (transitional), reed swamp (7), freshwater swamp forest (6), crop field vegetation (20), and homestead vegetation (38).

Freshwater swampforest, reed swamp, and floodplain grassland survive only as fragments, many of which are highly degraded, and in the near-term are threatened with extirpation from the region. Nearly all occurrences of these three threatened habitats occur within the nine key wetland sites identified above.

Wetland/wetland-dependent species presence and status

Waterfowl and wetland-dependent birds

Ornithology studies were undertaken to determine the current status and abundance of waterfowl and wetland-dependent birds in the region. The studies show that despite massive habitat losses, the region remains an internationally important wintering area of migratory waterfowl, principally ducks and shorebirds; supports large numbers of some resident species; and is also of undoubted importance for spring and possibly autumn passage migrants, for at least two shorebird species. In late January 1993, a total of 386,000 individuals were counted at 15 monitored sites; the counts are thought to represent at least 50% and possibly 75% of the total number of waterfowl present in the region at the time of the count.

A total of 125 waterfowl species are known or thought to have occurred in the region. Of these, 53 are or were resident breeding species or breeding summer visitors; their current status is one species globally extinct; nine species extinct in the region; six species no longer breeding but present as visitors; and many other species populations greatly reduced. Another 42 species were regular winter visitors or passage migrants; their current status is two species extinct in the region; six species almost extinct in the region; and many other species populations greatly reduced, especially wintering ducks and geese. The remaining 30 species were probably never more than rare winter visitors or passage migrants.

During the wetland ornithology field program, 161 waterfowl and wetland-dependent bird species were observed, including 89 of the 125 historic waterfowl species; 30 wetland-dependent species largely or wholly dependent on wetland ecosystems, of which eleven are birds of prey; and 42 other species, of which eleven are birds of prey. Of the 36 waterfowl species not observed, 17 are extinct or nearly so in the region; eight are scarce visitors to the region; six are extremely secretive and easily overlooked (mostly rails and crakes); three species are mainly associated with rivers with extensive sand banks, which occur in the region only along the Old Brahmaputra (aerial survey only), and two species that are easily observed and relatively common, for which the lack of observations is surprising. Of particular interest is the observation during the field studies of 36 nesting pairs of Pallas's Fish Eagle *Halietus leucorhyphus*; this population has international significance as the largest actively breeding population seen in recent years throughout the species' range.

Wetland-dependent mammal, amphibian, and reptile species

For wetland-dependent mammal, amphibian, and reptile species, 89 species in 37 families are thought to have occurred in the region. A full 35% of these species are either extinct, threatened, or commercially threatened. Almost all of the threatened species fall into one of three broad groups:

large ruminants; the larger predators; and commercially valuable species – mainly turtles, but also lizards, otters, Indian Pangolin, Hispid Hare, Freshwater Dolphin, Bull Frog, and Rock Python.

Eleven species (12% of the regional species total) are regionally extinct: Leopard, Tiger, the three rhinoceros species (Sumatran Rhinoceros, Javan Rhinoceros, and Great Indian Rhinoceros), Pygmy Hog, Wild Boar, Gaur, Wild Buffalo, Swamp Deer, and Marsh Crocodile. Eight of these species are classified by IUCN as (globally) Endangered, and two as Vulnerable (Gaur, Marsh Crocodile). Wild Boar survives in domesticated form.

Nine surviving species are classified by IUCN as threatened. Two are classified as Endangered (Hispid Hare, Asian Elephant), two as Vulnerable (Rock Python, Freshwater Dolphin), four as Indeterminate - known to be either Endangered, Vulnerable, or Rare (Bengal Fox, Spotted Pond Turtle, Sylhet Roof Turtle, Yellow Common Lizard), and one as K meaning status uncertain (Smooth Indian Otter). All of these species except for Bengal Fox and Sylhet Roof Turtle are also listed under CITES Appendix I or II.

A further eleven species are listed under CITES Appendix I or II: Indian Pangolin, Common Otter, Small Indian Civet, Jungle Cat, Fishing Cat, Common Roof Turtle, Ganges Soft Shell, Peacock Soft Shell, Flapshelled Spotted Turtle, Bengal Grey Lizard, Bull Frog. Finally, two species Malayan Box Turtle, Bengal Eyed Turtle) are expected to be given Commercially Threatened classification in the next edition of the IUCN Red Book.

Wetland plant species

The wild macrophytes of the region's lowlands consist of at least 216 species, including nine exotics. Though three of the nine habitat types are threatened (see above), all but three individual macrophyte are thought to be viable in disturbed settings (permanent water bodies, crop fields, homestead gardens and forests). Three macrophyte species are thought to be threatened. *Rosa involucrata* gunja kata, a wild rose, was formerly abundant in the reed swamps but is now rare throughout its range in South Asia. *Eurayle ferox* makhna and *Nelumbo nucifera* padma, both rooted floating plants, are now found only in Hail Haor.

Wetland values and resource utilization

Many wetland plants and animals are used locally and/or traded to urban centres and internationally. These uses include fodder, fuel, and fertilizer derived from wetland plants; tree branches used for fish aggregation; wild animal and plant foods; luxury items such as tortoise shell; and many others. In addition, wetlands provide important *in situ* services; the most important of these include likely erosion protection of village homesteads in the deeply flooded area; fish habitat and food; and flood storage.

Policy context

Through a variety of national and international policy instruments, the Government has clearly committed itself to environmentally sound management in general and of biodiversity assets, and to efforts to achieve and maintain environmental quality acceptable to extractive users and to sustainable ecosystem functioning. The relevant national policy documents are the *Memorandum for the Bangladesh Aid Group 1992-3*, *Fourth Five Year Plan 1990-5*, *National Environment Policy*, *National Environment Management Action Plan (NEMAP)*, and *Forestry Master Plan*. Relevant international agreements signed by the Government are *Ramsar Convention on Wetlands of Importance Especially as Waterfowl Habitat*, *Convention on International Trade in Endangered Species (CITES)*, *Rio Convention on Biological Diversity*, and the *World Heritage Convention*.

Institutions

Numerous government agencies have responsibilities related to wetlands: *Forest Department* (wildlife conservation and protected areas management, wetland ownership); *Ministry of Land* (wetland ownership); *Department of Environment* (water quality monitoring and pollution control); Department of Fisheries (fisheries management); *National Herbarium and National Botanic Gardens* (wild floral research and conservation); *Ministry of Irrigation* and *Bangladesh Water Development Board* (irrigation, drainage, and flood control); and *Bangladesh Chemical Industries Corporation* (owner of reed lands and large-scale biomass consumer, through Sylhet Pulp and Paper Mill).

Both national and international non-governmental organizations have been active in Bangladesh in addressing wetland issues. These include *International Union for the Conservation of Nature* (IUCN), *International Waterfowl and Wetland Research Bureau* (IWRB), *Asian Wetland Bureau* (AWB), *Nature Conservation Movement* (NACOM), and *Bangladesh Centre for Advanced Studies* (BCAS).

Other relevant institutional structures include the South Asian Association for Regional Cooperation (SAARC), and (proposed) committees to link NGOs in the region; Government and NGOs; and national and international NGOs.

Driving forces and issues

Over the coming years, a number of driving forces will tend to maintain or change the extent or character of wetlands: increasing rural-urban and rural-government links ('monetization'); continued dependence of local people on local resources for biomass and other necessities; rural impoverishment pushing local people into wetland resource gathering for own use and sale; expansion of new technologies ('modernization') in water management, agriculture, and other sectors; increasing and widening local, urban, and international markets and demand for wetland products; traditional cultural

Strengths, weaknesses, opportunities, and threats

The SWOT analysis of wetlands produced the following main points:

Current strengths

- Remaining wetlands have substantial value
- Important representative habitats still exist
- The tenure situation is uncomplicated
- Government development strategies and desirable improvements to wetlands are highly compatible (see Table 4.1)
- Some wetland education already taking place, at various levels within and outside government
- Some alliances between national and international NGOs are already in place

Current weaknesses

- Lack of viable protected freshwater wetland areas
- Some remaining wetland systems, species, and habitats are at critical levels for continued survival
- Wetland values i.e. current and potential contributions of wetlands to national development objectives are not adequately recognized, at all levels within and outside Government
- Information about wetlands is inadequate
- Current institutional arrangements for wetland management are inappropriate
- Wetland benefits are well below potential sustainable levels; little value is added to wetland products
- Distribution of wetland benefits could be more equitable (progressive)

Future opportunities

- Foster beneficial rural-urban links
- Transform and empower poor user groups to become resource managers
- Accelerate provision of alternative energy sources to rural areas, to displace demand for heavily exploited and threatened species and habitats
- Create employment in wetland primary production enhancement
- Develop enterprises based on value-added wetland products

Future threats

- Unsustainable levels of exploitation leading to declining extent and numbers of habitats and species
- Water pollution, from increased human activity and reduced natural purification services as wetlands deteriorate
- Disturbance, including hunting, which reduces usable habitat for many species
- Felling of mature lowland trees without replacement
- Suppression of natural regeneration of swamp forest trees by grazing and fuel collection
- Drainage improvements, flood control works, induced siltation
- Appropriation of control over resources by powerful outside interests from traditional community/local managers

Biodiversity (wetland and upland) objectives and initiatives

The draft final version of the study (April 1993) presented the Wetland Subteam's initial attempt to articulate concrete objectives and initiatives that would feed into the regional planning exercise. In subsequent months, these objectives and initiatives continued to develop, through dialogue with other members of the NERP team and village people involved in the participatory studies.

Both Wetland Subteam and other NERP team members tended to feel that biodiversity objectives/initiatives would likely be peripheral to the main thrust of the regional plan. Surprisingly, however, during the formulation of the regional plan strategy and the portfolio of initiatives, a strong consensus emerged in support of biodiversity objectives and initiatives, based on an appreciation of their relevance to core development objectives.

The elements of the regional plan that address biodiversity objectives and initiatives are:

- Strategic Thrust 5 - Biodiversity Enhancement and Sustainable Management
  - Initiative: Upland Biodiversity Conservation Studies and Implementation. Subsequently, included as a component of the Northeast Regional Environment Management, Research, and Education Project (NEMREP), for which a pre-feasibility study was produced
  - Initiative: Management of Internationally Significant Wetland Sites. In NEMREP.
  - Initiative: Threatened Ecological Community Recovery Program. In NEMREP.
  - Initiative: Recovery Plans for Threatened and Commercially Threatened Lowland Plant and Animal Species. In NEMREP.

- Strategic Thrust 6 - Improve Liveability of Rural Settlements
  - Initiative: Village Afforestation. Included in Flood- and Erosion-Affected Villages Development Project (FEAVDEP).

- Strategic Thrust 8 - Institutional Strengthening and Development
  - Initiative: Northeast Region Environmental Management, Research, and Education Centre (NEMREC). In NEMREP.
  - Initiative: Biodiversity Strategic Planning Exercise of the Ministry of Environment and Forests. In NEMREP.

Upland biodiversity (annex)
The upland studies were limited to a review of existing literature and statistics, plus short field trips.

Tropical forest in reasonably good condition occupies about 18,000 ha of uplands in the Northeast Region. This is mainly in Rema-Kalenga Wildlife Sanctuary (the only protected area gazetted in the region); in the Reserve Forest associated with it; and in the Juri Forest Range. Both areas are located in the hill areas on the eastern side of the region and contain some mixed evergreen/deciduous tropical forest. Juri Range also contains extensive stands of bamboo as pure patches and as undergrowth (about 13,000 ha are classified as bamboo lands).

In contrast, sal forest *Shorea robusta*, found at lower elevations along the northern boundary of the region on the western side, survives only in highly degraded form, and is considered to be threatened nationally.

The surviving tropical forests are remnants of much larger forest ecosystems replaced by agriculture (33% of upland area), economic forestry (27%), human settlement (17%), or simply degraded lands (13%).

The surviving tropical forests have value as:

- Surviving representatives of indigenous ecosystems;
- Key habitats of numerous threatened animal and plant species, including some locally upland-lowland migrating animals;
- Repositories of biodiversity with potential commercial, medical, and scientific value;
- Sources of forest products and services for local people, including indigenous people, and the nation.

Based on preliminary checklists, the region's uplands support over 200 species of birds, about 70 mammal species including nine species of primates, and about 800 woody plant species; with the addition of herbaceous and lower order species, the number of macrophytes could easily total twice this.

1. INTRODUCTION

1.1 STUDY CONTEXT

This report is one of 13 Specialist Studies produced by the North East Regional Water Management Project (NERP), Item 6 of the Flood Action Plan (FAP 6). These Studies provide the information base for the NERP regional planning process, which is described in the *Regional Plan* (pp. 1-4).

This Specialist Study provides information on biodiversity in the region. The draft final version of the Study was limited to *wetland* biodiversity, reflecting: (1) NERP's emphasis on water management; (2) the presence in the region of several wetlands suspected to be of international importance; and (3) the limited extent of upland areas within the region.

In this final version, the focus was expanded to include *upland* biodiversity. This was done so that NERP would have information on these assets; to draw attention to them in the context of the national development process; and in recognition of ecological and institutional links between biodiversity in wetland and upland settings. In practical terms, however, the upland field work and other investigations were much more limited than the wetland studies. Therefore, to avoid confusion and overemphasis of the rather sketchy upland information, the title *Wetland Resources Specialist Study* was retained. The upland study is documented in Annex E to this report.

1.2 STUDY OBJECTIVES

The specific objectives of this study and report are:

- To characterize the region's wetlands and their values;
- To identify driving forces, issues, strengths, weaknesses, opportunities, and threats to the region's wetlands;
- To establish wetland management objectives, so that these can be incorporated, as far as is appropriate, into overall regional development objectives;
- To identify key wetland management initiatives for further pre-feasibility study and possible inclusion in the Regional Plan; and
- To identify areas of upland biodiversity and assess their current extent and condition, identifying ecological and institutional links with wetlands

Underlying these objectives is the perspective that biodiversity has value to local people and to the nation. Biodiversity provides a range of goods and services, some with clear economic value, some intangible or taken for granted, which contribute to basic human needs and to economic development. The challenge will be to secure these benefits for future generations of Bangladeshis – not to preserve biodiversity for its own sake, or for the sake of scientists, tourists, or drug consumers in richer countries.

1.3 SCOPE OF STUDY

The description, analysis, and proposals presented here are based on:

1. Field studies of the wetlands of the Northeast Region during the period December 1991 to May 1993. These accounted for the greater part of the total investigations, and focused on:

   - Wetland appraisal and identification of key sites,
   - Wild wetland plants, including trees,
   - Waterfowl and wetland-dependent birds,
   - Wetland wild life, and
   - Wetland seasonal changes.

2. Village-level participatory studies with local people of six villages: two villages near each of three key wetland sites during the period January 1994 to March 1994.

3. Brief visits to the various upland areas of the region during the period January 1994 to May 1994.

Each of these areas of field work was complemented by information gained through literature review, visits to similar wetland sites in India, and discussions with individuals in Bangladesh and elsewhere involved in related work.

1.4 RELATED NERP STUDIES

Other NERP Subteams in Fisheries, Agriculture, Sedimentation, Hydrology/Geohydrology, Social Anthropology, Water Resources, and Economics covered these other aspects of the region and, in cooperation with the Wetland Subteam, its wetlands. Most of these groups are reporting their findings in their own Specialist Studies. Relevant information from these disciplines has been incorporated here where appropriate, for example, in the Ramsar sheets describing the key wetland sites (Annex C).

1.5 REPORT ORGANIZATION AND RELATIONSHIP TO REGIONAL PLAN

This report is organized into a main report of eight chapters, followed by six annexes. References and figures appear after the last chapter. The organization of the body of the report parallels the regional planning process and the Regional Plan main volume outline, to allow straightforward incorporation of wetland driving forces, issues, and so forth into their regional analogues. The annexes provide complementary or more detailed information, much of it oriented toward readers with specific technical interests. In particular, all information related to the upland study appears in Annex E; the main report deals only with wetlands.

1.6 REPORT REVISION HISTORY, INCORPORATION OF COMMENTS, AND RELATIONSHIP TO OTHER NERP REPORTS

A draft final version of this report was issued in April 1993. This final version reflects comments from CIDA and BWDB, plus additional information and analysis from the NERP team as a whole, and the Wetland Subteam. The list of key wetland sites has been expanded from six to nine; the new sites are Kaliajuri Area, Companiganj Area, and Bara Haor. New information has been added documenting the results of investigations of upland biodiversity, and of local people's perceptions of the history and value of nearby wetlands. A habitat type, flood plain grassland, has been added. Additional information on wetland animals has been provided. The species lists have been revised. An executive summary has been added.

A draft final version of the project pre-feasibility study *Northeast Region Environment Management, Research, and Education Project* (NEMREP) was issued in December 1993. Material from the draft final Specialist Study was extensively extracted and revised for use in this report. Some of this information has been re-inserted into this final Specialist Study. In addition, information on the proposed key biodiversity management initiatives, newly written for the NEMREP study, has replaced the former contents of Chapter 7, previously named *Key Wetland Management Initiatives*.

A draft final version of the project pre-feasibility study *Flood- and Erosion-Affected Villages Development Project* (FEAVDEP) was issued in mid-1994. A major component of this project is afforestation and habitat restoration around villages in the deeply flooded area, both to protect from wave erosion and to provide local people with a range of biomass products for building materials, fodder, fuel, food, and other uses. Text from this report has not been included here, but includes much additional information on wetland vegetation, in particular the potential for afforestation/habitat restoration.

The *Fisheries Specialist Study* identifies a number of mother fisheries (see Glossary). The four largest of these, Kaliajuri Area, Tangua Haor, Hakaluki Haor, and Kawadighi Haor, are also identified here as key wetland sites. Information from the *Fisheries Specialist Study* has been incorporated into the Ramsar sheets describing these and other key sites (Annex C).

1.7 DISSEMINATION OF RESULTS

The information provided here was presented and discussed in a seminar entitled *Biodiversity, Wetlands, and Surface Water Quality of the Northeast Region* held on 6 April 1994 in Dhaka. In addition, members of the Wetland/Biodiversity Subteam participated in several of the district-level seminars. Seminar proceedings are published as NERP reports.

1.8 NERP WETLAND SUBTEAM

The NERP Wetland Subteam consists of:

Field Research Team, Nature Conservation Movement

Anisuzzaman Khan	*Project Coordinator/Wildlife Study Leader*
Dr. Salar Khan	*Flora Advisor*
Dr. Ansar Karim	*Flora Study Leader*
S.M.A. Rashid	*Ornithology Study Leader/Wildlife Biologist*
Istiak Sobhan	*Flora Researcher*
Abu Saeed	*Ornithologist*

Participatory Village Studies Team, IDEA

Kalpona Bose
Milon Chowdhury
Matiur Rahman
Saroj Talukdar
Shuli Talukdar

Wetland Appraisal and Main Ornithology Surveys

Dr. Derek Scott, International Waterfowl and Wetlands Research Bureau

Environment Specialist

Dr. Sara Bennett, SLI/NHC Joint Venture

2. WETLAND STUDY OVERVIEW

2.1 RATIONALE

The wetland studies focus on the most important ('key') wetland sites in the region. The rationale for this is:

- There are severe constraints - financial, institutional, social, demographic - to improved wetland management. Under these circumstances, it was felt that a strategic approach (focusing on the most important wetlands) would have a greater likelihood of success than a comprehensive approach (preparing basic inventory and baseline data of 'all' the region's wetlands).

At the key sites, the investigations address selected wetland taxa – wild wetland plants (macrophytes); waterfowl and wetland-dependent wild birds; other wetland-dependent animals (mammal, reptile, amphibian), and selected aspects of wetland ecology – wetland seasonal changes and local people's dependence on and perceptions of wetlands. The rationale for these selections are:

- Other NERP Subteams in Fisheries, Agriculture, Sedimentation, Hydrology/Geohydrology, Social Anthropology, Water Resources, and Economics covered these other aspects of the region. Given this organizational setting, the Wetland Subteam chose to focus its field research efforts on those wetland values (plants, birds, animals, and their seasonal changes and relationships to local people) not being studied by any other NERP subteam, using the wetland system as the reference frame.

2.2 OBJECTIVES

The objectives of the wetland field studies were:

- ***Wetland appraisal and identification of key wetland sites.*** Make a regional overview of wetlands based on available information and field visits, noting the overall condition and status of wetland values. Identify those wetlands of greatest value, using extent, type, and quality of habitat and waterfowl as indicators, and paying particular attention to habitat for threatened or internationally-migrating animal and plant species, and examples of unique or threatened habitat types.

- ***Characterization of key wetland sites.*** At the identified key sites and at other selected sites, produce basic assessments of biological resources (specifically, amphibians, reptiles, birds, mammals, and macrophytes) and of the utilization of natural products (food, fodder, building material, and so on). Outputs to include species checklists, classification of habitats, and so on, cross-referenced to sites.

- ***Identification of areas of concern.*** In the course of field studies, identify areas of concern as a preliminary basis for the regional analysis (driving forces, issues, strengths, weaknesses,

opportunities, threats, and objectives). Formulate, on a preliminary basis, ideas for potential initiatives.

The objectives of the village-level participatory studies were:

- ***Gain appreciation of local people's perceptions of wetlands.*** Learn from local people their perceptions of the history and current status of wetlands, in particular remaining threatened habitat fragments

- ***Gain an appreciation of local people's knowledge of wetland benefits, utilization, and management.*** Learn from local people what benefits wetlands did and do provide to villagers; and what measures could be taken to secure that wetlands survive and continue to produce local benefits.

2.3 METHODOLOGY – WETLAND FIELD STUDIES

The wetland field studies had four components:

1. *Wetland appraisal and major ornithology surveys.* Two regional surveys, including ground surveys of 63 sites and three aerial surveys.

2. *Floral studies.* Five field visits, once every two months for ten months to 19 sites.

3. *Wild life studies.* Three field visits (pre-monsoon, monsoon, and post-monsoon) to the six key wetland sites.

4. *Monthly surveys of seasonal ornithological and other changes.* Twelve field visits, once a month for twelve months to 15 sites. Visits one and three were combined with the two wetland appraisal surveys.

2.3.1 Wetland appraisal and main ornithology surveys

Rationale

Prior information on all but the two best known sites, Hail Haor and Hakaluki Haor, was very fragmentary, and good quantitative data on the basin's waterfowl populations was almost completely lacking. Thus it was felt that the most urgent need initially was for rapid field surveys of the region, covering as many wetlands as possible.

This reconnaissance focused on the importance of the wetlands as habitat for waterfowl, for two reasons. First, the waterfowl of the Northeast Region are of interest in their own right, due to their large numbers and the fact that the basin is part of a major international flyway. Second, waterfowl are often regarded as good indicators of the general ecological status of wetlands, and thus good indicators of the value of sites from the point of view of biodiversity conservation. Absence of large numbers of waterfowl does not however mean that a site has little value. Sites may exist in the haor basin that are of negligible importance for birds but of outstanding limnological or botanical interest (for example, sites with endemic aquatic invertebrates or threatened species of aquatic plants).

Detailed limnological and botanical surveys throughout the region would be required to identify such sites.

Site evaluation

The evaluation of sites was based on criteria developed in relation to the Ramsar Convention (Tables 2.1a and 2.1b; information taken from the *Explanatory Note and Guidelines* that accompany the official *Ramsar Information Sheet*). These criteria, which are now widely recognized as a sound basis for the identification of "wetlands of international importance", are appropriate for use in Bangladesh which became a Contracting Party to the Convention in 1992.

In the absence of any formal criteria for the identification of wetlands of "national importance" in Bangladesh, those sites which narrowly fail to qualify as internationally important wetlands under the Ramsar criteria are regarded as being of "national importance".

Timing of surveys

Two surveys were carried out, one during late winter (dry season) between 18 Feb and 12 Mar 1992 and one during late spring (pre-monsoon period) between 19 Apr and 9 May 1992. These included extensive ground surveys (by vehicle, by boat, and on foot) as well as three aerial surveys, each of two to three hours in duration. Efforts were made to visit as many sites as possible throughout the region, and especially to visit any sites known or rumoured to be of particular importance for waterfowl.

Two surveys is the minimum number needed to assess the importance of wetlands for resident and migratory waterbirds: one during the mid-winter period to assess sites used as wintering areas by migratory species that breed at more northerly latitudes; and another during the main breeding season to assess sites used by resident breeding birds and any breeding summer visitors that spend the winter further south. Also, one of these surveys should be when water levels are at their lowest, to allow critical dry season refuges for waterfowl to be identified, given that water levels fluctuate widely and extensive desiccation occurs during the annual dry season. Finally, it was also clearly important for NERP to conduct a survey during the pre-monsoon period, since many existing and proposed water management projects are aimed at controlling the flash-flooding which occurs at this time. The impact of these projects on the wetlands, their waterfowl, and other wildlife populations is likely to be at its greatest during this pre-monsoon season.

A survey at the time of maximum flooding is usually less important, as at that time there is an abundance of wetland habitat available, the birds themselves are widely scattered, and it is often difficult to pinpoint the important areas.

Fortunately, the two surveys undertaken by NERP met most of these requirements. Wintering populations of waterfowl are still present in the region until early March, and this is the time when water levels are generally at or near their lowest levels. Late spring (the pre-monsoon period) is typically the season of flash-flooding, and is also the time when many of the waterbirds are preparing to breed. Although the main spring migration (Mar, Apr) was largely missed by these two surveys, some early migrants were already passing through the region by the end of the first survey, while a number of late migrants were still present at the time of the second survey.

Surveys at the height of the spring and autumn migration seasons to assess sites used as staging areas for migratory waterfowl, on their way between southern wintering and northern breeding areas, are

Table 2.1a: Ramsar Convention Criteria for Wetlands of International Importance

Ramsar Convention
The Ramsar Convention states that:

> "Each Contracting Party shall designate suitable wetlands within its territory for inclusion in a `List of Wetlands of International Importance.' - Article 2.1
>
> "In the first instance, wetlands of international importance to waterfowl at any season should be included. . . . [and also wetlands of] international significance in terms of ecology, botany, zoology, limnology, or hydrology." - Article 2.2

Montreux Conference of the Contracting Parties
Criteria for identifying wetlands of international importance were subsequently formulated and approved at the Montreux Conference of the Contracting Parties (Montreux Proceedings, Vol.1, Annex I, Rec. C.4.2 (Rev.)).

Criteria
A wetland is identified as being of international importance if it meets at least one of the criteria set out below:

1. *Criteria for representative or unique wetlands.* A wetland should be considered internationally important if:
   a. It is a particularly good representative example of a natural of near-natural wetland, characteristic of the appropriate biogeographical region; or
   b. It is a particularly good representative example of a natural or near-natural wetland, common to more than one biogeographical region; or
   c. It is particularly good representative example of a wetland which plays a substantial hydrological, biological or ecological role in the natural functioning of a major river basin or coastal system, especially where it is located in a trans-border position; or
   d. It is an example of a specific type of wetland, rare or unusual in the appropriate biogeographical region.
2. *General criteria based on plants or animals.* A wetland should be considered internationally important if:
   a. It supports an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plant or animal, or an appreciable number of individuals of any one or more of these species; or
   b. It is of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna; or
   c. It is of special value as the habitat of plants or animals at a critical stage of their biological cycle; or
   d. It is of special value for one or more endemic plant or animal species or communities.
3. *Specific criteria based on waterfowl.* A wetland should be considered internationally important if:
   a. It regularly supports 20,000 waterfowl; or
   b. It regularly supports substantial numbers of individuals from particular groups of waterfowl, indicative of wetland values, productivity or diversity; or
   c. Where data on populations are available, it regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl.

Table 2.1b: Ramsar Criteria (continued)

Guidelines for Application of the Criteria
To assist Contracting Parties in assessing the suitability of wetlands for inclusion on the List of Wetlands of International Importance, the Conference of the Contracting Parties has formulated the following guidelines for application of the Criteria:

a. A wetland could be considered of international importance under Criterion 1 if, because of its outstanding role in natural, biological, ecological or hydrological systems, it is of substantial value in supporting human communities dependent on the wetland. In this context, such support would include:

- provision of food, fibre or fuel;
- or maintenance of cultural values;
- or support of food chains, water quality, flood control or climatic stability. The support, in all its aspects, should remain within the framework of sustainable use and habitat conservation, and should not change the ecological character of the wetland.

b. A wetland could be considered of international importance under Criterion 1, 2 or 3 if it conforms to additional guidelines developed at regional (e.g. Scandinavian or West African) or national level. Elaboration of such regional or national guidelines may be especially appropriate:

- Where particular groups of animals (other than waterfowl) or plants are considered more suitable as a basis for evaluation; or
- Where waterfowl and other animals do not occur in large concentrations (particularly in northern latitudes);
- or where collection of data is difficult (particularly in very large countries).

c. The "particular groups of waterfowl, indicative of wetland values, productivity or diversity" in Criterion 3(b) include any of the following:

- loons or divers: **Gaviidae**;
- grebes: **Prodicipedidae**;
- cormorants: **Phalacrocoracidae**
- pelicans: **Pelicanidae**
- herons, bitterns, storks, ibises and spoonbills: **Ciconiiformes**;
- swans, geese and ducks (wildfowl): **Anatidae**;
- wetland related raptors: **Accipitriformes** and **Falconiformes**
- cranes: **Gruidae**
- shorebirds or waders: **Charadrii**; and
- terns: **Sternidae**.

d. The specific criteria based on waterfowl numbers will apply to wetlands of varying size in different Contracting Parties. While it is impossible to give precise guidance on the size of an area in which these numbers may occur, wetlands identified as being of international importance under Criterion 3 should form an ecological unit, and my thus be made up of one big area or a group of smaller wetlands. Consideration may also be given to turnover of waterfowl at migration periods, so that a cumulative total is reached, if such data are available.

also highly desirable. These were carried out later, as part of the Monthly Ornithology Surveys (see below).

Ground surveys
Most wetlands in peripheral areas of the basin were visited by ground transport. Sixty-three sites, mostly individual beels or small groups of beels, were visited by vehicle, by boat or on foot, 60 of these during the Feb/Mar 92 survey and 51 during the Apr/May 92 survey (48 sites were visited during both surveys). Most of the 12 sites visited in Feb/Mar 92 but not in Apr/May 92 were rather small, isolated and relatively unimportant beels in the Habiganj, Netrokona and Mymensingh areas. Together, these sites held less than 6% of the waterfowl recorded during the Feb/Mar 92 survey.

Aerial surveys
The aerial surveys focused on the large areas in the deeper, central portion of the haor basin, particularly along the lower Baulai and Kalni Rivers and three smaller areas (a 30 km stretch of the Old Brahmaputra south of Mymensingh, the Chapra and Singai beels east of Sylhet, and Jaor Beel near Sunamganj), which are far from the nearest vehicular access and, by the end of the dry season, inaccessible by boat. These were surveyed by air on 25 and 26 February and again on 9 May in a Cessna 182 on hire from Dhaka Flying Club. Many of the 63 sites visited on the ground were also surveyed from the air. The first day of aerial survey covered the central portion of the haor basin along the lower Baulai River; the second covered the east-central basin along the lower Kalni River to the Sylhet region and also wetlands along the southeastern rim of the basin (Hakaluki Haor, Kawadighi Haor and Hail Haor); and the third, in early May, covered the same areas along the lower Baulai and Kalni rivers, plus the Surma River between Sylhet and Sunamganj, and the important Aila Beel complex.

It had been anticipated that the aerial surveys would locate a number of sites with hitherto unknown concentrations of waterfowl. In fact, very few wetlands of any significance for waterfowl were located from the air. Most of the beels and oxbow lakes in the central part of the haor basin are too small, too widely separated, and too intensively fished and farmed to support waterfowl other than a few egrets and shorebirds. The only significant "new" concentration of ducks located from the air was in Maijeil Haor (Patachatal and Borachatal Beels), where there were an estimated 3,000 ducks on 26 Feb. A ground survey of these two beels on 8 Mar confirmed the presence of 4,180 ducks.

A list of the sites visited and survey itineraries are given in Annex A.

Coverage and limitations
During the two surveys, the investigators were able to visit all of the wetlands known or thought to be of special importance for waterfowl, as well as a large number of sites of only regional or local importance. Special attention was given to the ten sites described in the *Directory of Asian Wetlands* (Scott, 1989): eight of these were visited during both surveys, and the other two once each (Meda Beel during the Feb/Mar 92 survey and Aila Beel during the Apr/May 92 survey).

Only a tiny fraction of the 6,300 or so beels in the Northeast Region could be visited, but it soon become apparent that the great majority of these were of very little significance for wildlife, and it was felt that few, if any, wetlands of international significance had been overlooked.

