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Conservation of Biological Diversity in Bangladesh: Status, Trends, and Recommended Responses

by

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EXECUTIVE SUMMARY

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Status, Trends and Recommended Responses"

An Annex of the 1989 Bangladesh
Environment and Natural Resource Assessment

Studies indicate that tropical forest-associated biodiversity in Bangladesh is most threatened. Six percent of its original terrestrial habitat remains. Fish diversity remains high, but proposed flood control activities and mangrove conversion may reduce the diversity of open-catch fisheries significantly. Approximately 5,000 species of flowering plants, 500 species of fish, and 750 species of birds live in Bangladesh.

Bangladesh has two claims to biodiversity of global importance: Bengal tigers and rice. The Sundarbans mangrove region contains the world's only genetically viable tiger population. Unique wild and cultivated rice varieties are also found in Bangladesh.

Biodiversity and tropical forests are vital to the livelihoods of people living in the delta nation of Bangladesh, yet conservation of biodiversity faces severe constraints. The subsistence needs of millions of Bangladeshis for fuelwood, fish, and cash income (a need that increases exponentially with continuing population growth), coupled with a traditional attitude that biological resources are free for exploitation, create a climate inimical to sustainable natural resource development and biological diversity conservation. Although protected areas (0.8 percent of total land area) have been designated, they do not cover all habitat types, and no management plans have been implemented. Crop germplasm conservation institutions are weak. Weak support for institutions such as the Wildlife Circle and the National Herbarium illustrates underscores the lack of concern for biodiversity. Few efforts are being made to educate the general public and decision-makers about the threatened status and value of Bangladesh's biological diversity heritage.

Bangladesh has a cadre of dedicated, hard-working and knowledgeable biologists, foresters, fishery experts, and other relevant professionals. Policy reform, commitment to policy implementation, improved enforcement of legislation, financial commitments to wise management of natural resources, and strengthened institutions may still be able to redress biodiversity depletion in Bangladesh. There are indications of a grassroots-level appreciation of biodiversity that can be tapped to build a constituency.

Primary and supporting action options are outlined. Primary action priorities are:

– protect the economically and ecologically important Sundarbans mangrove ecosystem;

– improve knowledge of the life histories and reproduction of species harvested in open-catch fisheries for evaluating flood control and irrigation impacts;

– policy dialogue on forest product pricing, constraints on private sector forestry and other policies related to biodiversity management

– build wildlife management capabilities;

– support National Conservation Strategy process;

– and improve crop germplasm conservation.

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I. Introduction

This report aims to provide an overview of the current conditions and trends affecting the conservation of biological diversity in Bangladesh. It is based on literature review, interviews, and a two week fieldtrip to Dhaka, Sylhet, Chittagong, and Cox's Bazaar. A list of indiviuals contacted is appended to this document. Information was collected during May-June, 1989. This study is an appendix to USAID/Bangladesh's Environment and Natural Resource Assessment, prepared by the Center for International Development and Environment of the World Resources Institute. The Assessment will be used as a background document to assist the USAID mission in the preparation of its five year Country Development Strategy Statement (CDSS).

Economic Importance of Biodiversity

Biodiversity and tropical forests are vital to the livelihoods of people living in the delta nation of Bangladesh. A rich diversity of native fish species are critical to the economy and diet of the people of Bangladesh, providing approximately 80% of protein consumed--an important supplement to the rice based diet. Fishery exports rank second after jute as a source of foreign exchange. Over 70% of rural families participate in part-time fishing, and approximately 1.7 million people are directly engaged in commercial fisheries. The estimated annual production of fuelwood had a market value of US$ 100 million in 1984; estimates of annual fuelwood production/consumption range to over 8 million cubic meters. Bangladesh has been one of the world's leading exporters of reptile skins, although over-explotation has led to efforts to institute a ban on the export of some skins. Management of reptile and frog populations could result in sustained production of valuable exports. Other minor forest products, such as bamboo and golpatta (nipa) palm, figure prominantly in local trade. The substantial fertilizer value of the blue-green algae and other living organisms in floodwaters that annually renew agricultural lands has not been estimated.Genetic diversity important for improving Bangladesh agricultural production includes some 10,000 local varieties of rice as well as local varieties of legumes, fruits, and vegetables cultivated for sale and household consumption. Homestead forest production (based on a wide variety of annual and perennial species) contributes between one-third and one-half of rural family incomes.

II. Biological Diversity Status and Trends

With the exception of several small island states (e.g., Hong Kong, Singapore), Bangladesh is the most densely populated country in the world. Nearly 112 million people (most of them in rural areas) live in the country's 144,000 square kilometers, or more than 760 people/kilometer (WRI/IIED 1988). The annual growth rate of 2.7 percent is one of the highest in Asia. This extreme population density has created one of the world's most intensely utilized landscapes.

At least 94 percent of the original natural habitat areas in the country have been altered (MacKinnon and MacKinnon 1986). The remaining terrestrial natural habitats are to be found in the relatively sparsely populated Chittagong Hills, the Sundarbans mangrove forest zone, a few small areas in Syihet, and forest areas near Cox's Bazaar.

The overlap of geographic ranges for Indian, Himalayan, and Southeast Asian biotas contributes to the large number of species found in Bangladesh. Approximately 5,000 species of flowering plants (angiosperms) and 1,500 species of vertebrates are found in Bangladesh, although dozens of them are threatened, endangered, or recently extinct (Table 1). Because the data base is incomplete, these figures probably underestimate the number of species that are vulnerable to extinction. Endemism is relatively low (i.e., most species that occur in Bangladesh are also found in other countries).

Table 1. Approximate numbers of species in Bangladesh, excluding invertebrates.

Class	Total #	Minimal # Extinct	Minimal # Threatened
Angiosperms	5,000	?	?
Mammals	125	10	11
Birds	750	4	13
Reptiles	124	1	9
Amphibians	19	?	?
Fish	500+	?	?

Sources: Green (1989); Rainboth (1987); W. Harvey (personal communication 1989)

Because much of the Bangladesh landscape is so thoroughly dominated by human activities, this assessment will not look at biological diversity in terms of biogeographic distinctions, but will instead provide an overview of biological diversity by resource type. Thus, following a brief overview of landforms and climate, this section will look at Bangladesh's forest-associated biodiversity; agricultural biodiversity; and the biodiversity found in freshwater, coastal, and marine areas.

LANDFORMS AND CLIMATE

Bangladesh is dominated by one of the world's greatest river deltas. The Ganges-Padma, Bramaputra-Jamuna, and Meghna river systems flow through an alluvial plain comprising 90 percent of the country's land area before emptying into the Bay of Bengal. The topography of these lowlands, sometimes refered to as the Gangetic Plain, is not entirely flat. Levees, alluvial terraces, abandoned river channels, and backswamp depressions reflect the continuous flux of these rivers, both on a seasonal basis, and on a more permanent basis as the main channels shift across the landscape. The alluvial soils are composed of sand, silt, and clay (Green 1989). Their productivity is largely the result of annual flooding and alluvial deposition, and generally not the result of an accumulation of organic matter.

Steep, dissected hill terrains are restricted to the southeastern districts of Chittagong and the Chittagong Hill Tracts, and to a lesser extent the northeastern district of Sylhet. The Chittagong Hills are comprised of a series of parallel ridges running north- south along the Burma border from southeast of Cox's Bazaar, into the Indian state of Tripura, and then reentering Bangladesh in Sylhet where they terminate just beyond the border. At their highest, the folded belt of sedimentary sandstones, shales, and siltstones reach approximately 1,000m on the Burma border. In Sylhet, the ridges are generally 60-90m above sea level before dissolving into the Sylhet plain. Bordering the hill ranges on the west are low benchlands with red, lateritic, silty clay-loam soils.

Climatically, Bangladesh is characterized as having a tropical monsoon climate with high temperatures, high humidity, and heavy rainfall in the period between May and October. As much as 6350mm of rain falls in the Chittagong Hills and Sylhet (the average is 2500mm in eastern Bangladesh), while precipitation averages 1250 mm along the western border with India.

Most of the annual precipitation occurs during the southwest monsoon, although some significant thunder showers occur in April and May preceeding the monsoon. Cyclonic storms are generally associated with the monsoon season as well as the periods just preceding and following the monsoon, and are an important climatic feature of coastal areas.Temperatures typically range between 21 degrees C and 34.5 degrees C during the summer months. The winter months of November to March are cooler and relatively dry. Temperatures during this time range from an average minimum of 11.2 degrees C to an average maximum of 28.9 degrees C, while precipitation throughout the country during the winter rarely exceeds 50mm.

LAND USE

Tree cover is found on 19,915 km2, floodlands cover 28,350 km2, ponds, tanks, and ditches cover 9,158 km2, rivers and canals cover 8,300 km2, wetlands (haors, beels, and baors) cover 4,180 km2, estuaries cover 1,834 km2, and artificial lakes and irrigation canals cover 968 km2. Cultivatable land including floodlands is 82,000 km2. Non-urban housing covers 4,000 km2. (Bangladesh Statistical Yearbook 1986).

FOREST-ASSOCIATED BIODIVERSITY

Before human populations in what is now Bangladesh began to grow following the widespread introduction of agriculture, it is reasonable to speculate that nearly all land areas were forested. The floodplains and lowlands that constitute most of this area were forested by moist/dry deciduous or sal (Shorea robusta) forests (Green 1989). In coastal areas with acid-sulphate soils, and tidal flooding, extensive tracts of mangrove forest were found, dominated by sund'ri (Heritiera fomes), gewa (Excoecaria agallocha), and Golpotta palm (Nypa fruticans) (Snedaker 1987). In the Chittagong Hills, most areas were forested with tropical evergreen/semi-evergreen forests including Dipterocarpus spp., Artocarpus spp., Eugenia spp., and Ficus spp. (Sarker and Fazlul 1985). Finally, in low basin areas in northeast Bangladesh, where the ground is submerged during much of the monsoon, freshwater swamp forest dominated by Barringtonia acutangula and Trewia nudiflora were found in scattered areas.

