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Forest Biodiversity and Deforestation in Bangladesh: The Latest Update

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Abstract

Located in the Indo-Burma biodiversity hotspot, Bangladesh is a tropical country in Southeast Asia and a transitional point for flora and fauna between the Indo-Himalayan and Indo-Chinese subregions. About 11% land area (1,429,000 hectares) of the country is covered with four major forest types: mixed-evergreen forests, deciduous forests, mangrove forests, and freshwater swamp forests. Though Bangladesh is a small and densely populated country, it is the home of 1952 species of invertebrates, 653 fish, 50 amphibians, 147 reptiles, 566 birds, and 127 mammalian species of which many of them are globally threatened. We have discussed the latest status of all the major vertebrate groups in this chapter. Thirty-one species of vertebrates have gone extinct from Bangladesh over the last century. Many of the species are facing continuous threat of extinction due to deforestation and degradation of habitat caused by various anthropogenic activities. In this chapter, we are going to discuss about the current management and conservation practices and issues related to the forests and wildlife of Bangladesh.

Keywords: wildlife of Bangladesh, forest biodiversity, conservation, deforestation, evergreen forest, mangrove forest, protected area

1. Introduction

Bangladesh is a very small but densely populated country with very rich biological diversity. It is located at the cross roads of the Indo-Himalayan and Indo-Chinese subregions in the oriental region and is the transitional zone for the flora and fauna of the subcontinent and that of the Southeast Asia [1, 2]. The country is also a part of the Indo-Burma biodiversity hotspot, demanding high conservation priorities on a global aspect [3]. Because of its zoogeographical location, Bangladesh plays a significant role in terms of the migratory species, acting as the flyways or the staging ground for wildlife movements of the region [1].

Bangladesh has a total of 2,600,000 hectares of forest cover which is about 17% of the total land area of the country. About 61.52% of the forestlands (1,600,000 hectares) is owned and managed by the Bangladesh Forest Department (BFD), 26.80% of unclassified forest (697,000 hectares) is under the jurisdiction of the deputy commissioner (executive chief of district), and 10.38% of the land (270,000 hectares) is private woodland and community forests, controlled by the community [4, 5]. Despite of having a rich biodiversity, Bangladesh has one of the lowest per capita forestlands in the world [6] mostly due to the high human

population density in the urban areas. Moreover, the country has also experienced one of the highest rates of deforestation in south Asia, 2600 hectares per year [7, 8].

2. Forests of Bangladesh

Even in a small land area, Bangladesh hosts four major types of forests: (a) hill forests (mixed-evergreen forest), (b) sal forest (deciduous forest), (c) mangrove forest (natural mangrove), and mangrove plantation (**Figure 1**). Three other types of forest also contain substantial biodiversity of the country: (d) freshwater swamp forests, (e) homestead forest, and (f) village common forest, which is a natural forest conserved by communities for their uses [5, 10]. Many of these forests are protected by laws in Bangladesh, and designated protected areas (PAs) are shown in **Figure 2**.

2.1 Hill forests (mixed-evergreen forests)

Hill forests are mostly mixed-evergreen forests which cover 680,000 hectares of land and mostly situated in the northeast and southeast parts of Bangladesh [11–13]. The forests of northeast are mostly fragmented, and some relatively large patches of mixed-evergreen forests still exist in the Chittagong Hill Tracts (CHT) in the southeast [14]. The dominating plants in these forests are *Dipterocarpus turbinatus*, *D. pilosus*, *Swintonia floribunda*, *Hopea odorata*, *Syzygium grande*, *Salmalia insignis*, *Lophopetalum fimbriatum*, and *Duabunga sonnerationides*. Evergreen plants dominate the mixed-evergreen forests; however, deciduous plants are quite common and abundant [5, 15]. The mixed-evergreen forests of Bangladesh support large populations of wild mammals including Asian elephants, Asiatic black bear, hoolock gibbon, sambar deer, wild dog, leopard, and other globally threatened species [10, 16].

2.2 Sal forests (deciduous forests)

The Sal forest or moist deciduous forests of Bangladesh cover roughly about 120,000 hectares, which is about 0.81% land of the country. The central part of the country has the largest single mass of deciduous forest [17]. The single dominating

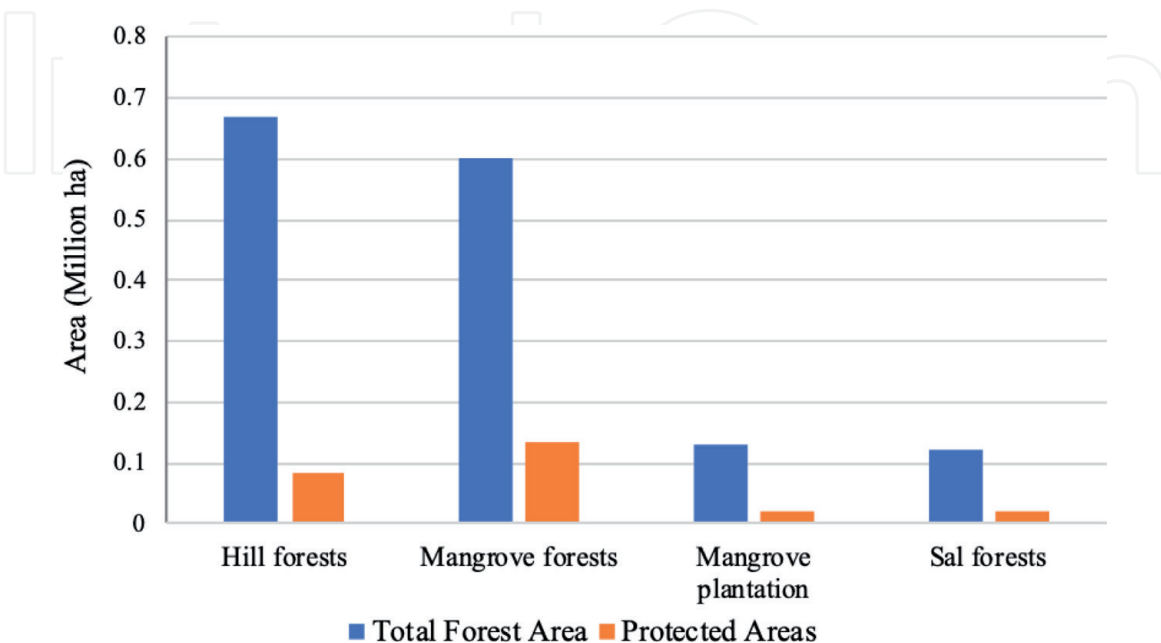


Figure 1. Various forest ecosystems by protected areas in Bangladesh (Source: [9]).