The only possible major gap in coverage is thought to have been in the northwest, between the Kaluma Kanda region and the west end of Gurmar Haor. Restrictions on flying within 10 miles (16 km) of

the Indian border ruled out an aerial survey, and shortage of time prevented a ground survey. Karchar, Joalbangha, Angurali or Shanir Haors, west of Sunamganj, were not visited during this part of the study; all but Joalbangha were however visited on a casual basis during the Monthly Monitoring Programme surveys, and Kaluma Kanda was visited during the Oct 92 wild life survey.

Coverage of most of the areas was thought to be good; generally greater than 50% and often in excess of 75%. It seems very unlikely that any major concentrations of birds (i.e. numbering in the tens of thousands) were overlooked. Thus, for the conspicuous and easily counted species (e.g. cormorants, herons, egrets, ducks, coots, gulls and terns), it is thought that the counts represent at least 50% and in some cases over 75% of the total present in the region at the time of the surveys.

The counts give only a general impression of abundance for hard-to-count inconspicuous, secretive, or widely dispersed species. These include Little Grebe (inconspicuous), Indian Pond Heron and Cattle Egret (widely dispersed in rice fields), most rails and crakes (secretive and inconspicuous), the snipes (inconspicuous and widely dispersed in rice fields) and many of the smaller shorebirds.

Other habitat types

Although these surveys focused very largely on the wetland ecosystems of the haor basin, some observations were made in the other major habitat types present in the region. In particular, observations were made on numerous occasions in agricultural land (principally rice fields) and homestead forest, both of which constitute very extensive habitat types in the Northeast Region. In addition, brief avifaunal surveys were carried out in two relict patches of tropical evergreen/semi-evergreen forest (West Banugach Reserved Forest east of Srimangal and Shatchari Reserved Forest near Madhabpur), while some casual observations were made in tea estates near Srimangal, and in secondary scrub near Moulvibazar and Srimangal.

Data gathering

Detailed records were maintained of all birds observed at the wetlands and elsewhere in the region, and counts were made of all waterfowl and most birds of prey. Details were also kept of all evidence of mammals, reptiles and amphibians in the wetlands (sightings of live animals, corpses, tracks, and so on). At each wetland, basic information was gathered on the condition of the wetland (water level, aquatic vegetation and surrounding terrestrial vegetation), fishing activities, hunting activities and the general level of disturbance from other human activities.

Waterfowl census data were recorded on the standard waterfowl census forms used by IWRB and AWB in the Asian Waterfowl Census. Examples of these census forms are given in Annex B. The counts made during the late winter survey have been submitted to IWRB for inclusion in the 1992 Asian Waterfowl Census Report and in the Asian Waterfowl Database maintained at IWRB Headquarters in the U.K. Copies of the original count data also remain on file at the NERP offices in Dhaka.

Investigators

The two principal investigators were Dr. Derek Scott (IWRB/AWB) and S.M.A. Rashid (NACOM). Dr. Scott is primarily an ornithologist with extensive experience in wetland assessment; he is the editor of the *Directory of Asian Wetlands*, and designer of the Ramsar data sheet. Mr. Rashid (M.Sc. Ecology, University of Kent 1991) has extensive experience in Bangladesh wetlands as both an ornithologist and wildlife biologist with particular interest in herpetology.

2.3.2 Floral studies

Rationale

The *Directory of Asian Wetlands* (Scott, 1989) and *Aquatic Angiosperms of Bangladesh* (Khan, 1987) provide preliminary lists of plants for some of the wetlands of the Northeast Region, but a full account of the region's plants with proper taxonomic identification is lacking.

The objective of the study was to provide a general assessment of wetland plant diversity of the Northeast Region, by studying a variety of sites representative of the complex ecological systems in the region; recognizing in particular the range and importance of human interventions.

Timing of surveys

Five field visits were made every other month from May 1992 to February 1993. During each visit, a set of 19 beel sites in nine different haor systems were visited (Annex A). Staff resources for each visit were 21 person-days or approximately one day per site.

Sample identification and preservation

Most of the plants were identified in the field. Samples of all plants, both those that could and could not be identified in the field, were collected. Two sets of samples were dried, pressed, identified, and preserved in the National Herbarium. Another set of aquatic macrophytes were preserved in formaldehyde, acetic acid, propionic acid, and glycerin mixed with water in various proportions and stored in the NERP field station in Moulvibazar.

Data collection and analysis

In each beel at each visit, the occurrence, abundance and phenology (relations between environmental and biological cycles) of plant species were recorded based on visual estimation. Interviews were conducted with local people regarding utilization of plants. Abundance assessment was subjective, into four abundance rankings:

- *Abundant:* species appeared to be dominant
- *Common:* species appeared to be common throughout but not dominant
- *Rare:* species found but not common
- *Absent:* species not found

Structural characteristics of plant communities were analyzed on the basis of qualitative data of species abundance in each site. The relative ecological complexity of each site was estimated from this data, in conjunction with data on resource utilization.

Limitations

Quantitative techniques were not used, nor were relationships between vegetation and environmental variables explored. Diversity index and productivity, highly desirable parameters for resource management, were not determined; this would require more rigorously defined quantitative field surveys, and repeated field studies would be required for a high degree of confidence to be achieved.

Investigators
The two principal investigators were Dr. Ansar Karim (Associate Professor of Botany/Plant Ecology, Chittagong University) and Istiak Sobhan (M.Sc. Botany, Dhaka University). Dr. Salar Khan, founder-director of and honorary advisor to the National Herbarium, provided crucial support in the area of plant identification.

2.3.3 Monthly Monitoring Programme (MMP)

Rationale
In the wetlands, water levels and patterns of human activity are changing throughout the year. At the same time, each species/community of plant, waterbird, and wildlife has its own requirements for reproduction, migration, and so on. If the objective is to improve the management of wetland biological resources, one requirement is an understanding of the relationships between external conditions and species requirements throughout the year.

Clearly, this is an ambitious undertaking. Intuitively, one would start with the readily observable parameters first. With the resources available, the NERP Wetland/Biodiversity Subteam chose to focus particularly on waterfowl distributions and related data such as water level, disturbance events such as fishing and hunting. Other data (on for example, wild life) was also collected on an opportunistic basis.

Timing of surveys and data collected
Visits were made to 15 wetlands during the last ten days of each month for one full year. As far as possible, the same individuals visited each month, covering the same area. All waterbirds were counted, and all evidence of breeding and migration was recorded. Information was also gathered on the condition of the wetlands (water level, aquatic vegetation), fishing activity, agricultural activity, hunting activity and the presence of other fauna (mammals, reptiles and amphibians). This information and the waterfowl counts was recorded on standardized data sheets (Annex B).

Site selection
The 15 sites selected for the monthly ornithology/ecology study are listed in Annex A. An indication is given of the nature of each wetland and its status with respect to flood control, drainage and irrigation projects. The criteria for site selection were:

- Readily accessible and relatively easy to census at all times of the year;
- Include a representative cross-section of the major wetland types present in the region;
- Include at least a part of each of the six most important wetlands in the region;
- Include some sites as yet unaffected by FCDI projects, at least one site within an existing full-flood embankment, and at least one site within an existing submersible embankment.

The 15 sites selected include two sites within full-flood embankments, two sites within existing submersible embankments, one site within an ongoing drainage improvement project, and nine sites as yet unaffected by FCDI projects. The fifteenth site is a totally artificial group of fish ponds within a privately-constructed full-flood embankment.

Coverage
An indication of the effectiveness of the Monthly Monitoring Programme in providing an adequate sample of the waterfowl present in the region has been obtained from the first and third censuses, which took place as part of much more comprehensive waterfowl counts throughout the region. During the Feb/Mar 92 survey, the 15 Monthly Monitoring Programme sites held 66% of the waterfowl recorded during the entire survey, while in Apr/May 92, the corresponding figure was 54%. Clearly, this sample size is sufficient to give a very good indication of the real fluctuations in waterfowl numbers in the region during the course of the year.

Data analysis
Monthly variation in waterfowl population by number of species and number of individuals, in the aggregate, and at each site, was plotted against time. Water level was also plotted as a function of time. Timing of disturbance events (fishing, hunting) was noted and compared to fluctuations in waterfowl numbers.

Waterfowl migration through the region was analyzed — the arrival and departure of winter visitors, the occurrence of passage migrants in spring and autumn, and the arrival and departure of summer visitors. Breeding seasons of waterbirds in the region were also analyzed. These are known to be complex, with some species breeding during the pre-monsoon period, others during the monsoon, and yet others after the monsoon.

Interesting observations (threatened species and so on) were noted and logged separately.

2.3.4 Wildlife studies

Rationale
A better understanding of wildlife was required to assess the contribution of this resource to society and to determine the effect of development interventions. There was little information on the wetland wildlife of the region.

Data gathering
Field surveys were undertaken at each of the six key sites during the pre-monsoon , monsoon, and post-monsoon periods. During the field work, information was collected and recorded through observations as well as discussions with local people. In addition, specimens were collected and preserved for later submission to the National Museum. The field information was supplemented with a literature review.

Data included:
- a check list of amphibians, reptiles, and mammals of the region; and,
- information on the exploitation and dependence of people on wetland animals.

Investigators
The two principal investigators were Mr. Anisuzzaman Khan and S.M.A. Rashid. Mr. Khan is a wildlife biologist who is also President of the NGO — Nature Conservation Movement. Mr. Rashid is a wildlife biologist specializing in animal ecology. Both have extensive field experience in Bangladesh.

2.4 METHODOLOGY – VILLAGE-LEVEL PARTICIPATORY STUDY

In January-March 1994, a village-level participatory study was undertaken. Six villages were selected for study, two associated with each of the three threatened habitats (floodplain grassland, reed land, swamp forest). The criteria used in the choice of study villages were a high degree of association (dependence on, involvement with, knowledge of) with a threatened habitat area, and logistical considerations, in particular, accessibility by women field workers.

Field data was collected by a team of men and women social anthropologists from IDEA. Preparation for the study included a one-day training session given by members of the Wetland Subteam, which covered both background material on the wetlands and threatened habitats, and the specific participatory study methods to be used.

The basic approach was for the workers to conduct semi-structured interviews, following a guide sheet of talking points, with village people of varying ages, occupations, economic and social status, and both genders, individually and in groups. Participatory maps were prepared during these interviews, showing the detailed land use pattern within the area associated/controlled by each village visited.

Men workers tended to talk to men informants, and women to women. The women tended to work in pairs, to minimize arousing villagers' negative reactions to women alone in public.

Most of the interviews were recorded, with the participants knowledge and permission, and Bangla notes were also taken. The notes and transcripts were transcribed and translated into English for analysis.

Preliminary results of this work are reported here. CIDA support to complete the analysis and write up the findings is not available. These activities will be completed and the results published with alternative support, if possible.

2.5 STUDY LIMITATIONS

For the most part, the approach described above served us well. A number of limitations, known at the outset or discovered in the course of the study, are recorded here for their value as lessons learned.

1. *Inter-disciplinary cross-fertilization.* Contact with other NERP subteams to exchange information on wetland values was limited during the initial period August 1991 to April 1993 of the most intensive and extensive field work. Some contact between subteams did occur within the NERP FCDI project monitoring activity (one of the monitored projects, Manu River Project, also contains a key wetland site, Kawadighi Haor), as well as informally in the field and in the office. Later on (January 1993 to June 1993), multi-disciplinary teams prepared prefeasibility studies of NERP-proposed initiatives, and this afforded opportunities for cross-fertilization.

   Comment: More early cross-fertilization would have somewhat improved the design and effectiveness of the studies, and the understanding ultimately gained of the region. The initial planning of multi-disciplinary investigations should target early cross-fertilization as a specific objective.

2. *Water quality*. Studies of wetland water quality were not undertaken. Water quality was independently identified as a concern by several of the NERP specialist areas (hydrogeology/hydrology, wetlands, fisheries, industrialization/urbanization, and rural social anthropology). A Water Quality Mission was undertaken by a Canadian Water Quality Specialist, assisted by NERP staff, in Apr 93. The results of this mission are reported in NERP internal documents and in the *NEMREP Prefeasibility Study*. The NEMREP project includes several initiatives to address water quality monitoring and management.

   Comment: NERP probably underemphasized the developmental importance of water quality, in keeping with the water *quantity* focus implicit in the Flood Action Plan. The NERP experience suggests that water quality should be given a higher profile in future water sector development efforts.

3. *Biodiversity assets vs. biodiversity benefits to society*. In the early studies, too much emphasis was placed on the biodiversity assets themselves, and too little on the benefits they provide to society. Though field investigators in the early period relied heavily on local knowledge from key informants, formal village-level participatory investigations were not begun until late in the field programme, after the draft Regional Plan had been prepared, in early 1994. The later studies attempted to use a participatory approach to confirm, quantify, and document details of specific benefits of biodiversity to local people; indigenous management and utilization practices (historical and current); resource conflicts; the role of exogenous actors (police, army, Government officials, lessees); and the gender equity and socioeconomic equity implications of these activities. These studies confirmed impressions gained in the earlier field work, and provided additional information and details which contributed to preparation of the NEMREP and FEAVDEP pre-feasibility studies.

   Comment: Evidently, the information provided from the earlier field studies was sufficient for the NERP team to appreciate the developmental value of biodiversity and incorporate clear recognition of it in the Regional Plan. The benefits of biodiversity to society in general, and to local people in particular, emerged in two strategic thrusts of the Regional Plan (thematic areas understood broadly throughout the NERP team as developmentally important): Biodiversity Enhancement and Sustainable Management, and Improve Liveability of Rural Settlements (which included a large project to improve homestead platforms, later named FEAVDEP, through *inter alia* habitat restoration/afforestation of lowland areas to protect villages from wave erosion and to provide biomass products for local use). Still, the wetland investigations would have been more sound had a participatory approach (beginning with a participatory identification of valued environmental components) been taken sooner.

4. *Wetlands vs. uplands*. Initially, the study addressed only wetland/lowland settings. Later on, a limited amount of field work in the region's upland areas was added to the study programme.

   Comment: This was probably unavoidable given the FAP context of the study. Another problem has been the continuing insufficient attention paid to biodiversity (wildlife) management by the Forest Department. Recent major forestry projects, Forestry Master Plan and Forestry III, despite objectives in this area, have not adequately addressed this area. The add-on of NERP upland investigations, and the inclusion of upland biodiversity initiatives to NEMREP, took place when it became clear that these forestry projects would produce limited data and recommendations relevant to the region.

4. *Participatory vs. traditional field studies.* The wetland studies focused first on traditional biological field studies. At a fairly late stage, participatory studies were designed and carried out.

   Comment: Development of participatory methods for the study of environmental components is an active area of research and exploration. During the two years of the NERP wetland studies, methods of this type became considerably more prominent and better documented. These methods are exciting, because they greatly expand opportunities for dialogue and two-way learning between technical experts and local experts; they can be used to build social and gender awareness and equity into resource studies; and they foster local involvement in identifying problems and developing solutions, and support local ownership of them.

3. INTERPRETIVE DESCRIPTION OF THE REGION'S WETLANDS

3.1 OVERVIEW

3.1.1 The Northeast Region

The Northeast Region covers an area of approximately 24,500 sq km, bounded by the international border with India to the north and east, the Old Brahmaputra to the west, and the Nasir Nagar (to Madhabpur) and Meghna rivers to the south (Figure 1). The greater part of this region is taken up by the haor basin which comprises the floodplains of the Meghna tributaries, and is characterized by the presence of numerous large, deeply flooded depressions, known as haors, between the rivers. This vast alluvial plain possesses some 6,000 permanent shallow water bodies known as beels (usually in the lowest parts of the haors or in abandoned river channels), surrounded by large areas of seasonally flooded plains. The basin is bounded to the north by the hill ranges of Meghalaya, to the south by the hills of Tripura and Mizoram, and to the east by highlands of Manipur. The numerous rivers rising in these hills provide an abundant supply of water to the plains and cause extensive flooding during the monsoon season, with much of the region being flooded to a depth of up to six metres. The drainage is southwest via the Surma, Kushiyara, Baulai, and Kalni rivers into the Meghna River and Bay of Bengal. Almost all land above the maximum flood level is under permanent cultivation and human settlement. There are extensive plantations and groves of trees around most villages and homesteads, and in many areas this creates an aspect of discontinuous forest.

The climate is subtropical monsoonal with an average annual rainfall of approximately 4,000 mm. Over 80% of the rain falls during the monsoon season from June to October. Temperatures normally vary between 26 and 31 C in the pre-monsoon period (Mar to May), 28 to 31 C in the rainy season, and 26 to 27 C in winter. Extreme temperatures at Sylhet in the ten-year period 1975-1984 were 6.4 and 39.3 C.

A large number of water resources development projects have been constructed (*Regional Water Resources Development Status*, NERP, 1992) and still more are proposed for the region (*Northeast Regional Water Management Plan*, NERP 1993).

3.1.2 The wetlands of the Northeast Region

Physical configuration

The haors, from which the region's central basin takes its name, are back swamps or bowl-shaped depressions between the natural levees of rivers, or in some cases, much larger areas incorporating a succession of these depressions. The haors flood to a depth of as much as six metres during the rainy season, and in many cases two or more neighbouring haors link up to form much larger water bodies. During the dry season, most of the water drains out, leaving one or more shallow lakes (beels). Many of these become overgrown with aquatic vegetation, and some dry out completely by the end of the dry season. The term beel is also used for oxbow lakes and other permanent water bodies in abandoned river channels; these are especially numerous along the lower courses of the Baulai and Kalni Rivers. As the monsoon flood waters recede during the dry season, rich alluvial soils are exposed around the margins of the beels, and these are extensively cultivated for rice.

The haor basin contains about 47 major haors and some 6,300 *beels* of which about 3,500 are permanent and 2,800 are seasonal. These wetlands vary in size from as little as a few hectares to many thousands of hectares. The principal systems are as follows:

- Baram, Banka, Habibpur, Maka, and Makalkandi haors, which unite to form a single large water body during the rainy season; the Ghulduba haors; and Ranga and Baudha beels. Located in the eastern and lowest part of the basin in Mymensingh.
- Tangua, Shanir, and Matian haors in the deep northern basin at the foot of the Meghalaya Hills. These form a single water body during the rainy season.
- Dekhar Haor, Pathar Chanli Haor, and Jhilkar and Jhinkar Haors, to the east of the Tangua system.
- The Jamaikata, Mahai, Nalua, and Parua haor system, on the eastern rim of the basin.
- Hakaluki, Chatal Bar, Haila, Kawadighi, Pagla and many smaller haors, in the central Sylhet lowlands.
- Hail Haor, between the Tarap and Banugach hill ranges in the southeast.
- Dingapota, Ganesher, Tolar, Anganer, Bara, and Humaipur Haors, in the south of the basin.
- Etna and Sania Haors, Kishorganj district.
- Khaliaghuri Haor, east Mymensingh.

Current conditions

Currently, the haors, beels, and ponds support major subsistence and commercial fisheries, the seasonally flooded plains support a major rice-growing industry, and the abundant aquatic vegetation provides rich grazing for domestic livestock and a source of fuel, food and fertilizers for the local people.

The region contains all of the nation's remaining large semi-natural freshwater wetlands, a landscape once characteristic of much of the country. The wetlands are home to a very wide variety of resident and migratory waterfowl, including an estimated 100,000 to 150,000 ducks, and provide a refuge for many other species of wildlife which are becoming increasingly rare elsewhere in Bangladesh.

Natural history

There has been mass extinction of the native flora and fauna of the haor basin of Northeastern Bangladesh. In its original form, the basin would have consisted of a rich mosaic of permanent and seasonal lakes and ponds with abundant aquatic vegetation, surrounded by vast areas of swampy ground with tall reeds and seasonally flooded grasslands. Swamp forest, dominated by *Barringtonia*, *Pongamia*, and other flood-tolerant tree species, would have covered the river levees, and provided a secure refuge for terrestrial wildlife during the monsoon floods. On higher ground, this would have given way to scrub jungle and dense stands of bamboo.

Wildlife would have been abundant. Marsh Crocodiles and Otters would have been common in every lake and swamp. One-horned Rhinoceroses, Wild Buffalo, and Swamp Deer would have grazed in the marshes, and Asian Elephants, Gaur, Sambar Deer, Hog Deer, and Wild Boar would have roamed the forests and tall grasslands. Tigers and Leopards would have been common, along with many smaller predators such as Wolves, Jackals, and several species of wild cat. And everywhere, there would have been birds — teeming flocks of migrant ducks and shorebirds from Siberia mingling in winter with the resident flocks of cormorants, pelicans, herons, egrets, storks, ibises, whistling-ducks, comb ducks, pygmy geese and many more species. During the breeding season, there would have been huge mixed colonies of cormorants, herons and storks in the patches of forest, while the marshes would have rung with the bugling calls of Sarus Cranes.

Today, although most of the permanent water bodies have survived, all other ecosystems have almost completely disappeared. Vast areas of the seasonally flooded plains have been converted to rice monoculture, while areas less suitable for rice are now heavily grazed by domestic livestock or cultivated for wheat and other crops. The swamp forests have been reduced to a few small patches, often no more than ten or twenty widely scattered and now very old trees, while virtually all land above the level of the monsoon floods has been utilized for permanent settlement, homestead forests, and public infrastructure. The swamp forests, scrub jungle, bamboo thickets and dense stands of reeds have disappeared almost without trace.

Although we have no good contemporary accounts of the haor basin in its natural condition, we can gain an impression of how it would once have appeared by visiting comparable areas in neighbouring countries where these ecosystems still survive in more or less their natural form. Kaziranga National Park and Manas Wildlife Sanctuary in Assam and Royal Chitwan National Park in Nepal still retain outstanding examples of floodplain wetland ecosystems and their associated forest communities, and provide a vivid contrast to the totally man-modified environments which now exist over most of the plains of the Ganges and Brahmaputra systems. Indeed, these three large and well-protected sanctuaries have become critical to the continued survival of a whole group of wildlife species which have now become extinct over most of their former ranges. These include the One-horned Rhinoceros *Rhinoceros unicornis*, Swamp Deer *Cervus duvauceli*, Hispid Hare *Caprolagus hispidus*, Swamp Partridge *Francolinus gularis*, Bengal Florican *Eupodotis bengalensis* and Marsh Babbler *Pellorneum palustre* — all now listed as threatened in the Red Data Book (IUCN, 1990a).

Recent events

The international significance of the wetlands of the haor basin for their waterfowl populations was first drawn to the attention of the international conservation community at an International Regional Meeting on Conservation of Wildfowl Resources held in St. Petersburgh (at that time Leningrad) in Sep 1968. At that meeting, Savage (1970) and Savage and Abdulali (1970) presented papers on the status of the main wildfowl resorts and wildfowl species in East Pakistan. They identified four wetland systems within the haor basin as being of special importance for waterfowl: Tangua Haor, Hakaluki Haor, Kawadighi Haor, and Hail Haor.

Further information on the important wetlands of the haor basin was presented by Fazlul Karim on behalf of the Forest Department at an International Conference on Conservation of Wetlands and Waterfowl held in Heiligenhafen, Germany, in Dec 1974 (Forest Department, 1976). This report placed special emphasis on the importance of Hakaluki and Hail Haors for their rich and diverse waterfowl populations. More recently, Scott and Poole (1989), in their *Status Overview of Asian*

Wetlands, stressed the importance of the wetlands of the haor basin, and urged that ongoing studies in the region be expanded with a view to the development of a regional wetland management plan.

Directory of Asian Wetlands

Two years prior to the NERP study, the wetlands of the haor basin were described in the *Directory of Asian Wetlands* (Scott, 1989). The *Directory's* information on the wetlands of Bangladesh was provided by Abdul Wahab Akonda of the Forest Department, and by S.M.A. Rashid and Raguib Uddin Ahmed of the Wildlife Society of Bangladesh.

The *Directory* identifies the wetlands of the haor basin of Sylhet and Mymensingh as a wetland ecosystem of outstanding international importance on the basis of criteria established in relation to the Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat.

The *Directory* treats the haor basin as a single wetland system. However, within this system, six of the larger haors and four individual beels are singled out as being of special importance for their wildlife, and are described in greater detail. Four of the haors (Tangua, Hakaluki, Kawadighi, and Hail) had long been known to be of outstanding importance for their waterfowl populations, while recent field surveys by Akonda, Rashid, and Ahmed had indicated that the other six sites (Dekhar Haor, Dubriar Haor, Meda Beel, Aila Beel, Kuri Beel, and Erali Beel) could at times support large numbers of waterbirds. However, much of the region remained poorly known, and it was acknowledged by these authors that other sites, equally important for wildlife, might remain to be discovered.

The *Directory* identified ten key sites within the haor basin. These sites were apparently selected for one of two reasons: either they were sites which had long been known to be of special importance for wildlife (Tangua Haor, Hakaluki Haor, Kawadighi Haor, and Hail Haor), or they were sites which the contributors to the Directory had surveyed and found to be particularly interesting (Meda Beel, Aila Beel, Dekhar Beel, Kuri Beel, Erali Beel and Dubriar Haor). It was recognized at the time that this list was not comprehensive, and that other equally interesting sites for nature conservation might remain to be discovered.

Other literature

Most of the published literature on the region, especially the earlier material, consists mainly of anecdotal information and descriptions of specimens collected in the area. These materials are discussed below under the appropriate resource subsystem (flora, water fowl, wild life). A more recent and detailed account of the wetland ecosystems of the haor basin is given by Syed Iqbal Ali (1990).

3.2 WETLAND APPRAISAL

3.2.1 Classification

The wetlands of the Northeast can be classified as follows:

A *Wetlands of international importance.* These are large sites comprised of either a single large beel (Hail Haor) or a group of beels that are of outstanding importance for wildlife and retain some natural qualities of considerable ecological significance in a regional context. These sites clearly qualify as wetlands of international importance on the basis of the Ramsar criteria

(Tables 2.1a and 2.1b) for identifying wetlands of international importance. These give prominence to overall importance for wildlife, especially waterfowl, and characteristics such as representativeness, uniqueness, high ecological diversity, and presence of threatened species.

B *Wetlands of national importance*. Mostly rather large beels or groups of beels supporting significant numbers of wintering waterfowl and in some cases also small populations of breeding birds. Some may be of particular limnological or ecological interest, but further study is required. These sites are of importance in a national context, but probably not of international importance. Sites which narrowly fail to qualify as internationally important under the Ramsar criteria would appear in this category. Official criteria to define wetlands of national importance do not exist in Bangladesh.

C *Other wetlands*. Sites of little importance for wildlife and of limited ecological significance; generally either small, isolated beels in densely settled areas or highly modified wetlands given over almost entirely to the cultivation of rice.

Table 3.1 shows the ranking of the major haor systems and the individual sites within them based on the initial wetland appraisal only. Note that the ranking is never absolute: a site can *increase* in rank if additional information documenting its value becomes available, and can *decrease* in rank if its ecological character were significantly compromised. Indeed, this is what happened: the initial list of six key wetland sites was expanded to nine, to reflect additional information gathered during the year of field studies (see next paragraph).

3.2.2 Wetlands of international importance (A sites)

Nine systems were identified as of outstanding national and international importance for their nature conservation values. They are:

1. Tangua Haor.
2. Pashua Beel, Gurmar Haor.
3. Hakaluki Haor.
4. Hail Haor.
5. Kaliajuri Area
6. Companiganj Area
7. Bara Haor
8. Kawadighi Haor.
9. Balai Haor.

Six of the sites were identified during the initial wetland appraisal fieldwork. The remaining three (Kaliajuri Area, Companiganj Area, and Bara Haor) were upgraded to key site status based on fieldwork undertaken during subsequent months. Annex C presents full information on each of these sites, in the format agreed to by the Contracting Parties to the Ramsar Convention for documenting Ramsar sites. Should the Government so choose, once approved these information sheets can be submitted to the Ramsar Secretariat. Brief descriptions of each key site are provided below.

Table 3.1: Importance of sites

SITE	RANK
A/a = outstanding (international) B/b = considerable (national) C/c = limited	
TANGUA HAOR	**A**
Pana Beel	a
Biaskhali Beel	b
Rauar Beel	a
Main Tangua Beel	a
West Tangua Beel	b
Two un-named *beels*	b
Ainna Beel	b
Ghaniakuri Beel	b
Arabiakona Beel	b
Un-named *beel*	b
Samsar Beel	b
PASUA BEEL, GURMAR HAOR	**A**
HAKALUKI HAOR	**A**
Kair Gang & *beel*	b
Haor Khal	a
Puala Beel	c
Pingla Beel	b
Chatla Beel	a
Tural Beel	b
Dulla Beel	b
Chakia Beel	c
Gharkuri Beel	b
HAIL HAOR	**A**
BALAI HAOR	**A**
Khakra Kuri Beel	b
Dubail Beel	b
Jugni Beel	b

SITE	RANK
A/a = outstanding (international) B/b = considerable (national) C/c = limited	
KAWADIGHI HAOR	**A**
Petangi Beel	a
Majherbanda/Ulauli	a
HAIL HAOR FISH PONDS	**B**
MAIJEIL HAOR	**B**
Patachatal Beel	b
b	b
Borachatal Beel	
b	
DAMRIR HAOR	**B**
Chalnia Beels	b
Deodar Beels	c
KANAMAIYA HAOR	**B**
Kanamaiya Haor	b
Pakertala Beel	b
MATIAN HAOR	**B**
Bara Beel	b
Banuar Beel	b
Palair Beel	b
UBDAKHALI HAOR	**B**
Uglar Beel	b
Meda Beel	b
Netrakona/Kaluma Kanda	c
ERALI BEEL	**B**

Table 3.1: Importance of sites (continued)

SITE	RANK
A/a = outstanding (international) B/b = considerable (national) C/c = limited	
PANGER HAOR Aila Beel Pangna Beel Karul Dhan Beel	B b b c
JURI RIVER	C
CHUNNIA BEEL	C
BARA HAOR Chapra, Singari etc.	C c
MEHDI BEEL	C
KHAI HAOR Deochapra Beel Dabor Beel	C c c
SURMA RIVER	C
SOMESWARI RIVER	C
PATNAI GANG	C
HALIR HAOR Kecharia Beel	C c
DUBRIAR HAOR Dubriar Beel Baisha Beel	C c c
KENDUA AREA	C

SITE	RANK
A/a = outstanding (international) B/b = considerable (national) C/c = limited	
BORADUBA BEEL	C
OLD BRAHMAPUTRA RIVER	C
LOWER BAULAI RIVER	C
LOWER KALNI RIVER	C
KHOWAI RIVER Sankardanga Beel Ratna Beel Khowai River	C c c c

1. Tangua Haor

Tangua Haor is of outstanding importance for its large and diverse waterfowl populations. It is perhaps the most "natural" large wetland remaining in the Northeast Region, and possesses extensive stands of emergent marsh vegetation. There is little permanent human settlement in the immediate vicinity, and there remain significant areas of higher ground between the beels which are not under cultivation and which still support some natural herbaceous vegetation.

This haor forms the core area of the northern haor system, which includes several other haors also of importance for waterfowl (such as Gurmar Haor, Kanamaiya Haor and Matian Haor). The Tangua Haor site itself consists of a group of large beels to the west of the Patnai Gang, close to the Indian border; its principal beels are Pana, Rauar, Tangua, Ainna, Arabiakona, and Samsar. Tangua Haor as a whole is unprotected from flash-flooding, although Arabiakona Beel and one or two small beels are surrounded by submersible embankments.

Table 3.2: Northern haor system, proportion of individuals Feb/Mar 92

Species	Percent
Great Cormorant	80
Little Cormorant	86
Oriental Darter	95
Asian Openbill	95
Fulvous Whistling Duck	93
Ruddy Shelduck	99
Cotton Pygmy Goose	86
Mallard	100
Spot-billed Duck	99
Red-crested Pochard	100
Baer's Pochard	99
Ferruginous Duck	99
Purple Swamphen	99
Eurasian Coot	96

Note: Northern haor system consists of Tangua Haor (core area), Gurmar Haor, Kanamaiya Haor, and Matian Haor.

The presence of a complex of large and relatively undisturbed beels still in a near-natural condition at Tangua Haor is undoubtedly a key reason for the major concentrations of waterfowl found in the northern system as a whole. The northern haors mentioned above together held 71% (76,500) of all waterfowl observed in Feb/Mar 92 and 44% (13,480) of those observed in Apr/May 92. The corresponding figures for Tangua Haor itself were 24% and 11%, respectively.

Largely confined to the northern system of haors are many species of waterfowl, especially the cormorants, Oriental Darter, several species of ducks and Eurasian Coot, undoubtedly because the system provides the largest contiguous area of permanent water in the region and remains relatively thinly populated. The outstanding importance of this system for some waterfowl species is demonstrated by the results of the Feb/Mar 92 survey (Table 3.2). The northern system is also very important for herons and egrets. It held 49% of all herons and egrets recorded during the Feb/Mar 92 survey and 68% of those during the Apr/May 92 survey.