Today, estimates of the remaining natural forest in Bangladesh total less than 4 percent of the country's land area (Gittins and Akonda 1982). An additional 4-6 percent of the land area is forested with plantations or substantially degraded natural forest areas. What remain of the natural forest habitats are limited to the Chittagong Hill Tracts, the Sunderbans, and areas in Sylhet and the Cox's Bazaar area.

These habitats are the last strongholds in Bangladesh for many species, the most prominent of which include the Indian elephant, Elephas maximus, Bengal tiger, Panthera tigris, spotted deer, Axis axis, oriental small-clawed otter, Aonyx cinerea, and the Hoolock gibbon, Hylobates hoolock (Green 1989).During the last century, at least a dozen forest-dwelling vertebrates have become locally extinct including the wolf, Canis lupus, two species of rhinoceroses, Rhinoceros spp. and Didermocerus sumatrensis, wild buffalo, Bubalus bubalis, swamp deer, Cervus duvauceli, and Bengal florican, Eupodotis bengalensis (Green 1989). In 1979, the estimated population size of the eight species of non-human primates indigenous to Bangladesh was 140,000 (Gren, 1978). Reduction in forest habitat and illegal harvesting over the past decade have resulted in decreasing populations of these primates, although exact figures are not available.

Since the remaining sal forests, which were once the most extensive in Bangladesh, have been reduced to such widely scattered, very small, and highly degraded fragments, it could be argued that they no longer harbor significant biodiversity resources. The freshwater swamp (haor) forests are likewise very small. These haors are, however, used by many migratory bird species at certain times of the year. They will not be further described in this document.

A. Tropical Evergreen/Semi-evergreen Forests

The tropical evergreen/semi-evergreen forest (sometimes referred to as Burmese rainforest) in the eastern part of the country is where much of the forest-associated biological diversity in Bangladesh is found. This forest harbors many more species than does the Sundarbans mangrove and has the highest level of species diversity of any terrestrial habitat in the country. The forest is typically a mixture of more than 100 species of tropical evergreen and deciduous trees (de Milde, et.al. 1985). Among the tree species found in these rugged Chittagong Hill areas are Chapalish (Artocarpus chaplasha), Telsur (Hopea odorata), Civit (Swintonia floribunda), Garjan (Dipterocarpus spp.), Narikel (Sterculia alata) and Koroi (Albizzia spp.; Rashid 1967). Dense thickets of bamboo (most often Melocanna bambusoides and Bambusa tulda) are also frequently associated with these forests.

Wildlife associated with Chittagong forest areas is diverse, but increasingly rare, particularly the primates and carnivores. Primates include the slow loris (Nycticebus coucang), the capped monkey (Presbytis pileatus), rhesus macaque (Macaca mulatta), and the hoolock gibbon (Hylobates hoolock).

At present, the tiger (Panthera tigris) may already be locally extinct in these forests, and the leopard (Panthera pardus) is threatened (Green 1989). Several smaller cats including the leopard cat (Felis chaus), clouded leopard (Neofelis nebulosa), marbled cat (Felis marmorata), and the golden cat (Felis temminckl) that inhabit these forests are all thought to be endangered or threatened. Three species of bear are thought to inhabit the hill areas including the Asiatic black bear (Selenarctos thibetanus), the Malayan sun bear (Helarctos malayanus), and the sloth bear (Melursus ursinus). Several civets are also found in these areas.

Large hoofed animals are increasingly rare in the diminishing forest areas of eastern Bangladesh. The gaur (Bos gaurus) is internationally endangered, and the benteng (Bos benteng), and the serow (Capricornis sumatrensis) are listed as endangered in Bangladesh. The serow is, however, reported by some to be relatively common in some remote areas of Chittagong Hill Tracts.. The wild buffalo (Bubalus bubalis) is believed to be extinct. Two deer species are still relatively common, the spotted deer (Axis axis) and the barking deer (Muntiacus muntiak), while the hog deer (Axis porcinus), and the sambar (Cervus unicolor) are less common. The wild boar (Sus scrofa), is reported to have become increasingly rare in many areas where it was previously plentiful.

Wild Indian elephants (Elephas maximus), once common to most forested areas in the country, are now on the verge of extinction in Bangladesh. Although there are various estimates of the elephants remaining, it appears that no more than 150 are resident in Bangladesh, with an indeterminate additional number crossing back and forth along the border with Burma. One group of approximately 32 resident elephants is isolated in the Chunati Wildlife Sanctuary in southeast Bangladesh. Few management options are available, and discussion centers on capture and domestication for use by the Forest Department (Woodford, 1988). Only the relatively undisturbed forest areas at Sangu in extreme southeast Bangladesh and forests in the Kasalong reserve forest appear to have enough habitat available to sustain an elephant population.

Many of the 28 species of bats reported for Bangladesh are found in the Chittagong area. Several porcupine, squirrel, shrew, rat and mice species occur in the region, although it is difficult to gauge the population status of any of them.

Avifauna in the Chittagong area is varied. Many of the 750 species in Bangladesh can be found in the Chittagong area. While most of the 13 bird species listed as threatened or endangered are wetland birds, the continuing diminution of forest habitats is contributing to the declining abundunce of a number of woodland species including the peccock pheasant (Green 1989). Bird species that are entirely arboreal and frugivorous (fruit eaters) are especially vulnerable, such as the green pigeons, including the magnificent green imperial pigeon.

Among the reptiles living in the Chittagong forest areas, several are listed as threatened or endangered. The Indian python (Python molurus), once common throughout the area is now considered vulnerable (Green 1989). Several turtles in the area may also be threatened or endangered.

While sacred gardens are not maintained in Muslim-dominated areas, they have been reported from tribal areas in the Chittagong Hill Tracts.

The forest-associated diversity in CHT and Sylhet has decreased over the past fifty years due to widespread and nearly continuous disturbance. The disturbances were especially severe with timber extraction during World War II troop movements and during the period following the War of Liberation (1971 - 1973). In the CHT, another major disturbance followed the construction of Kaptai dam (late 1960s), which displaced tribals from approximately 40% of their best agricultural land. This made them resort to using more extensive tracts of agriculturally-marginal forested lands, which contained tropical forest associated diversity, thereby disturbing the balance of indigenous land-use (A.S.S. 1984; Burger 1987).

In addition, Forestry Department harvest procedures commonly involve clear cutting followed by burning and then planting of single species plantations. In recent years there has been an emphasis on short rotation species. Plantations of short rotation species support even less wildlife and plant diversity than do long rotation plantation plots. Wildlife is severely affected by the replacement of natural forest and long rotation mixed hardwood plantations by short rotation monoculture plantations, which provide a sterile habitat for many of the species formerly there.

In the areas deforested for tea plantation development, "hot slopes" (south facing hill slopes that cannot be planted in tea) support a very depauperate association of weeds and sun grass (Imperata sp.). Nonetheless, on some tea plantations, one finds scattered secondary forest patches that continue to support birds (such as the red jungle fowl, and migratory tree-nesting and frugivorous birds) and other forest-associated wildlife.

B. Sundarbans Mangrove Ecosystem

The mangrove-dominated Ganges delta is one of the largest single tracts of mangrove forest in the world. Except for parts of the Chittagong Hills, it is also the only area in Bangladesh with significant natural habitat for wildlife. Intersected by a complex network of tidal waterways with varying degrees of salinity, the Sundarbans is home to several globally endangered species including the tiger (Panthera tigris) and the estuarine crocodile (Crocodylus porosus).

Covering approximately 5,770 km2, the Bangladesh Sundarbans is a unique and highly productive wildlife habitat situated at the interface of the Ganges and Brahmaputra watersheds to the north, and the Bay of Bengal to the south (Woodford 1988). Reaching nearly 80 kilometers inland from the sea, the Sundarbans ecosystem is found along a nearly 200 kilometer stretch of the Indian state of West Bengal and southwestern Bangladesh. It constitutes nearly one-half of the reserved forest lands in the country administered by the Forest Department (Das and Siddiqi 1985).

Mangrove forests are salt-tolerant ecosystems generally flooded with brackish water during high tides. Within the Sundarbans ecosystem, about two-thirds of the area is solid land while the remaining third consists of rivers, channels, and other watercourses (UN/ESCAP n.d.). Large volumes of freshwater from inland rivers mix with tidal incursions from the sea in this area, which dominates the regulation of mangrove forest ecosystems.

Because of the saline conditions, the forest flora of the Sundarbans is not diverse. Forest areas are dominated by a few species, most notably sund'ri (Heritiera fomes), gewa (Excoecaria agallocha), goran (Ceriops decandra), keora (Sonneratia apatala), and nypa or golpotta palm (Nypa fruticans). An additional 25 species are relatively common, but considerably less frequent in occurence (UN/ESCAP n.d.). Forest areas in the eastern and northern parts of the Sundarbans, which are better supplied with fresh water, are richer floristically than the more saline areas to the west and south.

The fauna of the Sundarbans, however, is relatively diverse. Unfortunately, wildlife in the area, like that in the Chittagong Hills, is under mounting pressure from overexploitation and habitat degradation. It is the most important habitat left for the long-term survival of the Royal Bengal tiger, Panthera tigris, and the estuarine crocodile, Crocodylus porosus (Seidensticker 1987).

Of the forty mammal species known to have occurred in the Sundarbans at the turn of the century, five are now extinct: the Javan rhinoceros (Rhinoceros sondaicus), wild buffalo (Bubalus bubalis), swamp deer (Cervus duvaucelli), gaur (Bos gaurus), and the hog deer (Axis porcini). The tiger population is estimated to range between 350 and 600 individuals. This population is the largest left in a natural environment, and may be the only wild population that is "genetically secure" (Woodford 1988). Although an average of 22 people a year have been killed by tigers since 1948, only five declared man-eaters have been shot by the Forest Department under provisions of the 1973 Wildlife Act that allows for the control of man-killers (Woodford 1988).