Figure 2.
 Location of the protected areas (PAs) in Bangladesh (Source: [11]).

plant of this forest is Sal (*Shorea robusta*). Most of the other plants of this forest are *Butea monosperma*, *Careya arborea*, *Terminalia belerica*, *Terminalia chebula*, *Dillenia pentagyna*, *Aphanamixis polystachya*, *Streblus asper*, and *Phyllanthus emblica* [15, 18]. This ecosystem is the home of the largest population of capped langur of Bangladesh [10].

2.3 Natural mangrove forests and mangrove plantation

The mangrove forests cover an area of 801,700 hectares along the coast of the Bay of Bengal. Out of the total coastal forest, 601,700 hectares are natural mangroves, the Sundarbans—the single largest chunk of productive mangrove forest of the world—and 200,000 hectares are coastal plantations [19, 20]. This forest

includes fairly dense evergreen plant species, which are adapted for life under saline conditions and frequent inundation by the tides. Major plants of this forest are *Heritiera fomes*, *Excoecaria agallocha*, *Sonneratia apelata*, *Avicennia officinalis*, *Avicennia alba*, *Hibiscus tiliaceus*, *Phoenix paludosa*, and *Acrostichum aureum* [20].

The Sundarbans harbors 334 species of plants and 269 species of wild vertebrates. The Sundarbans is currently the last abode of important elements of South Asia's threatened megafauna, including the Bengal tiger, Ganges and Irrawaddy dolphins and saltwater crocodiles, a number of threatened bird species, and at least 176 species of fish [5, 16]. The flagship tree species of Sundarbans, a mangrove *Heritiera fomes*, has also been declared as an "endangered species" in 2010 under the International Union for Conservation of Nature (IUCN) Red List category of threatened species [21].

2.4 Freshwater swamp forests

This type of forest is situated in the lowlands of the northeastern region of Bangladesh. Freshwater swamp forest consists of flood-tolerant evergreen trees of about 10–12 m in height. These trees have vast rooting system and form a close canopy. The major tree species of this forest are *Barringtonia acutangula*, *Millettia pinnata*, *Saccharum spontaneum*, *Phragmites karka*, *Acanthus ilicifolius*, *Alpinia allugas*, and *Schumannianthus dichotoma* [5, 10]. Seeds of these trees disperse through water and regenerate in mudflats. The freshwater swamp forests are the home of many species of wading birds, reptiles, and amphibians [5].

2.5 Homestead forest

There are approximately 25.53 million homestead forests in Bangladesh [22] to fulfill the basic needs of the householders such as fruits, vegetables, other foods, and timbers. Planting native fruits and timber trees and bamboos near homesteads is a traditional land use practice in Bangladesh; however, amount of this forest is declining at an alarming rate due to various reasons. Major plants of the homestead forests are *Mangifera indica*, *Artocarpus heterophyllus*, *Syzygium cumini*, *Bambusa* spp. *Areca catechu*, and *Musa* spp. Homestead forests are the home of many threatened mammals including jungle cat, fishing cat, golden jackal, Bengal fox, mongoose, and civets [5].

2.6 Village common forest

Village common forests are natural forests other than the government reserve forests near the households of the indigenous communities that are managed to fulfill their daily demands [23, 24] and also harbor considerable biodiversity. Most of the village common forests are situated in the southeastern hilly areas of the country. Village common forests are small forest patches but harbor a good number of threatened wild animals [13].

3. Protected areas of Bangladesh

Protected areas and forests of Bangladesh are home of many flagship species of global concern (Figure 2). Terrestrial PAs particularly in northeast and southeast regions of the country contain considerable biodiversity, and those in the CHT are part of the Indo-Burma biological hotspot. Madhupur National Park, the first protected forest situated in the central part of Bangladesh was established in 1962

under the provision of the Forest Act 1927. After the implementation of the Wildlife Act 1974, the legal status of the PAs was improved considerably. Several new PAs were declared after the signing of the Rio Convention in 1992.

A total of 41 protected areas have been declared for the conservation of wild animals of Bangladesh, of which 20 are wildlife sanctuaries, 17 are national parks, 2 are special biodiversity conservation areas, 1 is marine protected area, 1 is eco-park, and 2 are vulture safe zones (**Figure 2**). Moreover, five migratory bird flyway sites have been declared in 2011 for the conservation of migratory birds of the country. Many globally threatened species such as Asian elephant, Asiatic black bear, Malayan sun bear, leopard, clouded leopard, marbled cat, hoolock gibbon, slow loris, Chinese pangolin, and greater hornbill are still found in those PAs [5, 10].

The Sundarbans is the home of the only viable population of Bengal tiger in the country. Many other threatened wild animals like saltwater crocodile, Irrawaddy dolphin, white-bellied sea eagle, lesser adjutant stork, rock python, and king cobra are still in good condition in the Sundarbans [10, 16, 20]. PAs in deciduous forests (particularly Madhupur NP) also support a good population of capped langur.

Biodiversity and forests of Bangladesh provide a buffer against climate change and provide sources of natural products of value to both local villagers and in the markets. Forests also serve to hold soil from excessive erosion and to maintain the integrity of watersheds and freshwater supplies. Tourism, both foreign and domestic, to natural areas of the country has been advertised for its potential to allow sustainable development of ecosystems and to provide incentives to preserve these areas instead of converting them to other uses. Bangladesh has a great potentiality to develop sustainable ecotourism in the PAs spread over the whole country [25].