Tangua Haor was identified as a key site in the *Directory* and is described there in some detail. Three of the main beels, Pana, Rauar and Tangua, were included in the NERP monthly ornithology/ecology monitoring programme.

2. Pashua Beel, Gurmar Haor

The main value of Pashua Beel lies not so much in the beel itself, as in the fact that the surrounding area supports much the finest stands of natural floodplain vegetation located during the present surveys. These include a dense stand of *Pongamia pinnata* (koroch) forest, large areas of tall grasses

and patches of dense shrubbery. Although the main beel is intensively fished and there are a few small rice fields near the river embankment, there has obviously been little other exploitation in the area in recent years. Some people were observed harvesting grasses on the shores of the beel, presumably for fodder, but otherwise the area was undisturbed.

The Pashua Beel site consists of a single large beel with two smaller beels nearby in the extreme southeast portion of Gurmar Haor, adjacent to the Patnai Gang. The beels are surrounded by higher ground with dense grasses, scrub and *Pongamia* forest, the entire area covering about 400 ha. Gurmar Haor has recently been surrounded by a submersible embankment to protect against flash-flooding (Gurmar Haor Project, completed in 1991).

The importance of Pashua Beel in a regional context is quite outstanding. It contains what would appear to be the best remaining examples of the *Pongamia* forest and tall grassland ecosystems in the Northeast Region. It provides a secure roosting site for huge numbers of cormorants, herons and egrets (at least 4,600 in late Apr 92), and supports a number of species which are scarce or local elsewhere in the region (e.g. Purple Heron, Black-headed Ibis, Spot-billed Duck and Purple Swamphen). A large flock of Asian Openbills frequented the area from at least early Mar 92 until late Apr 92, and numbered about 400 at the end of Mar 92. Very few of this scarce species were observed elsewhere in the Northeast Region during the present surveys. Concentrations of 19 Pallas's Sea-Eagles in early Mar 92 and 28 in late Mar 92 are of great significance, as this is a globally threatened species. Finally, the area supports a much higher diversity of waterfowl and other wetland birds than any other site investigated. Fifty species of waterfowl were recorded at the beel during the two main surveys - 56% of all the species recorded during the surveys. Many passerines were observed in the surrounding forest and shrubbery.

Pashua Beel was leased to the Pearl and Fishery Resources Development Program on a nine-year lease in 1983. The head of this program is reported to have been a Minister under the Ershad regime. Armed guards were stationed at the beel to prevent illegal fishing, but it is apparent that these guards, and perhaps also a respect for the Minister, were effective in preventing other forms of exploitation as well. The lease came up for renewal in 1992 and was given out to a Member of Parliament on a three-year basis. So far this new lessee is maintaining the same level of protection as under the previous lease.

Pashua Beel was not mentioned in the *Directory*, as its importance had not been recognized at that time. The site was included in the Monthly Monitoring Programme.

3. Hakaluki Haor

Hakaluki Haor has long been known to be a major wintering area for migratory waterfowl, especially ducks, and is a popular duck-hunting area for sportsmen from Dhaka. The haor remains very important for wintering ducks, despite high levels of disturbance from hunters and fishermen, and is also a very important wintering area for migratory shorebirds. However, it seems to be much less important for cormorants, herons, and egrets, and appears to have only limited value for breeding birds. During the Feb/Mar 92 survey, Hakaluki Haor held 34% of all the waterfowl recorded, including 44% of the ducks and 31% of the shorebirds, but only 3% of the cormorants and 2% of the herons and egrets. At this time, the haor was particularly important for Great Crested Grebes (41% of the total), Lesser Whistling-Duck (67%), Northern Shoveler (73%), Little Ringed Plover (49%), Kentish Plover (86%), Asiatic Golden Plover (53%), Little Stint (74%) and Marsh Sandpiper (56%).

During the Apr/May 92 survey, the relative importance of the haor had fallen considerably, and it now held only 8% of all waterfowl recorded (with 14% of the ducks and 12% of the shorebirds).

The Hakaluki Haor site consists of a large group of *beels* surrounded by heavily grazed grassland and rice fields.

Hakaluki Haor was identified as a key site in the *Directory*, and is described in some detail. Three of the main beels, Haor Khal, Chatla Beel, and Pingla Beel, were included in the Monthly Monitoring Programme.

4. Hail Haor

The nature conservation values of Hail Haor relate primarily to its unique status in the region as the largest, shallow, permanent lake. The lake supports a very rich and diverse aquatic plant community, which in turn supports a wide variety of resident bird species, several of which are scarce or local elsewhere in the region (Yellow Bittern, Purple Heron, Watercock, Purple Swamphen and Black-breasted Weaver). The lake would undoubtedly be of great importance for wintering waterfowl were not it for the high levels of disturbance from fishing activities.

The Hail Haor site is a very large, rather isolated, shallow permanent lake with extensive floating and emergent vegetation, surrounded on three sides by low hills. It thus differs considerably in character from most other haors in the haor basin. The haor is included within an ongoing flood control and drainage project initiated in 1985 (Hail Haor Project). The project seems to have had little effect on the hydrologic regime within the basin, however.

Hail Haor was identified as a key site in the *Directory*, and is described in some detail. Parts of the haor were included in the Monthly Monitoring Programme.

5. Kaliajuri Area

Kaliajuri Area is a relatively undisturbed area representative of the deeply flood zone. It has also been identified as a mother fishery. The area has some swamp forest patches, and in the dry season extensive areas of winter grasses, such as *Hematheria protensa* chailla which is rot resistant and widely gathered and used in the construction of homestead erosion protection works.

6. Companiganj Area

Companiganj Area contains the best reed swamp remaining in the region and also has some floodplain grassland, which may be habitat for one or more threatened passerine bird species. It has also been identified as a mother fishery. Otters and large concentrations of turtles have been observed.

7. Bara Haor

Bara Haor contains the best floodplain grassland habitat remaining in the region, and some reed swamp and swamp forest areas. Breeding cormorants and breeding herons have been observed. As at Companiganj Area, the floodplain grassland may be habitat for one or more threatened passerine bird species.

8. Kawadighi Haor

Kawadighi Haor remains very important for a wide variety of waterfowl, despite the changes which must have occurred to these wetlands since the construction of the Manu River Project in 1976-83. The haor held 8.5% of the waterfowl recorded during the Feb/Mar 92 survey, and 5.3% of those

during the Apr/May 92 survey. The shallow beels with large areas of rotting aquatic vegetation and exposed mud were particularly attractive to shorebirds and several species of herons and egrets. The haor held 16% of all shorebirds recorded during the first survey, and 25% of those recorded during the second. The corresponding figures for herons and egrets were 23% and 17%, respectively. The beels may also be of some importance for breeding birds. In early May, Black-winged Stilts and Whiskered Terns were showing courtship and nest-building behaviour at Petangi Beel. Neither of these species has as yet been found breeding in Bangladesh.

9. Balai Haor

Observations during the present surveys suggest that the area is of special interest for its diversity of fauna and flora, the presence of at least two threatened species (Lesser Adjutant and Pallas's Fish-Eagle), and the presence of large concentrations of ducks during periods of deep flooding. Few ducks were observed at the haor in early Mar 92 and late Apr 92, when water levels were very low, but over 32,000 were present in late Mar 92 when water levels were high. The haor may also be of considerable importance as a staging area for passage migrants, because of its strategic position as the first or last major wetland that migrants encounter on their way to and from the lowlands of the Northeast Region. Much more work needs to be carried out before the importance of the site for nature conservation can be fully determined.

The Balai Haor site is an isolated haor between the Surma and Kushiyara rivers in the extreme east of the project area. It includes three principal beels (Dubail, Jugni, and Khakra Kuri) surrounded by heavily grazed pasture land and rice fields. Most of the many low embankments and margins of the water courses have been invaded by dense stands of the introduced exotic plant *Ipomoea acuatica* (kalmi) and this is now spreading out into the cultivable areas.

Balai Haor was not mentioned in the *Directory*. The site was included in the Monthly Monitoring Programme.

Kawadighi Haor comprises two large, shallow beels, Petangi and Majherbanda, and a third, smaller beel, Ulauli, adjacent to the latter. The Manu River Project, within which the haor lies, consists of a full flood control embankment, water control structures, and a pump house for pumped drainage. The project has caused some reduction in wet season water levels, but not as much as anticipated due to public cuts and overland flow from the adjacent Bhatera Hills. It is not clear how nor to what extent the project has actually affected waterfowl, positively or negatively. It seems clear however that if full flood protection were achieved as intended, further changes would occur.

Kawadighi Haor was identified as a key site in the *Directory*, and is described there in some detail. The haor was included in the Monthly Monitoring Programme. Also, Manu River Project was selected as a NERP project monitoring site.

3.2.3 Wetlands of national importance (B sites)

Hail Haor Fish Ponds

A group of privately owned and well-protected fish ponds south of Hail Haor. These are primarily of interest as a secure resting area for ducks which presumably feed at night in Hail Haor. Monthly Monitoring Programme site.

Patachatal Beel and Borachatal Beel, Maijeil Haor

Two large, deep beels with little emergent vegetation, surrounded by rice fields. Of principal interest as a resting area for wintering ducks which presumably feed in the surrounding rice-fields. Over 4,000 ducks were present in early Mar 9. Patachatal Beel was poisoned with rotenone during the first week of Apr 92 and stocked with carp hatchlings on 26 Apr 92, as part of the Second Aquaculture Development Project supported by the Asian Development Bank. A large numbers of turtles, snakes, and frogs were killed along with the gill fishes, possibly due to misapplication of the poison. Monthly Monitoring Programme sites.

Chalnia Beels, Damrir Haor

Two large, deep beels with little emergent vegetation, surrounded by rice fields. Of principal interest as a wintering area for ducks. A flock of 1,200 Tufted Ducks in late February was the largest concentration of this species recorded during the surveys. A pair of Pallas's Fish-Eagles nests nearby. Monthly Monitoring Programme site.

Erali Beel

A large, deep beel with little emergent vegetation, set amongst low hills and relatively isolated. The beel appears to be of very little value for waterfowl, but may be of considerable limnological and/or ecological interest because of its unique character and isolation. This wetland was described as a key site in the *Directory*. Monthly Monitoring Programme site.

Dekhar Haor

A number of large and small beels, mostly shallow with a considerable amount of floating and emergent aquatic vegetation, surrounded by rice fields. Kuri Beel differs from the others in being much deeper and being surrounded by steep grassy banks. The haor is of some value for a wide variety of wintering waterfowl, and also supports a small number of resident species. Almost 1,600 birds of 30 species were present in late February, including the only Bar-headed Geese recorded during the surveys. Dekhar Haor and Kuri Beel were described separately as key sites in the *Directory* . Monthly Monitoring Programme site.

Aila Beel and adjacent beels, Panger Haor

A group of four large beels and several smaller beels with some emergent aquatic vegetation, surrounded by rice fields. The system lies within a submersible embankment (Panger Haor Project). Apparently an important wintering area for ducks, gulls and terns. No survey was possible in late Feb 92 or early Mar 92, but a survey on 22 Mar 92 revealed 9,600 birds including 3,600 ducks, almost 400 Brown-headed Gulls, and 5,000 Whiskered Terns. On 21 Apr 92, the beels held over 8,000 ducks, the most recorded at any site during the Apr/May 92 survey. Aila Beel was described as a key site in the *Directory*.

Kanamaiya Haor including Pakertala Beel

Two large unprotected beels on the Patnai Gang, with some emergent aquatic vegetation. The beels are separated from adjacent Gurmar and Mohalia haors by submersible embankments. Of considerable importance for wintering ducks and shorebirds, holding almost 7,000 waterfowl in early Mar 92 when water levels were low, but of little if any importance for breeding birds. Much of the importance of this and the following site is likely to be related to the presence of the very important Tangua Haor a few kilometres to the north and Pashua Beel a few kilometres to the south.

Bara Beel, Banuar Beel, and Palair Beel, Matian Haor
Three large, shallow beels, with extensive floating and emergent vegetation, surrounded by rice fields. The beels lie within a submersible embankment (Matian Haor Project), and are adjacent to the Patnai Gang. Tangua Haor lies on the opposite side of the river. The beels are important for wintering ducks, and resident cormorants, herons and egrets, Cotton Pygmy Geese and the two species of jacanas. Over 6,300 waterfowl were present in Feb/Mar 92 and 725 in Apr/May 92. The dense aquatic vegetation provides nesting habitat for a variety of species. Monthly Monitoring Programme site.

Meda Beel and Uglar Beel, Ubdakhali Haor
Two medium-sized shallow beels with large areas of floating and emergent aquatic vegetation, surrounded by rice fields. The beels lie within a proposed project area (Ubdakhali). Probably of some importance for wintering ducks, although only 1,130 were recorded in Feb/Mar 92. No survey was carried out in Apr/May 92. Meda Beel was described as a key site in the *Directory*.

3.2.4 Other sites (C sites)

All the other sites listed in Table 3.1 are considered to be of very little importance for wildlife, other than those common and widespread species which have been able to adapt to man-modified environments and are able to tolerate high levels of disturbance.

The extensive floodplains along the lower Baulai and Kalni rivers, with their innumerable small beels and abandoned river channels, fall into this category. Almost the entire area which is not permanently under water has been converted to rice fields or is now heavily grazed pasture land. Aerial surveys in late February and in early May failed to locate any significant concentrations of waterfowl, and in fact, very few birds were seen other than Indian Pond Herons and several species of egrets. The rice fields may be of considerable importance for some wintering shorebirds, especially the snipe and Wood Sandpiper, but no single area appeared to be of special significance. The scarcity of most waterfowl species can readily be attributed to the absence of any major groupings of large beels (most beels being rather small and widely scattered), the high levels of disturbance from fishing and farming activities, and the almost complete absence of emergent marsh vegetation or other cover.

3.3 FLORA AND FOREST RESOURCES

3.3.1 General ecology of wetland vegetation

Physical environmental factors
Compared with other major natural forms of landscape, wetlands are young and dynamic. Many are physically unstable, changing in a season or even in a single storm. They change as vegetation changes, sediments are laid down, or land sinks. Due to continuous submergence, wetland habitat is characterized by anaerobic conditions which inhibits normal plant growth. A group of plants known as hydrophytes are adapted to withstand these extreme conditions, and these plants colonize wetland habitats.

Within a particular climatic setting (insolation, temperature, precipitation), the geographical and temporal extent of wetlands and the development of particular types of wetland vegetation is governed by the timing and duration of inundation or soil saturation events (hydroperiod), the flow regime,

chemical and particulate concentrations (water quality), and soil characteristics. Wetland conditions range from virtually perennial aquatic lowlands to seasonally dry uplands.

Hydroperiod is key to vegetation development and community dynamics. Hydroperiod is affected by topography, flooding and flood type (backwater, overbank), precipitation, and water table fluctuations.

Interannual variability in the timing and nature of the flood regime is important in determining the composition of plant communities and can be responsible for large variations in community distributions. The full extent of its influence is not yet well understood in relation to the germination of plant species.

The nature of the soil also has an important effect on the wetness of an area. Heavy clays drain most slowly and the effects of saturation therefore persist longer in such soils. Soil within the same haor system can vary in texture, drainage class, fertility, and other parameters. This variation can occur in an apparently random pattern, reflecting depositional or other processes that are no longer discernible, or there may be a definite pattern. The transition from the wettest to the driest areas in the floodplains occurs over distances varying from several miles to several meters.

Flood tolerance

The most flood-tolerant species can live and thrive in swampy conditions. These species can also grow on moist, well-drained sites, but they cannot compete successfully with species that normally inhabit and are specifically adapted to such sites. The least flood-tolerant species cannot tolerate flooding or waterlogging even for a short period. Between these extremes lies a large group of species that can tolerate varying degrees of flooding or waterlogging. Moreover, flood tolerance can vary with life stage. While many plants can withstand flooding for several days during the growing season, only a few plants can survive more than a few days of partial inundation at the seedling stage.

Human modification

In a heavily populated and extensively cultivated area such as Bangladesh, human activity is also a key factor in determining the extent and composition of wetland plant communities. A general overview of the region's natural history and the impact of human settlement has already been given (Section 3.1); the details of this interaction are presented in the literature review and in the discussion of each vegetation type below.

3.3.2 Previous studies

Botanical exploration in the Northeast Region began with Roxburgh (*Hortus Bengalensis*, 1814; *Flora Indica*, 1932) and William Griffith, whose 1835 collecting trip by boat began in Calcutta, passing through Pabna, Jamalpur, Mymensingh, and Habiganj, then along the Surma to Chhatak. During a second trip in 1838 he again travelled along the Surma. During these journeys, he recorded the marsh vegetation and aquatic flora of the jheels and haors. Somewhat later, in 1850, the author of *Flora of British India* (Hooker, 1872-1897) travelled along the Surma and visited the wetlands of Sylhet.

The first detailed collection of plant specimens from these wetlands was undertaken by Gibson in 1836. He travelled by boat from Calcutta to Dhaka, along the Ganges, and then on to the Surma to Chhatak, returning in 1837 to Calcutta with a full boat load of magnificent specimens. The next major collecting expedition was in 1869, when more than 14,000 specimens were collected by Clarke from Sylhet, Madhupur, and Comilla.

In 1903, the names and drawings of many aquatic plants from the haors of Sylhet appeared in *Bengal Plants* (Prain, 1903).

Three habitat types in the Sylhet region were identified on the basis of a collation of systematic botanical records (Kanjilal, 1934):

1. ***Upland vegetation.*** This types includes plants at the beel fringe and at all higher levels. We found all the genuses reported by Kanjilal that would be expected at the levels we studied (homestead and below): *Crataeva, Terminalia, Lagerstroemia, Ardisia, Trewia, Ficus, Clinogyne,* and so on. His list also includes genuses we did not find that are characteristic of higher elevations. These would are *Litsaea, Duabanga, Eugenia, Hypotianthera, Symplocos, Pealii, Rhabdia, Homonoia, Antidesma, Bunius, Cunia, Engelherdia, Draeaena,* and so on.)

2. ***Grassland.*** Emergent vegetation. Of Kanjilal's genuses, we observed *Hygroryza, Panicum, Phragmites,* and *Arundo*. We did not observe *Vossia, Myurus, Crusgali, Arundonella,* or *Thysanolana*; the situation is a bit confusing however as some genus names have changed.

3. ***Aquatic vegetation.*** Kanjilal lists the families Nymphaeaceae, Araceae, Lemnaceae, Alismataceae, Najadaceae, Eriocaulaceae and Cyperaceae. All were observed.

Schematic haor zonation showing the location of these communities is shown in Figures 3a through 3d.

Between the publication of *Bengal Plants* in 1903 and the creation of independent Bangladesh in 1971, very little systematic botanical fieldwork was undertaken. (The biological science departments of Dhaka University date only to the late 1930s.)

In the 1970s, the Bangladesh Agriculture Research Council took up a 'Botanical Survey of Bangladesh', and in 1975 the Bangladesh National Herbarium was established. Since then, field activities have intensified. A professional journal, *Flora of Bangladesh*, was established in 1972 and 36 issues were published through 1988.

Microphytes of the haors have also received some attention (for example Islam and Paul, 1978, which presented a hydrobiological study of Hakaluki Haor).

3.3.3 Plant communities (zonation) of the Northeast Region's wetlands

Wetland vegetation can be broken down into a number of communities or types. Each type is an aggregated assemblage of particular plant species, and is characteristic of a particular set of environmental conditions (hydroperiod, flow regime, water quality, soil).

The schematic of haor zonation shown in Figures 3a through 3d illustrates how geomorphologically defined areas are influenced by the fluctuating hydrological regime. Different plant communities occupy different habitats along the gradient of flooding and moisture.

Elements of the sequence of plant communities, or sometimes the entire sequence, may be absent from particular landscapes due to disruption from human activities. In the present study, we have identified eight communities (estimated number of species in parentheses):

1. ***Submerged plants*** (20)
2. ***Free floating plants*** (15)
3. ***Rooted floating plants*** (15)
4. ***Sedges and meadows*** (35)
5. ***Floodplain grassland*** (transitional; includes sedge/meadow and reed swamp species, plus grass species not yet identified)
6. ***Reed swamp*** (7)
7. ***Fresh water swamp forest*** (7)
8. ***Crop field vegetation*** (60)
9. ***Homestead vegetation*** (63)

These are described in detail below. Upland forests (i.e. communities above the floodplain homestead level) are discussed in Annex E, Upland Biodiversity.

The last two communities listed differ from the others in that their composition is strongly affected by human management and disturbance plays; many plants appearing in the other six communities appear in these two as well.

A checklist of the plants (systematic name, Bangla name, and habit) observed in each community is provided in Table D.1. Bangla names of trees and heavily utilized plants are widely known by local residents, and tend not to vary from place to place. Bangla names of smaller and less utilized plants are known now to only a few local people and tend to vary from haor to haor. For these plants, the Bangla names provided were obtained from the literature (Huq, 1986).

The list includes at least 216 species of macrophytic plants from at least 60 families. These include 65 obligate hydrophytes: plants that survive only when submerged in or floating on freshwater, or when on saturated soil. Of these plants, the most abundant belong to the families Gramineae (9 species), Nymphaceae (4), Hydrocharitaceae (5) and Lemnaceae (4). The list also includes about a dozen species of amphibian trees, shrubs, and climbers that prefer seasonally flooded areas. Nine species are exotics.

Kanjilal's upland vegetation no longer exists in community form at the lowland levels we studied. At our swamp forest level, only isolated forest patches remain, and at our crop field and homestead levels natural habitats have been completely displaced by synthetic communities. All Kanjilal's tree genuses survive in the homestead groves, however, except for those that one would expect to find only at higher elevations.

Three of the communities exist only as a few scattered small fragments, and are considered to be threatened: fresh water swamp forest, floodplain grassland, and reed swamp.

1. Submerged plants

The submerged plant community is one of the most prevalent in the haor area. It is comprised of about 20 plant species (Table D.1). Submerged plants remain fully submerged for their entire life cycle, except for the flower which occurs above the water surface. Some are rooted to the bottom

and some are freely suspended. All of these plants are monocotyledons, from ten pretty closely related families including Aponogetonaceae, Hydrocharitaceae, and Potamogetonaceae.

These plants are, for obvious reasons, highly susceptible to seasonal water level fluctuations. The community expands in area during the monsoon and contracts with the coming of the dry season. The plants start growing when water levels start rising at the very beginning of the monsoon, persisting throughout the wet season for as long as ample water is present. (In some haors, at the peak of the monsoon when wave amplitude and water depth are greatest, these plants can be very difficult to find.) When the water starts receding, most of these plants flower and fruit very quickly, thereby assuring offspring in the next year; though most of these species have rhizomes and can also reproduce vegetatively. Where the water recedes further, the plants become desiccated and decompose; in permanent water bodies, they can survive for a much longer period.

The composition and prevalence of this community differs from one haor to the next. For example: in Tangua Haor, we found that *Hydrilla* (kureli, jhangi) and *Potamogeton* (keorali) were the most abundant species, whereas in Balai Haor *Hydrilla, Najas* (goisa), *Ottelia* (panikola, kaorali), *Sagittaria* (chhotokul) and *Aponogeton* (ghechu) were the most abundant species. (*Hydrilla* is common in both haors but much more abundant in Tangua than in Balai.) Still different compositions are found in Hail Haor and Kawadighi Haor.

Community composition also varies between beels within a particular haor system: for example, in Hail Haor, beels such as Chanda situated on the eastern side have dense vegetation while the beels on the western side do not. Kawadighi Haor, Hakaluki Haor, and Murir Haor, also exhibit variation from beel to beel. In other haors, such as Tangua Haor, Balai Haor, and Maijeil Haor, the submerged plant communities of the various beels do not differ significantly.

Community composition also reflects species' water depth and chemical preferences. Most species prefer depths of 0.2 to 2 meters, but some prefer deeper (>2 m) water. Some also have chemical preferences (*Utricolaria* prefers lower pH, for example, rendering it useful as an indicator species).

2. Free floating plants

Free floating vegetation consists of plants that are most commonly found floating freely on and collecting nutrients from the water; most of them can also survive for a certain period with their roots on or in moist soil. This community is common but not dominant in the haors. It is comprised of about 20 plant species (Table D.1) from the classes Angiosperm and Pteridophytes. The most dominant family in this community is Lemnaceae. Other common families are Salviniaceae, Lentibulariaceae and Pontederiaceae. At the species level *Eichhornia* (kochuripana), *Utricularia* (chhotojhangi) and *Salvinia* (kuripana, indurkan, tetulapana) are the most abundant and can be found in almost all the *beels*.

This community is also affected by water level fluctuations, though they are in general less dependent on water and more adaptable than the submerged plants. Before the monsoon begins, they are found growing luxuriantly in the stagnant water within individual beels. They persist as the water rises, but as flooding becomes general and the beels fill up, they tend to be advected out from the haors into the rivers. Their main mode of propagation is vegetative, though many members of this community can produce seed.

Community composition differs sharply from one haor to another, but differences among beels within a single haor are not very significant. The highest concentrations of floating vegetation are found in Hail Haor and Balai Haor, followed by Kawadighi Haor. These haors are shallower and more enclosed than Tangua Haor, Gurmar Haor, and Hakaluki Haor where lower concentrations are found. The reason for this may be the relative shallowness and moreover the closed surroundings of the high-concentration haors, which restrict advection of the plants away from these systems.

3. Rooted floating

These plants root deeply in the soil and float leaves and flower on the water surface. To accomplish this, most plants have very long stalks for both leaf and flower, and a stem that remains under water, sometimes beneath the soil; a few plants have long stems rather than long stalks. This community is one of the most dominant in the *haors*. It is comprised of about 15 plant species (Table D.1). The most dominant families in this community are Nymphaeaceae and Menyanthaceae. At the species level *Nymphaea stellata,* (nilshapla), *N. nouchali* (sada, raktoshapla), *Nymphoides cristatum* (chandmala), *N. indicum* (panchuli), and *Trapa maximowiczii* (singra, paniphal) are the most abundant and common in all the beels.

Like the other wetland plant communities, these plants are also susceptible to seasonal water level fluctuations. In the permanent beels they can survive and regenerate for the whole year. But in seasonally flooded areas, the rhizomes or seeds remain buried under the soil during the dry season and then start sprouting with the arrival of water. As water levels increases, they then elongate their stems or leaf and floral stalks. They typically start flowering on a large scale when the water starts receding just after the peak flood. Almost all the plants of this community can propagate vegetatively as well as sexually.

Community composition also differs from haor to haor and even among beels within an individual haor system. Hail Haor has the most unique vegetation pattern of this type: *Nelumbo nucifera* (padma) and another unidentified *Limnophila* species are found there and are totally absent from the other sites. Moreover, *Euryale ferox* (makhna) which is abundant in this haor is very rare in all the other systems. Balai Haor also has extensive rooted floating vegetation coverage, mostly *Nymphaea* and *Nymphoides*. Murir Haor has a community similar in composition but less extensive. Kawadighi Haor's community is mainly composed of a grass, *Echinochloa colonum* (parua). Hakaluki Haor has abundant vegetation of this type near the haor but little in the haor itself. Tangua, Gurmar Haor, and Maijeil Haor have this community but it is less prevalent.

In Hail Haor and somewhat in Hakaluki Haor, differences between beels within a single haor system are very prominent. In the other haors, it is not very significant.

4. Sedges and meadows

This is an ecotonal type (transition area between two communities, such as forest and grass land, and as such usually exhibiting competition between species common to both) consisting of amphibian plants (plants that can tolerate wet or dry conditions). Usually, the leaves of these plants are exposed to the air and the roots remain under water, though inundation and desiccation are tolerated to some degree. This community has the highest species diversity of all the haor types, with at least 35 different species present (Table D.1). In this sense, it is one of the most important plant communities in the haor area.

The most dominant families in this community are Cyperaceae and Polygonaceae, followed by Gramineae and others. At the species level *Polygonum* (kukra, bishkatakali, and others), *Fimbristylis*

(joina and others), and various species of *Cyperus* (mutha) are most abundant and are more or less common in all the beels. Some other species like *Ipomoea fistulosa* (dhol kalmi), *Monochoria hastata* (baranukha, kechur), and *Hemarthria protensa* (chailla) are highly abundant in Balai Haor, Hail Haor and Gurmar Haor respectively. Most of the plants of this type are rhizomatous and can propagate vegetatively, but all of them produce seed as well.

Generally this vegetation type occupies the water margin. At the end of the dry season, this is the margin of the beels. As water levels increase during the wet season, the community in a particular spot is gradually submerged; new growth 'follows' the shallow water margin, and at the peak of flooding the community is found at the margin of the haor. Submerged individual's shoot parts die out and slowly decompose into the water, enriching it with organic matter.

Community composition varies from haor to haor, but differences among beels within a haor are not prominent; community composition seems to be particularly sensitive to the rate at which water levels increase. Hail Haor has the best community of this type, composed mostly of *Cyperus* and other grasses. Balai, Kawadighi, and Tangua also have good coverage but with different composition. In Tangua and Kawadighi, the community is dominated by grasses, whereas at Balai the dominant species are *Polygonum* and *Ipomoea*. Murir and Dubriar have the same composition as Kawadighi but lower concentrations. Gurmar Haor displays co-dominance of grasses and *Polygonum*. Erali has very little vegetation of this type.

5. Floodplain grassland

Floodplain grassland prefers reasonably well-drained land affected by flooding of fairly short duration, typically found in plain lands between a haor basin and steep hills. The community consists of various medium to high grasses. The most dominant species is *Vetiveria zizanioides* (binna), which in the extreme case can be virtually the only species present. Other associated species are *Phragmites karka* (khagra, nol), *Saccharum spontaneum* (khag), *Sclerostachya fusca* (khuri), and *Arundo donax* (baranol). Small annual grasses, herbs, and *Cyperus* are common in the dry season. The presence of tree seedlings and scattered older trees suggests that the grassland community may not be a climax type, though the succession process seems to be very slow. Formerly this was a key habitat for rhinoceros and other large mammals; in addition, a number of small bird species, some extant and some already extinct in the region, depend fully on it.

6. Reed swamp

Reed swamp (panjuban) is adapted to lands intermediate in height between the haor basin and homestead lands (kanda), typically on ridges out in the haors. These areas are fairly deeply flooded during the flood season and dry out during the dry season. The grasses *Phragmites karka* (khagra, nol) and *Saccharum spontaneum* (khag, aisha) predominate. Some sedge/meadow grasses are also found here, in lesser amounts, such as *Vetiveria zizanioides* (binna, gandhabena, *Sclerostachya fusca* (khuri), and *Arundo donax* (baranal, gobanal). Other than the grasses, woody shrubs like *Ficus heterophylla* (bonolat, baladumur), *Asparagus racemosus* (satamuli, hilum), and *Lippia javanica* (bhuiokra) are the more common species. *Rosa involucrata* (gunja kata), believed to be globally threatened, finds natural sanctuary in pristine reed lands. Another prominent species is *Asclepias*, a climber from Asclepidiaceae family. Mature reeds attain heights of six to seven meters, in earlier times affording important habitat for Single-Horned Rhinoceros, Barashinga, Bengal Tiger, and Asian Elephant.

The community is composed principally of perennials, making it particularly vulnerable to utilization pressure. Sustainable harvesting is possible if a rotation of at least three years is allowed, but reclamation of land for agriculture, indiscriminate reed cutting for building material, industrial raw material, and fuel, in particular for lime-burning, has all but eliminated the once vast reed lands of the region.

7. Fresh water swamp forest

Fresh water swamp forest consists of flood-tolerant evergreen trees. A fully-developed stand exhibits a closed canopy with mature trees standing ten to twelve meters tall. *Barringtonia acutangula* (hijal) and *Pongamia pinnata* (koroch) occur in varying proportions to form this vegetation type. *Crataeva nurvala* (barun), *Trewia nudiflora* (gotagamar, panidumur) and *Salix tetrasperma* (bias, panihijal) are frequently also present. These trees mostly produce their seeds in the monsoon period and they disperse them through water; ; seedlings grow in great quantities. In addition, woody shrubs such as *Phyllanthus disticha* (chitki), *Ficus heterophylla*, *Rosa involucrata*, and *Asclepias* climbers are found.