Other large mammals found in the Sundarbans and their estimated populations include the spotted deer, primary prey for the tiger (Axis axis; 40-80,000), wild boar (Sus scrofa; 20,000), smooth Indian otter (Lutra perspicillata; 20,000), and the Rhesus macaque (Macaca mulatta; >40,000). It should be noted that these estimates are very much in the realm of guesswork (Woodford 1988). It should also be noted that these populations are effectively isolated and not open to genetic exchange with other populations.

Reptiles are an important part of the fauna in the Sundarbans and total at least 35 species. Several of them are threatened or endangered including the estuarine crocodile (Crocodylus porosus), Indian python (Python molorus), and several species of turtles and monitor lizards (Green 1989; UN/ESCAP n.d.). The mugger crocodile (Crocodylus palustris) is now extinct. Five marine turtles are thought to frequent the Sundarbans coast. Eighteen species of snakes are in the area, more than half of which are venomous including the king cobra (Ophiagus hannah), spectacled cobra (Naja naja), three vipers, and six sea snakes.

650 species of birds have been recorded in Bangladesh, and another 100 species are probably present (Harvey personal communication 1989). At least 186 species are known to occur in the Sundarbans, including 95 species of waterfowl (mostly migratory) (Green 1989).

Several of the more notable of the 38 species of raptors include the magnificent and relatively common white-bellied sea eagle (Haliaeetus leucogaster), Pallas's fish-eagle (Haliaeetus leucoryphus), and the very rare grey-headed sea eagle (Ichthyophaga ichthyaetus). At least nine of the dozen kingfishers in Bangladesh frequent the area. Numerous wading species of herons, egrets, storks, sandpipers, and curlews can be seen on sandbanks and waterways (Green 1989). Woodland birds in the Sundarbans include woodpeckers, barbets, drongos, mynahs, minivets, and babblers.

Integral to the ecosystem is the diversity of fish and crustacea found in the area. These species will be discussed in the section on freshwater, coastal and marine diversity.

The Sundarbans area biodiversity is threatened by industrial pollution from upriver, shrimp-pond conversion projects overharvesting of timber (Blower 1985), and decrease in freshwater flushing so necessary for the reproduction of many species.

FRESHWATER, COASTAL AND MARINE BIOLOGICAL DIVERSITY

Wetlands are a major component of Bangladesh. At least 50% of the country can be classified as wetland during part of the year. Wetlands include rivers, streams, shallow freshwater lakes and marshes replenished by annual floodwaters (haors, baors, and beels), water storage reservoirs, seasonally flooded cultivated plains, fish ponds, and mangrove swamps (see Sundarbans forest described above) -- a total of between seven and eight million hectares (Scott and Poole, 1989). These wetlands provide critical habitat for birds and ducks as well as for fish and other aquatic biota. The Sylhet haors are on the migration flyway of Siberian ducks and geese which feed in Bangladesh wetlands between October and March (Kabir, 1989). A recent review of Asian wetlands (Scott and Poole, 1989) and a directory of Bangladeshi wetlands (AWB, 1989) includes further detail on the Bangladeshi wetlands and the biodiversity they support.

Rivers are the dominant feature of the Bangladesh landscape Much of the country is comprised of the deltas of the three major river systems, the Ganges-Padma, the Brahmaputra-Jamuna, and the Meghna. In all, there are more than 230 major inland waterways, most of them tributaries or distributaries of the three major river systems (Bangladesh Bureau of Statistics 1987). Bangladesh has some 580 kilometers of coastline along the Bay of Bengal (Library of Congress 1980). Nearly 1,800 km2 of the Sundarbans ecosystem is comprised of river channels, estuaries, and other watercourses.

Tropical fish communities are, in general, highly diverse and Bangladesh is no exception. Estimates on the number of fish species found in Bangladesh vary widely. Rainboth (1987, personal communication 1989) estimates there are well over 500 fish species in the freshwater, estuarine, and coastal waters of Bangladesh. This does not include species from forest rivers and streams in the Chittagong Hills, which are largely undescribed. By comparison, only 250 species are known to inhabit the entire Mississippi basin (Rainboth 1987).

Fish species known or suspected from the estuaries of Bangladesh come to nearly 400 species (Rainboth 1987). Not all of the species are permanent residents of the Sundarbans and other estuarine areas. Many are freshwater fish that use these habitats temporarily during periods of peak runoff, spending most of their life cycle inland. Other species spend much of their life cycles in offshore waters, but depend on the use of mangrove forests for nursery areas. Because of their importance to fish species that spend most of their lives in other waters, the aquatic habitats of the Sundarbans and other estuarine areas are essential to the productivity of both inland and coastal fisheries.

Among the 83 fish families found in estuary habitats in Bangladesh are the Requiem sharks, Carpet sharks, Hammerhead sharks, Swordfishes, Stingrays, Eagle rays, Guitar fishes, Ladyfishes, Tarpon, Bonefishes, Freshwater and Moray eels, Pike congers, Snake eels, Herrings and Shads, Anchovies, Featherbacks, Lizardfishes, Milk-fishes, Carps, Sea-catfishes, Freshwater-catfishes, Needlefishes, Halfbeaks, Barracuddas, Gouramies, Halibuts, Tuna and Mackerals, and Soles. A complete list of these species is found in Rainboth (1987). Various species of prawn, lobster, crabs, and shrimps contribute to the diversity of crustacea found in estuarine habitats.

Some sources indicate that as much as 90 percent of the fish caught in Bangladesh comes from inland, or freshwater habitats (Library of Congress 1980); others suggest the inland fish catch to be closer to 70-75 percent of the total (Bangladesh Bureau of Statistics 1988). Somewhat over 100 species of strictly freshwater species have been identified in the inland river systems (Rainboth 1987), but this is certainly an underestimate due to the fact that rivers in the Sylhet and Chittagong areas have not been systematically sampled, and that sampling in other areas has been biased toward collecting commercial fish species (Rainboth 1987).

Little information could be found on the marine fish species in coastal Bangladesh. It is known that many frequent estuarine areas, including the Sundarbans for periods of time, most notably for nursery purposes.No information was available on the status of open water marine fish species in the northern Bay of Bengal. It appears that offshore fishing by Bangladesh and trawlers from Thailand and India does not fully exploit the marine resource base at present.

The only coral reef area is found about 8 km from the southernmost extremity of Bangladesh surrounding St. Martin's Island. Although scientific knowledge of the area is limited, it is believed to be a submerged reef (Wells 1988). Shell and coral collection, for the tourist trade in Cox's Bazaar, has apparently destroyed parts of the reef, and sewage effluents, dynamite fishing, and recreational pressures also are contributing to its degradation (UN/ESCAP n.d.). St. Martin's Island has been proposed as a marine park, in part because it is an important nesting area for the olive ridley (Lepidochelys olivacea) and green turtles (Chelonia mydas), and an important wildfowl wintering area (Wells 1988).

While the effects of human activity on habitat loss and the erosion of biological diversity are readily apparent in terrestrial environments, human impacts on aquatic resources are much less visible (Rainboth 1987). Many of the impacts that affect terrestrial diversity also damage the habitat for fishlife in the inland and coastal waters. Such activities including agrochemical and sewage pollution, irrigation and flood control projects, deforestation, siltation, boulder harvesting, and the loss of "terrestrial" wildlife that interact with the aquatic ecosystems all contribute to changes in the diversity and productivity of fisheries that are such a vital part of Bangladesh's economy and diet.

AGRICULTURE-ASSOCIATED DIVERSITY

Bangladesh's landscape is primarily agriculturally managed. Diversity in this landscape includes crop germplasm, livestock genetic resources, and the species and communities of wild animals and wild plants adapted to agricultural regimes. It was estimated that some 60 to 70 species of wild plants could be found in an average hectare of cultivated land, albeit often in small populations. Agriculture-associated wild species are found in rice fields, in homestead orchard-gardens (a.k.a. "village forests"), along roadsides and bunds, on riverbanks, at the edges of ponds, in the marshy low areas in haors/beels, in the secondary growth associated with "hot slopes" of newly opened tea plantations, and in the tribally-managed secondary growth used to support pan (Piper sp.) vines.

As part of the Gangetic Plain and Southeastern Asian center of variation, Bangladesh has been home to germplasm resources of some of the world's most important crops: pigeon pea, eggplant, sugarcane, mango, rice, banana, citrus, yam, taro, tea, cotton, and sesame.IBPGR priorities for crop germplasm conservation in this region are: okra, eggplant, cucurbits, citrus, banana, mango, jute, onion, garlic, grain legums, sweet potatoes, and oil seed Brassicacede (Arora, 1989). Agricultural conversion of lands, modernization of agriculture, and adoption of modern varieties has contributed to the depletion of these resources upon which future agricultural advances may well depend. The degree of genetic erosion is not documented. Knowledge of the status of most germplasm resources is limited. The status of rice is best known.

Eighty percent of Bangladesh cropped land is planted in rice in four distinct growing seasons. Surveys indicate that 32 percent of the rice currently planted is of modern varieties (MV). The remainder are traditional varieties or improved traditional varieties. Indications are that the area under MV is expanding. An upazila by upazila survey in 1980 compiled a list of 10,000 traditional cultivar names. Based on a cursory examination of that survey, researchers at Bangladesh Rice Research Institute (BRRI) estimate that there are 10,000 varieties of rice being planted in Bangladesh. These include particularly interesting fragrant rices, salt-tolerant rices, and deepwater rices. In addition, wild and weedy rices of genetic importance, some of them of limited distribution, are found in Bangladesh.

Livestock and forestry genetic resources are not well documented. The red jungle fowl, ancestor of the modern chicken, is native to Bangladesh, but populations are diminishing. The mithan, a domesticated gaur, is kept by hill tribes in the Chittagong Hill Tracts, but the status of those populations is unknown. The mithan has been used to crossbreed with cattle in Bhutan to increase their size and butterfat content of the milk, and is of potential value for genetic improvement of cattle in the tropics (NAS, 1983). Other native livestock and wild relatives (such as gaur, wild buffalo) are also becoming rare or are already extinct within Bangladesh.

