MANAGEMENT PLANS FOR LAWACHARA NATIONAL PARK

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LIST OF ABBREVIATIONS

ACF - Assistant Conservator of Forests
ACR - Annual Confidential Report
ADB - Asian Development Bank
AIG - Alternative Income Generation
BDR - Bangladesh Rifles
BFRI - Bangladesh Forest Research Institute
BGD - Bangladesh
cc - cubic centimeter
CCF - Chief Conservator of Forest
CEGIS - Centre for Environmental and Geographic Information Services
CF - Conservator of Forest
CIFOR - Centre for International Forestry Research
cm - centimeter
dbh - diameter at breast height
DCF - Deputy Conservator of Forest
DCCF - Deputy Chief Conservator of Forest
DFID - Department for International Development
DFO - Divisional Forest Officer
DR - Deputy Ranger
e.g. - for example
EIA - Environmental Impact Assessment
et al. - and others
etc. - etcetera
FAO - Food and Agriculture Organization
FD - Forest Department
FG - Forest Guard
Fr - Forester
FR - Forest Ranger
FRMP - Forest Resource Management Project
FSP - Forestry Sector Project
GIS - Geographic Information System
GoB - Government of Bangladesh
ha - hectare
HEED - Health Education and Economic Development
HSI - Habitat Suitability Index
i.e. - that is
IEC - Information, Education and Communication
IRG - International Resources Group
IUCN - International Union for Conservation of Nature and Natural Resources
km - kilometer
km2 - square kilometer
LDF - Landscape Development Fund
m - meter
m2 - square meter
MSc - Master of Science
NACOM - Nature and Conservation Movement
NGO - Non-Governmental Organisation
NIC - Nature Interpretation Centre
No. - Number
nos - numbers
NP - National Park
NSP - Nishorgo Support Project
NTFP - Non-Timber Forest Product
OIC - Officer in Charge
PA - Protected Area
PBSA - Participatory Benefit Sharing Agreement
PhD - Doctor of Philosophy
PP - Project Proforma
pp. - pages
PRA - Participatory Rural Appraisal
RF - Reserved Forest
RIMS - Resource Information Management System
RoW - Right of Way
RRA - Rapid Rural Appraisal
spp. - species (plural)
TA - Technical Assistance
Tk - Taka
TV - Television
UNDP - United Nations Development Programme
USAID - United States Agency for International Development
US$ - United States dollars
WC - Working Circle
WMNC - Wildlife Management and Nature Conservation
WNCC - Wildlife and Nature Conservation Circle
WS - Wildlife Sanctuary
WTO - World Tourism Organization

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

A basic principle of Protected Area (PA) management is that every PA should have a management plan that guides and controls the management of PA resources, the conservation of biodiversity, the uses of area and the development of Park facilities. This Management Plan provides five year development programs with framework activities and guidelines for sustainably managing the Lawachara National Park and its interface landscape. The Plan is based on a sustainable planning approach comprising, i) protection and conservation of all remaining natural forests and constituent biodiversity in the Park, ii) conversion of monocultures of exotic tree species into natural and man made regeneration of indigenous species by gradually opening the canopy, iii) development of co-management agreements (and linking PA conservation with benefit sharing arrangements) with key stakeholders to reduce ongoing habitat damage by helping them achieve sustainable livelihoods through participatory forest use and alternative income generation activities, and iv) provision of support to better administration and management of the Park including capacity development, infrastructure, training, and wider extension and communication.

The present situation (description of the Park, biodiversity protection and management, human use and biotic interactions, natural resources use patterns, interface landscape, etc.) with a documentation of main findings and issues is assessed in Part I of the Plan. Based on the findings of Part I, the Part II of the Plan recommends strategic programs and priorities for future development and management of the Park. The stakeholders consultations on the draft Plan were held with public representatives (local MP, chairman and members of Union Parishads and Poursabha), FD field staff, BDR, potential members of user groups and co-management committees, village elites, leaders, journalists, NGOs, tribal leaders and forest villagers, saw mill owners, timber traders and mahaldars (forest contractors).