Swamp forest is adapted to monsoon flooding for three to four months, to depths of 0.5 to 2.5 m; thus, much of the area now under monsoon rice would once have been occupied by swamp forest. Remnant forest patches are now restricted to areas sloping away from village highland down towards the haor, helping to shelter homesteads from wave erosion; to elevated ridges between beels; and to stream levees. These patches currently vary from a few plants to several hectares of more than a thousand trees. Depending on local conditions, particularly the extent of human disturbance, the luxuriance of the vegetation varies, from sparse low trees with undergrowth grasses, as at Rangchi and Rupnagar in Tangua Haor, to dense closed canopy with poor undergrowth, as at Pashua Beel in Gurmar Haor.

Rangchi within Tangua Haor has an area of about 3 ha. The density is 300 trees per hectare and average breast girth is 110 cm. At Pashua Beel in Gurmar Haor and at Nurpur in Johlbhanga Haor, the density is nearly 600 trees per hectare, and average girth is 30 cm. The principal trees of these forests are *Barringtonia* and *Pongamia*.

A detailed account of the status and distribution of these forest patches type does not exist. Some larger patches are listed with the revenue officers of the districts; these are leased out, mostly to jalmohal owners who use the branches for fish entrenchment. Swamp forest has been so nearly eradicated that a recent analysis of the dendrological regions of Bangladesh, carried out in association with the FAO land resource appraisal for agriculture (1988), could state that all areas inundated for most or all of the wet season are unsuitable for any tree species. Admirably, the Bangladesh Forest Research Institute quickly corrected this impression in *Trees for Lowlying Areas of Bangladesh* (Alam *et al.*, 1991).

Traditionally, forests were managed communally to provide protection of village highland from wave erosion; coppices were harvested in three years' rotation for fuel wood, housing posts, and fish entrenchment (katha). One or two branches per year can be taken on a sustainable basis. In recent years, however, outsiders (typically a jalmohal lessee) have taken control, increasing the frequency of the coppicing and the number of branches. In 1992 at Rangsi this reached tragic levels: virtually all the branches were taken from all the trees. Some of the trees may survive, if they are allowed to recover for several years.

Under sustainable management, yields of Tk 40,000 per year are possible; coppicing can begin when trees are five to seven years old, and natural regeneration is good. The upper limit of population density in mature stands is about 400 trees per hectare and the market value is Tk 30 to 50 per branch.

8. Crop field vegetation

This is a disturbed community, composed of both wetland plants and smaller dryland herbs found in other communities also. Community composition depends on the degree of waterlogging in each particular field. Cyperaceae is the dominant family in this community; a large number of other, unrelated plant families, ranging from Amaranthaceae, Euphorbiaceae, and Compositae to Gramineae are also present.

In this setting, these plants are weeds and are destroyed by farmers. These plants survive in this hostile setting by surviving unfavourable periods and multiplying rapidly.

9. Homestead vegetation

Homestead vegetation is a very important plant community, though a synthetic one. The community includes two types of plant: those cultivated for their economic value, and those that are self-propagating. Plants of the first category can be found all over the country, and composition within this type is more or less uniform. The composition within the second type is more interesting, in that it reflects the composition of nearby natural communities, including communities and species that have otherwise vanished locally, and contains some strong clues as to local vegetation composition in times past. Homesteads around Hakaluki Haor, the study site closest to the hilly rain forest, has the largest number of trees of this type. Sunamganj homesteads contain more *Barringtonia, Pongamia*, and *Trewia* trees than Moulvibazar homesteads, which suggests that the swamp forest was much more prominent in Sunamganj than in Moulvibazar.

3.3.4 Plant utilization

Currently utilized wetland plant products and services are grouped as follows (after AWB, pers. comm.):

- Starch (energy) foods (grains and starchy roots),
- Other foods (vegetables)
- Fodder and forage
- Medicine
- Thatching and mat-making
- Fuel
- Erosion protection
- Fisheries habitat
- Industrial raw material
- Fertilizer

In addition, the wetlands of the region are potential providers of:

- Pollution abatement
- Biogas production

Table 3.3 shows the known uses in the Northeast Region for each species.

Table 3.3: Wetland plant utilization (see text for codes)

Species	fs	fv	fp	m	fb	fu		ft		bf	pa	bg	c	ff	b	vo	sf	eo	sm	dt	or	ts	ex	ot	
SUBMERGED																									
Aponogeton natans	X	X																							
Aponogeton undulatus	X	X		X																					
Aponogeton appendiculatus	X	X		X																					
Blyxa sp.																									
Ceratophyllum desmersum			X			X																			
Hydrilla verticillata			X	X						X															
Lagarosiphon roxburghii										X															
Myriophyllum tuberculatum			X	X																					
Myriophyllum tetrandrum			X	X																					
Najas sp.																									
Ottelia alismoides	X	X	X																						
Potamogeton crispus			X	X																					
Potamogeton mucronatus			X	X																					
Rotala rutundifolia																									
Sagittaria guayanensis spp. *lappula*				X																					
Sagittaria sagittifolia				X																					
Vallisnaria spiralis										X											X				
Azolla pinnata										X															
Eichhornia crassipes			X							X		X									X				
Lemna perpusilla										X															
Pistia stratiotes										X		X													
Salvinia cucullata										X															
Salvinia natans										X															
Spirodela punctata																									
Spirodela polyrhiza																									
Utricularia exoleata				X																					
Utricularia aurea				X																					

Species	fs	fv	fp	m	fb	fu		ft		bf	pa	bg	c	ff	b	vo	sf	eo	sm	dt	or	ts	ex	ot	
Utricularia stellaris				X																					
Wolffia arrhiza										X															
Wolffia microscopica										X															
ROOTED FLOATING																									
Echinochloa colonum	X		X			X																			
Eurayle ferox	X			X																					
Hygroryza aristata	X		X																						
Limnophila indica			X	X																	X				
Limnophila sessiliflora			X	X																					
Limnophila heterophylla			X	X																					
Mersilea quadrifoliata		X		X																					
Nelumbo nucifera				X									X								X			X	
Nymphaea stellata	X	X	X	X								X									X				
Nymphaea nouchali	X	X	X	X								X									X				
Nymphoides cristatum			X	X																	X				
Nymphoides indicum			X	X																	X				
Panicum paludosum			X			X																			
Pseudoraphis spinescens			X																						
Pseudoraphis brunoninan			X																						
Trapa maximowiczii	X		X											X											
SEDGES & MEADOWS																									
Aeschynomene aspera						X				X											X				
Aeschynomene indica						X															X				
Alternanthera philoxeroides		X	X																						
Arundo donax			X		X																				
Cleome hasslerana				X																	X				
Clinogyne dichotoma					X																				
Colocasia esculenta		X		X																					
Cyperus			X		X																				
Eclipta alba				X																					
Eleocharis dulcis			X																						

Species	fs	fv	fp	m	fb	fu		ft		bf	pa	bg	c	ff	b	vo	sf	eo	sm	dt	or	ts	ex	ot	
Enhydra fluctuans		X		X																					
Fimbristylis dichotoma																									
Fimbristylis miliacea																									
Fimbristylis squarrosa																									
Hemarthria protensa			X		X																				
Ipomoea aquatica		X	X																		X			X	
Ipomoea fistulosa						X															X				
Ludwigia abscendens			X																						
Ludwigia repens																								X	
Monochoria hastata				X																					
Oryza rufipogon	X		X																						
Polygonum glabrum				X																					
Polygonum stagninum				X																					
Polygonum lanatum				X																					
Polygonum pedunculare				X																					
Polygonum barbatum				X																					
Rumex maritimus				X																					
Setaria glauca			X																						
Setaria fusca			X																						
Schoenoplectus articulatus			X		X																				
Scirpus juncoides			X																						
Sclerostachya fusca			X		X																				
Sesbania roxburghii						X				X															
Vetiveria zizanioides					X	X																			
Xanthium indicum		X		X																					
Reeds																									
Asclepias sp.				X																					
Asparagus racemosus				X																					
Ficus heterophylla var. *heterophylla*						X																			
Lippia javanica				X		X																			
Phragmites karka					X																	X		X	

Species	fs	fv	fp	m	fb	fu		ft		bf	pa	bg	c	ff	b	vo	sf	eo	sm	dt	or	ts	ex	ot	
Rosa involucrata						X																		X	
Saccharum spontaneum					X	X																X		X	
Swamp Forest																									
Barringtonia acutangula				X		X		X														X			
Crataeva nurvala						X																X			
Phyllanthus disticha				X		X																			
Pongamia pinnata				X		X																X		X	
Salix tetrasperma						X																X			
Trewia nudiflora				X		X																X			
CROP FIELD																									
Alternanthera sessilis		X	X																						
Amaranthus spinosus		X		X																					
Ceratopteris thalictroides		X	X																						
Chenopodium ambrosoides																									
Cotula hemispherica				X																					
Croton bonplandianum			X																		X				
Cynodon dactylon			X																						
Cyperus cephalotes					X																				
Centipeda orbicularis				X																					
Dentella repens																									
Digitaria longiflora			X																						
Eleocharis atropurpurea			X																						
Eleusina indica			X																						
Heliotropium indicum				X																					
Leucas lavendulifolia				X																					
Lindernia crustacea																									
Paspalum conjugatum			X																						
Rottboellia protensa																									
Rorippa indica																									
Solanum khasianum		X		X																					
Solanum filicifolium				X																					

Species	fs	fv	fp	m	fb	fu		ft		bf	pa	bg	c	ff	b	vo	sf	eo	sm	dt	or	ts	ex	ot	
Solanum nigrum				X																					
Spilanthes acmella				X																					
HOMESTEAD																									
Aegel marmelos				X									X	X								X			
Alstonia scholaris				X		X																X			
Albizia sp.																						X			
Albizia procera																						X			
Alpinia sp.				X																	X				
Anthocephalus chinensis						X																X			
Areca catechu				X										X								X			
Artocarpus heterophyllus														X								X			
Bombax ceiba				X	X	X																X	X		
Bambusa sp.		X			X	X																X		X	
Calamus tenuis					X																				
Cassia siamea						X																X			
Caryota urens															X						X	X			
Centella asitica		X		X																					
Cleorodendrum siphonanthes						X															X				
Cocos nucifera					X									X		X						X			
Datura suaveolens				X																					
Diospyros perigrina				X										X						X			X		
Erythrina variegata				X		X															X				
Erythrina ovalifolia				X		X															X				
Ficus bengalensis				X		X							X											X	
Ficus rumphii						X																X			
Ficus religiosa				X		X							X									X		X	
Ficus hispida		X																				X			
Ficus				X		X																			
Lagerstromia speciosa						X															X	X			
Mangifera indica				X		X								X								X			
Mikania scandens			X	X																					

Species	fs	fv	fp	m	fb	fu		ft		bf	pa	bg	c	ff	b	vo	sf	eo	sm	dt	or	ts	ex	ot	
Mikania cordata			X	X																					
Musa paradisiaca var. *sapientum*		X												X											
Ocimum americanum				X									X												
Pandanus					X																				
Samanea saman						X																X			
Syzygium fruticosa						X								X								X			
Syzygium cumini				X										X								X	X		
Tamarindus indica				X		X								X											
Terminalia catappa				X										X								X			
Zizyphus mauritiana						X								X											

Reliable quantitative information is not available for most of these products and services. In the few instances where order of magnitude estimates are possible and useful, these are presented below. This would include amounts currently harvested per unit area, extent of utilized area, unit price, and unit cost of collection and processing, and so on. Additional study is clearly required, focusing on the items of greatest current and potential importance.

Starch (energy) foods (FS)

During times of scarcity, local people eat grains of *Oryza rufipogon,* (jhara dhan), *Echinochloa colonum* (parua), *Eleocharis dulchis* (panichaise), and *Hygroryza aristata* (phutki). Rhizomes of *Aponogeton* (ghechu) and *Nymphaea* (nilshapla, sada, raktoshapla) are also eaten. Seeds of *Euryale ferox* (makhna) and *Nelumbo nucifera* (padma) are eaten raw or roasted. The seeds of *Ottelia alismoides* (panikola, kaorali), *Nymphaea stellata* (nilshapla) and *Nymphaea nouchali* (sada, raktoshapla) are made into puffed grain by frying, and may be eaten in this form or prepared into confectionery.

Trapa maximowiczii (shingra, paniphal) produces a nut which is commercially sold in both local and urban (Dhaka) markets.

Other foods (vegetables) (FV)

The stems and leaves of various plants are eaten as vegetables: this would include *Alternanthera sessilis* (haicha, sachishak), *A. philoxeroides* (helencha), *Ipomoea aquatica* (kalmi shak), *Colocasia esculenta* (kachu), *Xanthium indicum* (ghagra, khagra), *Centella asiatica* (thankuni), *Amaranthus spinosus* (kata note), *Chenopodium ambrosoides* (chapali ghash), *Enhydra fluctuans* (helencha, harhach), *Mersilea quadrifoliata* (sushnisak), and *Aponogeton* (ghechu).

Nymphaea and *Ottelia alismoides* floral stocks are also eaten as vegetables.

Eichhornia crassipes, Monochoria hastata, Nelumbo nucifera, Sagittaria sagittifolia and *Limnophila* are used as vegetables in many other countries, but not much in Bangladesh.

Fodder and forage (FP)

Most wetland plants can be used as food for livestock. Most of the grasses such as *Hygroryza aristata, Oryza rufipogon, Panicum paludosum, Echinochloa colonum, Setaria glauca, Cynodon dactylon, Pseudoraphis, Arundo donax, Eleusina indica, Paspalum* are extensively used as fodder. The members of **Cyperaceae** family are also used.

In the monsoon, when grass is less abundant, the major source of cattle food becomes *Eichhornia crassipes*, *Nymphaea*, and *Nymphoides*; other smaller herbs are also used.

Medicine (M)

Local people use many wetland plants as medicine. *Polygonum* is well-known for its antibacterial effect.

Another well-known species is *Eclipta alba*, which is used as a hair tonic.

Limnophila indica is used as an antiseptic; is mixed with coconut oil to make a liniment for treatment of elephantiasis; and is used in the treatment of certain types of fever, when the plant's juice is rubbed on the body of the patient.

Nymphoides indicum is used to treat fever and jaundice.

Nelumbo nucifera is used as a cardiac tonic, diuretic, scyptic, and antipyretic; the seeds are used as a cooling balm in skin disease; and seeds are also given for piles and ringworm.

Monochoria hastata is used against diarrhoea and dysentery, and as an aphrodisiac.

The flowers of *Nymphaea nouchali* are used to treat bloody dysentery and in gynaecological complaints; the powdered rhizome is used to treat piles, dysentery, and dyspepsia.

The flowers of *Nymphaea stellata* are used in preparing a cardiac tonic.

Cyperus tubers are regarded as tonic and stimulant.

Pistia stratiotes are used to treat diarrhoea, skin disease, gonorrhoea, syphilis, and others.

Ottelia alismoides and *Ipomoea aquatica* are used against haemorrhoids.

Phyllanthus is utilized as an abortifacient and diuretic.

Alternanthera sessilis, Scirpus and *Rorippa indica* have antidiarrhoeal activity.

Spilanthes acmella is used against toothache.

The juice of *Heliotropium indicum* is used in leprosy.

Cynodon dactylon, Utricularia, Sagittaria, and others are also used.

Thatching and mat-making (FB)
The grasses which are used in the Northeast Region as thatching material and to make protective screens around homesteads are *Selerostachya fusca* and *Vetiveria zizanioides*. The latter species is also a very good soil binder.

An highly-prized mat known as sithal pati is made from *Clinigyne dichotoma*. A 1.5 m x 2 m mat sells at times for Tk 15,000 (about US$400). This is the basis of an important cottage industry.

Fuel (FU)
Barringtonia and *Pongamia* are exploited for homestead construction and for fuel wood.

All the grasses are dried and used as cooking fuel.

Other plants such as *Ficus heterophylla, Ipomoea fistulosa, Lippia javanica* and reeds are also used extensively as fuel.

Erosion protection

Barringtonia and *Pongamia* forest is considered very effective in protecting homesteads from wave erosion and storm damage, which are common problems around the haors and larger beels during the

monsoon. A number of the remaining forest areas are managed by local community management groups for this purpose.

Fisheries (FT)

Wetland vegetation makes a number of key contributions to the openwater fishery: providing shelter for the juvenile and adult fish; providing food in the form of periphyton on the stems and leaves of submerged vegetation; and supporting the base of the food chain through decomposition of plant material in the water.

The branches of *Barringtonia* are considered by local fishing folk and fisheries lease holders alike to be essential to fish production, indeed vital for the sustainability of the openwater fishery as a whole.

Industrial raw materials

Reeds (*Phragmites karka, Saccharum spontaneum*) locally known as pajuban, were intended to be an important constituent of the raw material for the Sylhet Pulp and Paper Mill (SPPM). In 1977, an estimate of the reed area available for commercial exploitation was estimated to be more than 30,000 ha, with a biomass production of 4.5 MT ha^{-1} (air dry basis). The present official Forest Department estimate of reed area is about 27,000 ha, but in fact there is no trace of reeds on most of it. Productivity of the remaining reeds has also decreased to an estimated 2 MT ha^{-1}. SPPM took 22000 ha of land from the Revenue Department for reed cultivation a number of years ago, but this was unsuccessful (propagation was limited to 2000 ha only in the Chhatak, Companiganj, and Jaintiapur areas) and now the land is being returned to Forest Department management.

More than 90% of the lime requirement of the country comes from the Northeast region, and the region's lime-burning industry made extensive use of reeds as fuel, which resulted in extensive destruction. The industry now uses natural gas.

Rosa involucrata is an threatened plant in Bangladesh which finds natural sanctuary in the pristine reed lands. Conversion of reed land to agricultural use and over-exploitation of reeds for lime-burning are the main threats to the conservation of this vegetation.

Fertilizer (BF)

Eichhornia crassipes, once considered to be a pest, is now being used as compost fertilizer in the Northeast Region (it is also used in parts of India). The ash of the plant, which contains 30% potash, 7% phosphoric acid and 13% lime, makes an excellent fertilizer; in Sudan, it increased peanut production by over 30% (Maltby, 1986).

Other soft aquatic herbs can also be used in compost: for example, *Azolla* is used as an important bio-fertilizer all over the world.

Pollution abatement (PA)

Aquatic plants are proving an asset in the treatment of sewage and polluted water. *Lemna* can remove 50% of nitrogen, 67% of phosphorous, and nearly all the heavy metals from the water. Calcutta's sewage has undergone natural purification in the complex of wetlands east of the city for at least 50 years; the facility also supports a rich fishery.

In Madras, *Eichhornia crassipes* is being used to clean tannery effluents that would otherwise contaminate groundwater.

In Malaysia, the aquatic plant *Azolla* is being used to treat wastewater both from sugar refineries and from a rubber processing plant.

In the U.S. (Maltby, 1986), *Phragmites, Arundo donax* and *Salix* sp. have been shown to filter sediment load from dredged material.

Biogas (BG)
Another possible use of *Eichhornia crassipes, Lemna, Nymphaea* and so on is to production of biogas. Up to 40 litres of gas can be produced from 100 kg fresh weight of plants. By-products of biogas production can be used as fish feed.

3.3.5 Threatened communities and species

The freshwater swamp forest (*Barringtonia acutangula, Pongamia pinnata*, and *Crataeva nurvala*) is the native vegetation of much of the region and indeed of much of Bangladesh. It has disappeared from the country except for the small patches remaining in the Northeast Region, plus individuals surviving on homestead lands throughout the country.

The reed lands have also been reduced to remnant areas, and will likely disappear unless action is taken. In particular, *Rosa involucrata* gunja kata, a wild relative of the garden roses, was abundant in the reed lands of Bangladesh. It was abundant in the northern districts a century ago. This plant is now rare as a result of the destruction of reed land habitat. It is now restricted to the undisturbed haors of Sunamganj.

Euryale ferox makhna and *Nelumbo nucifera* padma, both rooted floating plants, are also threatened. They are found only in Hail Haor now.

The major causes of decline of these plants are conversion of wetlands for paddy cultivation, increasing cropping intensity, and the increasingly intensive tillage required by HYVs which disturbs the seed banks of wild vegetation.

3.4 WETLAND BIRDS

3.4.1 Introduction

The ornithology surveys (main and monthly) were undertaken to determine the current status and abundance of waterfowl and wetland-dependent birds occurring in the wetlands of the haor basin, and to understand seasonal changes and events. Wetland-dependent birds are those that depend ecologically on wetlands; this category would include the two fish-eagles, the Osprey, several kingfishers, and a number of marsh-dwelling passerines. Of less interest were the many other bird species that frequent the wetlands but are not dependent upon them; this category would include various birds of prey and many of the small birds typical of homestead forests and gardens.

The present status of the 125 species of waterfowl which are known or thought to have occurred in the wetlands of the Northeast Region, and a summary of the observations of the 89 species that were recorded during the present surveys, is presented in Annex D. (Eighty-seven species were recorded in the 68 wetlands, and two others, Black Bittern and Slaty-breasted Rail, were observed in rice fields).

3.4.2 Previous studies

Hume (1888) is one of the most useful early accounts of the birds of Sylhet: 178 species are listed, including Pink-headed Duck *Rhodonessa caryophyllacea* which is now globally extinct. Stuart Baker (1922-1930) did some work on the birds of the Northeast, which include several references to "plains of reeds", a habitat type now all but disappeared from the region. More recently, Mountfort (1969) summarized the observations of the 1966 World Wildlife Fund Expedition to West and East Pakistan. Haroun Er Rashid (1967) reviews bird species status in Bangladesh by region, one of which is the haor basin (his North-East Lowlands), but by his own admission status information is based on assumptions more than positive records, largely due to imprecise locality information in earlier accounts.

Harvey (1990), in a recent comprehensive listing of the birds of Bangladesh takes a cautious approach and includes only those species and records for which there is full documentation. The list provides a status indication for each species in each of six regions, one of which is the Northeast, plus useful information on habitat preferences and breeding seasons. The status summaries relate almost entirely to the last twenty years. The former status of species that are now rare or locally extinct is little mentioned, even though many would once have been widespread and common here. Another recent list, S.U. Sarker and K.Z. Husain (1990) included 174 bird species that occur in the wetlands and mangrove areas of Bangladesh, with a discussion of conservation implications.

There have been a few studies relating specifically to the waterbirds of the Northeast. Some preliminary investigations were carried out by Forest Department, University of Dhaka, and Bangladesh Zoological Society personnel; most of this work focused on Hakaluki Haor and Hail Haor. Annually since 1987, excepting 1989, mid-winter waterfowl censuses were undertaken in the Northeast by Forest Department and NACOM personnel in the years, as part of the IWRB/AWB Asian Waterfowl Census (see Section xx.xx). These censuses covered only four sites (Hakaluki, Hail, Kawadighi, and Tangua Haors), and the counts give only a rough indication of species present and relative abundance.

The ten site accounts in the *Directory* give preliminary lists of waterfowl known to occur at each site. Other useful sources of information on the birds of the wetlands of the region include D.J. Millin (1984-88, unpublished list of bird sightings at Hail Haor) and J.D. Woolner (1986-91, unpublished notes on 108 species), and Altamash Kabir (unpublished notes on scarce waterfowl in the region). Khan (1987) summarizes the status of the storks and other large waterbirds in Bangladesh and refers to the importance of the haor wetlands but few specifics. Similarly, many other recent authors refer to the importance of the haors for waterbirds, especially migratory species and several rare and endangered species, but without any useful quantitative information.

A review of this literature, when combined with the current data set, identifies a total of 125 species of waterfowl that are known or thought to have occurred in the haor basin:

- 53 are or were resident breeding species or breeding summer visitors, of which
  - 1 species: globally extinct
  - 9 species: extinct in the Northeast Region
  - 6 species: extinct in the Northeast Region as breeding birds, though they still occur as non-breeding visitors
  - Many other species: populations greatly reduced (notably Oriental Darter and Cotton Pygmy Goose).

- 42 are or were regular winter visitors or passage migrants from more northerly breeding grounds. Of these,
  - 2 species: extinct in Bangladesh
  - 6 species: almost extinct in the Northeast Region
  - Many other species: populations well below former levels, especially wintering ducks and geese.

- 30 were probably never more than rare winter visitors or passage migrants, at or near the edge of their normal distribution, or stragglers from neighbouring regions.

3.4.3 Species observed and species groups

Two hundred and eighty-four species of birds were recorded in the Northeast Region during the NERP field program. A master checklist is provided in Annex D. These 284 are grouped as follows:

- *True waterfowl*: 89 species.

  Thus, of the 125 waterfowl species known or thought to have occurred in the wetlands of the Northeast Region, 36 species were not observed. These can be grouped as follows:

  - 17 species: extinct or almost so in the region.
  - 8 species: scarce visitors to the region.
  - 6 species: extremely secretive and easily overlooked. Mostly rails and crakes.
  - 3 species: birds mainly associated with large rivers with extensive sand banks (River Lapwing, Black-bellied Tern and Indian Skimmer). In the Northeast Region, this habitat type appears to be restricted to the Old Brahmaputra River in the extreme west, which was surveyed by air only.
  - Indian Shag: not uncommon in the wetlands of central Bangladesh. Lack of observation is surprising.
  - White-breasted Waterhen: reported to occur at wetlands throughout the country, and is a noisy and conspicuous bird, often living in close proximity to human dwellings. Lack of observation surprising.

- *Other birds*:

  - Wetland-dependent birds: 30 species. These are species which are largely or wholly dependent on wetland ecosystems. Of these, 11 species are birds of prey.

  - Other birds observed in wetlands or adjacent floodplains: 42 species. Of these, 11 species are birds of prey.

  - Dry-land birds: 123 species. About half of these species are mainly confined to the West Banugach and Shatchari Reserved Forests; the rest were observed in the reserved forests and in other dry-land habitats (tea estates, homestead forests, secondary scrub, and so on). Of these, 11 species are birds of prey.

3.4.4 True waterfowl

The two NERP main ornithology surveys (18 Feb 92 to 12 Mar 92 and 19 Apr 92 and 9 May 92) were the most comprehensive waterfowl surveys ever undertaken in the wetlands of the haor basin. The

results of the waterfowl counts are summarized by site in Figure 4 and in Table 3.4a and 3.4b; by species group in Table 3.5; and by individual species in Table 3.6.

These surveys show that despite the massive habitat losses, the haor basin remains an internationally important wintering area for migratory waterfowl, principally ducks and shorebirds. It continues to support large numbers of some resident species, notably Little Grebe, Little Cormorant, a variety of herons and egrets, both species of whistling-duck, both jacanas, Common Moorhen and Purple Swamphen. The region is also undoubtedly of some importance for passage migrants in spring, and perhaps also in autumn, at least for two shorebird species, Ruff (an early migrant) which was observed in early March and Asiatic Golden Plover (a late migrant) which was observed in late April and early May.

Waterfowl populations, main ornithology surveys

Geographical distribution

Nearly all the waterfowl were found at the fourteen principal wetland systems listed in Table 3.4a: 95% in Feb/Mar 92 and 90% in Apr/May 92. The northern haor system (Tangua Haor, Matian Haor, and Gurmar Haor complex) and Hakaluki Haor together held much the largest concentrations: about 71% (76,500) in Feb/Mar 92 and 44% (13,480) in Apr/May 92. Aila Beel also held a large concentration of ducks in late Apr 92; it was not included in the Feb/Mar 92 survey.

Feb/Mar 92 survey

A total of 108,000 waterfowl of 77 species were counted during the Feb/Mar 92 survey. This is a substantial population, but, given the vast extent of the wetlands of the haor basin, very low in comparison to other wetland systems at about the same latitude in southern Asia. There are many quite small wetlands in the much less densely populated parts of Southwest Asia (e.g. in Iran and Pakistan) which regularly support between 250,000 and 500,000 waterbirds in winter. No reliable information is available on the numbers of waterfowl wintering in the Northeast Region in the past, but there can be little doubt that there has been a drastic decline in numbers, perhaps to only a few percent of former levels. The Feb/Mar 92 survey occurred a few weeks before the spring migration, which would have peaked sometime between mid-Mar 92 and mid-Apr 92.

A total of 76,000 ducks were counted in Feb/Mar 92. If it overall coverage is assumed to be on the order of 50-75% (see Section 2.4.1), then the total number of ducks present would be about 100,000-150,000.

Most or all of the waterfowl recorded during the Feb/Mar 92 survey were birds that had overwintered in the haor basin, as little evidence for the start of spring migration was found through early March. Even so, the Feb/Mar 92 count was probably much lower than a count in December or January would have been, given the heavy hunting pressure throughout the region which would have reduced population levels.

Apr/May 92 survey

Far fewer birds (only 30,300 of 67 species) were observed during the Apr/May 92 survey, as by this time the great majority of winter visitors had departed, and the spring migration of waterfowl was almost over. At the 48 sites covered during both surveys, the total number of waterfowl had fallen from 98,850 to 21,000.

Table 3.4a: Summary of Waterfowl Counts by Major System

Site ref.	System	Survey	Total Species	Grebes	Cormorants	Herons	Storks	Ibises	Whistling Ducks	Geese	Ducks	Rails	Jacanas	Shorebirds	Gulls	Terns	Total Count
2	Central Haor Basin along Baulai R (aerial only)	1	10	-	58	822	-	-	-	-	200	-	-	150	3	435	1668
		2	5	-	3	589	-	-	-	-	-	-	-	-	-	5	597
7-8	Hail Haor	1	27	3	-	372	-	-	200	-	696	11	7	326	-	-	1615
		2	26	10	-	461	-	-	53	-	14	21	64	104	8	203	938
9-10	Kawadighi Haor	1	37	14	-	1890	-	-	59	-	5017	17	301	1421	12	465	9196
		2	26	5	40	1023	-	-	-	-	30	-	102	350	8	41	159
11-12	Maijeil/Balaganj Haor (Patachatal, Borochatal)	1	19	8	-	3	-	-	250	-	3931	-	-	43	3	15	4253
		2	13	-	6	6	-	-	-	-	162	-	13	48	-	13	248
13-16	Dubriar Haor and Chalnia, Deodar Beels	1	28	23	5	158	-	-	515	-	1331	2	6	67	7	-	2114
		2	19	10	98	175	-	-	36	-	6	-	11	61	5	26	428
18-26	Hakaluki Haor	1	48	79	166	162	-	-	6800	-	26832	200	3	2737	77	75	37131
		2	37	-	4	61	-	-	1112	-	685	1	5	162	59	404	2493
27-29	Balai Haor*	1	30	6	39	107	3	-	-	-	80	2	3	319	-	-	559
		2	28	8	78	342	13	-	188	-	94	12	12	418	-	-	1165
38-39	Dehkar Haor and Kuri Beel	1	30	58	281	343	-	-	350	4	316	-	-	154	-	72	1578
		2	15	35	42	31	-	-	-	-	-	1	1	15	-	4	129
41-43	Aila Beel, Pangna Beel**	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No count
		2	28	2	345	29	-	-	850	-	7189	7	-	40	36	41	8539
46	Pasua Beel	1	31	10	415	871	128	11	-	-	1332	163	-	406	10	350	3696
		2	40	6	2516	2144	300	4	200	-	494	432	-	58	80	100	6334
48-49	Kanamaiya Haor	1	37	9	972	282	-	-	3904	-	976	-	-	692	24	95	6954
		2	13	-	300	30	-	-	33	-	101	-	-	4	35	10	513
50-52	Matian Haor	1	35	39	632	496	-	-	-	-	4380	10	52	653	-	125	6387
		2	19	78	161	168	-	-	-	-	93	1	138	11	3	72	725
53-63	Tangua Haor	1	50	219	2070	473	-	-	5543	-	11230	5061	630	553	14	209	26002
		2	31	373	1156	401	-	-	452	-	231	382	43	56	158	164	3416
64-65	Meda Haor	1	18	4	49	62	-	-	780	-	353	-	3	10	-	70	1331
		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No count

Notes: Survey 1 = Feb/Mar 92. Survey 2 = Mar/Apr 92. Most of the sites were also counted in late Mar 92 (see Figure 4 and Annex F).