Virtually nothing is known of the soil fauna and microorganisms important to agricultural production. Nor are insects, outside of major pests, well described.

Institutional Players: Mandates, Capacity and Funding

Biodiversity depletion is not yet perceived as a major issue in Bangladesh, and as a consequence the institutional base for biodiversity management is undeveloped. Institutions for gathering information about the status of biodiversity exist, but they are underfunded. There is no central coordinating body to direct the biodiversity research activities of these institutions. Nonetheless, there does exist a small core of qualified and dedicated individuals capable of gathering information and developing biodiversity management plans if given the opportunity. No public institution has a significant mandate to manage or conserve biodiversity. There are no major NGOs or other private sector institutions devoted to biodiversity concerns. Conservation of biodiversity requires that long term planning be institutionalized as biodiversity-related institutions are strengthened in other ways.

INSTITUTIONS THAT AFFECT BIODIVERSITY

Public Sector

The same institutions that affect the implementation of any type of policy or program affect biodiversity conservation. For more information on important GOB institutions with a role to play in the conservation of biodiversity and natural resources management, see separate appendices on institutions and NGOs.

Private Sector

Tea plantation owners probably represent the only private sector group interested in wildlife maintenance. Together they manage a large block of Sylhet land (several hundred thousand acres) bordering Bangladeshi and Indian forest lands. They are currently de facto primary stewards for biodiversity in the Sylhet region. They are organized into clubs and have an interest in birding, hunting, and other wildlife related sports (rather similar to British gentry). They do not have, however, a formal club dedicated to wildlife sports. It was estimated that 100,000 acre of tea plantation lands could be dedicated to forested corridors for wildlife to move between forest department lands. If tourism and hunting were encouraged in Sylhet, it might be profitable for tea plantations. (Wild bird and venison command high prices.) Land use constraints on leased government lands and constraints on private forestry currently limit actions by this private sector.

The private sector concerned with harvest of aquatic diversity (fish, shrimp, crabs, frogs, etc) was not contacted as part of this limited assessment. Their concerns and opportunities for activities with them are not explored here, but should be considered by those planning biodiversity activities.

SPECIFIC INSTITUTIONS DIRECTLY INVOLVED IN CONSERVATION AND MONITORING OF BIODIVERSITY

Crops

The Bangladesh Agricultural Research Council (BARC) is currently considering actions to meet the need for national crop germplasm security, but there is as yet no national crop germplasm conservation system.Major activities in crop germplasm conservation are carried out by several institutions responsible for specific crops (Bangladesh Rice Research Institute, Bangladesh Jute Research Institute, Bangladesh Tea Research Institute, and the Sugarcane Research and Training Institute). In addition, Bangladesh Agriculture Research Institute (BARI) has responsibility for all crops not covered by crop-specific institutions.

The Bangladesh Rice Research Institute (BRRI) is a comparatively strong research institution linked with IRRI. In 1985, the BRRI germplasm bank moved into a modern facility built with assistance from JICA. The facility includes short term storage (20-22 degrees C) for active collections and medium term (0-5 degrees C) storage units to accomodate 10,000 accessions of base collections. BRRI currently holds 5,000 accessions of rice, and researchers indicated that probably 4-5,000 more accessions would give them a good representation of Bangladesh's rice resources. The actual number of varieties covered by existing accessions is not known, but some duplication is likely.

IRRI has expressed concern that Bangladeshi rice germplasm collections are still incomplete. IRRI annually sends one scientist to lead a four week national collecting expedition. Duplicates from collecting expeditions in Bangladesh are deposited in BRRI. A computerized database system is under development. Currently four scientists (no PhDs) are working with germplasm conservation and evaluation. BRRI has sent Bangladeshi researchers to IRRI for training in germplasm conservation. The director felt that they needed more people working in evaluation. It has been proposed that the BRRI germplasm conservation unit be separated from the plant breeding unit and be given better funding.

At present, collection efforts are severely limited by lack of travel support and vehicles. It appeared that there were no specific plans to cover the costs for maintaining the new facility (interviewee stated that it depended on having people interested in germplasm involved in the annual budget process). Back up generators were in place, but voltage regulators were only being used on a few of the storage units. The gene bank building contains facilities for quarantine, drying, and fumigation. Land is available for the growing and evaluating of accessions. A small tissue culture lab is also part of the facilities.

BRRI makes no effort to monitor the status of wild rice populations or trends in loss of traditional varieties. No in situ reserves are maintained or planned. Ex situ banking is their only response to the need for germplasm conservation.

The Bangladesh Jute Research Institute began operating a large gene bank with medium (14 degrees C) and long term (-20 degrees C) storage units in 1982.Capacity is 100,000 accessions. Sugarcane and tea collections are maintained in living clonal collections in their respective institutes.

The Genetic Resources Division of the Bangladesh Agriculture Research Institute (BARI) (physically adjacent to BRRI) has been charged with conserving the germplasm of 156 crops (not including cultivated fruit trees, estimated at over 60). Systematic collections were begun after the division's establishment in 1983. They currently have 1,125 accessions from 56 crops. Their major focus has been on collection and evaluation of pulses. GTZ funded the installation of one long-term cold storage walk-in unit with back up generator and dehumidifier. A medium term walk-in unit supplied by IBPGR remains unassembled due to a lack of some parts (which IBPGR reportedly refused to supply). The core staff of the Genetic Resources Division includes five scientists and ten support staff. The budget varies from year to year. BARI's Genetic Resources Division is quite weak despite its possession of a long term storage unit.

Livestock and Fish Farm Genetic Resources

Facilities dedicated to conservation and evaluation of livestock and fish farm genetic resources were not visited. Reportedly they are, as in most countries, less well developed than those for crop germplasm.

Wild Plant and Animal Biodiversity

Institutions concerned with wild plant and animal diversity are likewise weak despite a cadre of well-trained biologists who are ready to do significant work if funded. The National Herbarium, the National Botanical Garden, and the Forestry Research Institute are the main entities involved in plant conservation. The Zoology Department of Dhaka University is the major entity involved in animal conservation.

During the British colonial period, information on the plant diversity was not maintained by any institution situated within the current borders of Bangladesh. The National Herbarium in Dhaka was established in 1970 when Bangladesh was still part of Pakistan in order to carry out a five year Botanical Survey. Following the 1971 War of Liberation, the interrupted survey was renewed as the Botanical Survey of Bangladesh. BARC, the umbrella agency under which the herbarium is currently administered, issued a five year contract to the herbarium and provided it with a rented house for its collection. In 1989, they are still housed in a rented building which accommodates twenty cabinets and 100,000 specimens (no bryophytes, algal or fungal collections). There are no air conditioning units or dehumidifiers, and insect infestation prevention is difficult to achieve under current conditions.The library, of critical importance for the work of an herbarium, is very small. Thus, the physical facilites, and the collection itself are poor for a national herbarium. Current annual budget for salaries, field trips, and maintenance is at the level of one million Taka per year. International activities are minimal. Specimens are exchanged with Edinburgh, Calcutta, and Kew. Five to ten botanists from other countries visit the Bangladesh National Herbarium each year.

The staff is well trained and dedicated. At present, there is no director, because there is no one qualified to take the position who is willing to give up his/her current position. There are approximately ten active plant taxonomists in Bangladesh today, and ten students in training.

The Flora of Bangladesh, in preparation since 1971, has produced 36 fascicles covering 48 families (the smallest families). The flora itself includes some 5,000 angiosperm species in 186 families. In addition, the staff of the herbarium have published numerous articles (many of them in the Bangladesh Journal of Botany) as well as books including The Aquatic Angiosperms of Bangladesh, Fiber Plants of Bangladesh, Timber Plants of Bangladesh, the Medicinal Plants of Bangladesh and others.

A tentative list of 30 endangered species has been drawn up, but no field studies have been done to assess population sizes and status due to insufficient funding. The herbarium has no vehicle, but ten collecting trips are carried out each year. Constraints to collecting and monitoring the flora also include civil unrest in the Chittagong Hill Tracts, the least botanized part of the country. The herbarium is, however, initiating an ethnobotanical studies program in anticipation of easing tensions in the CHT so that botanists will be able to collaborate with tribals to document the flora and its utility.

The acting director identified three priorities for the herbarium. Most important is increased training of plant taxonomists to carry out the work. Second is public education in conservation and the implementation of a conservation strategy. Third is an inventory of the economic and ecological utility of the Bangladesh flora, including continued taxonomic research to complete the Flora of Bangladesh. In order to achieve these goals, the herbarium and ODA (British Overseas Development Agency) have submitted a proposal for a project to strengthen the herbarium over a five year period. The project, submitted to the Ministry of Education through BARC, is still under consideration by the Bangladeshi government (Secretary of Forests was looking at it and then it is destined to travel to the Planning Commission, then GOB will submit a formal proposal to ODA), will include a permanent building, a library, staff training, and a vehicle. The fate of this proposal hinges on the Forestry Department's willingness to allow the herbarium to build and maintain a permanent building at the National Botanical Garden (analyzed below) that the Forest Department operates. Speculation has it that the Herbarium and Botanical Garden may well be placed under the proposed Ministry of Environment that could be attached to the Ministry of Agriculture or to Science and Technology under the Ministry of Education.

The National Botanical Garden functions as a recreational area under the Forestry Department management. Visitor numbers range from 1,000 per day in the summer to 20,000 per day in winter. Budget, including salaries, is approximately 2,500,000 Taka per year. The garden is not managed as an extension, research, or ex situ conservation unit. It produces no publications and has no classrooms. It was established in 1963 and covers an area of 208 acres. The British contractor who planned the garden's development in 1963 included plans for facilities for carrying out educational and conservation activities. Currently efforts are being made to have those facilities constructed as an alternative to accepting the Herbarium's move. If current activities are any indication, it is unlikely such facilities would be properly utilized by Garden staff.