4. The status of wildlife diversity in Bangladesh

Bangladesh is the home of 1952 species of invertebrates, 653 fish species (251 freshwater; 402 marine) [2, 10, 16], 50 species of amphibians, 147 species of reptiles, 566 species of birds including residents and migrants, and 127 species of mammals [16]. Many of these species are reported from Bangladesh in the last couple of decades; especially the number of amphibians and reptiles has grown up very fast, and it is expected to go even higher in near future [26, 27]. A total of 11 species of mammals, 19 species of birds, and 1 species of reptile has gone extinct from Bangladesh over the last century [16]. Many species such as hoolock gibbon, long-tailed macaque, Malayan sun bear, Asian elephant, and gharial are at the brink of extinction and demand attention for conservation management [16]. Distribution of some distinct wildlife species has been mentioned with the major forest types in Bangladesh (**Figure 3**).

4.1 Amphibians

Among the 50 recorded species of amphibians, 46 species are found in forested areas of which 36 species are exclusively restricted to different types of forests [16]. The number of recorded amphibians from Bangladesh is even higher in other reports, and the reported species is up to 57 [27]. About 33% amphibian species are threatened in different categories (**Figure 4**). According to IUCN's Red List, Fuller's caecilian (*Chikila fulleri*) and Khare's stream frog (*Pterorana khare*) are critically endangered and restricted to the particular forests in Bangladesh. Bush frogs like Doria's pygmy frog (*Chiromantis doriae*), Anderson's bush frog (*Philautus andersoni*), and pied warty frog (*Theloderma asperum*) are endangered species and only found in mixed-evergreen forests of the country. Cascade frog (*Amolops marmoratus*) is a vulnerable species and restricted to some particular hill streams of Bangladesh.

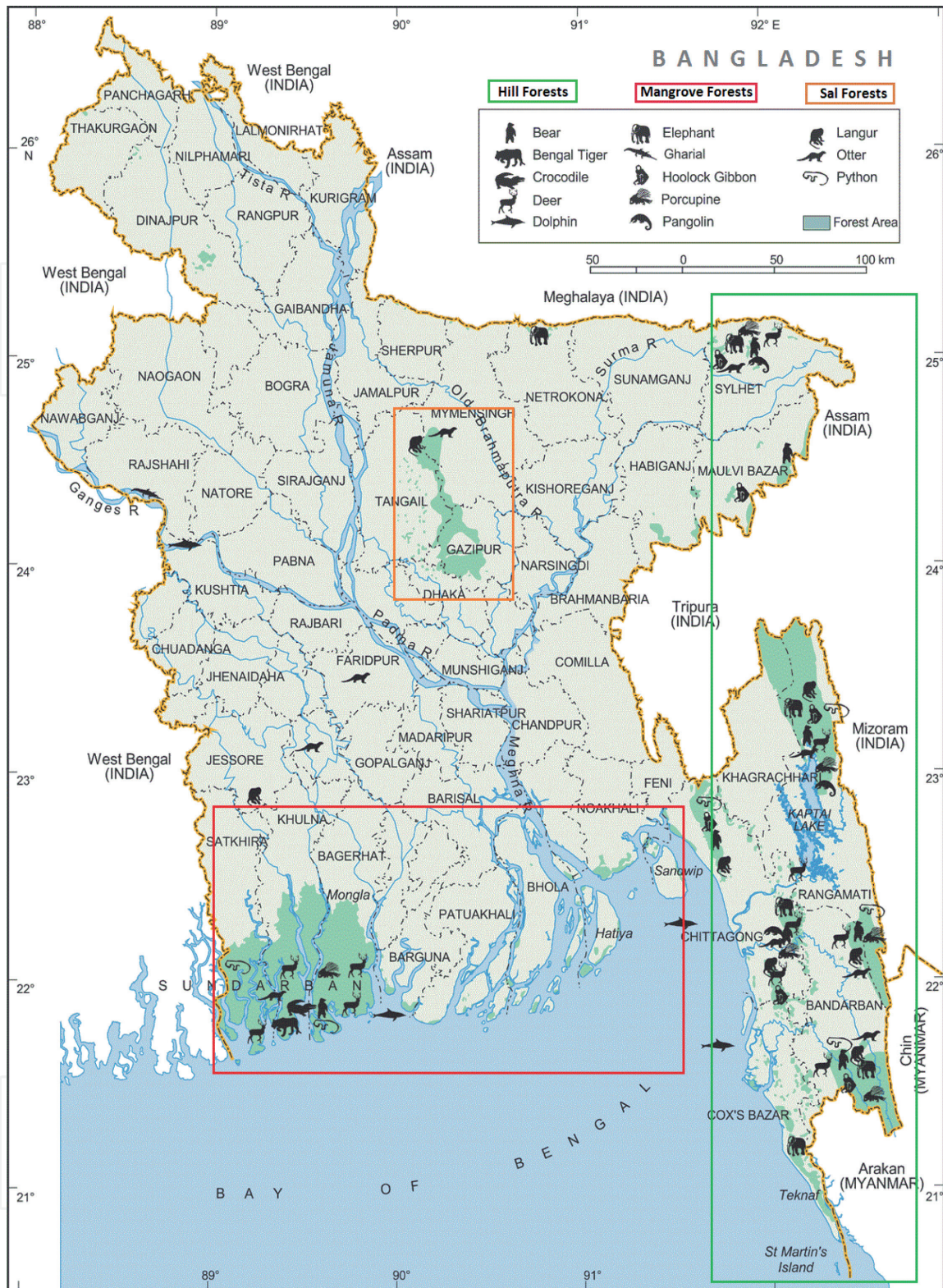


Figure 3. Major forest types of Bangladesh with distinct wildlife species (Source: [9]).

4.2 Reptiles

A total of 30 species of turtles and tortoises, 35 species of lizards, 80 species of snakes, 2 species of crocodiles, and 1 gharial species has been reported from Bangladesh [16]. Forests of the country harbor 110 species of reptiles, of which 98 species are exclusively restricted to the different types of forest. About 38% reptiles of the country are threatened under different categories (**Figure 5**). Marsh crocodile (*Crocodylus porosus*) has been extinct from the wild. Gharial (*Gavialis gangeticus*) is at the brink of extinction and has been categorized as “critically

endangered.” Salt water crocodile (*Crocodylus palustris*) is also facing different kinds of conservation threats and categorized as “endangered” [16].