Table 3.4b: Summary of waterfowl by sites

* aerial survey only

Site name	Feb/Mar 92 survey			Apr/May 92 survey		
	Date(s)	Spp.	Count	Date(s)	Spp.	Count
Old Brahmaputra River	25/2*	5	145			
Lower Baulai River	25/2*		1668	9/5*	5	597
Lower Kalni River	26/2*	9	1017	9/5*	3	123
Sankardanga Beel	9/3	13	126			
Ratna Beel	9/3	11	146			
Khowai River	9/3	15	335			
Hail Haor	21/2 23/2	23	729	2/5	25	920
Hail Haor Fish Ponds	18/2	14	886	29/4	6	18
Petangi Beel	22/2 8/3	21	4844	3/5	19	519
Majherbanda/Ulauli	22/2	32	4352	29/4	19	1080
Patachatal Beel	8/3	19	3073	28/4	12	234
Borachatal Beel	8/3	4	1180	28/4	4	14
Dubriar Beel	5/3	6	108	26/4	15	218
Baisha Beel	5/3	10	103	26/4	8	93
Chalnia Beels	20/2 5/3	19	1892	26/4	5	58
Deodar Beels	5/3	3	11	26/4	2	59
Juri River	20/2 5/3	14	105	25/4	5	8
Kair Gang and *beel*	7/3	17	857	25/4	1	40
Haor Khal	7/3	27	7385	25/4	26	505
Puala Beel	20/2	15	1380			
Pingla Beel	19/2	6	51	30/4	8	192
Chatla Beel	19/2	26	17841	30/4	15	1680
Tural Beel	19/2	11	98	30/4	3	20
Dulla Beel	19/2	4	2021			
Chakia Beel	19/2	3	120			
Gharkuri Beel	19/2	22	7378	30/4	3	56
Khakra Kuri Beel	6/3	22	192	27/4	15	589
Dubail Beel	6/3	17	131	27/4	12	440
Jugni Beel	6/3	13	236	27/4	14	136
Chunnia Beel	6/3	5	104	27/4	5	33
Erali Beel	6/3	4	6	27/4	3	62
Chapra, Singari etc.	26/2*	1	1			
Mehdi Beel	5/3	10	474	26/4	10	187
Deochapra Beel	29/2	14	247	20/4	9	55
Dabor Beel	29/2	10	69	20/4	5	12
Kuri Beel	29/2	18	374	20/4	9	27
Goraduba Beel	29/2	8	186			

Table 3.4b: Summary of Waterfowl by Sites

Site name	Feb/Mar 92 survey			Apr/May 92 survey		
	Date(s)	Spp.	Count	Date(s)	Spp.	Count
Dapha, Ruwa, Guinga	-29/2	23	1018	20/4	10	102
Jaor Beel				9/5*	3	15
Surma River	1/3 4/3	8	181	21/4 24/4	2	5
Aila Beel				21/4	21	8327
Pangna Beel				21/4	12	153
Karul Dhan Beel				21/4	13	59
Someswari River	1/3 2/3 4/3	30	1718	21/4 23/4	24	2023
Patnai Gang	3/3	9	110	23/4	8	624
Pasua Beel	4/3	31	3696	22/2 4/4	40	6334
Kecharia Beel	4/3	7	62	22/4	7	29
Kanamaiya Haor	2/3 4/3	30	1875	22/4 23/4	8	183
Pakertala Beel	2/3 4/3	30	5079	22/4 23/4	10	330
Bara Beel	2/3 3/3	29	3389	22/4	17	335
Banuar Beel	2/3	14	1252	22/4	10	298
Palair Beel	3/3	19	1746	23/4	12	92
Pana Beel	2/3	29	9220	22/4	14	515
Biaskhali Beel	2/3	20	426	22/4	10	132
Rauar Beel	2/3 3/3	29	6054	22/4 23/4	24	1059
Main Tangua Beel	2/3	20	2306	22/4	15	1055
West Tangua Beel	2/3	11	2922	22/4	part of above	
Two unnamed *beels*	2/3	11	1317	22/4	part of above	
Ainna Beel	2/3	5	294	22/4	part of above	
Ghaniakuri Beel	3/3	9	348	23/4	5	20
Arabiakona Beel	3/3	13	1062	23/4	6	431
Unnamed Beel	3/3	17	1789	23/4	9	118
Samsar Beel	3/3	10	264	23/4	11	86
Uglar Beel	11/3	15	1083			
Meda Beel	11/3	11	248			
Netrokona/Kaluma Kanda	11/3	16	301			
Kendua area	10/3	5	33			
Boraduba Beel	12/3	8	172			

Table 3.5: Summary of waterfowl counts by group

FAMILY SUB-FAMILY	TOTAL SPECIES	FEB/MAR		APR/MAY	
		SPECIES	COUNT	SPECIES	COUNT
Grebes	2	2	488	1	534
Cormorants	2	2	5,331	2	6,091
Darters	1	1	21	1	21
Bitterns, herons and egrets	13	10	8,334	12	6,062
Storks	2	2	137	1	315
Ibises and spoonbills	2	1	11	2	4
Whistling Ducks	2	2	18,831	2	3,054
Geese	1	1	4	0	0
Ducks	18	17	56,954	13	9,519
Rails, moorhens, coots etc	4	4	5,466	4	866
Jacanas	2	2	1,059	2	428
Painted snipes	1	0	0	1	3
Stilts and avocets	2	2	1,271	1	376
Pratincoles	2	2	3	0	0
Plovers	7	7	2,635	3	610
Sandpipers, snipes, godwits	19	17	4,942	16	400
Gulls	2	2	199	2	409
Terns	5	3	2,150	4	1,608
TOTAL	**87**	**77**	**107,836**	**67**	**30,300**

Table 3.6: Summary of waterfowl counts by species

Species	Feb/Mar 92	Apr/May 92
Tachybaptus ruficollis Little Grebe	353	534
Podiceps cristatus Great Crested Grebe	135	0
Phalacrocorax carbo Great Cormorant	54	1
P. niger Little Cormorant	5,277	6,090
Anhinga melanogaster Oriental Darter	21	21
Botaurus stellaris Great Bittern	1	0
Ixobrychus sinensis Yellow Bittern	0	3
I. cinnamomeus Cinnamon Bittern	0	8
Nycticorax Black-crowned Night-Heron	136	33
Ardeola grayii Indian Pond Heron	977	280
A. bacchus Chinese Pond Heron	0	2
Bubulcus ibis Cattle Egret	324	1,675
Butorides striatus Little Heron	7	6
Egretta garzetta Little Egret	1,121	970
E. intermedia Intermediate Egret	498	866
E. alba Great Egret	2,539	1,855
Unidentified egrets	2,120	201
Ardea purpurea Purple Heron	5	35
A. cinerea Grey Heron	606	128
Anastomus oscitans Asian Openbill	135	315
Leptoptilos javanicus Lesser Adjutant	2	0
Threskiornis melanocephalus Black-headed Ibis	11	3
Platalea leucorodia White Spoonbill	0	1
Dendrocygna bicolor Fulvous Whistling-Duck	9,815	1,263
D. javanica Lesser Whistling-Duck	9,016	1,791
A. indicus Bar-headed Goose	4	0
Tadorna ferruginea Ruddy Shelduck	337	40
T. tadorna Common Shelduck	0	1
Nettapus coromandelianus Cotton Pygmy Goose	111	206
Anas penelope Eurasian Wigeon	101	91
A. falcata Falcated Teal	1	0
A. strepera Gadwall	507	51
A. crecca Common Teal	73	4
A. platyrhynchos Mallard	16	0
A. poecilorhyncha Spot-billed Duck	243	122
A. acuta Northern Pintail	20,283	72
A. querquedula Garganey	15,457	8,658
A. clypeata Northern Shoveler	12,913	214
Netta rufina Red-crested Pochard	87	5
Aythya ferina Common Pochard	119	0
A. baeri Baer's Pochard	697	0
A. nyroca Ferruginous Duck	1,973	1
A. fuligula Tufted Duck	2,351	54
A. marila Greater Scaup	5	0
Unidentified ducks	1,680	0
Gallicrex cinerea Watercock	2	11
Gallinula chloropus Common Moorhen	10	120

Table 3.6: Summary of waterfowl counts by species

Species	Feb/Mar 92	Apr/May 92
Porphyrio Purple Swamphen	134	670
Fulica atra Eurasian Coot	5,320	65
Hydrophasianus chirurgus Pheasant-tailed Jacana	1,022	393
Metopidius indicus Bronze-winged Jacana	37	35
Rostratula benghalensis Greater Paintedsnipe	0	3
Himantopus Black-winged Stilt	1,267	376
Recurvirostra avosetta Avocet	4	0
Glareola maldivarum Oriental Pratincole	1	0
G. lactea Little Pratincole	2	0
Vanellus cinereus Grey-headed Lapwing	685	24
V. indicus Red-wattled Lapwing	3	1
Pluvialis fulva Asiatic Golden Plover	821	585
P. squatarola Grey Plover	5	0
Charadrius dubius Little Ringed Plover	357	0
C. alexandrinus Kentish Plover	752	0
C. mongolus Mongolian Plover	12	0
Limosa Black-tailed Godwit	402	93
Numenius arquata Eurasian Curlew	0	3
Tringa erythropus Spotted Redshank	135	18
T. totanus Common Redshank	3	20
T. stagnatilis Marsh Sandpiper	434	6
T. nebularia Common Greenshank	119	7
T. ochropus Green Sandpiper	8	4
T. glareola Wood Sandpiper	848	133
Actitis hypoleucos Common Sandpiper	26	12
Gallinago stenura Pintail Snipe	41	6
G. gallinago Common Snipe	553	31
G. megala Swinhoe's Snipe	2	0
Calidris minuta Little Stint	741	4
C. temminckii Temminck's Stint	132	6
C. subminuta Long-toed Stint	0	2
C. alpina Dunlin	3	0
C. ferruginea Curlew Sandpiper	22	4
Limicola falcinellus Broad-billed Sandpiper	1	0
Philomachus pugnax Ruff	912	51
Unidentified shorebirds	560	0
Larus brunnicephalus Brown-headed Gull	185	408
L. ridibundus Black-headed Gull	14	1
Chlidonias hybrida Whiskered Tern	2,139	1,597
C. leucopterus White-winged Tern	0	1
Sterna aurantia River Tern	10	0
S. hirundo Common Tern	0	8
S. albifrons Little Tern	1	2
TOTAL WATERFOWL	**107,836**	**30,300**

Very little breeding-related activity (showing courtship behaviour, calling, prospecting for nests sites or nest-building) was observed, though many of the resident birds had assumed breeding plumage. The only species of waterfowl which appeared to be breeding or about to breed were Little Grebe, Lesser Whistling-Duck, Cotton Pygmy Goose, Spot-billed Duck, Pheasant-tailed Jacana, Bronze-winged Jacana, Black-winged Stilt and Whiskered Tern.

The breeding seasons of waterbirds in Bangladesh are, however, known to be complex. Some species begin breeding in the pre-monsoon period; others (mainly the herons and egrets) breed during the monsoon, while yet others (for example, Little Cormorant and Oriental Darter) breed during the dry season. According to Harvey (1990), of the 33 species of waterfowl found breeding in Bangladesh in recent years, six begin nesting in March, six in April, ten in May, four in June, four in July, one in August, one in September and one in November.

Only about 20,000 of the 30,300 waterfowl recorded were resident birds and hence potential breeding birds. This is a remarkably low figure again in view of the extent of the haor basin wetlands and their obviously high productivity (illustrated by fisheries production). The other 10,000 birds recorded were winter visitors or passage migrants (for example, the flock of 7,000 Garganey at Aila Beel) not yet departed for more northerly breeding grounds.

Waterfowl populations, monthly surveys

The studies were initiated in February 1992. At this time, water levels were decreasing. Unprecedented early rains (late-March and early-April) provided water to the wetlands at Balai and raised water levels at some of the other sites (Patachatal and Erali). This probably resulted in an increase in waterfowl population which may have skewed the counts. It was subsequently established that the peak population occurs in January and that the February 1992 population was, in fact, post-peak. It was also concluded that during May and June, there was an increase in the number of species which coincided with the beginning of the southward migration of waders and other birds. The total number of waterfowl for the monitored sites in January 1993 totaled 386,000 individuals which is more than double the waterfowl thought to be supported by the region's wetlands. Monthly variations are illustrated in Annex F, Figure F-1.

In all the monthly monitoring sites the waterfowl population varied inversely with water level. The year-round monthly monitoring studies confirmed this variation. During the full monsoon, almost all the wetlands are under water. Since no habitat was available to the waterfowl, they were absent in most sites except for some at Kawadighi, Hail and Balai Haors. At these two sites, because of either embankments or drainage congestion and a reduced water discharge, the physical features appear to be changing. As a result, more vegetative cover and micro-habitat were available to both resident and migratory species.

The observations led to the conclusion that availability of cover, supported by shelter and protection increase the waterfowl population both in number of individuals and species. The number of individuals, however, was independent of the number of species. For example, some species were represented by a single individual while some numbered in the tens of thousands.

The presence of birds was also affected by human activities in the wetlands. This was well illustrated by the monthly surveys. During November and December, 1992 intensive fishing were carried out at Kuri, Erali, Kawadighi haor which involved more than one hundred people at a time. This resulted in the sharp decline in the waterfowl population, when actually the population was supposed to be

reaching its peak. Again, disturbances at Tangua beel and other adjacent areas compelled the birds to move to Pashua beel and other nearby wetlands. As a result, Pashua, which is not being fished this year, had the largest aggregation of waterfowl in January 1993 of any area in the region. The numbers estimated (239,827 individuals) surpassed the total regional figures for the northeast mentioned by Scott (1989) and Scott & Rashid (1992). Similarly, because of some protection at Haorkhal, the numbers were higher but did not reach the estimated peak. This may be attributed to illegal hunting and other human activities which caused disturbances.

The monthly observations are provided in Annex F (Waterfowl Count Data). Key observations are summarized as follows:

- January is the peak month for the major influx of migratory waterfowl, particularly ducks and most ducks leave by May. From April the waders start their migratory journey southwards, with the highest numbers staging in the northeastern wetlands during May/June. Waders wintering in the northeastern region start arriving as early as late-July. The water levels were at the peak during that time which forced the waders to stay at the available higher grounds.

- Some of migratory birds, both ducks and waders overstayed in the northeastern region. These might be either young ones or old and sick ones but their numbers were few. Among them were Garganeys, Gadwalls, Golden Plovers and Black-tailed Godwits.

- Some water-dependent waterfowls (Cormorants, Herons, Bitterns, Jacanas, Watercocks, Whiskered Terns) breed in and around the wetlands. The breeding period for Bitterns extended from April to June; Jacanas from May to August; Whiskered Terns from June to August; Cormorants from June/July to September; Herons from May/June to August/September.

- Whiskered Terns were earlier thought to be winter visitors but recent studies in the region showed that they are resident birds and breed in the wetlands of the region. This is the first record of the species breeding in Bangladesh. NERP/NACOM has detailed photographic evidence of this.

- Even the endangered Pallas's Fish Eagle has managed to reproduce on the limited habitat available in the northeastern region. The nests were built on old nest sites at very low heights since big and high trees are scarce. These nests measured as much as 3-4 m. Fortunately for the birds, local people were not hostile to them although there were complaints that the eagle picks up domestic chicken and ducklings. This is an adapted behaviour owing to the fact that its natural food is scarce and that since it is at the top of the food chain, it is a predator by habit.

- Resident waterfowl are also affected by increases in water levels. During the monsoon period, the resident population moves to higher ground, the whereabouts of which are not yet known. This suggest that because of environmental factors, resident birds migrate locally.

- Those wetlands supporting vegetation even during the peak monsoon, retained some bird population. This was supported by observations at Kawadighi, Hail, Pashua and Tangua haors. Despite physical changes in the wetlands, if birds (not all) find cover, they tend to stay for either food, shelter or nesting (e.g. Jacana, Watercock, Whiskered Tern).

- Human activities such as fishing and cultivation, affects the waterfowl population in the wetlands. The disturbance caused by either human presence or activities distracts the birds. As a result, they had to increase their flight time in search of food or roosting areas. This is accomplished at the expense of energy stored in the body as fat. If the energy loss exceeds the gain the birds move to other places where the energy costs are low. This also happens during unfavourable environmental conditions such as flooding.

Threatened waterfowl species

Ten waterfowl species attributable to the Northeast Region appear on the IUCN *Red List of Threatened Animals* (1990; the IUCN status categories are shown in Table 3.8). For these ten species, Table 3.7 gives the IUCN (global) status, the presumed (pre-NERP) status in Bangladesh, the NERP observations, and relevant remarks. Only two of these species were observed during the NERP field studies. Table 3.7 also documents 'interesting observations', mainly observations indicating a new (regional or national) status for a species, and observations of rare and unusual species.

Several lists of bird species considered to be nationally "threatened" or "endangered" including some wetland species occurring in the Northeast Region, do exist (Annex D). Two of these lists appeared in different versions of the Draft National Conservation Strategy for Bangladesh, in the Wildlife and Protected Areas section; a third list was prepared by NACOM in 1991. All of the lists exhibit poor species choices. Some species known to be on the verge of extinction in Bangladesh are omitted, for example Black-necked Stork and Red-naped Ibis; and other very common and widespread species are included, for example Little Grebe, Northern Shoveler, and Brahminy Kite.

A national list of endangered species, consistent with reasonable criteria and developed by a committee of national experts, would be a useful tool.

3.4.5 Birds other than waterfowl

Birds of prey were found to be surviving extremely well in the region. Two species of kite were common and widespread, the Brahminy Kite as a resident and the Black Kite primarily as a winter visitor. Concentrations of over 100 kites were observed on several occasions at rubbish tips and at beels which were being drained for fishing. The White-rumped Vulture was also common and widespread. Over 150 were recorded during the Apr/May 92 survey including one flock of 80 at Kawadighi Haor. In addition to these common species, 171 raptors of 13 species were recorded during the Feb/Mar 92 survey, and 72 raptors of ten species during the Apr/May 92 survey.

Four species were observed during the Feb/Mar 92 and Apr/May 92 surveys which had not previously been recorded in Bangladesh (Swinhoe's Snipe, Red-throated Pipit, Firethroat and Black-browed Reed-Warbler) and three species of doubtful previous occurrence (Griffon Vulture, Pin-tailed Pigeon and Wedge-tailed Pigeon), as well as several species which had not been recorded in Bangladesh in recent decades. A full report on these observations is being prepared for publication in the scientific literature.

Threatened bird species (other than waterfowl)

Eight non-waterfowl species attributable to the Northeast Region appear on the IUCN *Red List of Threatened Animals* (1990). For these species, Table 3.7 indicates the IUCN (global) status, the presumed (pre-NERP) status in Bangladesh, the NERP observations, and any relevant remarks. Only one of the IUCN threatened species was observed during the NERP field studies.

Table 3.7: Threatened bird species and other interesting observations

Species	Status/observations (prior to NERP studies)	NERP observations			Remarks
		Date	Number observed	Location	
Pink-headed Duck	***Extinct***				Globally extinct.
Spot-billed Pelican	***Indeterminate*** Extinct in Bangladesh				
Dalmatian Pelican	***Endangered*** Extinct in Bangladesh				Formerly winter visitor.
Oriental White Stork	***Rare*** Extinct in Bangladesh				
Marbled Teal	***Vulnerable*** Extinct in Bangladesh				
Swamp Francolin	***Vulnerable*** Extinct in Bangladesh				
Bengal Florican	***Endangered*** Extinct in Bangladesh				
Common Crane	Extinct in Bangladesh				Formerly winter visitor.
Black-necked Stork	Extinct in Bangladesh				Formerly breeding species.
Black Ibis	Extinct in Bangladesh				Formerly breeding species.
Painted Stork	Extinct in the NE region				
Woolly-necked Stork	Extinct in the NE region				
Greater Adjutant	***Endangered*** Extinct in the NE region				
White-winged Wood-Duck	***Vulnerable*** Extinct in the NE region				
Comb Duck	Extinct in the NE region				
Sarus Crane	Extinct in the NE region				
Lesser Adjutant	***Vulnerable*** ?Extinct as breeding bird in Northeast Region	6 Mar 92	pair	Khakra Kuri Beel Balai Haor	Rare visitor outside of Sundarban.
White-bellied Heron	***Endangered*** ?Extinct as breeding bird in the NE region				Still occurs as winter visitor.
Great Cormorant	?Extinct as breeding bird in the NE region				Still occurs as winter visitor.

Species	Status/observations (prior to NERP studies)	NERP observations			Remarks
		Date	Number observed	Location	
Black-crowned Night-Heron	?Extinct as breeding bird in the NE region				Still occurs as winter visitor.
Grey Heron	?Extinct as breeding bird in the NE region				Still occurs as winter visitor.
Black-headed Ibis	?Extinct as breeding bird in the NE region				Still occurs as winter visitor.
White Stork	Very rare				Winter visitor.
Glossy Ibis	Very rare				Winter visitor.
White Spoonbill	Very rare				Winter visitor.
Grey Lag Goose	Very rare				Winter visitor.
Bar-headed Goose	Very rare				Winter visitor.
Demoiselle Crane	Very rare				Winter visitor.
Great Crested Grebes	Scarce winter visitor	Feb/Mar 92	135	11 sites	
Great Cormorants	Small numbers confined to coastal zone	Feb/Mar 92	54	11 sites	First observation of this species outside coastal zone in recent years.
Chinese Pond Heron	Rare visitor	Apr/May 92	1 1	Pashua Beel Hail Haor	
Asian Openbill		Feb/Mar 92 Apr/May 92	135 315	mostly Pashua Beel	
Fulvous Whistling Ducks		Feb/Mar 92	9815	mainly Tangua Haor	Largest concentration of this species recorded in the subcontinent in recent years.
Falcated Teal		?	drake	Pana Beel, Tangua Haor	Only the second record of this species in Bangladesh in recent years.
Spot-billed Ducks	Rare winter visitor	Feb/Mar 92 Apr/May 92	230 112	Tangua Haor complex	Many birds showing signs of breeding.
Red-crested Pochards	Vagrant	Feb/Mar 92	87	4 sites, Tangua Haor complex	Only two other recent records.
Ferruginous Duck		Feb/Mar 92	1970	nearly all in Tangua Haor & adjacent sites	
Greater Scaup	Not seen in Bangladesh for many years	22 Mar 92	3 female 2 male	Pana Beel, Tangua Haor	Very rare winter visitor to Indian subcontinent.
Grey-headed Lapwing		Feb/Mar 92	685	24 sites	

Species	Status/observations (prior to NERP studies)	NERP observations			Remarks
		Date	Number observed	Location	
Swinhoe's Snipe	Never observed in Bangladesh; assumed to be regular winter visitor	23 Feb	2	rice fields, Hail Haor	
Spotted Redshanks	Scarce winter visitor	Feb/Mar 92 Apr/May 92	135 18	10 sites 4 sites	First recorded in Bangladesh in 1990.
Baer's Pochards	***Vulnerable***	Feb/Mar 92	660 37	Pana Beel, Tangua Haor 6 sites	This concentration of almost 700 in the *haor* basin is of considerable international significance: species is scarce throughout its winter range (south China, Vietnam, Thailand, Burma, northeastern India, occasionally Nepal)
Pallas's Fish-Eagle	***Rare*** Endangered in Bangladesh	Feb/Mar 92 Apr/May 92	30 adults 26 immat 17 adults 8 immat	27 sites	This may be one of the largest remaining populations in the world. Birds appear to be residents. Most adults paired and much display noted. Three occupied nests found. Major concentrations at Pashua Haor (2 adults + 17 immature), Tangua Haor (8 adults + 5 immature). Likely endangered in the rest of Bangladesh. Occurs from Kazakhstan and Pakistan east to China and Burma, but populations appear to be declining everywhere.
Jerdon's Moupinia	***Vulnerable***				Has not been observed in the NE region in many years. Small bird of floodplain grasslands and scrub; can be overlooked. May still survive in small pockets of near natural vegetation.
Black-breasted Parrotbill	***Indeterminate***				Has not been observed in the NE region in many years. Small bird of floodplain grasslands and scrub; can be overlooked. May still survive in small pockets of near natural vegetation.
Swamp (Long-tailed) Prinia	***Rare***				Has not been observed in the NE region in many years. Small bird of floodplain grasslands and scrub; can be overlooked. May still survive in small pockets of near natural vegetation.
Blyth's Kingfisher	***Indeterminate***				Has been observed in recent years in the NE region.
March Babbler	***Insufficiently Known***				Has been observed in recent years in the NE region.

Table 3.8: : IUCN Threatened species categories

Code	Category	Definition
Ex	Extinct	Species not definitely located in the wild during the past 50 years (criterion as used by CITES). On a few occasions, the category **Ex?** has been assigned. This denotes that it is virtually certain that the taxon has recently become extinct.
E	Endangered	Species in danger of extinction and whose survival is unlikely if the causal factors continues operating. Included are species whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be a immediate danger of extinction. Also included are species that may be extinct but have definitely been seen in the wild in the past 50 years.
V	Vulnerable	Species believed likely to move into the **Endangered** category in the near future if the causal factors continue operating. Included are species of which most or all the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental disturbance; species with populations that have been seriously depleted and whose ultimate security has bot yet been assured; and species with populations that are still abundant but are under threat from severe adverse factors throughout their range. In practice, **Endangered** and **Vulnerable** categories may include, temporarily, species whose populations are beginning to recover as a result of remedial action, but whose recovery is insufficient to justify their transfer to another category.
R	Rare	Species with small world populations that are not at present **Endangered** or **Vulnerable**, but are at risk. These species are usually localised within restricted geographical areas or habitats or are thinly scattered over a more extensive range.
I	Indeterminate	Species *known* to be **Endangered**, **Vulnerable** or **Rare** but where there is not enough information to say which of the three categories is appropriate.

Source: 1986 IUCN Red List of Threatened Animals.

Cont'd on following page

3.4.6 Discussion

The main reasons for the disappearance of so many wetland bird species from the Northeast Region are undoubtedly the massive conversion of floodplain grasslands and seasonal swamps to agricultural land, and almost complete elimination of swamp forest and other native floodplain forests which provide secure roosting and nesting sites for large waterbirds. Direct persecution by man has doubtless played a significant role in the demise of some species, but loss of permanent wetland habitat seems to be of less importance. Indeed, much of this habitat still remains.

On the whole, migratory waterfowl have survived better than the resident species. The migratory species are in many ways much less demanding than the resident species in that all they require is an ample food supply and secure "loafing" and roosting areas. For many of the migratory waterfowl, there remains an abundance of suitable feeding habitat and habitat loss has not been the principal problem. However, resident species require secure nests sites, free from disturbance for several months each year. Species which build their nests on floating aquatic vegetation, such as Little Grebe, the jacanas and Whiskered Tern, face no difficulties, as plenty of suitable habitat remains. The grebe and the two jacanas at least are still fairly common and widespread breeding species in the region.

Table 3.8.2: IUCN Threatened Species Categories (cont'd)

Code	Category	Definition
K	Insufficiently known	Taxa that are *suspected* but not definitely known to belong to any of the above categories, because of lack of information.
T	Threatened	Threatened is a general term to denote species which are **Endangered, Vulnerable, Rare, Indeterminate,** or **Insufficiently Known,** used to identify species comprised of several sub-species which have differing status categories.
CT	Commercially threatened	Species not currently threatened with extinction, but most or all of whose populations are threatened as a sustainable commercial resource, or will become so, unless their exploitation is regulated. This category applies only to species whose populations are assumed to be relatively large. In practise, this category has only been used for marine species of commercial importance that are being overfished in several parts of their ranges.

Source: IUCN Red List of Threatened Animals

However, species which nest in dense reed-beds or in rank vegetation at the water's edge, such as Yellow Bittern, Purple Heron, Spot-billed Duck, Purple Swamphen, and some of the other Rallidae, are now confined to those few large permanent wetlands or less intensively cultivated areas where such vegetation persists (such as Hail Haor, Balai Haor, Pashua Beel, and Tangua Haor). One species of extensive reed-beds and grassy marshes, the Sarus Crane, has disappeared entirely.

Cormorants, darters, pelicans, most species of herons and egrets, storks, and ibises are colonial breeders, nesting in tall trees, often in huge mixed colonies. Under natural conditions, these colonies would have existed at traditional sites in tall stands of swamp forest in the haors or in gallery forest along the river levees. It is almost certainly the destruction of these forests in the haor basin that has been the primary factor responsible for the disappearance of many of the former breeding species (Great Cormorant, Spot-billed Pelican, five species of stork, and two species of ibis) and present scarcity of some others (such as Oriental Darter). The disappearance of the White-winged Wood-Duck and Comb Duck can also be attributed to the destruction of the forests, as the former is very much a bird of forested wetlands, while the latter requires holes in large trees for nesting.

Undoubtedly, direct persecution in the form of hunting and egg-collecting combined with high levels of disturbance have contributed to the decline of many of these species. Wherever waterfowl are

totally protected from hunting, they rapidly become extremely tame, and are able to utilize wetlands which in the Northeast Region would be far too heavily disturbed. A good example of this can be seen at Dhaka Zoo, where in winter as many as 10,000 ducks can been seen on the small, artificial lake inside the perimeter fence. A similar concentration of ducks occurs on the small lake in the grounds of Calcutta Zoo, while at New Delhi Zoo, there is a large breeding colony of Painted Storks within a few yards of the thousands of people who visit the zoo every day.

The bird community to have suffered the worst as a result of habitat loss in the haor basin is that which relies on the floodplain grasslands. These grasslands, with tall stands of elephant grass interspersed with marshy pools and wet meadows, must once have been very extensive in the basin, but have now been totally converted into rice fields or grazed almost bare by domestic livestock. Only one species of waterfowl, the extinct Pink-headed Duck, seems to have been dependent on this habitat type. However, at least twelve species which are typical of this habitat and which are known or thought to have occurred in the Northeast Region are now either very rare or extinct in Bangladesh. These include: Swamp Francolin *Francolinus gularis,* Bengal Florican *Eupodotis bengalensis*, Australasian Grass Owl *Tyto longimembris*, White-tailed Bushchat *Saxicola leucura*, Jerdon's Bushchat *Saxicola jerdoni*, Swamp (Long-tailed) Prinia *Prinia burnesii cinerascens*, Large Grass-Warbler *Graminicola bengalensis*, Bristled Grass-Warbler *Chaetornis striatus*, Marsh Babbler *Pellorneum palustre*, Jerdon's Moupinia *Chrysomma altirostris*, Black-breasted Parrotbill *Paradoxornis flavirostris*, and Slender-billed Babbler *Turdoides longirostris*. The present surveys failed to locate any of these, although there are single records of two species, Jerdon's Bushchat and Marsh Babbler, in the Northeast in recent years (Harvey, 1990).

Despite these dramatic losses in its avifauna, the haor basin still continues to support a wide variety of bird species, many of which are very common. Most of these species have survived because they have been able to adapt to, and in some cases benefit from, man's changes to the environment. The dominant birds of the cultivated plains and homestead forests are those species which can live alongside man, and several have become true commensals, now being almost confined to man-made environments (e.g. House Crow, Common Myna and House Sparrow). The homestead forests, in particular, constitute a rich and varied habitat with a great diversity of bird species. Most of these were originally birds of open woodland and forest edge, although a few species more typical of true forest are able to exist in some of the denser stands. In general, however, the species which have been able to adapt to these man-made environments and live in close proximity to man are the commonest and most widespread species in the Subcontinent, and thus of no conservation concern.

Amongst wetland birds, those species that have been able to switch from natural grassy marshes to rice fields have been very successful. Several of these, notably the weavers and munias, are seed-eaters, and can become serious pests in the rice crop, while others, such as various species of wagtails, pipits and warblers, are insectivores and are probably beneficial to the farmer. A number of waterfowl have also been able to take advantage of the rice fields, and most of these remain common. Those species most frequently observed feeding in this habitat included Indian Pond Heron, Cattle Egret, Little Egret, Lesser Egret, Asiatic Golden Plover, Grey-headed Lapwing, Temminck's Stint, Pintail Snipe, Common Snipe, Marsh Sandpiper and Wood Sandpiper. The two snipe and the Wood Sandpiper were particularly common, and for these species, the rice fields of the haor basin may now constitute a very important wintering area. Several species of ducks feed in rice fields at night, particularly the two whistling-ducks, and Openbill Storks will also utilize this habitat. However, even in disturbance-free areas, most large waterbirds seldom visit rice fields, presumably because of the absence of suitable food items.

Most other wetland birds have been able to survive in the haor basin either because they are migrants, moving to less densely populated regions further north to breed, or because they have been able to utilize the small remnants of natural or near-natural vegetation which persist in areas of "waste" ground, on abandoned plots, or on "marginal" land which has not as yet been brought under cultivation or human settlement. Only in Tangua Haor, Matian Haor and Gurmar Haor complex in the north are there sufficiently large tracts of relatively undisturbed wetlands to support the less adaptable species, and several species are now almost entirely confined to this part of the basin.

One group of birds which seems to be surviving extremely well in the haor basin are the birds of prey. Birds of prey are generally regarded as good indicators of "environmental health" because of their position at the top of the food-chain. Any serious build up of harmful pesticides and other bio-accumulative pollutants in natural ecosystems is quickly reflected in a rapid decline in the number of birds of prey. It seems likely, therefore, that excessive use of harmful pesticides is not as yet a serious problem in the Northeast Region. In the future, populations of these species could be monitored as indicators of pesticide contamination levels.