The Garden contains 730 species, primarily exotics. Individuals from a few endangered tree species have been planted on garden property. It does not exchange materials with other national gardens. Police are currently encamped on the Garden grounds to protect workers who are attempting to build a dike to protect the Garden against floods. The flood of 1988 destroyed many of the plantings, including the medicinal plant garden. Neighboring landholders are vigorously opposing the construction of this dike.

The Forestry Research Institute at Chittagong is also a major institution concerned with botanical diversity, primarily forest trees and bamboo. FRI's major client is the Forestry Dept, but NGOs and pulp/paper industries are also clients. FRI was supported by USAID in the 1950s and 1960s, and FRI has developed into one of the premier research institutions in Bangladesh. It has a good sized, capable and dedicated professional staff who are concerned about the depletion of forest biodiversity. The FRI Master Plan includes germplasm conservation as one of its objectives, but funding for this activity has been limited.

Ex-situ conservation efforts include a four hectare plantation of seven endangered tree species, nursery propagation of endangered tree species, a major bamboo garden (.5 ha) containing 29 species (some of which have yet to be identified) including 42 genotypes of 12 species which have different genetically determined flowering times, an arboretum, an arboretum of cane, and a 2 acre medicinal plants garden. Ex situ conservation efforts are limited by the availability of land.The Forestry Department has not given them appropriate land for ex situ plantings (e.g., last year it offered them a plot on Indian border in Chittagong Hill Tracts (CHT) that they are unable to monitor due to restrictions on travel in CHT). FRI needs land near Chittagong on which to build an ex situ conservation center. FRI herbarium contains 10,000 specimens of timber species. A wood sample library is also maintained. There are plans to publish a Forest Flora of Bangladesh; a checklist of forest flora has been completed.

The University of Dhaka and Chittagong University stand out as institutions involved in zoological surveys. Husain has documented the history of wildlife conservation in Bangladesh and provided a bibliography of major works on the taxonomy, status and distribution of wildlife in Bangladesh (Husain, 1986). Currently, the University of Dhaka is involved in two major projects: migratory ducks of Sylhet, and an inventory of the wildlife of Chunati Sanctuary near Cox's Bazaar. These types of regional studies are badly needed. The Wildlife Society of Bangladesh and the Bangladesh Bird Preservation Society are both housed in the Zoology Department of the University of Dhaka.

A zoo does exist in Dhaka, but its effective function is limited to public exhibition (i.e., no effective ex situ conservation function).

A survey of the status of the birds of Bangladesh by interested individuals is nearing completion (William Harvey personal communication 1989). There has been no field-based national bird list, but the ongoing survey, begun in 1971, is based entirely on confirmed field sightings. Findings indicate that previous workers have significantly underestimated the avian diversity of Bangladesh. Sightings have been entered into a computerized data base and publication is expected in the near future. To date, some 650 species of birds have been identified and another 100 species are strongly suspected of being present. In addition, Chittagong Hill Tract species are not well documented due to restrictions on travel in that area. The Forest Department, the Asian Wetland Bureau of the Institute for Advanced Studies of the University of Malaysia, and the Nature Conservation Movement of Bangladesh recently initiated an effort to improve Bangladesh's status as the least well known area in Asia in regard to wetlands and migratory waterbirds (Bakewell and Howes, 1989).

Apparently, institutions dedicated to fish diversity are relatively weak based on this brief assessment. Most fishery institutes emphasize improving production of a few taxa. Taxonomic work and fish reproductive studies are poorly supported beyond the limited purview of aquaculture research institutions. One institution recommended for its dedicated staff and basic collection is the Chandpur Freshwater Fisheries Institute on the Meghna River. Chittagong University includes a unit dedicated to marine fisheries that was recommended as an institution capable of research into marine diversity.

There are no outstanding collections of fish specimens and limited taxonomic work has been done. Identifications are often based on natural history work done decades ago by one Indian scientist. This basic lack of taxonomic knowledge severely limits one's ability to carry out the fish distribution and life history surveys that are essential for monitoring the status of fish biodiversity. In addition, few Bangladeshi researchers are trained in carrying out research to monitor fish migration, reproduction, and population dynamics. The species of open catch fish fry industries and open catch fisheries are poorly known. The lack of basic taxonomic and ecological research, and any strong institutions that support that type of research, make it impossible to assess accurately the impact of new technologies, flood control structures, and pollution upon the remarkable fish diversity of Bangladesh.

Forests and Wildlife

The Forest Department is charged with carrying out wildlife management as well as forest management. In 1989, soon after this assessment was completed, a separate Ministry of Environment and Forests was established. It is not known to what degree this will influence the institutional aspects of wildlife and forest management.

(See separate appendix on forestry for more information on the institutional structure and capacity of the Forest Department; the following comments are specifically related to the Forestry Department's mandate and capacity to manage and monitor the biodiversity of plants, wildlife, and fish. That capacity is, however, related to the structure and functioning of the Forest Department as a whole.)

The Forest Department is designed to operate as it did during the British colonial period. Forests are categorized as : 1) reserve forests (all activities regulated by Forest Dept.); 2) protected forests: (a few activities prohibited but collection of firewood is permitted), 3) unclassified state forests (originally the natural mixed forests, no activity prohibited). The extent and management of these lands is elaborated upon in the NRA forestry section. There is no institutional unit designed to monitor and protect populations of natural forest species. Nor are management regimes designed to ameliorate the impact of logging on natural forest species.

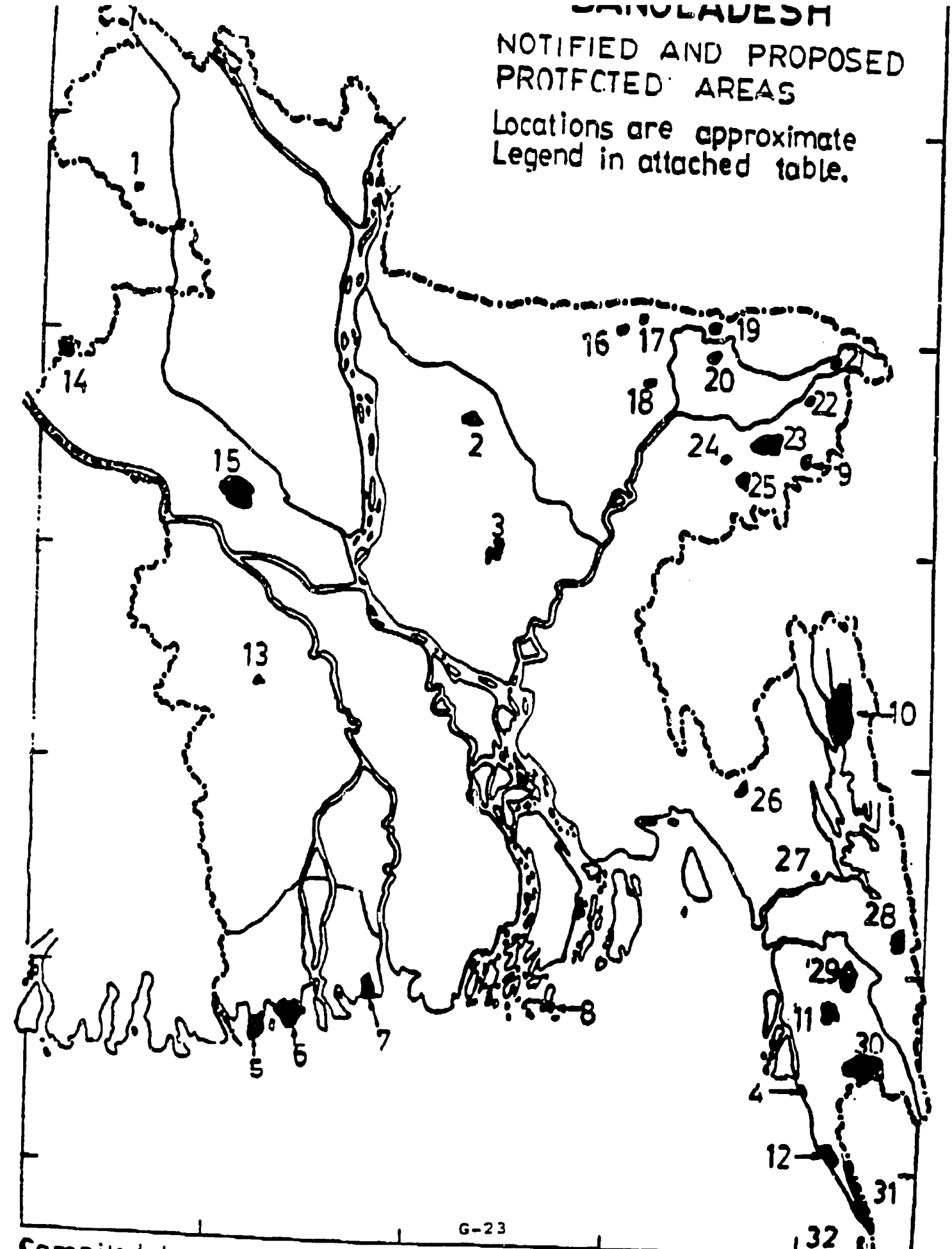
The Forest Department's mandate in wildlife management can be traced to the 1973 Wildlife Protection Act that led to the establishment of the Wildlife Circle, one of seven "circles" under the Chief Conservator of Forests. A Wildlife development scheme was included in the first Five Year Plan that ran through 1977.The Two Year Plan (1977-1979) also included the Wildlife Circle development scheme, as did the second Five Year Plan (1979-1983). The government, however, did not provide sufficient funds for the Wildlife Circle to undertake activities. In 1983, the Wildlife Circle was eliminated for the third Five Year Plan (1984-1989). Currently, there are plans to revive the Wildlife Circle in the fourth Five Year Plan.

In June 1989, the Forest Department was drawing up a new organogram that situates the Wildlife Circle within a new Environment section within the Forest Department. Environmental Divisions (equivalent to District Offices) that function as field offices to carry out programs would be located under the Wildlife Circle.