About 87% turtle species are threatened, of which 14 species are “critically endangered” and 4 species are “endangered” and “vulnerable” each. Larger-sized turtles and tortoises are more vulnerable to local consumption for meat and are victim of illegal trade. Large snakes (e.g., pythons and boas) and venomous snakes (e.g., cobras) are also threatened due to illegal trade for skin and venom. Reticulated python (*Malayopython reticulatus*), Burmese python (*Python bivittatus*), monocled cobra (*Naja kaouthia*), spectacled cobra (*Naja naja*), and king cobra (*Ophiophagus hannah*) are frequently associated with illegal trade and are threatened with various categories [16].

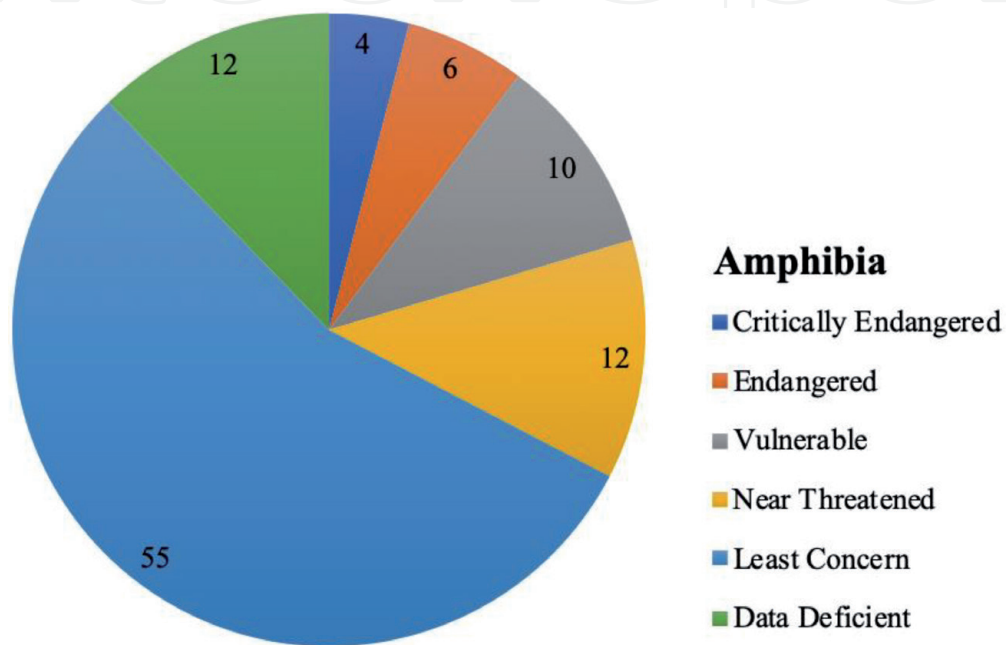


Figure 4.
 The latest threat status of amphibians in Bangladesh (percent value, N = 50).

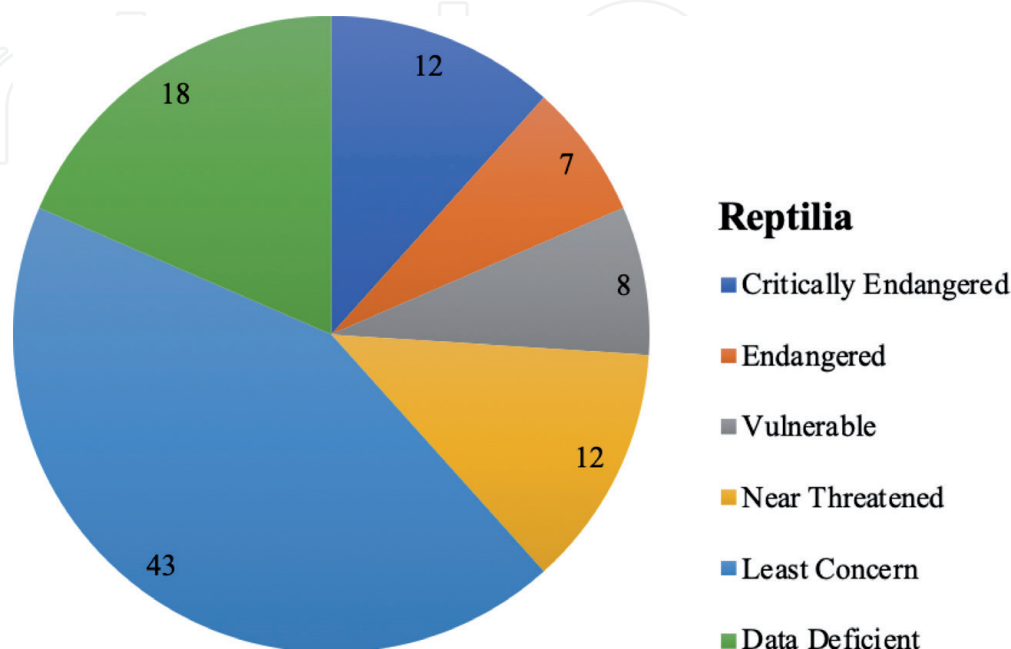


Figure 5.
 Latest threat status of reptiles in Bangladesh (percent value, N = 147).