It rapidly became apparent during the surveys that a major limiting factor for many waterfowl species in the Northeast Region was not so much a shortage of wetland habitat *per se* (i.e. habitat where birds could find sufficient food) but a shortage of undisturbed habitat where birds could feed, "loaf", and roost in peace. This was particularly important for the ducks which, because of heavy hunting pressure in the region and probably elsewhere in the flyway, are very wary of humans. At most of the larger beels, intensive fishing activity in Feb/Mar 92 was causing constant disturbance to waterbirds, while at many of the smaller beels, the presence of large numbers of farmers in the rice fields surrounding the beels precluded their use by many waterfowl species. As noted above, it was at those beels which were being protected from fishing during the 1991/92 season that some of the largest concentrations of ducks were observed, for example at Chatla Beel, Aila Beel, and Pana Beel.

Heavy hunting pressure is clearly an important factor in limiting the distribution of waterfowl in the region through the direct disturbance which it causes. This is especially the case with shooting, which reinforces the wariness of the birds and prevents them from utilizing areas with high densities of humans, whether or not they are hunters. However, the impact of hunting on waterfowl populations through direct mortality (hunter kill) is less clear. Shooting may not have a significant impact, as there are relatively few hunters with guns, and their efficiency would appear to be low. A more important factor may be the effects of constant disturbance on the species' energetics. Birds which are spending much of their time on the wing, avoiding hunters and other forms of disturbance, have less time to feed, and may, by the end of the winter, be in poor condition. This could lead to reduced survival during the northward migration in spring and reduced breeding success. A series of weights of netted or shot birds throughout the winter, compared with weights of birds at totally protected wetlands (e.g. at the Bharatpur Sanctuary in Rajasthan) might throw some light on this matter.

While the number of waterfowl shot might be relatively small, the number of waterfowl caught in flight nets would appear to be substantial. Flight-netting occurs in all the main areas for wintering waterfowl, and is very common. The mere fact that one hunter had 80 live birds in his possession at one time suggests that this form of hunting birds for human consumption is a particularly deplorable hunting technique, since it is likely to kill scavengers of dead fish indiscriminately. Birds of prey such as Brahminy Kite, Black Kite, Pallas's Fish-Eagle and Grey-headed Fish-Eagle are particularly at risk. There is also, of course, the possibility of harmful effects on the consumers of the dead birds. There have been numerous cases of severe food-poisoning resulting from the consumption of poisoned birds,

one of the most famous being at a banquet for participants in a conference on wildlife management and sport hunting in Iran in the 1960s. (The speciality on the menu was Chukar Partridge, which subsequent investigation revealed had been "hunted" by poisoning springs).

As a basic tool for conservation management, there is a need for a well-reasoned and officially-recognized list of nationally-threatened birds and other wildlife in Bangladesh, based on well-formulated criteria and representing a consensus of opinion. This might best be achieved through the establishment of a panel of experts including representatives of relevant Government departments, academic institutions and NGOs.

3.5 WILDLIFE

3.5.1 Introduction

The present study focuses on mammals, amphibians, and reptiles. Wildlife, in a literal sense, refers to all organisms living in a natural state. Wildlife, in a restricted sense, always includes to wild terrestrial vertebrates, and may include other organisms depending on the context. A typical definition is that provided by Article 2, Bangladesh Wildlife (Preservation) (Amendment) Act, 1974: "any vertebrate creature, other than human beings, fish, and animals of usually domesticated species, and includes the eggs of birds and reptiles". More recent usage has tended to be more inclusive, of *e.g.* vertebrate pests and butterflies.

3.5.2 Previous studies

Most of the old documents, of which the District Gazeteers are most noteworthy, described some part of the Greater Sylhet district as an important fishing and hunting ground. Mitra (1957), Mountfort and Poore (1967 and 1968), Kanjilal (1934), Savage (1970), as well as Savage and Ali (1970) have described various aspects of the biological resources and their habitat in the North Eastern part of the country. Khan (1982), Scott (1989) and Ali (1990) described the freshwater wetland system in more detail.

In the fourth century, Ibn Batuta travelled through Meghna River and its distributaries while moving from Sonargaon to Sylhet. During his journey by boat, he described that most river banks and marshes were dominated by densely populated cluster villages, hats, and bazars.

These and other old documents report that human population was dense and that village settlements in the high lands (kandas) were clustered and primitive. The antiquity of human habitation is also indicated by the Behli family in Shanir Haor, who claim family history in that location extending back 1500 years or so. The conflict between the larger wildlife and human beings has likely long been acute due to the limited terrestrial habitat in the haor system during the monsoon.

3.5.3 Species observed and species groups

A checklist of mammalian, amphibian, and reptilian species known or thought to be present in the region, now or in the past, is provided in Table D.2, Annex D. For each species, this table reports the systematic, English, and Bangla names; IUCN status; CITES status; Wildlife Act status; and, for species thought to be present currently, the observation type leading to the entry (animal seen, field sign seen, recently captured live specimen examined, reported to NERP by local observers, literature; presumed present).

Overall, 89 species in 37 families are thought to have occurred in the region. Of these, 78 species in 32 families are still present; 31 are mammal species, 35 reptile, and 12 amphibian.

3.5.4 Threatened and commercially threatened species

A full 35% of the regional mammal, reptile, and amphibian species are either extinct, threatened, or commercially threatened. Almost all of the threatened species fall into one of three broad groups: large ruminants; the larger predators; and commercially valuable species – mainly turtles, but also lizards, otters, Indian Pangolin, Bull Frog, Hispid Hare, Freshwater Dolphin, and Rock Python.

Eleven species (12% of the regional species total) are regionally extinct: Leopard, Tiger, the three rhinoceros species (Sumatran Rhinoceros, Javan Rhinoceros, and Great Indian Rhinoceros), Pygmy Hog, Wild Boar, Gaur, Wild Buffalo, Swamp Deer, and Marsh Crocodile. Eight of these species are classified by IUCN as (globally) Endangered, and two as Vulnerable (Gaur, Marsh Crocodile). Wild Boar survives in domesticated form.

Of the species thought to be present, a total of nine are classified by IUCN as threatened. Two are classified as Endangered (Hispid Hare, Asian Elephant), two as Vulnerable (Rock Python, Freshwater Dolphin), four as Indeterminate - known to be either Endangered, Vulnerable, or Rare (Bengal Fox, Spotted Pond Turtle, Sylhet Roof Turtle, Yellow Common Lizard), and one as K meaning status uncertain (Smooth Indian Otter). All of these species except for Bengal Fox and Sylhet Roof Turtle are also listed under CITES Appendix I or II.

A further eleven species, not classified as threatened by IUCN, are listed under CITES Appendix I or II: Indian Pangolin, Common Otter, Small Indian Civet, Jungle Cat, Fishing Cat, Common Roof Turtle, Ganges Soft Shell, Peacock Soft Shell, Flapshelled Spotted Turtle, Bengal Grey Lizard, Bull Frog. Finally, two species (Malayan Box Turtle, Bengal Eyed Turtle) are expected to be given Commercially Threatened classification in the next edition of the IUCN Red Book.

3.5.5 Wildlife utilization

Six major uses of wildlife and their by-products were identified:

Food
Medicine
Trade
Pet
Bait
Recreation

Food

Freshwater turtle meat is widely used as source of protein in the study area. In most of the wetlands, the temporary dry season fishing camps (khola) are built near the water bodies. Most of the fishermen living in these camps regularly consume turtle meat which they catch from the water bodies. In addition, lease holder of some of the water bodies enter into a contract with the turtle collectors to provide them with the live turtles. Resident fishermen also trap turtles throughout the year — either for their own consumption or to sell in the market. In total, about 35 turtle markets operating twice a week were identified in the area. The Shantals, Khasias and Hindu communities consume turtles as food, for medicine and for other religious occasions. The species consumed are Common Roof

Turtle (*Kachuga tecta*), Brahminy Turtle (*Hardella thurjii*), Peacock Soft Shell Turtle (*Aspideretes hurum*), Spotted Pond Turtle (*Geochlemys hamiltoni*), and Spotted Flapshell Turtle (*Lissemys punctata*).

The remains of turtles found near human habitations indicate that the group was part of man's diet for centuries (Das, 1985). Today turtle flesh is consumed by a great many communities throughout the world. Sometimes as a source of protein and sometimes as a luxury food. A survey of restaurants in various countries indicates that freshwater turtles top the list of the 10 most popular meats.

Other wildlife consumed as food includes snakes and porcupines. All snake species and porcupine available in the wetlands are consumed by ethnic minority people.

Medicine

A total of eleven species of reptiles and mammals are used to treat diseases of both humans and their domestic animals. The most common uses are extracts of oil from turtles, dolphins, lizards, snakes and even from the jackal. The oil is used to treat rheumatic fever, respiratory diseases, asthma, skin diseases, and as a preventive against colds. Some of the by products from Porcupine quills, extract from lizards and turtles are also believed to have aphrodisiac values.

In India, the flesh of the flapshell turtle is prescribed as a cure for tuberculosis. Charaka, the ancient Hindu physician, recommended turtle meat in case of indigestion, weakness of body and they have been used by the Chinese since at least 2737 B.C. It is in China where the greatest number of turtles are used for medicinal purposes.

In Manikganj and in some part of Chittagong, the turtle's carapace is burned to ash and this ash is commonly used to treat the skin diseases of cows and buffalo as well as burns to humans. Venom from the krait and cobra are used by gypsies (bede) in the region to cure various chronic diseases.

Trade

Frogs and turtles from the wetlands were a most important non-traditional export commodity for Bangladesh. Between 1974 and 1987, the country earned Tk 315,170,000 by exporting live turtles (*Source: Export Promotion Bureau*). In today's commercial world, most parts of the turtle have some value. The flesh is consumed, the neck and tail bones and the viscera are used in soup, the fat is needed for soups and creams, the oil forms a cosmetic base, the flipper and neck skins of the larger varieties are tanned and used to manufacture leather articles such as handbags and shoes, the shell is used for making jewellery and ornament cases. Juveniles, as well as adult turtles are sold as stuffed curios to tourists in various countries, to be hung on walls for decoration. The tortoise-shell is one of the most expensive animal products — weight for weight, it is more valuable than ivory. In 1977 alone, India exported more than 82,000 kgs of raw tortoise-shell.

A review of Japanese Customs Statistics indicate that Bangladesh (then East Pakistan) first exported monitor lizard skins to Japan in 1958. In that first year, 4000 kgs of skins were exported and in the next two successive years, 40,000 kg and 65,000 kg of skins were exported. During the period from 1971 to 1987 Bangladesh exported 445,946 kg of monitor lizard skins to Japan (Khan, 1988). Despite the ban on export of lizard skins, a large quantity are smuggled out of the country. In 1988, Traffic Japan reported that Japan imported the skins of 730,000 endangered lizards from Bangladesh (*Khaleej Times*, Sept, 2, 1988).

Between 1972 and 1987, bull frogs were one of the major export commodities of Bangladesh. A considerable numbers of frogleg processing plants were established in the Chittagong and Khulna areas. It has been reported that on an average, Bangladesh exports the legs of 70 million frogs per year (Choudhury 1986). It was also noted (Ali 1985) that 3-4000 tons of frog legs were exported from India annually.

Skins of snakes, cats, mongoose, and otters are also used in trade. Venom extracted from poisonous snakes is a very valuable raw material in the preparation of antivenom serum and is also widely used in antirheumatic diseases.

Pets

Otters, mongoose, and turtles are used as pets and as captive animals for various purposes. Trained otters in southwestern Bangladesh are widely used by fishermen for herding fish into their nets. Raising and training these otters is also a profitable business.

Bait

Frogs and toads are used by people dwelling in and around the wetlands of the region for bait. They used frog baited hooks which attracts carnivorous fish. Each of these individually baited hooks are tied in a line which is 200-300 meters in length. Usually there are 200 hooks on the line. The frogs are hung vertically, hooked through the vertebral column with strong nylon string, usually 0.5 m in length, just at the surface of water. The limited movement which these frogs can make causes splashing and attracts the fish.

Recreation

Most of the wetland wildlife have recreational value both locally and at zoos and museums. Among the people of wetlands, numerous myths, ritual beliefs, and historic religious and cultural values exist, involving snakes, turtles, lizards, frogs, otters, and mongoose.

3.6 SEASONAL CHANGES, RELATIONSHIPS, AND EVENTS

The wetlands of the haor basin are situated in a highly seasonal environment. Temperatures in mid-winter regularly fall below 10 C, while during the pre-monsoon period they often exceed 35 C. Over 80% of the annual rainfall of about 4,000 mm falls during the monsoon season from June to October, and the region may remain completely dry for weeks on end during the winter months. Wetlands which are dry or almost completely so in late March or early April may be flooded to a depth of six metres by the end of the monsoon. During the pre-monsoon period, flash-flooding may cause river levels to rise by as much as four metres in just two or three days. These wide fluctuations in the physical conditions are reflected in the changing structure of the plant communities in the wetlands, as well as in the agricultural activity and fishing activity of the local people. These in turn affect the wildlife populations. Waterbirds, being highly mobile, are especially well adapted to these fluctuating conditions, being able to move rapidly from one region to another as feeding conditions change.

3.7 IMPACTS OF WATER RESOURCES DEVELOPMENT PROJECTS

3.7.1 Concepts and assessment methodology

It should be clear at this point that the wetlands of the Northeast Region are complicated, dynamic resource systems. It is also clear from the project monitoring, evaluation, and planning work done by NERP so far that the actual (as opposed to planned) impacts of water resources projects are complex.

Conceptually, the interaction between projects and wetlands can be represented by an n x m matrix, where n is the number of project types, or better still, types of project activities, and m is the number of wetland resource subsystems. Project types would include submersible flood protection, full flood protection, and drainage improvement. Project activities, both normal and abnormal, would include: preconstruction activities such as surveys; construction activities such as site preparation, channel excavation, and spoil disposal; operation and maintenance activities such as agricultural changes, structure operation, breaches, and public cuts; and abandonment activities (such as reclamation of infrastructure areas for other uses). Wetland resources subsystems would include the beel fishery, floodplain fishery, submerged vegetation, reed community vegetation, migratory water fowl, and resident water fowl. Not infrequently impacts on specific species would be of interest.

The value of n is at least 25 and the value of m is at least 30 (two fisheries systems, seven plant communities, roughly ten threatened animal species, and roughly ten bird species). Even supposing that 90% of the n x m potential interactions are trivial still leaves about 70 potentially significant interactions between projects and wetlands.

The n x m matrix under discussion is in fact a standard tool of environmental impact assessment. Composed of n rows and m columns, each cell of the matrix represents a potential interaction. The tool is developed and used in the context of a systematic review of potential impacts, which should be undertaken by representatives of the range of stakeholder interests and relevant technical disciplines. This is the approach NERP has been taking in the prefeasibility studies of specific proposed projects. Those interactions flagged as potentially significant are to be investigated further at the feasibility stage.

3.7.2 Quantitative model - impacts of cropping changes on wetland habitats and floodplain grazing

A key concern in many of the proposed FCDI projects is the impact of expected cropping changes on wetland habitats and grazing area. We have devised a quantitative model to predict these changes. Like the cropping change model itself, the wetland/grazing change model is driven by land type shifts. Therefore it is quantitative and fully consistent with the cropping changes, and with the engineering hydrology analysis which predicts the land type shifts.

First, we must define wetland/grazing land types in terms of the conventional land types/uses. These are:

- 'Winter grazing area'. Defined as higher (F0, F1, and F2) lands lying fallow in the dry winter season, plus any perennially-fallow highlands. This land would have limited residual moisture. While it is clear that animals do graze on such areas, productivity per unit area is not known.

- 'Winter wetland'. Defined as low (F3) land lying fallow in the dry season, plus any perennially-fallow lowland (F4), *beel*, and channel areas. This land would likely have considerable residual moisture and could support a range of wetland plant communities.

- 'Summer wetland'. Defined as summer-inundated (F1, F2, and F3) land lying fallow in the summer, plus perennially-fallow lowland (F4 area), *beel*, and perennial channel areas. This land would be inundated to >0.3 m and would support submerged, free-floating, rooted floating, and sedge/meadow plant communities.

The quantitative analysis is derived from pre-and post-project land type and cropping areas. An example is shown in Table 3.9.

Table 3.9: Example, floodplain grazing and wetland changes - Dharmapasha-Rui Beel Project

Land Type	Winter Grazing Area			
	FWO	FW	Change	%
sc/wf F0	2338	2253	-85	
sc/wf F1	1616	1292	-324	
sc/wf F2	2880	2880	0	
Fallow Highland	50	40	-10	
Total	6,884	6,465	-419	-6

Land Type	Winter Wetland			
sc/wf F3	256	0	-256	
F4, Beel, Channel	2953	2953	0	
Total	3,209	2,953	-256	-8

Land Type	Summer Wetland			
wc/sf F1	0	0		
wc/sf F2	665	665	0	
wc/sf F3	4859	5114	255	
F4, Beel, Channel	2953	2953	0	
Total	8,477	8,732	255	3

FW areas shown here do not reflect cultivable land acquired for infrastructure (see Land Use, Section 7.8.1). 'sc' - summer cultivated. 'wc' - winter cultivated. 'sf' - summer fallow. 'wf' - winter fallow.

4. POLICY AND INSTITUTIONAL CONTEXT

4.1 INTRODUCTION

Policies and institutions affecting wetlands, like wetland resources themselves, cut across sectoral boundaries, bound up in a complex web of sectoral resource management policies, legislation, and organizations. This chapter describes wetland-related aspects of:

- *Policy context*
  - National policies
  - Key international agreements
  - Legislation and standards

- *Institutional context*
  - Central government agencies
  - Local government agencies
  - NGOs (international, regional, local); and
  - Government/NGO links
  - Donor agencies
  - Public participation: community management and education; role of elected officials; community/NGO links
  - Projects and programmes: ongoing projects and programmes of relevance to wetlands

Land tenure, resource management, research, and human resources development aspects are an integral part of the above areas, and are documented within relevant sections.

Our main observations on institutional arrangements are summarized at the conclusion of this section.

4.2 POLICY CONTEXT

The Government of Bangladesh has clearly committed itself to:

- Environmentally sound management in general,

- Environmentally sound management of biodiversity assets, including ecologically valuable areas such as wetlands and particular communities and species, and

- Efforts to achieve and maintain environmental quality, including air and water quality, which is acceptable to domestic, industrial, and agricultural users, and which support sustainable ecosystem functioning, including fisheries production

International agreements and national policies relevant to NEMREP are catalogued in Table 4.1 and described below.

4.2.1 National and Sectoral Policy Statements

Memorandum for the Bangladesh Aid Group 1992-93. This document summarizes the 'New Development Perspective', the Government's "vision for the future development of the country consistent with participatory democracy." Overall goals are identified, and among nine strategies specified to meet these goals is:

> "ix. integration of national conservation strategy to prevent the degradation of the environment and improve its capacity of sustainable development with multi-level economic planning." - p. 2

Eight 'selected development issues' are identified and discussed in the document. One of these is "Environmental Protection and Management"; part of the discussion of it reads,

> "For protection and conservation of natural resources and to link all developmental activities with the environment for ensuring sustainable development, the following objectives will be pursued during the FFYP period -
>
> "(a) control and prevention of environmental pollution and degradation related to soil, water, and air;
>
> "(b) promotion of environment friendly activities in the field of development;
>
> "(c) preservation, protection, and development of natural resource bases;
>
> "(d) strengthening the capabilities of public and private sectors to manage environment concern as a basic requisite for sustainable development; and
>
> "(e) creation of people's awareness for participation in environment protection activities.
>
> "For attainment of the above objectives, the Ministry of Environment and Forest has already initiated a number of actions in different areas. . . . draft national environmental policy . . . draft National Conservation Strategy . . . provision for reflecting Environmental Impact Assessment (EIA) in all public sector projects. Similar measure is underway for the private sector projects. The Pollution Control Office set up in 1977 has been thoroughly reorganised, expanded and elevated as the Department of Environment. The existing Environmental Legislation is begin revised in order to re-orient it to the requirement of the present time. . . . [MOEF] has also prepared a draft National Management Action Plan to address major environmental issues and concerns . . . Environmentally vulnerable areas have been identified for priority action taking into consideration the developmental needs." - p. 76.

National Environment Policy. This is the Government's most comprehensive statement of overall environmental policy. It consists of an introductory statement; six objectives; policies in each of

Table 4.1: International Agreements and National Policies Affecting Wetlands

POLICY DOCUMENT	STATUS & DATE
Memorandum for the Bangladesh Aid Group 1992-93	April 1992.
Fourth Five Year Plan 1990-5	Revised Draft, March 1991.
National Environment Policy	Approved April 1992.
National Conservation Strategy (NCS)	Reviewed by concerned Ministries. Submission to Cabinet imminent.
National Environment Management Action Plan (NEMAP)	In preparation.
Forestry Master Plan	In preparation.

INTERNATIONAL AGREEMENT	STATUS & DATE
Ramsar Convention on Wetlands of Importance Especially as Waterfowl Habitat	Ratified 30 April 1992. Sundarban declared as country's first Ramsar site
Convention on International Trade in Endangered Species (CITES)	Ratified 20 Nov 1991.
Rio Convention on Biological Diversity	Signed June 1992. MOEF is preparing instrument of accession.
World Heritage Convention	Accepted as member 3 August 1983. Instrument of accession deposited 1983. Ratification incomplete. Two cultural heritage sites have been inscribed in the World Heritage list. [but see CIDA, 1989, p. 20; 'signatory 1987, part of Sundarban East sanctuary declared']
UNESCO Man and the Biosphere Programme	Accepted as member. National Committee exists.

15 sectoral and issue areas; and a short section on institutional arrangements. Points of particular relevance are (page numbers refer to the English translation in typescript):

Objectives:

"Maintenance of the ecological balance and over all progress and development of the country through protection and improvement of the environment. . ." - p. 2

"Ensuring sustainable, long-term, and environmentally congenial utilisation of all national resources" - p. 2

Policies:

"Conserve and develop wetlands and protect migratory birds. . . ." [(6), Forest, Wildlife, and Bio-diversity] - p. 4

"Prevent activities which diminish the wetlands/natural habitats of fish and encourage promotional measures in this regard. . . ." [(2), Fisheries and Livestock] - p. 4

"Ratify all environment-related International Laws/Conventions/Protocols that Bangladesh considers ratifiable and amend/modify existing laws/regulations in line with the ratified laws/conventions/protocols." [(4), Legal Framework] - p. 7

Institutional arrangements

"MOEF would coordinate the implementation of this policy. A National Environment Committee with the Head of Government as the Chairperson be constituted to giver overall direction for implementation of the environment policy." - p. 7

Fourth Five Year Plan 1990-5. "Since Bangladesh is a small country with very large population, extra care is required to ensure that economic development does not lead to increased deterioration of its ecology and environment." (From Chapter I, Framework for the Perspective Plan, p. I.3.)

The Plan does not, however, dedicate a chapter or section to environmental concerns as such. These are dealt with sectorally; some of the relevant aspects are noted below.

In agriculture (Chapter V, Section B), flood-prone wetland areas are recognized as marginal for agriculture, and expansion or improvement of cropping in these areas is not sought:

"Floods are a fact of life and a part of the ecosystems of Bangladesh affecting land use pattern and the agricultural system of the country. While effective flood protection measures will form an integral part of development efforts during the Fourth Plan period, production plans in the crop sub-sector would focus attention on low-risk areas with less reliance on summer crops particularly in flood-prone areas." - p.V.A-13

In flood control and water resources (Chapter V, Section B), the need for integrated planning, which could include consideration of wetland values, is noted:

"The FFYP would focus attention on these aspects [agriculture, fishery, land use, and other environmental and socioeconomic considerations] in planning and implementation of future . . . programmes through integrated planning by involving all concerned agencies of the Government as well as the local people." - p. V.B-10

In fisheries (Chapter V, Section C):

"Protection and conservation measures will include: . . . imposition of penalty on the industrial dumping of untreated and harmful industrial wastes into any open water system." -p. V.C-5

In forestry (Chapter V, Section E),

> "To preserve the national heritage, a network of protected areas characterising different types of terrestrial life and ecosystems will be established to help maintain biodiversity, and preserve gene pools and critical habitats of rare and endemic plants and animals. The national botanical gardens will be further developed. Measures will be taken to preserve and protect the national parks system in its existing form. Particular emphasis will be given to wildlife protection and preservation through strict enforcement of existing laws and establishment of game sanctuaries." - p. V.E-11

National Conservation Strategy. The NCS is "the blueprint for the integration of both environmental and economic concerns" (p. I). It has been reviewed by the relevant ministries and its submission for Cabinet approval is thought to be imminent. It states that:

> "A national policy should be formulated for preservation of wildlife. The proposed policy will include an objective statement specifying areas protected for preservation and regeneration of wildlife . . . [It] should be linked with the national forest policy to avoid conflict." (p. 119).

It also says that

> "The Protected Areas System of National Parks, Wildlife Sanctuaries, and Game Reserves should be expanded and maintained since they are the areas of unique richness in biodiversity." (p. 155)

National Environment Management Action Plan. Currently, a set of sectoral discussion papers prepared by the NEMAP consultants are being circulated to Government for review. Each paper identifies sectoral policy, key environmental issues, intersectoral linkages, relevant GOB environmental policy, an environmental action plan (long list of desirable actions), and key areas of intervention (short list). NERP has been able to obtain copies of papers covering the areas of agriculture, fisheries, water resources, forestry, and coastal and marine resources management.

Forestry Master Plan. The Forestry Master Plan (FMP) Project concluded earlier in 1993. It produced a plan for the forestry sector and supporting reports. The Plan is under review by the Government.

4.2.2 International Agreements

Rio Convention on Biological Diversity. This instrument was adopted and signed by 157 nations including Bangladesh (and Canada) at the United Nations Conference on Environment and Development (UNCED) on 14 June 1992 at Rio de Janeiro, Brazil. MOEF is preparing the instrument of accession. The Convention "establishes new legal commitments on conservation, finance, access, technology transfer and benefit sharing that are likely to make it an extremely important instrument for the conservation of biological diversity in the years ahead. It has both conservation and development objectives and there is a strong link between the needs of people and conservation." Among other things, the Convention requires Contracting Parties (quotes taken from Biodiversity Coalition, 1992):

- "to develop national strategies, plans, and programmes to conserve and use sustainably biological diversity . . .
- "[to] integrat[e] . . . conservation and sustainable use of biological diversity into sectoral and cross-sectoral plans and policies . . .
- "to identify components of biological diversity important for conservation and sustainable use; to identify threats to them; and to monitor them . . .
- "[to] establish[] 'a system of protected areas or areas where special measures need to be taken';
- "[to] regulat[e] (private) or [to] manag[e] (public) biological resources important for biodiversity conservation to ensure their conservation and sustainable use . . .
- "[to] rehabilitat[e] degraded ecosystems and promot[e] recovery of threatened species . . .
- "to legislat[e] for protection of threatened species;
- "[to] prevent[] introduction of exotic species;
- "[to] encourag[e] and maintain[] relevant practices of indigenous and local communities;
- "[to] support *ex situ* conservation 'predominantly for the purpose of complementing *in situ* measures' and to support setting up facilities in countries of origin, especially countries of origin, and to help recovery and re-introduction of threatened species . . .
- "to adopt 'measures that act as incentives for the conservation and sustainable use of components of biological diversity' . . .
- "to develop research and training capabilities especially in developing countries . . .[and] to conduct public education and awareness programs . . .
- "to adopt EIA procedures for projects 'likely to have significant adverse effects on biological diversity with a view to avoiding or minimising such effects.' . . .
- "to facilitate access to genetic resources for environmentally sound uses, although access must be 'on mutually agreed terms' and 'subject to prior informed consent' . . . parties are encouraged to conduct their research on genetic resources in the country of origin and should share benefits . . . with the Party providing the resources . . .
- "to provide or facilitate access to technologies relevant to the conservation and sustainable use of biological diversity; and technologies that make use of genetic resources and do not significantly damage the environment . . ."

Additional articles of the Convention encourage Parties to facilitate information exchange and technical and scientific cooperation to help developing states to strengthen their human skills and institutions; and provides for developing countries to participate in and have priority access to the

results of biotechnology research. Each Party "undertakes to provide financial support ' in accordance with its capabilities' for national measures to achieve the Convention's objective. Developed country Parties 'shall provide new and additional financial resources to enable developing country Parties to meet the agreed full incremental costs' of implementing the Convention."

Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat. The Ramsar Convention is an inter-governmental treaty which provides the framework for international cooperation for the conservation of wetland habitats. Wetlands are recognized as being of international importance because local human impacts such as exploitation and pollution can affect wetlands in other countries; many wetland animals migrate through several countries; and many countries required advice and support from others in order to conserve their own wetlands. The Contracting Parties to the Convention (Switzerland Fed. Off. Environ. For. Landscape, undated):

- Accept the obligation to include wetland conservation within their national land-use planning;
- Have to promote the wise use of wetlands in their territory and maintain the ecological character of these wetlands (characteristics such as quality of soil, water, plants, and animals);
- Must establish nature reserves in areas of special ecological value;
- Undertake to train personnel in wetland research, management, and wardening;
- Designate the world's most significant sites for inclusion in a "List of Wetlands of International Importance"; and
- Undertake to cooperate for the management of shared water systems and the conservation of shared migratory species.

The Convention is the only inter-governmental agreement to deal with wetland conservation. It was drawn up in 1971 at an international meeting in Ramsar, Iran, and entered into force in 1975. More than 55 countries are party to the Convention; 11 are in Asia (Iran, Pakistan, Russia, Jordan, Japan, India, Nepal, Vietnam, Sri Lanka, China, and Bangladesh). Several hundred sites, covering 34 million hectares, have been designated in the list of wetlands of international importance. A key role in the creation of the Convention, and continuing technical support, is provided by the International Waterfowl and Wetlands Research Bureau (IWRB) in Slimbridge, England.

Periodically, conferences are held (Italy, 1981; Netherlands, 1984; Canada, 1987; Switzerland, 1990; Japan, 1993); these provide the Contracting Parties the opportunity to carry out some of their commitments under the Convention (accept new members and sites; review site status and pledge assistance, and so on). In 1992, an Asian Wetland Symposium, under the auspices of International Lake Environment Committee Foundation, was held in Japan in anticipation of the June 1993 conference of Contracting Parties (Isozaki *et al.*, 1993).

The Sundarbans is so far Bangladesh's only Ramsar site. It is 40,000 ha in size, making it the third largest in Asia and sixteenth largest in the world.

Convention on International Trade in Endangered Species (CITES). "Illegal trade in wildlife, including ivory and skins but excluding fish and timber, is probably the world's second largest illegitimate business (only narcotics are worth more) . . . CITES aims to eradicate illegal trade in wildlife and its products, and to ensure that future transactions are held at sustainable levels by the use of mandatory permits." (UNEP, undated).

Two Appendices attached to the Convention, periodically updated, list species that are threatened or potentially threatened by international trade. Mandated activities under the convention are coordinated by the CITES Secretariat on behalf of the contracting parties, and include administration of the mandatory permit system, plus external projects such as wildlife studies and support for realization of economic potential of properly regulated trade in wildlife.

The CITES programme in Bangladesh is implemented and monitored by the Forest Department. There is no National Committee for the country. Numerous wildlife species found in Bangladesh are currently listed in the CITES Appendices.

World Heritage Convention and *UNESCO Man and the Biosphere Programme*. Bangladesh is also a party to the World Heritage Convention, which is designed to protect cultural and natural heritage areas of outstanding universal value, and a participant in the UNESCO MAB Programme. There are no biodiversity-related measures currently active under either agreement.

4.2.3 Legislation, regulations, and standards

Wetland ownership. Permanent settlement of land dates to the 1790s for purposes of collection of revenue. Under this settlement, landed estates including forests, wetlands, and water bodies were settled on landlords (*zamindari*), and actual occupants of the land became tenants-at-will. Various reforms were introduced to curb abuses, but the system persisted until passage of the State Acquisition and Tenancy Act of 1950. With this act, the *zamindari* system was ended, and all types of rent-receiving interests in land were to be acquired by the State on payment of compensation to *zamindari* and tenants. The Act also abolished private ownership of forests, wetlands, and water bodies. In 1956, a policy decision was taken for the Government to acquire all remaining rent-receiving interests in the country, popularly known as "wholesale acquisition of *zamindaries*". Inadequate and fraudulent land settlement records dating or dated to this period continue to hinder resource management (particularly forest management) in some areas (Appendix 6, pp. 4-6, FMP, 1992a).

Hunting and protected areas. The Bangladesh Wildlife (Preservation) Order, 1973 "provides for the preservation, conservation, and management of wildlife in Bangladesh." The law indicates if, when, how, and under what permits "game" and "protected" animals may be hunted. It makes provision for declaration of wild life sanctuaries and national parks, and indicates activities prohibited from such areas (pp. 56-58, Huq, 1991).