The Wildlife Conservator, would be freed of his/her administrative duties and dedicate 100 percent of his/her time to wildlife management programs. The previous Wildlife Circle included 112 staff; plans are to add 27 more people to give the new Wildlife Circle a staff of 139. At present, however, only one person with substantial administrative duties deals with matters related to wildlife: a Senior Research Officer assigned to wildlife management matters.

In addition to its mandate to manage wildlife within forested lands, the Forestry Dept is also charged with administering and managing the protected areas system established under the Wildlife Act of 1973 (described in Greene, 1989). The system includes national parks, wildlife sanctuaries, and game reserves. (Map of areas and their names is attached – reprinted from Greene, 1989.) National parks (four) are primarily recreational areas in areas of scenic beauty. Wildlife sanctuaries (seven) are areas where hunting is prohibited and wildlife maintenance is paramount. Game reserves (one) are maintained for wildlife protection although hunting permits are available. The existing protected areas officially cover 117,579 ha (0.8 percent) of total land area, but they do not represent a full range of the habitats present in Bangladesh. The Wildlife Advisory Board, established in 1976 to approve major wildlife and protected area management decisions, has been inactive for several years. It is unclear how proposed wildlife reserves are receiving official recognition at present. No development or management plans have been implemented for any of the protected areas.

None of the protected areas (Figure 1) are tied into international networks, such as the Man and the Biosphere (MAB) Biosphere Reserve program, or UNESCO's Natural World Heritage Sites, or Wetlands of International Importance.



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Compiled by H. Rashid, POUSH (July 1989)

11 July 1989

POUSH

List of Notified and Proposed Protected Areas in Bangladesh

(Locations are Shown in attached Map)

Name of Area		
National Parks		
1. Ramsagar NP	52	1974
2. Madhupur NP	8,436	1987
3. Bhawal NP	5,022	1987
4. Himchari NP	1,729	1980
Wildlife Sanctuaries		
5. Sundarbans West WS	9,069	1977
6. Sundarbans South WS	17,878	1977
7. Sundarbans East WS	5,439	1977
8. Char Kukri-Mukri WS	40	1981
9. Rema Kalenga WS	1,095	1981
10. Pablakhali WS	42,087	1981
11. Chunati WS	7,761	1986
Game Reserves		
12. Teknaf GR	11,615	1981
Proposed Wildlife Sanctuaries		
13. Ata Danga Baor		
14. Bil Bhatia		
15. Chalan Beel		
16. Meda Beel		
17. Tanguar Haor		
18. Aila Beel		
19. Dekhar Haor		
20. Kuri Beel		
21. Erali Beel		
22. Dubriar Haor		
23. Hakaluki Haor		
24. Kawadighi Haor		
25. Hail Haor WS	(1,427)	
26. Hazarikhil WS	(2,903)	
27. Rampahar-Sitaphar WS	(3,026)	
28. Bogakine Lake (Rinkheong)		
29. Chimbuk		
30. Sangu-Matamuhari		
31. Naaf River		
32. Jinjiradwip (St.Martin's Island) and Jinjira Reefs		

Note: List Compiled by Haroun Er Rashid

IV. Social and Politico-Economic Constraints to Biodiversity Conservation in Bangladesh

Conservation of biodiversity faces severe constraints in Bangladesh. The political economy affects biodiversity in many negative ways at present. The subsistence needs of millions of citizens for fuelwood, fish, and cash income (a need that increases exponentially with continuing population growth) coupled with a traditional attitude that biological resources are free for exploitation, creates a political climate inimical to sustainable development of natural resources and conservation of biological diversity. Nonetheless, policy reform, commitment to policy implementation, improved legislation, financial commitments to wise management of natural resources, and strengthened institutions may still be able to turn the tide of biodiversity depletion in Bangladesh. There are indications of a grassroots- level appreciation for biodiversity, particularly for birds, that could be tapped to build a constituency. The utility of wild fauna is also appreciated by some; for example, farmers scatter temporary perches in their paddy fields to attract drongos that devour insect pests.

There is, however, at present no strong political commitment to biodiversity as an issue. Nor is there a strong financial commitment to foster the longterm, sustainable economic benefits that can accrue from biodiversity management. Biological resources have been treated as free goods for exploitation, not as renewable resources that require policy to encourage their maintenance. Lack of concern for biodiversity is evident in the lack of support for institutions such as the Wildlife Circle and the National Herbarium. Public awareness of biodiversity issues is minimal. There are few efforts to educate the public about the existence and values of biological diversity. Nor have there been concerted efforts to determine the concerns of fishermen, frog collectors, honey collectors, or others who depend on biodiversity for a living. There has not been the political commitment necessary to develop long term strategies to conserve biological diversity or to strengthen the institutions necessary to carry out such a strategy.

Policies designed to address other issues have negative impacts on biodiversity. Bangladesh is not alone in this, but as countries develop they have acknowledged the importance of biodiversity for the continued well-being of their economies and moved to implement strong policies to maintain and enhance biodiversity.

Policies encouraging the use of High Yielding Variety packages (including pesticides and herbicides) to increase agricultural productivity do not also address mitigation of the negative impacts of agricultural chemicals on fisheries production or aquatic diversity. Policies to support government owned industries, such as buying timber from government forests at artificially low prices, undermine the values of forests and the diversity they contain, as well as discourage private involvement in forestry and therefore in associated wildlife management.

Resistance to pricing policy reforms will come from at least two fronts, subsidized industry interests and Forestry Department officials who profit from overharvesting timber and selling it to subsidized industry at market prices.This practice is possible because government industries require more wood than can be legally harvested according to management plans and therefore are authorized to pay open market prices for a portion of their wood input purchases. Contractors reportedly give Forest Department overharvest offerings priority treatment over offerings from private producers.

The choice of industry for subsidy and development by donors and government has also contributed to depletion of biodiversity. Many of these decisions, however, were made in an era when long term impacts were not considered. For example, Asia's largest paper mill was constructed with donor support in Sylhet. It consumes 70,000T (approx. 50 cu ft / ton) of biomass annually and has contributed to the overharvesting of forests, because of pressure to supply the mill instead of follow harvesting schedules. Currently, however, there does not appear to be the political will to consider ways to alter the demand on forest resources presented by that industry.

Legislation directly affecting biodiversity has been described in detail in the 1989 CIDA evaluation and the NCS Phase II Proposal (Jan 1985). Legislation relating to biodiversity is general and responsibilities for enforcement are not clearly delegated. While the written laws themselves need to be updated and made more specific, a more significant problem is poor enforcement of existing legislation.

The Wildlife Act of 1973 limits hunting methods, restricts trade and trophy hunting, and gives the government the power to establish and administer parks and reserves. The Forest Department is responsible for enforcing hunting regulations and can request the services of police.

The effect of this legislation is weakened by the range of political and economic factors that denies the written laws much of their intent or execution. In spite of the Wildlife Act of 1973, hunting is largely uncontrolled. There is considerably less hunting today than even a decade ago, but that is because of the drastically reduced populations of game animals due to overhunting and habitat destruction. The Bangladesh government is a signatory to the CITES Convention that controls the trade of animal products, but there is limited government capacity (personnel and political will) to abide by the rules of the Convention (Khan, 1988). The Fish Preservation Act of 1950 prohibits destructive methods of fishing and gives the government the power to regulate fishing activities, but much illegal activity is occuring.

Lack of political interest in biodiversity has led to lack of interest in careful implementation of the system of protected areas. The reserve system that has been created was not planned with guidance from a priority setting body, and insignificant funds have been dedicated to the protection and management of the parks and reserves. Most protected areas are subject to the same land uses that occur on other forest lands (e.g., plantation forestry, logging, cultivation, and agricultural allotments for settlers).

In an exceptional case, a citizens' group has been formed to protect and manage Chunati Reserve where firewood harvest, illicit logging, and conversion of land into agriculture have reduced the size and quality of the reserve to the point where elephants and other wildlife in the reserve face a situation of increasingly insufficient access to food and water. This local NGO ("Pothikrit, with the assistance of "POUSH") is involved in a wide range of local development activities of which biodiversity protection is but one. They are attempting to work with the government to deal with a microcosm of Bangladesh as they attempt to deal locally with increasing population, overexploitation of resources, and poor access to human services. Activities they support include wildlife protection, afforestation, social forestry, agroforestry, education, and human services to meet local needs. Successful collaboration with local and national government, is slowly being achieved.

The ability of the Forest Department to manage wildlife is severely limited. This is reflected in insufficient funding for wildlife activities, a lack of properly trained personnel and equipment, and a lack of research into wildlife management techniques appropriate to Bangladeshi species and environments. Wildlife management projects do not require large sums of money ($10,000 to $30,000 US), but they do require political commitment to wildlife management as a priority.

For example, a policy-making survey on commercially valuable frog populations that are being severely depleted by overharvesting has been planned by the Forest Department, but approval of the project is pending in the External Resource Division (ERD) of the government. The monsoon period during which the project must be completed has already begun.

Bureaucratic procedures make it difficult to request that the project be postponed until next year when approval will have to be sought anew.

Ownership of biodiversity is unclear, and this contributes to an emphasis on exploitation. Forests and aquatic habitats hold most of Bangladesh's biodiversity, yet there are no clear owners who claim full responsibility for trees, forests, forest biota, or aquatic habitats and fish. Tenural arrangements are complex and conditional. In theory, individuals cannot cut trees without forest department approval, and therefore do not fully own their trees. Yet it is impossible for the Forest Department to monitor all tree cutting, and difficult for the Forest Department to protect trees from thieves. A recent example in Sylhet involved a tribal village which was robbed of a block of village forest trees by outsiders who cut them down and hauled them off in a truck.The Forest Department and local officials, unsure of jurisdiction, could do nothing to protect the trees so the villagers hired a unit of the Bengal Rifles to protect the trees from illegal cutting.