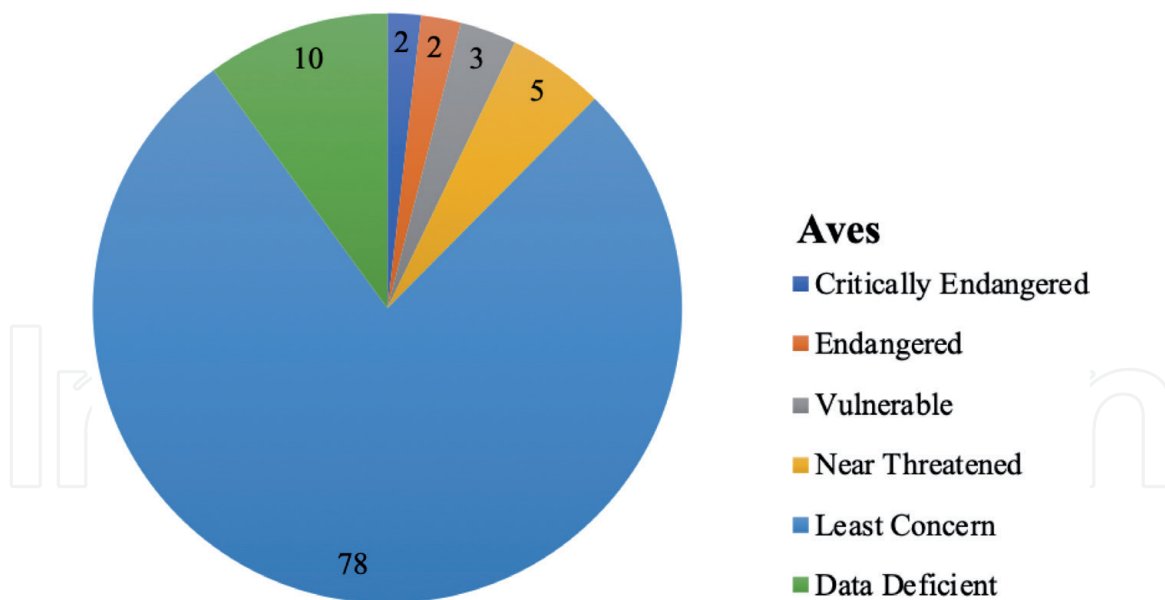


Figure 6.
The latest threat status of birds in Bangladesh (percent value, N = 566).

4.3 Birds

Bangladesh harbors a total of 566 species of birds [16]. A large number of birds (19 species) have already been extinct from the country, and currently 68 species of birds are facing conservation threats of various kinds (**Figure 6**). Among the regionally extinct birds, seven species were forest dwellers, six species were from grasslands and bamboo tickets, and five species were wetland birds. Terrestrial birds are more likely to face greater threats of extinction. Size and weight were another important factor for their extinction. Among extinct birds, 11 species were large sized, e.g., spot-billed pelican (*Pelecanus philippensis*), greater adjutant (*Leptoptilos dubius*), sarus crane (*Antigone antigone*), white-bellied heron (*Ardea insignis*), Indian peafowl (*Pavo cristatus*), and green peafowl (*Pavo muticus*) [16].

Out of the 10 species of critically endangered birds of Bangladesh, eight species are migratory, and other two species are resident. Survival of migratory birds in Bangladesh mostly depends on the health status of the migratory bird habitats. Two species of critically endangered migratory birds, spoon-billed sandpiper (*Calidris pygmaea*) and Indian skimmer (*Rynchops albicollis*), are only found in two isolated coastal sites in southern Bangladesh, and their survival is greatly dependent on the habitat protection [16]. The causes of declining population of critically endangered white-rumped vulture (*Gyps bengalensis*) are mostly related to the use of a lethal veterinary drug “diclofenac” in Bangladesh [28].

4.4 Mammals

Bangladesh is the home of 127 species of mammals [16], 10 species of primates, 27 species of rodents, and 29 species of bats; the Asian elephant and the Bengal tiger are the most notable species. Forests of Bangladesh are the home of 86 species of mammals, of which 60 species are fully restricted to forests. Eleven species of mammals have already been extinct from the country. The extinct species are mostly large mammals, and principal causes of their extinction were uncontrolled hunting and habitat loss. The existing large mammals of Bangladesh are facing continuous pressure of extinction threats. About 40% mammals of the country are threatened, and 33% are data deficient (**Figure 7**). Nineteen species of mammals are “critically endangered,” and many of them are at the brink of extinction, e.g., long-tailed macaque (*Macaca fascicularis*), hog

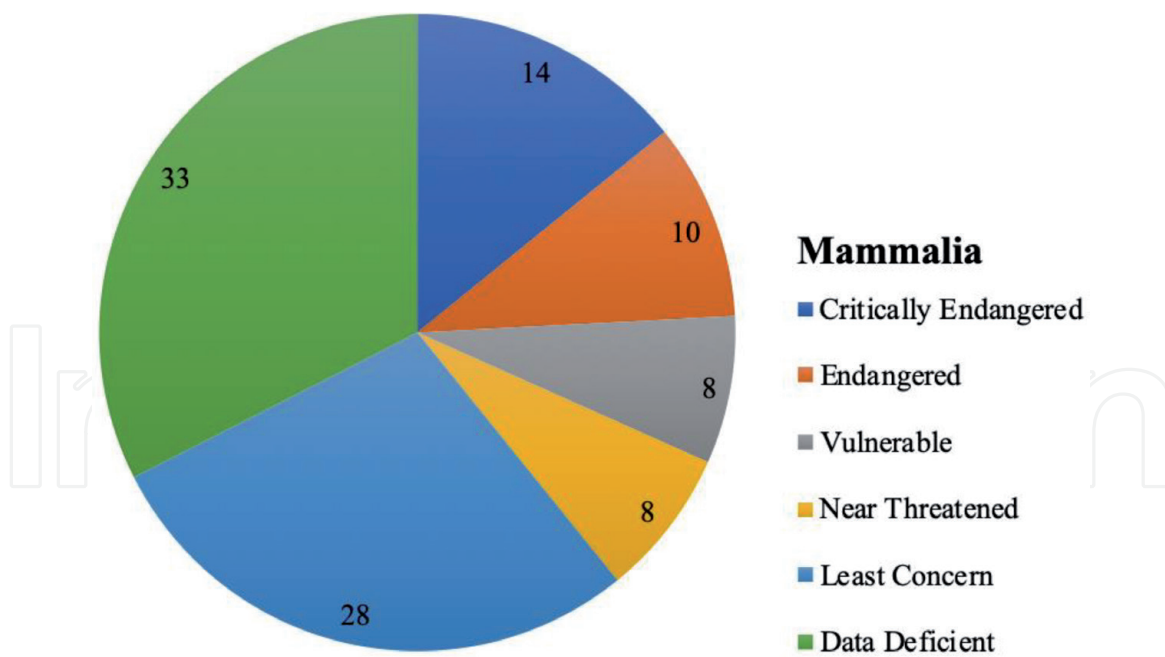


Figure 7.
 Threat status of mammals in Bangladesh (percent value, N = 127).

deer (*Axis porcinus*), sambar deer (*Rusa unicolor*), gaur (*Bos gaurus*), Malayan sun bear (*Helarctos malayanus*), Eurasian otter (*Lutra lutra*), clouded leopard (*Neofelis nebulosa*), leopard (*Panthera pardus*), and Indian pangolin (*Manis crassicaudata*) [16].