Pollution. The Environment Pollution Control Ordinance 1977 provides for the "control, prevention, and abatement of pollution of the environment of Bangladesh." (p. 73, Huq, 1991) This superseded the Water Pollution Control Ordinance 1973.

Forests. The Forest Act 1927 is the basic law governing public forests in Bangladesh. Wildlife exploitation within these areas are regulated by the Rules to Regulate Hunting, Shooting, and Fishing within the Controlled and Vested Forests 1959. No swamp forests are included in the government

reserved and other forests, so this type of legislation has little direct linkage to wetlands. There is, however, an indirect linkage: to prevent illegal removal of public forest products, the Transit Rules made under the Forest Act prescribe *inter alia* controls on removal of timber and other products from non-Forest Department lands, including wetland swamp forests, and "it is the general impression that the Transit Rules have become an instrument of harassment" (Appendix 6, p. 9, FMP, 1992).

Fisheries. The East Bengal Protection and Conservation of Fish Act 1950 provides for the protection and conservation of fish in the inland waters of Bangladesh.

Proposed legislation. New legislation entitled Environment Protection Act is currently in preparation by the government. NERP has not yet obtained any information about it.

Water quality standards. Draft water quality standards dated late 1992 were obtained by NERP. NERP has not yet been able to confirm their current status.

4.3 INSTITUTIONAL CONTEXT

4.3.1 Regional governmental associations

The South Asian Association for Regional Cooperation (SAARC), which has as members Bangladesh, Bhutan, India, Nepal, Maldives, Pakistan, and Sri Lanka, is in the process of setting up a Technical Committee on Environment.

In addition to this, formation of a specialist Regional Wetlands Committee and a SAARC Environmental NGO Network were suggested in the *Recommendations on a [Regional] Environmental Action Plan - for Consideration by SAARC Summit*, prepared at a November 1992 meeting of the Bangladesh, India, Nepal, and Pakistan members of the Global 500 Forum (established at Rio di Janeiro in 1992 to "link the members of UNEP's Roll of Honour"). As far as NERP can ascertain, this document has not been officially acknowledged by SAARC. Some environmental issues were discussed at the Summit, which took place in April 1993, but wetlands were not.

4.3.2 Central government agencies

Wetland Ownership: Ministry of Land and Forest Department

The large freshwater wetlands of the Northeast are owned almost entirely by the Ministry of Land. This agency is mandated to raise revenue from its land assets, and this is mainly accomplished through renting or leasing use rights of various types, such as fishing rights through the District Commissioners' offices. Neither MOL nor the DCs have a mandate for or expertise in resource management, or any history of contact with donor agencies or donor-funded technical assistance.

MOL can assign the leasing function to other government agencies. The best known example is the assignment of small fisheries (< 8 ha) lease sales to local government. MOL receives a nominal fee in recognition of its ownership.

MOL has on previous occasions entered into management agreements with resource management agencies. The best known example is an agreement with the Forest Department to afforest coastal *char* lands.

In 1973, Sylhet Pulp and Paper Mill took possession from the Forest Department of about 50,000 ha of land nominally under reed forest to provide raw materials for the mill, but this was unsuccessful. As a result, in early 1993, SPPM proposed to return this area to the Forest Department in exchange for 20,000 ha of land at higher elevation. Negotiations between SPPM and FD are ongoing.

Land tenure disputes, with some court cases originating in documents dating or dated to Independence, and ongoing encroachment of MOL and FD land are important problems.

Wildlife Conservation and Protected Areas Management: Forest Department

In 1973, a Wildlife Circle was established in support of the wildlife preservation legislation passed in that year. In 1976, a Wildlife Advisory Board was established under that legislation. The Wildlife Circle "operated until 1983, when it was disbanded due to budgetary constraints following a review by the Enam Committee. The majority of the 112 staff of the Circle were merged into other operations within the Forest Department." In 1985, in response to a request from the Wildlife Advisory Board, "the Government appointed a Task Force composed of members from inside and outside Government to examine the current status of wildlife, identify causes for its depletion, and suggest appropriate arrangements to improve conservation." The Task Force reported in June 1986 and recommended *inter alia* that the existing protected area system be consolidated and augmented, and that a wildlife and protected areas management organization be created within the Forest Department (Wildlife Task Force, 1986). No action has been taken on any of the significant Task Force recommendations (all quotes and conclusion are from AWB, 1991, pp. 13-14).

Of the numerous nominally protected areas in the country, staff with roles defined to include protected area management are on station only in the Sundarban and in Bhawal National Park 40 km north of Dhaka.

As was mentioned above, the CITES programme in Bangladesh is implemented and monitored by the Forest Department, which participates in meetings of the parties to the Convention, provides documentation to animal traders, and imposes bans on prohibited items.

Fisheries Management: Department of Fisheries

The Department of Fisheries is responsible for biological management of the open water fishery. Its structure and activities are documented in the *Fisheries Specialist Study*.

Wild Floral Research and Conservation: National Herbarium and National Botanic Gardens

The Bangladesh National Herbarium is a component of the Bangladesh Agriculture Research Council, Forestry Division. It is engaged in "(I) exploration and collection plant resources; (ii) providing identification services to various institutes, agencies, and individuals; (iii) publication of the flora of Bangladesh and other floristic reports, and (iv) international exchange of herbarium specimens and publications. BNH is headed by a Director with a sanctioned strength of 13 professional and 10 support staff. It is planned to develop BNH as an autonomous research institution under the MOEF" (p. 21, Appendix 8, Forestry Master Plan, 1992a).

BNH facilities and those of the National Botanic Gardens are being consolidated and upgraded under an ODA-funded project.

Irrigation, Water Development, and Flood Control: MIWDFC, BWDB, WARPO, FPCO, and Others

The Ministry of Irrigation, Water Development, and Flood Control has overall responsibility for water resource development in Bangladesh. This responsibility is exercised through the Bangladesh Water Development Board, the Water Resources Planning Organization, and the Flood Plan Coordination Organization.

Other agencies involved in water resource development are the Local Government Engineering Department (LGED) which has responsibility for some smaller-scale infrastructure, Ministry of Food which allocates foodgrain to BWDB earthwork construction, the Ministry of Land Administration and Land Revenue which acquires land needed in the construction of civil works, and the Bangladesh Space Research and Remote Sensing Organization (SPARRSO) which handles various types of data.

Water Quality Monitoring and Pollution Control: Department of Environment, Department of Public Health Engineering, Municipal Corporations, and Bangladesh Chemical Industries Corporation

Department of Environment. The Environment Pollution Control Board and Environment Pollution Control Cell was established in support of the Environment Pollution Control Ordinance 1977 with responsibilities limited to pollution control aspects.

Environment pollution control projects were initiated in 1978 by appointing five divisional officers with a working force of 118 personnel. The offices were: Dhaka Division, Dhaka; Research Laboratory, Dhaka; Chittagong Division, Chittagong; Khulna Division, Khulna; and, Rajshahi Division, Bogra. The main objectives were:

- Surveying industrial units and identifying the industries creating pollution.
- Reducing air and sound pollution.
- Collecting water samples from rivers, lakes, and samples of ground water for testing their quality.
- Testing the water supplied to major towns and implementing pollution control rules and laws.
- Acting upon public complaints.
- Surveying river water and coastal area water for taking pollution control measures.
- Taking necessary action against waste dumping.
- Surveying and researching bio-gas production.

Between 1978 and 1985, the Environment Pollution Control Cell was funded under the development budget. In 1985, a Department of Environment Pollution Control (DEPC) was established under the GOB revenue budget. It has four divisional offices (Chittagong, Khulna, Rajshahi, and Dhaka) with eleven staff each, plus 14 head office staff in Dhaka. Each of the divisions has a laboratory to undertake necessary tests and analysis. Major achievements included:

- Relocation of tanneries from the Buriganga River
- Ban on toxic waste imports
- Preparation of national environmental quality standards (DOE, 1991b)
- Prevented registration of eight harmful pesticides
- Identified 2072 industries causing pollution through a survey of 5967 industries
- Collected water samples from 27 rivers, analyzed these and established a data bank

- Collected and analyzed 434 ground water samples
- Established 379 bio-gas plants

In 1990, the Ministry of Environment and Forests was created, composed of two departments, Environment and Forestry. Within it, DEPC became the Environment Pollution Control Directorate. Recent activities include preparation of new water quality standards and a project to collect and analyze surface water samples from each district.

Department of Public Health Engineering (DPHE). The Department of Public Health Engineering is responsible for rural water supply and sanitation.

Municipal Corporations. The Municipal Corporations in each major urban centre are responsible for urban infrastructure, which includes urban water supply and sewage conveyance and treatment systems, development zoning, and so on.

Bangladesh Chemical Industries Corporation (BCIC). The Bangladesh Chemical Industries Corporation, under the Ministry of Industries, is by far the largest public sector industry, with 22 enterprises, including four pulp and paper mills, and employing over 30,000 people to produce a wide range of products.

Regional environment-related higher education: Shahjalal University of Science and Technology
Shahjalal University of Science and Technology, Sylhet. There is an Environment Committee at the University which has expressed an interest in increasing university involvement in regional environmental concerns, including water quality monitoring, fisheries management, and afforestation. The proposed Biology Department currently under consideration by the academic council may also afford an opportunity for an emphasis on locally relevant environmental issues in the new faculty positions, courses, and research activities that this would entail.

4.3.3 Non-governmental organizations

International and regional NGOs
Several international and regional NGOs have played key roles in the creation of international and regional agreements, resources, and fora which have been of immeasurable value in assisting Asian countries, including Bangladesh, to address national biodiversity concerns. Each of these organizations will likely to continue to serve in this capacity.

International Union for the Conservation of Nature. IUCN, founded in 1948 with the sponsorship of France, UNESCO, and the Swiss League for the Protection of Nature, is an umbrella organization whose members include 61 state, 128 government agencies (more than half are developing countries), and most of the major non-governmental conservation organizations such as the national branches of the World Wide Fund for Nature (formerly World Wildlife Fund). It is the largest international group concerned with natural resource management. Asia regional office in Bangkok 1991. Regionally, IUCN activities include publication in 1990 of the *Directory of Asian Wetlands*; and sponsorship in December 1991 of the *International Conference on Waterfowl and Wetlands* in Karachi (Scott, 1992).

IUCN has been active in Bangladesh since 1985, and established a country office here in 1989. IUCN has been involved in the preparation of the National Conservation Strategy for a number of years; and

co-sponsored a *National Workshop on Sustainable Management of Freshwater Wetlands in Bangladesh* (December, 1992).

International Waterfowl and Wetland Research Bureau. IWRB, founded in 1954, has a small staff which stimulates and coordinates waterfowl and wetland activities worldwide. It played a key role in the creation of the Ramsar Convention, to which it continues to provide technical support. IWRB's Waterfowl Division coordinates the monitoring of waterfowl populations in over 90 countries (including Bangladesh) through the International Waterfowl Census (IWC). The results of these, and of other studies coordinated through the research group, are used to formulate management plans for waterfowl populations and recovery plans for threatened species. IWRB's Wetland Division coordinates activities through a wetland management group. Activities include the compilation of regional wetland inventories, the preparation and implementation of management plans, the publication of wetland management handbooks, and the organization of waterfowl and wetland workshops and training courses.

In Bangladesh, IWRB initiated the annual waterfowl count program (responsibility for the count in Asian countries was shifted to AWB in 1992), which includes sites in the Northeast Region.

Asian Wetland Bureau. AWB, founded in 1983, is an independent non-profit organization dedicated to promoting the protection and sustainable utilization of wetland resources in Asia. The headquarters office is located in Kuala Lumpur, Malaysia; Indonesia, the Philippines, and India have national offices. Funding sources for conservation activities include contributions from international environmental NGOs, revenues from environmental consulting, and private contributions. AWB works in four specific areas: biological diversity; water resources; institutional strengthening and public awareness; and environmental management and policy. Its activities include organizing wetland study and management courses and scientific symposia, and publishing reports and a twice-yearly newsletter (*Asian Wetland News*).

In Bangladesh, AWB has had responsibility (since 1992) for the annual International Waterfowl Count, in cooperation with IWRB. AWB has provided consultants to some development projects (Forestry III project appraisal/World Bank, NERP), and has participated in the annual Flood Action Plan conferences. AWB will likely merge with IWRB.

National NGOs

Nature Conservation Movement. NACOM, formally established in 1987, concerns itself with nature conservation and field research, focusing mainly on wetland ecosystems, with special emphasis on herpetology. The organization has been involved in a variety of projects across the country, including:

- Teknaf peninsula wild elephant population management plan (WWF);
- Wildlife surveys — of Hispid Hare and Pygmy Hog (IUCN/SSC), Monitor Lizard (IUCN/WTMC), Sarus Crane (ICF), Otter (WWF), Estuarine River Terrapin (WWF), Freshwater turtle trade monitoring ("Care for the Wild" and University of Kent DICE), Padma River Gharials
- Marine turtle nesting beach surveys; turtle egg artificial hatching experiments, involving local people nest and egg protection (NACOM/Forest Department Joint Venture)

- Coastal wetland assessment — with Asian Wetland Bureau, as part of World Bank Forestry III project appraisal
- NERP wetland studies
- Three rural Nature Conservation Centres at Whykeong, Cox's Bazaar District, Kapasia, Gazipur District, and Sardarpara, Munshiganj District, involving local people fully in operation and management and emphasizing non-formal education (Nagao Environmental Foundation, Japan; BRAC)
- Production of *Wetlands of Bangladesh* (1994) in cooperation with BCAS

Bangladesh Centre for Advanced Studies (BCAS). BCAS, established in 1984, addresses a broad range of environmental policy and research issues. Projects of relevance to the wetlands of the Northeast Region have included: environmental research projects in the surface water sector, in particular environmental case studies of haor and pond ecosystems; public consultations for a *People's State of the Environment Report* (in prep.); and, in cooperation with NACOM, production of *Wetlands of Bangladesh* (1994).

4.3.4 Government/NGO links

One of the recommendations of the 1991 Karachi meeting (see IUCN activities above) was that the Government should designate a Wetland Committee that would include representatives of a wide range of interested parties from inside and outside government. Since that time, a group of environmental NGOs met with the Secretary, MOEF, for discussions, but this has not yet been institutionalized.

It is now usual at national (FAP), regional (SAARC), and international (Rio) meetings for NGOs to convene parallel meetings and forward their recommendations to the governmental sessions. Also, Audubon (U.S. non-profit conservation organization) has been designated by a group of international environmental NGOs, to monitor and disseminate information about the Flood Action Plan, with the aim of influencing donor governments, particularly in Europe.

4.3.5 Donor agencies

Numerous donor agency environmental reviews were prepared in the late 1980s and 1990s. The more recent ones each note the special significance of the wetlands of the Northeast Region (p. 39, Dean and Treygo for CIDA, 1989; p. 25, USAID, 1990; and pp. ix and 34-35, World Bank, 1991), whereas the older ones do not (ADB, 1987; Barker for UNDP, 1988; DANIDA, 1988). Table 4.2 indicates which donors are supporting projects and programmes of relevance to the region's wetlands.

4.3.6 Public participation

The region's wetlands contribute to the livelihood of a high percentage of the local community through floodplain agriculture, open water capture fisheries, swamp forest plant products, domestic water supply, and provides a means of transportation and communication. In addition, these wetlands support a great variety of plant and animal species.

People, in and around these wetlands, have evolved indigenous management systems. Although in principle, the land tenureship lies with the Land and Revenue Department of the Government, in practice the resources at a subsistence level are being manipulated by the people of the locality. The involvement of local people in wetland management is of prime importance since they are an active part of the ecosystem.

There are various systems used in the region to guide the exploitation of the resources. Jalmohals are leased out under the guiding principles of nitimala. This approach is based on a peoples-participatory approach to fisheries resource management. Mosque-based hijal forest management involves local participation in management of community forests and reflects the concept of sustainable resource utilization. Garubala is a term used in the region to describe the system of community management of livestock. These indigenous community management systems within the wetlands are under threat because of shifts in the social power structure and because of conflicts at the political level.

The United Nations has suggested that it is more useful to conceive of community participation as taking place in small communities comprising individuals "at the lowest level of aggregation at which people organize for common effort" *(Popular Participation in Decision Making for Development*, 1975). Accordingly, participation is considered to entail the voluntary and democratic of people in "(a) contributing to the development effort, (b) sharing equitably in the benefits derived thereof, and (c) decision-making in respect of setting goals, formulating policies, and planning and implementing economic and social development programmes" (Midgley 1986).

People's participation involves community action and, particularly in the context of the wetlands, needs to ensure that the poorest of the poor have an effective role — in choosing social actions, in implementing decisions, and in deriving equitable benefits from the programmes. Specific areas in which there is an urgent requirement for public participation needs to be engendered are:

- Lowland floodplain /haor forest management.
- Sustainable utilization and protection of wetland weeds and wildlife.
- Integrated management of wetland ecosystems.

4.3.7 Projects and programmes

Current, future, and proposed projects and programmes in and affecting the wetlands of the Northeast Region other than water resources projects are listed briefly in Table 4.2. Additional information is given on the Annual Waterfowl Count.

Existing water resources projects are shown in Figure 5. Existing projects are documented in the NERP Regional Water Resources Development Status (NERP, 1992). The water resources projects proposed in the NERP regional plan are documented in a series of pre-feasibility studies and in the Regional Plan itself.

Annual Waterfowl Count. An international waterfowl count has been organized by IWRB in January every year since 1987. Count data has been submitted by Bangladesh every year since that time. Sites in the Northeast Region have been included for the last two years. Count sites are fixed, and include 6 sites in the Northeast Region.

Table 4.2: Projects and programmes of relevance to the wetlands of the Northeast Region

Name/Relevance	Department/Donor	Time
Development of Cane, Bamboo, and Murta Plantation: wetland plantation of murta	Forest Department ADB, UNDP	1992-5 Tk 54 million
Development of Conservation and Management of Wildlife: major wetland wildlife component	Forest Department ADB, UNDP	1992-5 Tk 100 million
Survey of Endangered Wildlife of Bangladesh: wetland wildlife component	Forest Department proposed to Japan, USA, IUCN	proposed Feb 1991 USD 0.44 million
Strengthening of Bangladesh National Herbarium: upgrade floral research and conservation facilities	Forest Department ODA	NA NA
Management of Wetlands and Conservation of Biodiversity in Bangladesh: develop and implement management plan for important inland wetlands, conserving their biodiversity	Department of Environment proposed for GEF funding	project concept paper, Mar 1992 USD 2.48 million, first two years only
Environment Study, Flood Action Plan 16: Take wetland values into account in EIA guidelines for water projects; special studies of selected wetland values	Flood Plan Coordination Office USAID	1991-1993 NA
Forest Resources Management Project: Wildlife management	Forest Department World Bank	1992-1999 USD 63 million
Forestry Master Plan: Fundamental sectoral policy and organizational changes	Forest Department ADB, UNDP, FAO	1991-3 USD 1.9 million
Second Aquaculture Development Project: Floodplain stocking; wetland wildlife impacts	Department of Fisheries ADB	1992-5 Tk 990 million

5. DRIVING FORCES AND ISSUES IN WETLAND RESOURCES MANAGEMENT

5.1 DRIVING FORCES

1. Increasing rural-urban and rural-government links ('monetization').
As links between rural and urban areas, and between rural areas and government agencies increase, the balance of power between local people and powerful individuals within and outside the local community is changing. The development of improved transportation and communications infrastructure is increasing outside entrepreneurs' access to rural resources. New sources of income, information, and influence are increasing local elites' power within their communities. And within local communities as a whole, from the top of the power structure on down, shifts from traditional cultural to modern consumer 'money-economy' values are gradually taking place.

As a result, powerful individuals are increasingly taking management control of wetland resources away from traditional community management groups, and denying traditional resource users their customary access rights. As managers and users change, so management objectives and practices change, from longer-term sustained community benefits to short-term one-time cash profits.

Examples of this are the changes in swamp forest management and in restriction to wetland access.

Rural-urban links can also have positive effects. In particular, they provide opportunities for alliances between local resource user groups and urban-based conservation activists and resource scientists. These have been limited so far, however.

2. Continued dependence on local resources for biomass and other necessities.
For most of the region's residents, local resources are the only source of biomass for fuel, building materials, and to a certain extent fodder; soil nutrients (fertilizer/compost); medicines; and other necessities. As a result, there is continued strong local demand for wetland products, and market values for them exist and remain relatively high. This heavy demand pressure coupled with weak resource management, sets the stage for localized over-exploitation (yields decreasing even as exploitation effort is increasing).

3. Rural impoverishment.
Wetland resource gathering is attractive to those for whom it provides better economic returns than the alternative activities open to them. Of all households, 50% are functionally landless, rural unemployment and underemployment is very high, and rural population is increasing faster than rural employment creation. As other economic options disappear, increasing numbers of rural residents will likely engage in wetland resource gathering.

The increased harvesting pressure already has or will push systems beyond sustainable levels; the result is declining total production. The large numbers of resource gatherers involved and their lack of alternative survival strategies implies that improved resource management — even for improvements that maintain current yields — will not be easy, and will depend on working in partnership with the resource gatherers themselves.

Rural impoverishment can also occur as the result of specific 'development' activities: oustees from sites adjacent to wetlands can also contribute to wetland exploitation. For example, BFIDC's planned conversion of ~400 ha yr^{-1} of upland forest to tea and rubber plantations will displace biomass gatherers and settlers, who may then become dependent on resources from nearby Hail and Hakaluki Haors.

4. Expansion of new technologies ('modernization').
Many of the new technologies that have been introduced to the region are accompanied by adverse impacts on the wetland values. Examples:

- High yielding variety (HYV) technology packages (HYV seeds, irrigation, fertilizer, pesticides) can boost encroachment rates and consume and pollute water.
- Diesel pumps are used to pump out marginal wetland areas for conversion to agricultural use.
- Improved fishing implements such as boat mechanization and ice plants can boost fishing effort and increase overall fishing efficiency.
- Mechanized boats contribute to water pollution and increase the scope and efficiency of transport access to wetland areas.

Not every technological change affects wetlands adversely, however, and some changes can have definite benefits:

- Rural electrification and LPG extension can lessen pressure on species used as biomass fuel.
- Technology-induced increases in employment and income in other sectors can lessen overall pressure on wetland resources.

5. Widening markets and increasing local, urban, and international demand for certain wetland products.
Demand for wetland products is increasing broadly, with increasing local rural population, increasing urban population and wealth nationally, and increasing penetration and intensity of international demand. This demand can be species-specific or more general (for fuel, for example). Over the last century or so, worldwide, many species have been wiped out or brought to the brink of extinction as the result of intense species-specific demand. This type of demand — often reflecting a new fashion (locally or internationally) in food, clothing, or medicine, or the entry of new entrepreneurs into a trading circuit — can intensify rapidly and is hard to predict. Examples of species of the Northeast Region known to be vulnerable are:

- Turtles. Demand as table food.
- Frogs. International demand as table food.
- Snakes. Hong Kong, Singapore demand for skins
- Lizards. Japanese demand for skins to be used for shoes, bags, and so on.

6. Traditional cultural emphasis on rice and rice cultivation.
Management decisions are influenced by factors other than economic return. In Bengali society, there is an extremely strong preference for rice. Rice connotes pleasure and plenty: rice cultivators have

considerably higher status than those dependent on other wetland resources (such as fish, wild plants, waterfowl), and many feel that a meal lacking rice cannot nourish or satisfy hunger.

This leads to wetland management practices such as induced silting up of wetlands to create areas suitable for rice cultivation and pumping out marginal areas to facilitate early planting - even when rice cultivation may not be the most economically attractive use of these areas.

7. Increasing concern for environment and wetlands.
Both nationally and internationally, interest in environmental matters, including concern for wetland values, is increasing dramatically. There are many signs of this, among them the signing of the Ramsar Convention and other international agreements by Bangladesh, the increasing numbers of environmental NGOs, donor country environmental reports and guidelines, and so on. Overall, interest in and institutional resources for wetland management improvements is much higher than even a few years ago, and will likely continue to increase.

8. National political changes.
The change to a democratically-elected government in 1990 has opened up public discourse and policy in a variety of areas, among them environmental management. This affords an opportunity to re-examine entrenched policies and attitudes towards wetlands, and established wetland management practices. The democratic government also has a less ambivalent stance with regard to public participation, a key element of any realistic improvement to wetland management systems.

9. GOB ownership of wetland areas, bureaucratic inertia, and the practice of 'compromise'.
By definition, the Government owns all areas submerged to greater than a designated depth. Tenure over wetlands and other government-owned lands is vested in an agency (Ministry of Land) with a revenue collection mandate and no interest or expertise in resource management. MOL generally leases out its holdings — be they fisheries, quarries, grazing lands, swamp forests.

The system is essentially a remnant of the British colonial period, held in place not by current economic or policy interests of the central government but by bureaucratic inertia and the practice of 'compromise' (A.S. Huque, 1989) wherein a bureaucrat and a prospective lessee agree on a lease fee well below the market price.

The lease fees appear under the heading 'Land Revenue Tax' in the government budget. Land Revenue Tax is a negligible proportion of government revenues. In 1986-7, gross Land Revenue tax was Tk 649 million or 1.7% of Tk 37,253 million total gross revenues. Even of this small amount, well over 80% is retained at the district level for collection costs, reducing the proportion of total gross revenue to 0.24%.

The beneficiaries of the current leasing system are the money lenders and lessees who derive hugh profits from land leases; those paid to collect the tax; and specific government agencies holding accounts to which the tax is credited. These vested interests are so powerful and so weakly opposed that the system looks likely to stay in place indefinitely, despite the many ways in which it opposes stated national interests:

- Tax theorists generally view rents and taxes as stimulative of resource depletion and degradation. This runs counter to stated Government policy to promote sustainable resource management.

- Rents and taxes on wetlands transfer wealth from rural areas to the centre, and from poor resource gatherers to members of the elite; again, Government policy is to focus development efforts on (to direct government resources towards) rural areas and socioeconomically disadvantaged groups, which would include most families dependent on fishing and other wetland resources.

- The land revenue system subsidizes concentration of control over resources in the hands of a few individuals (lessees and their government counterparts) also counter to Government policy prohibiting large landholdings and encouraging control of resources by *bona fide* users.

10. Regional infrastructure development.
Regional infrastructure development can clearly have major impacts on wetlands. Roads and highways can alter drainage patterns and stimulate economic activity. Water resources development for agriculture — flood control, drainage, irrigation — can change inundation timing and levels, alter low flows, and affect water quality, to name but a few potential direct impacts.

11. Development in upstream areas.
Development in upstream areas — changes in agriculture, land use, water resources use, and so on — can affect wetlands by changing water quantity and quality. An important example is the proposed dam at Tipaimukh.

12. Climate change.
Climate change as a driving force for the wetlands of the Northeast Region pales beside the pressures of human exploitation, at least in the near term. Over longer periods, a century and more, climate change will likely be an important factor. Current models of anthropogenic climate change are not yet accurate enough to provide useful information on the scales of interest (current models do not agree on whether or how much the monsoon circulation will intensify, for example).

5.2 ISSUES

1. Improved wetland management is highly congruent with the national development strategy, despite the perception that 'conservation' is an 'anti-development luxury'.
Table 5.1 illustrates the congruence between national strategy and the wetland management improvements.

Key wetland values (benefits) include:

- of direct benefit to local residents ...

  - primary production of economically valuable wetland plant and animal products (including openwater fishery)

  - employment related to wetland products, both in primary activities such as gathering and secondary activities such as manufacturing)

  - hydrologic services such flood peak reduction through diversion and storage

Table 5.1: Correspondence between Government development strategies and desirable wetland management improvements

GOB strategy	Wetland management improvement
Decentralized participatory planning	Improve understanding of and dialogue about wetlands among development policy-makers, project teams, and local community-based user groups. Shift from centralized to local community-based wetland management.
Development of rural economy; involvement of and benefits for the poor	Enhance wetland benefits. Increase wetland value-added, especially for items with export potential. Shift from centralized to local community-based wetland management.
Appropriate transfer and adaptation of technology, targeted toward supporting employment in the agricultural and manufacturing sectors	Transfer and adaptation of technology to: enhance wetland benefits, increase wetland value-added, mitigate adverse wetland impacts of other activities.
Promote competitive private enterprises, thrust on export-oriented business	Seek maximum sustainable yields of wetland products, especially those with export potential. Increase wetland value-added, especially for items with export value.
Integrate national conservation strategy to prevent degradation of the environment	Stabilize, preserve, and enhance wetland values. Improve the information base for wetland management decision-makers.

- ecosystem services such as water purification, contributions to soil quality
- erosion control by lowland trees and other plants

- of indirect benefit to local residents; of national and international interest ...
  - biodiversity, broadly defined (see Glossary); in particular, preservation of threatened species
  - representative ecosystems and habitats (reed land, mature swamp forest community)
  - integrity of flyway for internationally-migrating waterfowl
- of direct benefit to the rural poor ...
  - progressive equity distribution of wetland benefits mentioned above (benefits go overwhelmingly to the poorest). This characteristic has been nullified in the area of openwater fishery, by the fishery leasing/land revenue system.

The last wetland value listed is key. Government policy targets the hard-core poor. Wetlands, which provide vital benefits to this group, should be explicitly incorporated as an element of strategy to reach this target, for rural poor with access to wetland areas.

There is a need for wetland education for development policy-makers, planners, project teams, local communities, and other interested parties wetlands, to counter the perception that initiatives related to wetlands are by definition 'conservation-oriented' with the meaning 'anti-development'. Until wetlands are understood to be valuable and important, and lines of communication are open between interested parties, it will be difficult to address the rest of the issues discussed here.

A start has been made in this area with a MOEF, CIDA, and IUCN co-sponsored a national-level workshop on *Conservation and Sustainable Management of Freshwater Wetlands in Bangladesh* in December 1992.

2. Wetland values need to be incorporated into development planning.
Wetland benefits need to be recognized and factored into development planning, to reduce environmental damage through appropriate mitigation, and to prevent falsely optimistic estimates of project returns by including losses of wetland value due to projects in project economic assessments. Both economic and other indicators (for example equity, quality of life) should be used as appropriate. The result should be the best use of each wetland site.

3. Wetland benefits need to be stabilized, preserved, and enhanced.
Almost every wetland value listed represents an area where management improvements could induce additional benefits. The potential for management improvement in each area needs to be examined critically. Additional benefits, and the efforts required to achieve them, need to be assessed in the same way that other development alternatives are assessed, and prioritized alongside them on the basis of appropriate indicators.

Both traditional and creative approaches to improved wetland management should be examined: wildlife sanctuaries, semi-protected areas under local management, rotating preserves, zoning (for example, to limit water resource infrastructure development in certain areas), and so on.

4. The responsibility for and rewards of day-to-day wetland resource management belong in the hands of local communities and user groups.
Improved wetland management to optimize wetland benefits, and sustainable manufacturing based on wetland products will be possible only if resource use (benefits) and management control (responsibility) rest, in the long term, with the same entity.

As noted above, one of the most attractive characteristics of wetland production is its progressive equity distribution (in the absence of distorting policies): the benefits go mostly to poor rural residents. A logical corollary is that resource management responsibility should be devolved to this group ('community-based management'). Private corporations, local and other government agencies, and similar entities will have other appropriate roles, but overall stewardship should rest with local communities/user groups.

5. The information base for wetland management decision-makers needs to be improved.
Informed decision-making will require better information about wetlands: what they are, how they are changing, who exploits them, for what goods and services, and how much these goods and services

are worth. The need for information runs from original research to routine monitoring; study programs should carefully focused to meet the needs of resource managers and users. Establishing alliances between Bangladeshi investigators and institutions and the international scientific community will be key.

6. The value added to wetland products needs to be increased, especially for items with export potential.

Currently little value is added to the bulk of wetland products: plants and animals are gathered, undergo basic processing (drying, bundling), and are then sold. There is a need to develop regional industries (cottage or larger-scale) to produce more finished, higher-value wetland goods, such as water hyacinth paper and furniture.

Boosting the value added to wetland products would increase demand for and market value of wetland raw materials; increase wetland-based employment and wages; and increase the value of wetlands relative to other land uses, thereby providing additional incentive to manage wetlands more wisely.

7. Critical wetland areas need to be protected.

Had one or more protected freshwater wetland areas been established (say in the 1870s at the time that the Sundarban Reserve Forest was established), many extinctions could have been avoided and a number of unique ecosystems preserved. This is still the case. The six key wetland sites documented in this study should receive immediate attention to establish viable protection and management.