The Forest Department is responsible for activities that reduce forest area or prevent regeneration of forests. Yet the Forestry Department itself is not fully responsible for forest loss. The historical emphasis of the Forest Department has been on regulating the harvest of timber, not on maintaining the resource for the future (see separate annex on forestry for more detail). Yet, in the context of economic conditions where a child can earn the equivalent of a man's daily wage by selling firewood collected in one hour from a state-owned forest, it becomes impossible for the limited staff of the Forestry Department to effectively stop illicit harvest of firewood in areas easily accessible to the public. To retain limited control over forest lands, beat officers are forced to negotiate their degree of control with local people and local interest groups. Fines for cutting trees are minimal and forest guards are paid minimal salaries. This sets a clear economic situation that works against protection of forests. Demand for fuelwood and timber is so high that tea plantation owners must hire armed guards to protect shade trees necessary for tea production from removal during the night.

Reforestation efforts produce only roadside belts of trees, partly due to harvesting of young trees for firewood (and reportedly partly due to unscrupulous planting operations).

The Chittagong Hill Tract (CHT) situation merits mention because it contains 5,000 to 10,000 ha of semi-natural tropical moist forest and therefore may still be a region of high biodiversity. The Forest Department control over CHT, however, has been minimal for years due to armed insurrection. For some time, a large area of "unclassified state forest" has been subject to slash and burn farming; this land is nominally under the control of the District Commission, not the Forest Dept. This situation, combined with the conflict between the tribal populations and the government has made it difficult to maintain the forest cover.

Historically, tribal groups extracted a variety of goods from forest lands, and their land management practices reportedly allowed regeneration of forest habitat. In an effort to increase administrative control over the CHT, the government has offered leases to 50 acre blocks to attract settlers to plant rubber plantations as well as other tax incentives to encourage settlement. In the absence of Forest Department authority, there is no regulation of forest cutting outside of the reserved forest lands, which have been progressively cut and cleared by farmers, immigrants, and the military.

Thus the Cox's Bazaar and Sylhet forests are the only tropical moist forests under effective control of the Forest Department. This increases the urgency of the need for careful management of the forests scattered outside CHT. In the Sylhet region, these are the lands bordered by tea plantations, thus making tea plantation participation in Sylhet forest management particularly critical. These are also areas with teak plantations nearing harvestable age. Because schemes for short rotation give forestry officials the opportunity to log out and sell valuable old teak stands and replace them with poorly adapted short rotation exotics, it has been predicted that within five years, there would be no more teak long rotation stands (with their associated biota).

Wooded areas arising from natural regeneration are cleared for plantations. Afforestation by indigenous species (fast growing, locally adapted indigenous species do exist) is not an option currently favored by the Forest Department. This attitude is incompatible with maintenance of biodiversity. This description does not, however, characterize the attitude of everyone in the Forest Department, and there is, therefore, opportunity to develop a consensus for change.

FRI scientists are eager to participate in in situ conservation. Forest Department policies encourage the destruction of indigenous forest species that could be profitably managed for timber and fuelwood production. Furthermore, there are no plans for natural forest management of the few remaining stands.

While questions about the impact of flood control structures on fisheries have been raised publically in recent years, there has been what one interviewee described as a persistent resistance to scientific research to answer these questions.

In general, in the opinion of many interviewees, there have been too many seminars decrying the lack of information and lack of attention to particular issues and too few follow-up efforts to gather data or create political momentum to move the issue forward. This may be due, to some extent, to lack of donor interest in supporting action.

There is no national body that coordinates natural resource policy or its implementation. National policy is dominated by sectoral and sub-sectoral concerns. The agriculture sector, for example, doesn't consider the impact of its initiatives on soil and water biodiversity.

There are, however, indications that the Bangladeshi government and the international donor community are beginning to recognize the need to conserve some of Bangladesh's biodiversity by building a national strategy to gather the data necessary for formulating and implementing management plans. Indications that the National Conservation Strategy project proposal may soon be approved, and talk of the need for a regional or national germplasm conservation system are welcome signs of change.

With these constraints in mind, the opportunities for successful actions are covered in sections V and VI.

V. Priority Biological Diversity Conservation Concerns

Given development interests, and the politico-economic situation and status of biodiversity described in the previous sections, four areas have been selected as critical areas of concern where focused action is most likely to have a successful impact. The primary areas of concern are Sundarbans and freshwater diversity. Of secondary importance are wildlife management and crop diversity conservation.

A. Conservation of the Sundarbans Ecosystem

The Sundarbans constitutes the largest natural habitat area in Bangladesh, and together with the adjacent Indian Sundarbans, forms the largest mangrove forest ecosystem in the world (with the possible exception of the Niger River delta in Africa). Modification or degradation of this ecosystem will not only be a tremendous loss with serious consequences for Bangladesh, but for the rest of the world as well, as documented by the Smithsonian Sundarbans Workshop held in Washington, D.C. in 1987 (proceedings to be published in 1990).

In the Sundarbans is found the world's largest population of the Royal Bengal tiger (Panthera tigris). While there are approximately 4,000 individuals elsewhere, these animals all live in relatively small populations in isolated habitats. Because tigers have lethal recessive genetic problems that are exacerbated by inbreeding, it is estimated that a minimum population of approximately 200 breeding animals is needed to avoid these deleterious effects (Seidensticker, personal communication 1989). No other habitat in Asia is sufficiently large to sustain such a population. A reduction in the 5,000 km2 Sundarbans tiger habitat, or a significant population decline in its major prey species, the spotted deer, will leave the tiger with little chance for long-term survival anywhere in the world.

At present, over 300,000 families depend on gathering wood, collecting honey, harvesting golpatta palm, and fishing in the Sundarbans. It is estimated that an additional 50,000-100,000 are employed in activities to process and market raw materials from the Sundarbans (Timberg 1987).In addition, a considerable amount of economic activity in the Khulna, Jessore, and Barisal areas adjacent to the Sundarbans are dependent on the Sundarbans. Small river ports serve as a base for a substantial volume of small-scale wood processing and fishing operations (Timberg 1987).

The wider importance of an intact Sundarbans ecosystem is considerable. It serves to protect human settlements in adjacent areas from the ravages of cyclones, acts as a tremendous nutrient producer for fisheries, and protects the potentially valuable, if underutilized, offshore fisheries by trapping sediment and providing essential nursery habitat (Seidensticker 1987).

Management of the system to increase production of food, fiber and other materials by the Forest Department appears to have been done with reasonable care and control, although there is evidence of over exploitation of sund'ri and gewa in the area (Timberg 1987).

The Forest Department has successfully maintained the tiger population (Seidensticker 1987). The Forest Department is aided by the severe conditions which impede access and threaten visitors (sudden violent storms, poisonous snakes, lack of drinking water, tigers, etc.). (The Forest Department acknowledges that the tigers help them to control illicit timber harvesting in the area.) The current status and prognosis for the Sundarbans is significantly better than that for other parts of the protected areas system. Research and management plans have been been initiated. There is a good foundation from which to proceed, and there are indications that the Forest Department will continue its proven management of the area.

The optimal value from the Sundarbans ecosystem will depend on the maintenance of its integrity as a natural ecosystem. Any proposals or plans to change the manner and type of resource use, e.g., introduction of plantation forestry without careful evaluation of the effect on deer (tiger prey) and tiger populations, must be carefully evaluated. With these factors in mind, the most productive investments for international conservation interests, for the tiger, and for many Bangladeshis are likely to come from efforts to strengthen the sustainability of current economic activities in the Sundarbans.

B. Freshwater Aquatic Diversity

The aquatic diversity of Bangladesh is impressive; it is also economically important and nutritionally vital. Over half of the average Bangladeshi's protein intake comes from inland, open catch fisheries.Given that 50 percent of the land surface of Bangladesh is covered with water during some part of the year, and that the conditions of bodies of water change during the year, it is not surprising that the aquatic environment has offered a rich opportunity for reproduction and diversification of life forms important to the Bangladeshi economy. There are no trash fish – virtually all species are eaten and contribute protein to human diets.

Concerns have been raised that flood control efforts, road building, and agricultural intensification are having a negative impact on fisheries and thereby on food for the poor. Yet there is very little hard data on the levels of depletion of fisheries, differential impact on particular species, or the causes of the perceived depletion. Aquaculture has been suggested as a mitigation response. But there is no indication that aquaculture could match the productivity of natural fisheries which exploit the seasonal availability of large nutrient-rich areas to develop large populations, or that the poorest segments of the population would have equal access to that production.

Intuitively it would seem that in Bangladesh open catch fisheries have many advantages: biological diversity offers risk-spreading advantages against pathogens or susceptibility to pollutants, numerous species partition niches in a way that makes maximum use of available habitats, etc. Yet there is no data on which to test the hypotheses.

Data is desperately needed in order to evaluate the impacts of proposed flood management plans, groundwater development plans, and irrigation schemes. The basic taxonomy, habitats, life cycles, and productivity of freshwater biota are poorly known. Without this basic data, no one can accurately predict or evaluate impacts, or design successful mitigation responses.

C. Wildlife Management

The status of terrestrial wildlife is presently very bad, and the prognosis for future populations is dismal if current management trends continue. Most wildlife is associated with Forest Department lands. The Forest Department also manages lands covered by the protected areas network in a fashion similar to its management of the other lands under its juridiction. Given the current weakness of wildlife management capability and emphasis in Bangladesh, the best opportunity to reverse these trends lies in improving the wildlife management capabilities of the Forest Department.

An assessment of specific training needs should be carried out after the new Ministry of Environment and Forestry has been organized, and the new Wildlife Circle established. Training programs are essential to improving prospects for wildlife in Bangladesh. Strengthened wildlife management will also depend on improved natural forest management, and forest management practices that emphasize planting mixed stands of indigenous species instead of monocultures of eucalyptus and other exotics. A halt to the conversion of natural forest stands and mixed hardwood plantations to exotic monoculture plantations is essential to the survival of many forest-associated species in the Chittagong Hill Tracts (CHT).

Several areas in the CHT, the most biologically diverse area in Bangladesh, deserve strengthened protection. The largest protected area in the country is the 42,087 ha Pablakhali Nature Reserve in the northeast corner of the CHT.