5. Threats to the forest and wildlife

Like most other developing countries, Bangladesh is facing different kinds of threats to the forest and its wildlife. With accelerating economic development and the growing population, it is easily understandable that many of these threats will intensify in future leaving a huge challenge for conservation professionals [5, 10, 29]. Some of the major threats are important to discuss which have been summarized below.

5.1 Direct threats

5.1.1 Hunting and poaching

Hunting and poaching is one of the major threats for wildlife species in Bangladesh especially for the game species. Wild animals are hunted illegally either for local consumption for meat and trophies or for international trade. Poachers usually target animals that are in high demand in illegal market. Tigers are killed for the hide as well as other body parts to be used in traditional Chinese medicine. Other smaller cats are also poached for their hides. Deer are hunted for meat and skin, whereas elephants are killed for the ivory. Turtles and tortoises are poached for meat and demand in pet markets. Many birds like hill myna, parrots, and sunbirds have a great demand in illegal pet markets. Python skin and snake venom have also high demand in illegal markets [4, 30, 31].

5.1.2 Local and international trade

Illegal wildlife trade is one of the most serious threats to wild animals in the region, and Bangladesh is no exception. For its geographic location, being

conveniently located between India and Myanmar, Bangladesh is being used as a source of animals as well as the transit route of international wildlife trade. Wildlife species are killed for their meat, skins, bones, fur, and other body parts which are used for traditional medicine, clothing, jewelry, and trophy and also for unconventional exotic food. These animal products have demands mostly in the international illegal market, and their destination is the traditional Chinese medicine market [32].

While wildlife poaching and trafficking pose a great threat to the flagship species of the country but the status of the lesser known species (e.g., golden jackal, civets, mongoose, and small cats), the latest situation is currently unknown. These animals play a vital role in the ecosystem, and if this process continues, the conservation of mammalian species of the country would be a huge challenge [32].

5.1.3 Local consumption

There are at least 29 ethnic communities in Bangladesh, and most of them find their protein source from wild animals. These ethnic communities are spread over the country, but most of them inhabit in the southeastern and northeastern part of Bangladesh. Ethnic communities usually hunt wild animals such as wild boar, barking deer, Indian hare, small cats, primates, mongoose, civets, squirrels, rats, bats, turtles and tortoises, snakes, and frogs [32].

5.1.4 Use of live animals

Some of the wildlife species have growing demand as pet or zoo animals in both local and international markets. Wildlife traders illegally collect the harvested animals from the poachers. Keeping wild animals in private collection or establishment of mini zoo is not legal in Bangladesh according to the existing laws, but many private collections are established in several parts of the country. Most commonly found animals of these private collections include but not limited to hoolock gibbon, rhesus macaque, pig-tailed macaque, Assamese macaque, slow loris, spotted deer, barking deer, marbled cat, fishing cat, civet, large birds, pythons, cobras, turtles, and tortoises. This is a total violation of the Bangladesh Wildlife (Conservation and Security) Act, 2012, as most of these animals are protected by the current laws of the country [4, 32].

5.1.5 Human-wildlife conflict

Human-wildlife conflict is currently a burning issue as it influences a group of people against wild animals and also against the people who want to conserve and restore wildlife [33]. The growing human population of Bangladesh is forcing rapid urbanization and habitat loss for the wildlife and also forcing wild animals to live in close proximity to humans. Many wildlife species of Bangladesh such as Bengal tiger, Asian elephant, leopard, fishing cat, golden cat, jungle cat, civets, etc. are facing various threats of extinction due to human-wildlife conflict [30, 31].

5.1.6 Moving vehicle as a growing threat

Roads through the natural habitats are intrusion to the wildlife habitats which adversely affect the wild animals. Effect of road ranges from habitat loss and fragmentation to the distribution pattern [34] of the animals, movement and reproductive behavior [35], and direct mortality by the moving vehicles [36, 37]. In Bangladesh, many forest areas have been bisected by roads, highways, and railway tracts which contribute negatively in losing biodiversity at a much faster rate. Nocturnal animals

are also harmed by the bright headlights at night and are often killed by the moving vehicle. Many threatened species are also killed by the vehicles on a regular basis.

5.1.7 Tourist pressure

Excessive and uncontrolled tourism activities pose a great threat to wild animals especially for small forest patches like Satchari and Lawachara National Parks. These parks are critical habitats for critically endangered mammalian species like hoolock gibbon and other primates. With the growing tourist activities in the core of these critical habitats especially during winter season, the daily activity of wildlife activities is heavily impacted both diurnal and nocturnal species. The breeding activities are interrupted by such unwise human activities [4].

5.2 Habitat degradation and fragmentation

Habitat fragmentation and degradation are currently the most important factor for the biodiversity loss in Bangladesh. With the ever-growing human population in the country and coupled up with other reasons, wildlife habitats are being destroyed and fragmented in an alarming rate [5, 10, 15], and as such, different vertebrate wildlife groups face conservation threats at various levels (**Figure 8**). We would like to summarize the major reasons of habitat degradation and fragmentation in a very brief way.