8. A relentless focus on strategic interventions will be key.

Pressures on the remaining wetlands are heavy and resources (both financial and institutional) to address wetland issues are severely limited. There is a need to narrow the focus to a few key interventions and follow through.

6. ANALYSIS OF STRENGTHS, WEAKNESSES, OPPORTUNITIES, AND THREATS TO WETLANDS

6.1 INTRODUCTION

The wetland management strategy must take into account:

- the current strengths and weakness of the wetlands and wetland management systems,
- the threats that will be impinging upon wetlands and improved wetland management in the future, and
- opportunities to achieve improvements in wetlands and wetland management systems.

In general (but not always), strengths and weaknesses are linked to issues; and threats and opportunities are linked to driving forces.

6.2 STRENGTHS

Much of the prehistoric wetland system of the Northeast Region is gone, and what remains is under heavy pressure. Despite this, the system itself, and the human and institutional setting, has some key strengths:

- *Remaining wetlands have substantial value.* Several key wetlands of outstanding international and national value still exist; a large number of wetlands of significant national or regional value exist; and there are many sites of significant local value. Local residents, particularly the poor, derive significant benefit from these sites. The key sites support most of what remains of the international flyway and biodiversity at all scales (communities, species, and within species), and harbour several internationally threatened species.
- *Important representative habitats still exist*, some only as remnants, though all have been extensively modified relative to prehistoric conditions (in particular, virtually all of the larger animal species have disappeared).
- *The tenure situation is uncomplicated.* Ownership of the core areas of the key sites, including all perennial water bodies and much adjacent land, rests almost entirely with a single entity — the Government. Implementation of changes in national wetland management policy, once fully committed to, could be relatively quick and straightforward. There would not be a need for funds to compensate private landowners directly (though other types of compensation could be necessary).
- *Government development strategies and desirable improvements to wetland management are highly compatible.* See Table 5.1.

- *Some wetland education is already taking place*, at various levels within and outside Government. Tentative lines of communication for dialogue on wetlands among various government agencies, national and international non-governmental organizations, donors, and to a much lesser degree local communities, have evolved. Recent policy moves have been in the right direction with the signing of the Ramsar Convention and the other policy statements that are being developed.

- *Some wetland research and monitoring is already taking place*, and *some key alliances with the international scientific community are already in place*.

- *Some alliances between national and international NGOs are already in place*. National and international NGOs with an interest in wetlands have been active within the country for several years, and have influenced Government, donor, and project planners activities.

6.3 WEAKNESSES

The wetlands of the Northeast are vulnerable in many ways. The most important of these are:

- *Lack of viable protected freshwater wetland areas*. Had one or more protected freshwater wetland areas been established (say in the 1870s at the time that the Sundarban Reserve Forest was established), many extinctions could have been avoided and a number of unique ecosystems preserved. This is still the case. Establishment of protected areas now could prevent many future extinctions and ecosystem losses.

- *Some of the remaining wetland species and habitats are threatened*. A number of species and habitats are at critical levels.

- *Wetland values are not adequately recognized*. Also, the current and potential contributions of wetlands to national development objectives, are not understood. Both statements are true at all levels, both inside and outside government.

- *Information about wetlands is inadequate* for good decision-making.

- *Current institutional arrangements for wetland management are inappropriate*. MOL has no interest or expertise in resource management, yet it controls the key wetland core areas. It has been strong enough to retain this control despite the fact that it runs counter to various aspects of the national interest. Agencies (MOEF, MIWDFC, MOFL) who have interest and expertise (if in need of strengthening) in wetland resource management have little power, statutory or real, to influence what happens in the wetlands. These agencies are relatively weak and historically have been reluctant to form alliances due to other conflicts.

- *Wetland benefits are well below potential levels; little value is added to wetland products*. Benefits are less than what they might be because resource management is inappropriate or poorly organized, and does not focus on adding value to wetland products.

- *The equity distribution of wetland benefits is less progressive than it could be*, as a result of inappropriate resource management, specifically, the Land Revenue Tax system.

6.4 THREATS

- *Over-exploitation.* Certain species are being harvested at levels or in ways that are unsustainable (yields are declining even though exploitation effort stays constant or is increasing).

- *Habitat destruction.* Certain habitat types and species dependent on them are gradually being eliminated.

- *Water pollution.*

- *Disturbance (including hunting).* Disturbance (including hunting) is reducing usable habitat significantly.

- *Felling of mature lowland forest trees.* Removal of mature trees is replacing coppicing as the harvesting method of choice. Immediate returns are higher, but in longer term returns are lower.

- *Suppression of natural regeneration of swamp forest trees.* Few saplings of swamp forest trees survive due to grazing and fuel collection.

- *Drainage improvements, flood control works, induced siltation.* All of these flood plain manipulations tend to reduce the extent and duration of wetlands.

- *Traditional management systems are being challenged by powerful interests.* Powerful interests threaten to reverse wetland benefits historic equity distribution profile, and appropriate resources traditionally under the control of local communities.

6.5 OPPORTUNITIES

- *Foster beneficial rural-urban links.* Foster linkages between rural user groups and urban/government-based resource scientists and NGOs concerned with wetlands.

- *Transform and empower poor user groups to become resource managers.* Train community-based user groups in basic resource management techniques. Provide legal aid and other support to help them maintain or regain their traditional access and other rights.

- *Displace demand for heavily exploited and threatened species.* Accelerate provision of alternative energy sources to rural areas to reduce pressure on biomass fuel species.

- *Create employment in wetland primary production enhancement.* Develop semi-domesticated farming of high-valued species, especially those with export potential.

- *Develop enterprises based on value-added wetland products.*

7. WETLAND MANAGEMENT OBJECTIVES

7.1 INTRODUCTION

Objectives by definition are quantified targets within a set time frame. They should be achievable, within the framework of available professional, financial, and other resources.

If new methodologies or institutions (for community-based management, for example) need to be developed in order to achieve a particular objective, estimates of the amount of time and resources required may be difficult. In this case, a series of phased objectives leading up to the main objective is indicated, to assist in understanding what is realistic and achievable; as the phases are executed, downstream objectives may need to be reviewed and revised.

The objectives presented here were used as input to the regional development objectives and the water management objectives of the North East Regional Plan. They therefore record the wetland objectives stated from a specialist perspective, before incorporation into the Plan.

7.2 MAIN OBJECTIVES

1. To maintain the major part of the region's remaining biodiversity for future generations.

   Comments: This objective includes wetland biodiversity, but extends well beyond this to include the biodiversity residing in wild upland species and in local varieties of domestic plant and animal species as well. To monitor and evaluate achievement of this objective, 'maintenance of remaining biodiversity', baseline data (appropriately defined and focused) and ongoing monitoring of the remaining regional biodiversity is needed.

2. To maintain or enhance the ecological character of the key wetland sites for future generations.

   Comments: These sites are the main repositories of wild wetland species' biodiversity. This implies that major development activities (FCDI, floodplain fish stocking, roads and highways, industrial development) in these areas, and within their upstream basin areas, need to be planned, implemented, operated, and maintained with a high degree of sensitivity to wetland values; or foregone. This also implies improved local wetland resource management. To monitor and evaluate achievement of this objective, baseline data (appropriately defined and focused) on the ecological character of the key wetland sites in needed.

3. During the period 19___ to 20___, afforest ____ ha per year with swamp forest tree species.

   Comments: Time frame and area would be quantified based on what is feasible; this would require additional investigation.

SUBSIDIARY OBJECTIVES

These objectives relate to specific targets that must be met in order to achieve the main objectives.

1.a By 2000, to develop a baseline data set (appropriately defined and focused) on the remaining biodiversity in the region. From 2000, to continue assimilating and analysing a monitoring data set.

2.a By 1995, complete the baseline data set (appropriately defined and focused) that begun under NERP on the ecological character of the six key wetland sites. From 1995, to continue assimilating and analysing a monitoring data set.

2.b By 2000, institutionalize a regional capability to review major development plans for impacts on regional biodiversity and the six key wetland sites.

Comments: EIAs are or will soon be required for most types of major development. DOE is or will be responsible for reviewing these. To support EIA preparers and DOE in this effort as it relates to regional biodiversity and key wetlands, a network of interested parties should be institutionalized. The network should include persons residing in or near each of the key sites, representing the full range of socio-economic classes and occupations, men and women; local and regional technical experts; national technical experts; and international experts as needed. 'Institutionalization' of this network needs to be defined, but would include locating and identifying interested persons, meetings to exchange information, and some form of regular contact (such as a newsletter or meetings).

2.c By 2000, institutionalize sustainable community-based management of wetland resources at the six key sites.

Comments: Serious thought is required to define this objective further. How do the terms 'institutionalize', 'sustainable', and 'community-based' apply to these wetlands? To specific subsystems (such as migratory waterfowl)? Should these areas (or subunits of them) have official status (Ramsar site, protected area, rotating refuges)? Each key site would likely require a period of intensive input (say two years, with year one for research and local consultation, and year two for design and implementation of new management systems), followed by follow-up of intermittent outside input on a steadily decreasing basis (over say three years), after which management would be under purely local control with supportive linkages to Government and non-government institutions as appropriate. To complete the intensive input at all the sites in the six year period before 2000, input would have to be provided to two sites during 1994-95, two during 1996-7, and two during 1998-9. Also, there is clearly an opportunity for synergy with the regional wetland network; this needs to be explored.

8. KEY WETLAND MANAGEMENT INITIATIVES

Remarks in this section link the information provided by the Specialist Study with the final content of the Regional Plan.

Conceptualization of key wetland management initiatives was begun during the Specialist Study period, continued through the finalization of the Regional Plan, and was completed during preparation of prefeasibility studies. During this process, the wetlands theme came to be seen as but one facet of several broader concerns, for (a) biodiversity in both wetland and upland settings; (b) water quality management; and (c) development of flood- and erosion-affected villages.

Five of the Regional Plan's eight strategic thrusts include initiatives addressing these concerns. Initiatives which address wetland management are marked with an asterisk (*).

- Thrust: Urban Infrastructure Protection and Development.
  - Initiatives (all included in NEMREP):
    Regional Water Quality Characterization
    Industrial Pollution Abatement at Smaller Industrial Facilities
    Duckweed-Based Domestic Waste Treatment

- Thrust: Integrated Development of the Deeply Flooded Area.
  - Initiative: *Pulp and Paper Mill Effluent Treatment* (in NEMREP)

- Thrust: Biodiversity Enhancement and Sustainable Management.
  - Initiatives (all included in NEMREP):
    Upland Biodiversity Conservation Studies and Implementation.
    *Locally Based Management of Internationally Significant Wetlands.**
    *Threatened Ecological Community Recovery Programme.**
    *Recovery Plans for Threatened and Commercially Threatened Lowland Plant and Animal Species.**

- Thrust: Liveability of Rural Settlements.
  - *Initiatives*:
    Village Water Supply and Sanitation
    Village Afforestation (in FEAVDEP)*

- Thrust: Institutional Strengthening and Development.
  - Initiatives (all in NEMREP):
    *Northeast Region Environmental Management, Research, and Education Centre.**
    *Surface Water Quality Management Strategic Planning Exercise.**
    *Biodiversity Strategic Planning Exercise for the Ministry of Environment and Forests.**

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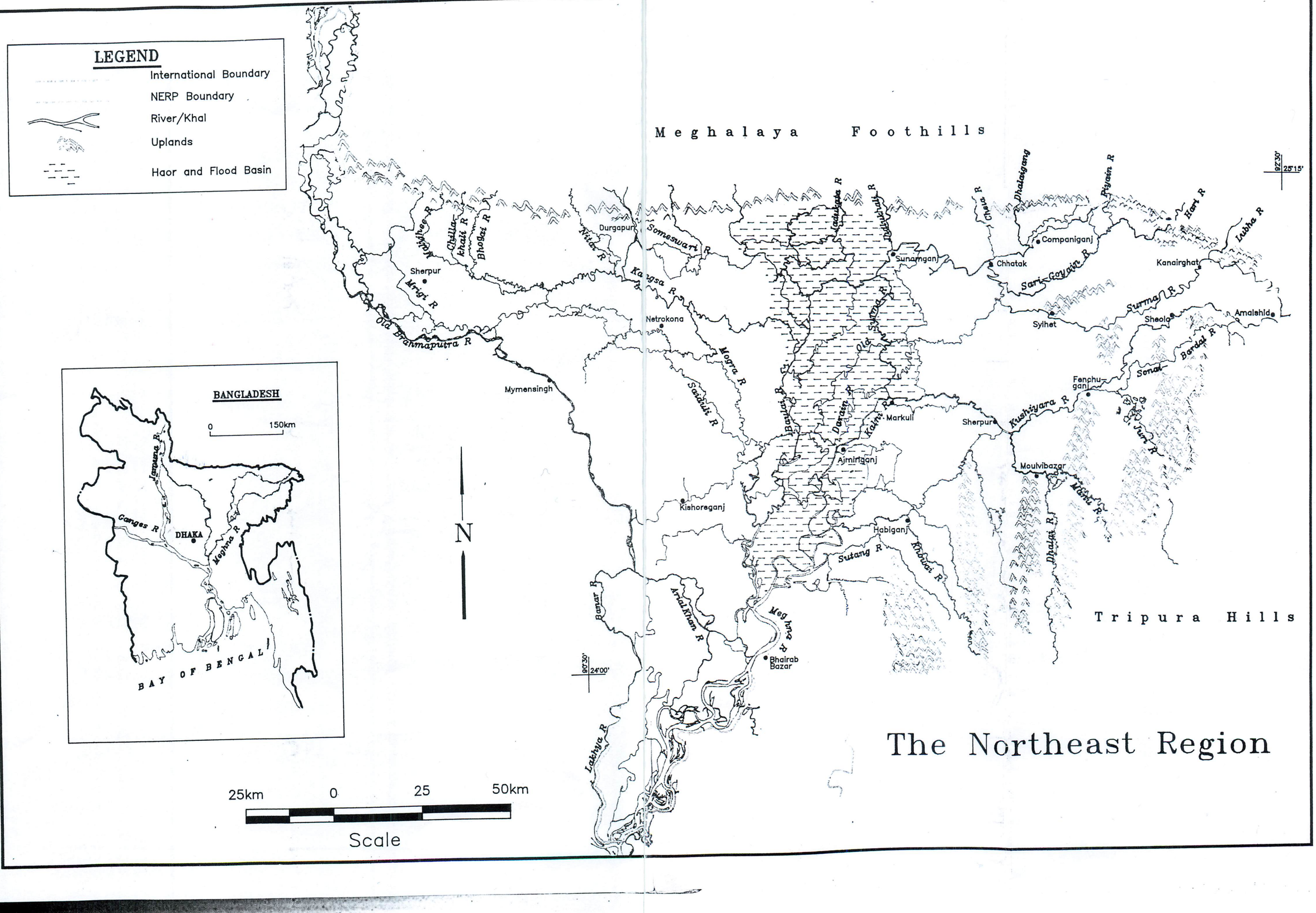
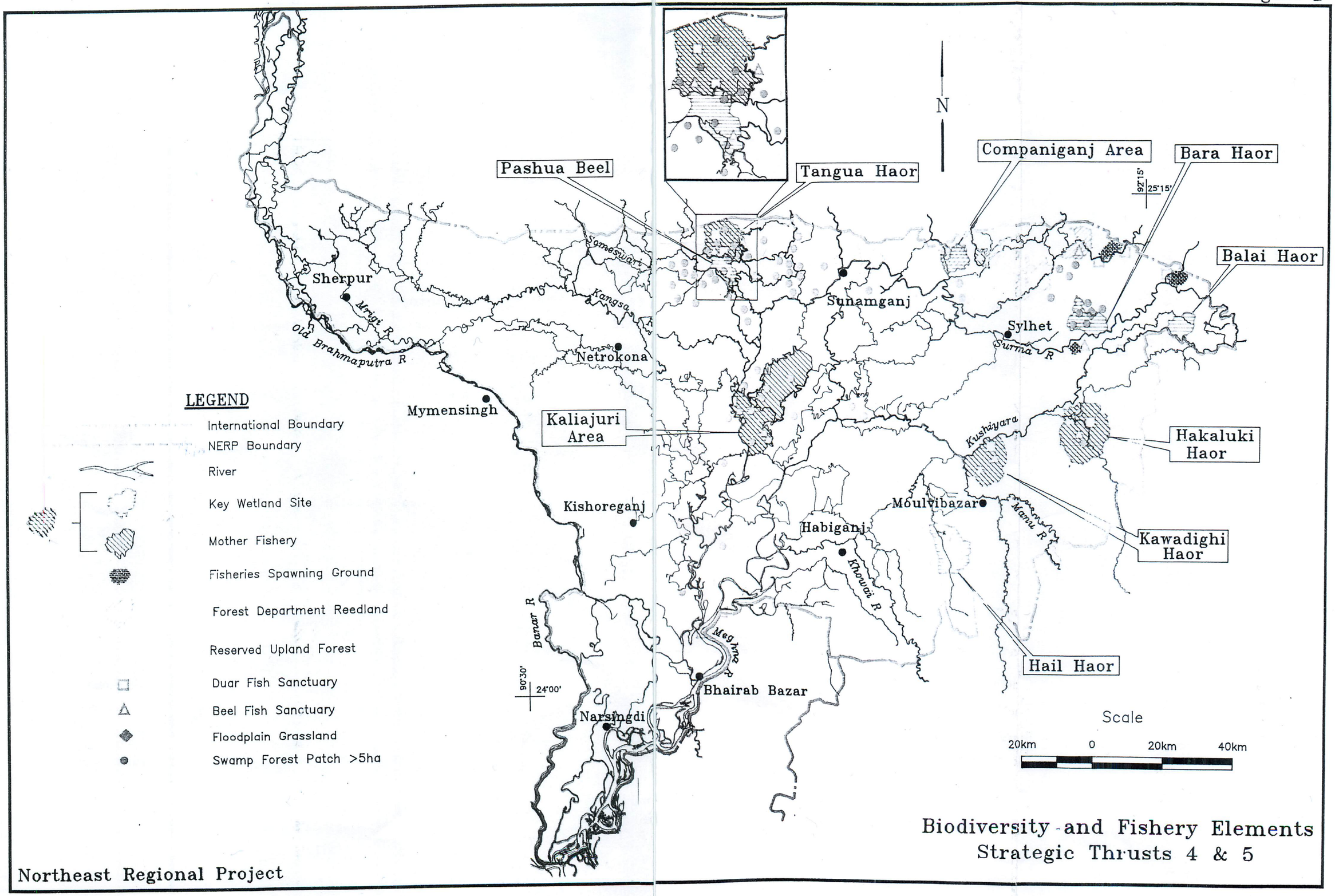
FIGURES

Figure 1



The Northeast Region

Figure 2



Biodiversity and Fishery Elements
Strategic Thrusts 4 & 5

Northeast Regional Project

Northeast Regional Project

Schematic zonation, haor habitats

winter/March

Prepared by: Istiak	September 1995
Computer Drafting by: Jalal	AutoCAD Drawing

FILE: NERP-08.DWG

Figure 3a

Northeast Regional Project

Schematic zonation, haor habitats rising water/May-June

Prepared by: Istiak	September 1995
Computer Drafting by: Jalal	AutoCAD Drawing

FILE: NERP-088.DWG

Figure 3b

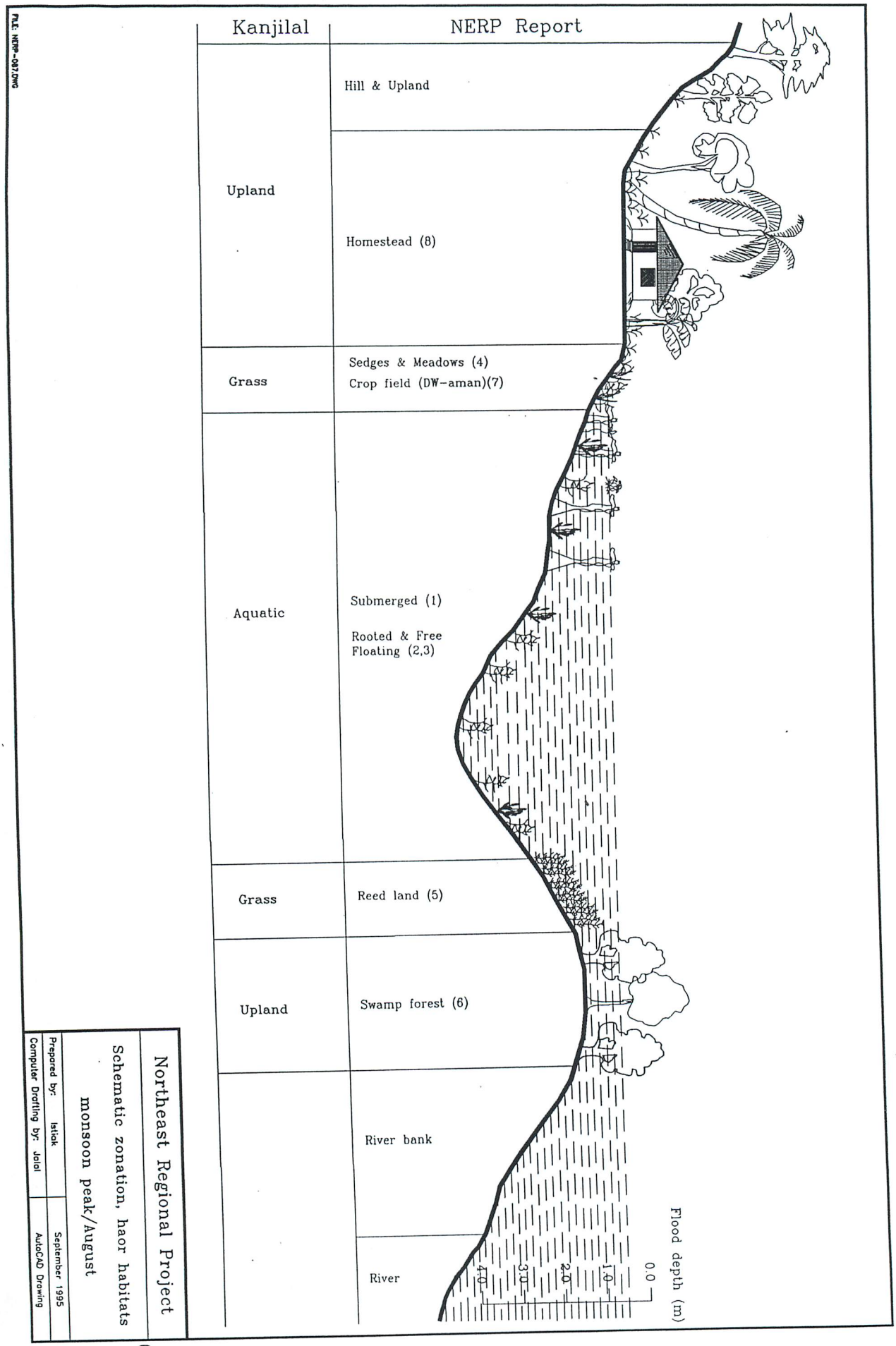

FILE: NERP-087.DWG
Kanjilal
NERP Report
Hill & Upland
Upland
Homestead (8)
Grass
Sedges & Meadows (4)
Crop field (DW-aman)(7)
Aquatic
Submerged (1)
Rooted & Free Floating (2,3)
Grass
Reed land (5)
Upland
Swamp forest (6)
River bank
River
4.0
3.0
2.0
1.0
0.0
Flood depth (m)
Northeast Regional Project
Schematic zonation, haor habitats
monsoon peak/August
Prepared by: Istiak
September 1995
Computer Drafting by: Jalal
AutoCAD Drawing

Figure 3c

Northeast Regional Project

Schematic zonation, haor habitats water recession/Oct.-Nov.

Prepared by: Istiak	September 1995
Computer Drafting by: Jalal	AutoCAD Drawing

FILE: NERP-088.DWG

Figure 3d

Figure 4: Summary of waterfowl counts by major system

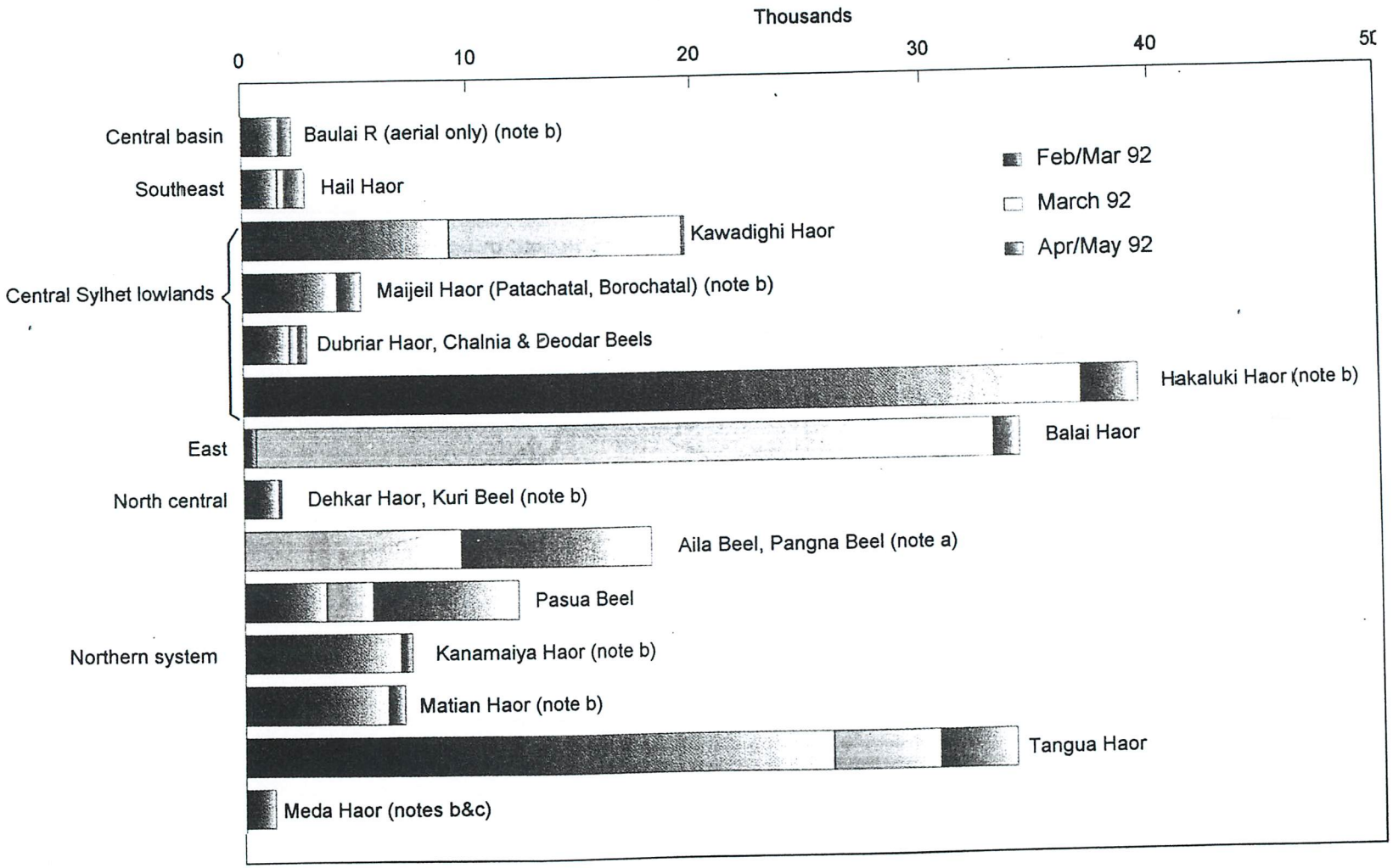
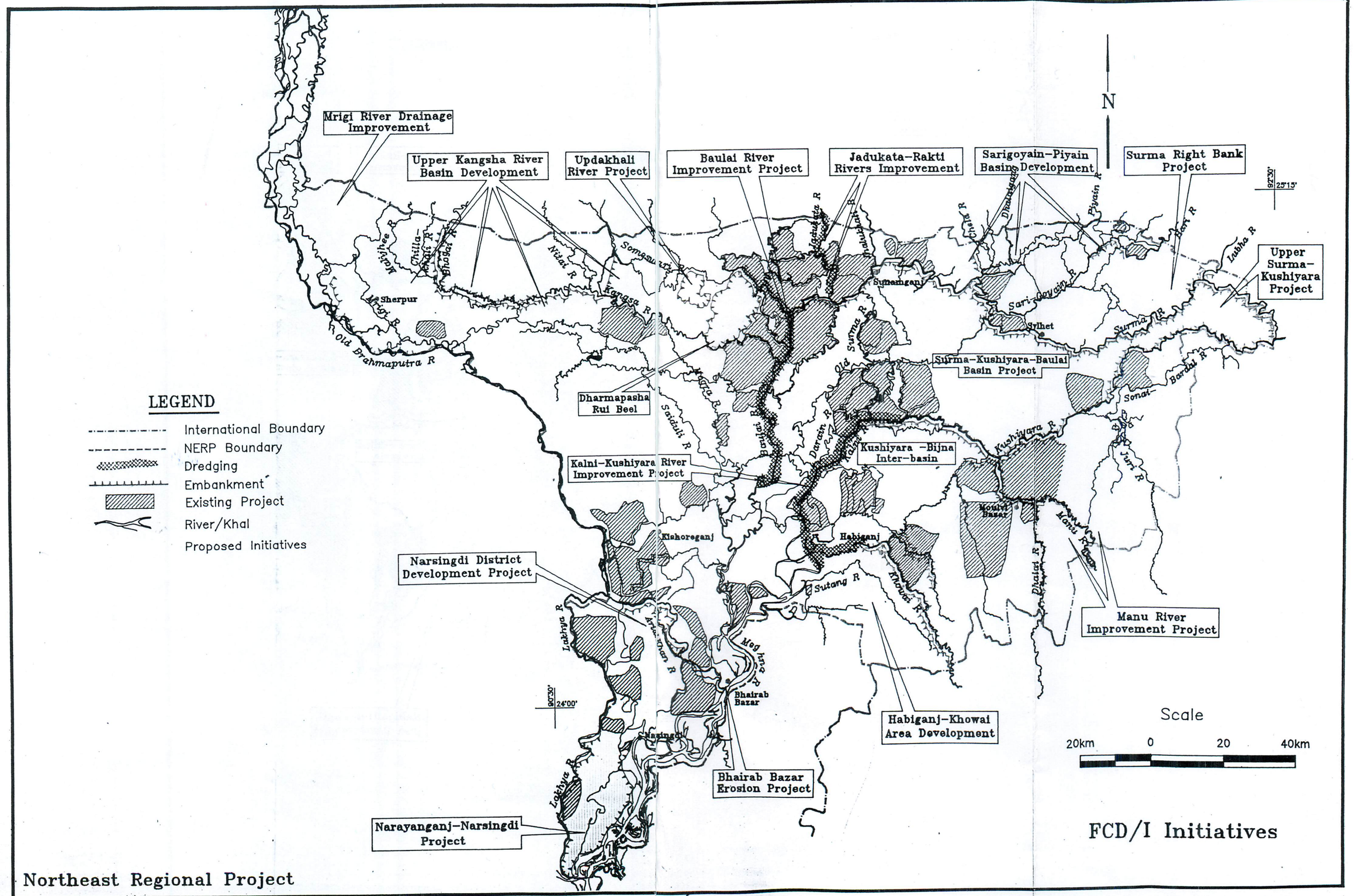


Figure 5


Mrigi River Drainage Improvement
Upper Kangsha River Basin Development
Updakhali River Project
Baulai River Improvement Project
Jadukata–Rakti Rivers Improvement
Sarigoyain–Piyain Basins Development
Surma Right Bank Project
Upper Surma–Kushiyara Project
Surma–Kushiyara–Baulai Basin Project
Kushiyara –Bijna Inter–basin
Kalni–Kushiyara River Improvement Project
Dharmapasha Rui Beel
Narsingdi District Development Project
Habiganj–Khowai Area Development
Bhairab Bazar Erosion Project
Manu River Improvement Project
Narayanganj–Narsingdi Project
N
Sherpur
Sylhet
Sunamganj
Habiganj
Kishoreganj
Bhairab Bazar
Moulvi Bazar
Old Brahmaputra R
Mogra R
Saidulli R
Lakhya R
Meghna R
Sutang R
Khowai R
Manu R
Dhalai R
Surma R
Kushiyara R
Piyain R
Barak R
Jiri R
90°30'
25°15'
24°00'
LEGEND
International Boundary
NERP Boundary
Dredging
Embankment
Existing Project
River/Khal
Proposed Initiatives
Scale
20km 0 20 40km
Northeast Regional Project
FCD/I Initiatives