Although part of the reserve has been flooded by the Kaptai reservoir, and other areas have suffered from unrestricted grazing, settler allotments, and shifting cultivation by tribals displaced by the reservoir, it still contains one of the largest, but rapidly dwindling, natural forest areas in Bangladesh (Sarker and Fazlul 1985). It is considered to have some of the finest lowland forest and wetlands remaining in Bangladesh (Asia Wetland Bureau 1989). At present insurgency activities make improved management problematic, but future management prescriptions for this area should be carefully assessed in light of recent trends toward normalcy. Management options should focus on natural forest management to maintain diversity while extracting useful products on a sustainable basis.

Also deserving of strengthened protection is the Teknaf Game Reserve near Cox's Bazaar, one of the country's last strongholds for the elephant. Finally, consideration should be given to assessing the feasibility of declaring part of the Matamuhari district along the Burmese border as a national park. This corner of the country contains perhaps the largest contiguous area of natural forest in Bangladesh. Its ability to maintain biological diversity is helped by its continuity with natural habitat areas on the other side of the Burma border, offering the option of a "peace park" such as those established by Costa Rica and Panama to cover parks on both sides of a national border.

D. Crop Diversity Conservation

Bangladesh is home to crop germplasm important to Bangladesh and the world. Local agricultural scientists and the government are concerned about the conservation of germplasm. Timely action must be taken considering perceived rates of depletion. On the other hand, reliable germplasm banks are expensive to maintain and require longterm commitment of staff and funds if they are to merit investment. The current capacity of Bangladesh to conserve germplasm is very limited. Serious, longterm commitment to maintenance of germplasm bank facilities is also lacking. Recent studies by NAS (unpublished) have determined that regional cooperation networks are more likely to meet national needs for germplasm conservation than are national systems for each country (which tend to be underfunded and fail once established). There are, moreover, opportunities for Bangladesh to encourage the development of and participate in a regional germplasm network. Such participation would be enhanced by further strengthening the capability of Bangladesh to bank, evaluate, and use germplasm of a few crops (e.g., rice and perhaps pulses).

VI. Recommendations to USAID/Dhaka and the Donor Community

Options given are rather general. Decisions about priorities will vary according to donor advantages and opportunities. No specific steps are described here. To develop a strategic approach to any one of these areas will require a more indepth study to develop the information base necessary to select the most effective approach. A major focus of the recommendations is to build the critical information base and institutional capacity necessary to developing successful biodiversity management programs in Bangladesh.

A. PRIORITY OPTIONS (in order of priority)

The following six priorities represent the minimal requirements necessary to maintain Bangladesh's present biological diversity. These recommendations are listed in order of priority based on a combination of factors including: importance of the resource to livelihoods and nutrition in Bangladesh; global significance of the diversity; opportunities to enhance policy dialogue; opportunities to implement conservation activities; and present prospects for success.

1. Sundarbans protection

– Establish monitoring and research center to study hydrology and ecology of the Sundarbans.

– Document economic and resource values of current resource extraction activities.

– Study tiger-prey population dynamics.

– Strengthen Forest Department control and licensing capacity.

– Actively promote adoption of a management plan that builds on current use of the Sundarbans. This plan could build on the ODA 1985 draft management plan (to which the authors of this paper did not have access), on the IUCN plan (Seidensticker and Hal 1983), and on Forest Department plans.

– Prevent diminution of tiger territory (e.g. prevent restriction of tigers to small core areas, restrict human access to sensitive habitat areas, discourage activities which increase tiger-human conflicts, resist any development or land use conversion incompatible with tiger conservation including activities that reduce deer populations below the level needed to maintain tiger population).

2. Fishery-related research basic for evaluating flood control and irrigation impacts

– Fund taxonomic, life history, and ecological studies of the rich diversity of fish species.

– Analyze the economic values of particular species and of open-catch fisheries as they contribute to rural diets.

– Gather data on productivity of open-catch fisheries and productivity of aquaculture mitigations. Evaluate performance of aquaculture mitigations several years after they have been instituted.

– Evaluate policies and resource access issues that may impact effectiveness of aquaculture mitigations.

– Support development of an independent institution that can do the research listed above as well as monitor fish populations.

3. Policy dialogue

– Dialogue on the use of jointly programmed local currency for biodiversity, wildlife management and forestry activities.

– Dialogue to modify forestry policy on management of natural forests, timber pricing, land use and tenure constraints, and other policy constraints to forestry (identified in NRA forestry section).

– Explore options to support/establish a non-government institution to do policy analysis on forestry, fishery, and biodiversity issues.

– Analyze policy constraints to private sector activity in forestry.

4. Wildlife Management

– Wildlife management training that teaches techniques and planning useful in areas under forestry management is needed for forest department at all levels (from forest guards up to conservators) in order to plan and implement a wildlife management program.

– Wildlife management training should be offered to private sector groups such as tea plantation owners and managers who have expressed interest in wildlife management.

– Workshops on biodiversity management, its importance, national commitment, etc., should be offered to educate district commissioners and other public servants who make major decisions about land use.

– Prevent settlement or forest conversion in protected area systems, particularly those that still contain significant tropical evergreen forest.

– Habitat assessment and biodiversity survey should be conducted in Cox's Bazaar area forests and in CHT.

– Assess requirements needed to strengthen protected areas at Teknaf and Pablakhali. Explore feasibility of establishing protected area in the Matamuhari area along the Burmese border.

– Strengthen links between Dhaka University and government agencies charged with wildlife conservation.

5. Support National Conservation Strategy Process

– Explore options to use local currency to strengthen NCS preparation.

– Get involved in NCS process so final NCS product will be one the implementation of which will be supported by donors.

– Support development of a national body to coordinate implementation of the NCS.

– Follow up on NCS recommendations on protected areas system.

– Encourage cooperation between staffs working on the NCS and the Forestry Master Plan.

6. Crop germplasm conservation & evaluation

– Strengthen national capabilities in rice germplasm conservation and evaluation. This will also enhance Bangladesh's opportunity to participate in a regional germplasm conservation network.

– Develop BRRI's ability to monitor populations of wild rice in situ as well as trends in distribution of traditional varieties

– Work out plan for longterm maintenance of gene bank facilities already in place, a plan that includes funding guarantees. Such a plan will depend on coordination between the various institutions involved in genetic resources conservation (listed in this document).

– Investigate options for regional network (possibly SAARC sponsored).

B. SUPPORTING ACTION OPTIONS (not in order of priority)

1. Restoration ecology

– Explore options for restoration efforts using indigenous species, especially on deforested khas lands.

– Analyze land availability and tenure arrangements that limit or facilitate such activities.

2. Flora and fauna survey

– More work is needed on the survey of flora and fauna initiated by the Herbarium and Botanical Garden and the University of Dhaka Zoology Department. Support for the Flora of Bangladesh project would include small grants for travel, and training of taxonomists (to be coordinated with ODA-funded project that is pending).

– Support surveys to document local uses of biota in order to a) assess potential for development and b) develop data base for use in evaluating the potential impact of flood control or other development on biodiversity.

– Support studies showing the contribution of biota to the local and national economy. Such data would be useful for assessing costs and benefits of particular development options.

3. Education about biodiversity & its management

– Increase public awareness through the media (could work with the Forum of Environmental Journalists) and through classroom programs.

– Offer targeted workshops for district commissioners and other key players affecting management plan implementation.

– Include education about population growth impact on access to biological resources.

4. Assist Forest Department and NGOs to review protected area priorities.

– Assess status of current areas

– Assess wetland proposed sites and other unprotected sites that should be included in network.

5. Projects that reduce pressures on forests

– Support investigation of indigenous species that show promise for use in such projects.

– Design and implement projects in afforestation, social forestry, agroforestry, private sector involvement in fuelwood production, etc.

– Focus on afforestation of khas lands.

– Stress short rotation on private lands and long rotation on Forest Department lands.

6. Donor coordination

– Take advantage of opportunities in NCS process and through LCG on environment and natural resources.

7. Small grants program to fund biodiversity research and development administered by an intermediary

Activities identified during this assessment that merit, and would benefit greatly from, small grant support include:

– Forest Research Institute rare plant monitoring and ex situ conservation activities

– Bangladesh Rice Research Institute collecting and population monitoring trips

– National Herbarium collecting and population monitoring trips

– Chandpur Fisheries Institute collecting and population monitoring trips

8. Transfer pollution control technology to limit destruction of aquatic biodiversity

9. Improve environmental impact assessments

– Strengthen capability of GOB and private sector to assess and monitor environmental impacts of development on biodiversity

– Improve donor performance in environmental impact assessment, especially in evaluating impact of donor-funded projects on aquatic resources

10. Consider sustainability of resource base for inputs when identifying appropriate types of industries to promote in Bangladesh

11. Support the development and implementation of locally adapted Integrated Pest Management systems to reduce use of pesticides that have a negative impact on biodiversity

12. Support in-depth study of resource tenure systems and resource managers

Identify the major players ("stakeholders") who make decisions about land and water use (at local, district, and national level) in order to target policies toward affecting their decisions.

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BIODIVERSITY ASSESSMENT APPENDIX

Assessment based on following Level of Effort:

Fieldwork and Washington: Janis B. Alcorn (20 person days)
Washington: Nels Johnson (10 person days)

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Dean Alter, ANE/TR
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Chunati villagers - several men, women and children
Cox's Bazaar Mahila Girl's College
Mr. D.K.Das, Forest Research Institute
R.L. Bankik, Forest Research Institute
S.M. Hasan, Forest Research Institute
K. Alam, Forest Research Institute
Roadside plantation experiment - P.I. and investigator
Betagi Social Forestry Project - one person
from FRI, 2 farmers and one family
Friends of Earth/Bangladesh

USAID/Dhaka

Priscilla Boughton
Malcolm Purvis
Brad Fujimoto
Steve Bennett
Ray Morton
Letifur Rahman
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Farmer in Village outside of Cox's Bazaar
William Harvey, British High Commission
Mr. Alam, Chunati
Mr. Shafiq, Chunati
Lufter Rahman, Honorary warden, Chunati
Ranu Rani Deq, Head mistress, Primary School, Chunati

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