5.2.1 Illegal timber extraction

Timber harvest from the natural forests is currently banned in Bangladesh as a measure to restore country's forestland. But, timber extraction is still going on, in many cases with the support from corrupt forest managers. It is assumed that local timber merchants persuade unemployed poor people to take down the large-sized hard wood trees from the forests and sell it to the local market. In many of this forestland, the upper canopy is not connected, and forests are fragmented [15]. Distant canopy cover creates problem to highly arboreal mammals, e.g., hoolock

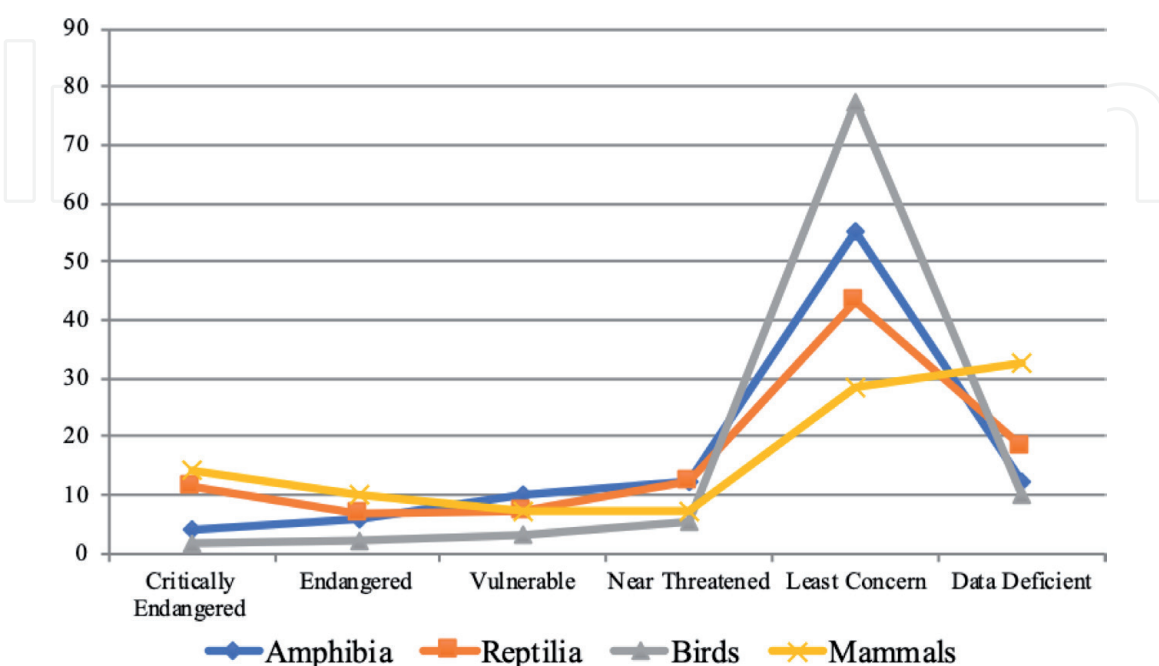


Figure 8.
 Overall threat status on the vertebrate wildlife groups in Bangladesh.

gibbons, capped langurs, macaques, and squirrels for their movement and breeding activities. Fragmentation of forest also restricts the movement of mammals from one habitat to another, which poses more threats to their existence. Moreover, due to the softwood demand in plywood industry, illegal poaching of softwood trees is also happening in Bangladesh, which would otherwise provide food for the wild animals [4].

5.2.2 Fuel wood extraction

Almost all households, in and around the forests, use fuel wood for daily livelihood. Majority of the fuelwoods are sourced from the nearby forests. The local people generally collect dead or fallen trees or branches, which do not contribute directly to the destruction of trees in the forest; but it has other ecological consequences. Some local community members live on selling the fuelwood extracted from the forest. Fallen leaves collection is a major problem in deciduous forests in the central as well as in the northern part of the country. Leaf and fuelwood collectors clean up the undergrowth of the forest and also cut down seedlings which hinder regeneration of the forest [4].

5.2.3 Expansion of agricultural activities

Several crops are extensively cultivated on the hill slopes and in the low-lying areas in and around the forestland in Bangladesh. Pineapple, banana (*Musa* spp.), citrus, bean (*Vigna* spp.), and papaya (*Carica papaya*) are mainly cultivated on the hilltop. Paddy (*Oryza* spp.) is cultivated in the low land between two hills [4]. For making the land cultivable, local people usually clean the forest floor, burn the unwanted vegetation, and cultivate the desired crops, resulting in destruction of natural vegetation. Local farmers slowly expand their cultivation land each year, which causes rapid fragmentation of the forestland. Expansion of agricultural land is one of the major problems of deforestation in Bangladesh except the Sundarbans mangrove forest [5].

5.2.4 Modification of undergrowth

Alteration and modification of undergrowth vegetation is one of the major conservation issues, a lot of the forestlands are facing in Bangladesh. Both the Bangladesh Forest Department (BFD) and local community contribute to this factor. Collection of dead leaves from the forest floor prevents natural seed germination, which eventually hinder undergrowth plant diversity. The forest department permits local people to clean up undergrowth and eventually plant canes (*Calamus rotang*) in the forestland. The rapid growth and aggressive nature of canes prevents growth of other plant species. The forest department also encourages bamboo plant during winter season, which results the monoculture of bamboo undergrowth and ultimately contributes to the topsoil erosion of the forests [5].

5.2.5 Grazing by livestock

Deforestation is closely associated with overgrazing in many parts of the world, and Bangladesh is no exception [4]. Overgrazing by domesticated animals and farming play a major role in natural forest regeneration. Free-range cattle in the forestland would eliminate seedlings, which would potentially regenerate the forest. Grazing also accelerates soil erosion [10].

5.2.6 Land erosion

Huge landslide during rainy season in the hilly region (Chittagong and CHT) of Bangladesh is quite common and one of the major reasons for the lack of vegetation cover of the area. Landslides change the hydrological pattern of forest and could be an issue for animal movement [2].

5.3 Indirect threats

5.3.1 Poor institutional capacity

The Ministry of Environment and Forests (MoEF) is the sole authority from the government side to implement and enforce natural resource-related activities and laws. The Bangladesh Forest Department and Department of Environment operates under the MoEF and two major wings to manage natural resources in Bangladesh. However, limitations like poor institutional capacity, lack of logistical and operational support, and insufficient funding and manpower are holding the country behind. Most of the field offices in the peripheral forest range have no vehicles or travel allocations to make necessary field interventions [4].

5.3.2 Lack of coordination among different agencies

There is lack of coordination in the management of biodiversity and natural resources among different government agencies in Bangladesh. For example, there are overlaps between the jurisdictions of the Bangladesh Forest Department, Department of Environment (DoE), and Ministry of Land (MoL). Coordination gaps or overlaps are also found among different projects and among different donor agencies, especially in high-profile areas like the Sundarbans. Lack of coordination is also observed at the transboundary level, especially between water rights and usage between Bangladesh and neighboring countries that are the upstream sources of water [4].

5.3.3 Policy and information gap

Information is not widely available in Bangladesh, and with regard to field level baseline data on natural resources, there is no single place to get everything. Aside from some modest university efforts, there is a dire lack of scientific data on forest, wetland, and aquatic species. This information is crucial for effective management of natural resources and biodiversity of the country. There are no long-term monitoring efforts to evaluate any changes in species occurrence, abundance, and distribution in Bangladesh [4]. Bangladesh managed to have a number of sound environmental policies, but that is not enough, and there are many gaps. For example, donor-initiated conservation projects are not sustained after the funding tenure is over. The government either does not have their interest or no self-funding capability to continue the project initiated by a donor agency [32].

5.3.4 Lack of enforcement

Environmental crime is not treated as seriously as other types of crime either by the local communities or by the law enforcement agencies. Although there are laws related to natural resources in Bangladesh, enforcement of these laws is very poor. Poachers are often politically connected and often are protected by their leaders or contractors [4]. Even when a case makes it into the court, there are no incentives (monitory or logistic) for the forest officials who are willing to testify before court.

5.3.5 Inadequate and poorly managed protected areas

Many of the forests in Bangladesh are recently declared as protected areas, but the actual implementation is still in very rudimentary stage (**Figure 2**). The idea of the PA is not very welcomed and well perceived by the local people, and also there is lack of coordination between the stakeholders and the government. Although there are dozens of PAs in the country, many are 500 hectares or less: too small to provide adequate habitat to preserve biodiversity. In addition, protected area system includes only forestland and does not include some of the most critically important wetland habitat of the country.

5.3.6 Corruption

Corruption is evident at all levels of the government system in Bangladesh where biodiversity and forest conservation are an integral part. It is expected that folks with strong political connections or wealth can circumvent existing laws to obtain individual favors, rights to use protected land, and immunity to environmental crimes [4].

5.3.7 Lack of awareness

Most country people are not properly aware of the importance of maintaining a healthy biodiversity and its conservation. Being a developing country, Bangladesh is fighting with poverty, high population density, and lack of education. Most local stakeholders have no idea about the existing laws of the land, especially with regard to environmental crimes [32].

5.3.8 Climate and biophysical changes

Climate change is being recognized as a global crisis threatening any forms of life on the face of earth. The biophysical changes in the environment have an underlying effect on the present and future biodiversity in Bangladesh [19]. Some of these biophysical factors are changes in temperature and precipitation pattern, sea level rise, frequent natural disasters, increase of salinity in the southern coast, drastic changes in upstream water flow, high sedimentation in inland water, etc. [38].

5.3.9 Alternate income and recent human migration

Most people living in and around the forests and protected areas support themselves using forest resources collected either legally or illegally. Bangladesh already has a very high population density, and this problem has been intensified by allowing thousands of outside people settled in by the government in the southeastern part of the country. The presence of large refugee camps of Rohingya people from Myanmar in Teknaf Wildlife Sanctuary has already been identified as a major threat for the biodiversity of the region. With no other income options, these Rohingya people are engaged in unsustainable practices in forest resources along the coast. This problem would even go out of control if it is not taken seriously and a solution is chalked out by the governments of the two neighboring countries [2, 13].

6. Conclusion

The high and rapidly growing population of Bangladesh places a great strain on the natural resources, and PAs are no exception [39]. The situation in Bangladesh

is not atypical; the majority of PAs around the world, not only those in developing countries or the tropics, face a variety of problems [40]. Among many others, shortage of skilled manpower, insufficient logistics, political influence, corruption, and lack of interagency coordination are some of the major reasons for the improper enforcement of law. Review and proper implementation of laws; institutional development; promotion of collaboration among different agencies; habitat protection and restoration; and human-wildlife conflict mitigation are some of the urgently needed factors for the conservation of wildlife and forest in Bangladesh.

Although there are lots of limitations, Bangladesh has several laws and policies that still safeguard the existing forest and wildlife species, and we hope that proper implementation of these laws would help to thrive the unique biodiversity and diverse wildlife of the country. Some of the important laws and policies for the conservation of forest and wildlife of Bangladesh are Forest Act, 1927; Wildlife (Conservation and Security) Act, 2012; Environment Conservation Act, 1995; Environment Protection Act, 2000; Climate Change Trust Act, 2010; Biological Diversity Act, 2012; Forest Policy, 1994; Environment Policy, 1992; Wetland Policy, 1998; and Coastal Zone Policy, 2005. The country needs to work hard to implement these laws and eliminate corruption from the government system.

The Bangladesh Forest Department (BFD) is the primary government agency that deals with forests and forest management and monitoring of biodiversity. The BFD manages PAs, forests, and most biodiversity activities in the field and operates through three management plan divisions. BFD's Wildlife Crime Control Unit (WCCU) was established in 2013 to combat wildlife trafficking and coordinate efforts with other agencies both national and international. Bangladesh Forest Department's capability for preventing wildlife crimes is currently not sufficient, and the country should invest more resources and manpower to the agency.

The BFD manages two large safari parks: Bangabandhu Safari Park, Gazipur, and Dulahazra Safari Park, Cox's Bazar. These facilities maintain animals in near natural conditions and also serve as a repository for animals that have been confiscated through the illegal wildlife trade. The BFD also manages a few botanical gardens around the country, and the National Botanical Garden in Dhaka displays many native and exotic species sells roses and fruit trees to the public, and engages in minor activities in the field; their space limitations prevent the addition of new species that may need ex situ conservation.

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