The NP, notified in 1996 with a total forest area of 1250 ha (of West Bhanugach RF), has remnants of biologically rich forests located in the high rainfall bio-geographic zone with evergreen and semi-evergreen forests, characterized by high rainfall and a multi-tier vegetational assemblage of rich biodiversity. West Bhanugach RF originally supported mixed tropical evergreen forests, which over the period have been substantially altered due to heavy biotic interference and plantations established after clear-felling of natural vegetation. The situation got exacerbated with large scale encroachment of forest land as a result of which these forests have become fragmented with much reduced extent of suitable habitats and ensuing adverse effects on the ecological boundaries and wildlife of the Park. However, at places good natural regrowth, particularly of ground flora and middle story, has come up over the period due to favorable climatic and edaphic conditions, thereby enhancing the Park's *in-situ* conservation values. Consequently, the vegetation in many areas of Lawachara has approached towards natural structure and species.

Six ecosystems in the Park and its interface landscape can be identified as i) high forests represented by the remaining patches of natural forests, ii) plantations including the monoculture of exotics, iii) grasslands and bamboos, iv) wetlands, v) Tea Estates, and vi) cultivated fields : the first three being the largest in extent and also important from PA management point of view. Important biological values of the Park include shelter to biodiversity comprising important flora and fauna, habitat connectivity, presence of threatened and endemic species, and improving degrading habitat. It represents a fragile landscape with a rich biodiversity, which if not conserved, may be lost for future generations. Its main ecological functions are catchment conservation of several rivers and water bodies (haors, beels, ponds, etc.), control of soil erosion, ecological security, irrigation and agricultural production, carbon sink and environmental amelioration. The Park provides significant scope for wildlife education and research, nature interpretation and conservation awareness. Socio-economic values of the Park are important because a number of communities including ethnic minorities reside within and around the forests on which they depend for their livelihood. So the Park also is a potential source of eco-tourism, aesthetic and cultural values, scenic beauty and ethnic diversity. Its conservation values are regional and national but also with local implications.

The Plan is developed by following a landscape approach of Park management by focusing on an appropriate scale in order to integrate relevant habitat/forest system, ecosystem and relevant social/institutional system. The Plan focuses on protecting and conserving the rich biodiversity of the Park in accordance with sound principles of sustainable environmental and socio-economic development and the Forest Policy of 1994. The interface landscape exercises influence around the boundaries of the Park. In total 18 villages and 6 Tea Estates fall within the zone of influence and an assessment of potential stakeholders has been included in the Plan. It addresses the basic consumption needs of identified villages

of interface landscape and co-management activities in the context of a broader economic, natural resource and socio-institutional environment of Lawachara.

Main long-term management aim is to maintain the maximum possible area under forest cover, and to maintain the forest and its constituent biodiversity in the best possible condition. Main management objectives during the five year plan period are to:

- ➔ develop and implement a co-management approach that will ensure long-term protection and conservation of biodiversity within the Park, while permitting sustainable use in designated zones by local people as key stakeholders.
- ➔ conserve the biodiversity of the Park by following co-management approach based on building partnerships with all the stakeholders and sharing benefits with local communities and key stakeholders.
- ➔ refine and strengthen the policy, operational, infrastructural and institutional capacity framework for PA management
- ➔ conserve and maintain viable wildlife population including endangered, threatened, endemic and rare species of plants and animals
- ➔ restore and maintain as far as possible the floral, faunal, physical attributes and productivity of the forest eco-systems
- ➔ encourage eco-tourism in suitable zones and develop visitor amenities
- ➔ implement income generation activities for sustainable livelihood development and enhance skills of local stakeholders

The main framework activities to be undertaken for achieving the above-stated objectives include amongst others:

- ➔ Survey, demarcate and mark the Park boundaries;
- ➔ Develop a co-management model and relevant policy guidelines, and establish co-management agreements linking PA conservation with benefits sharing arrangements with key stakeholders;
- ➔ Survey biodiversity resources;
- ➔ Strengthen FD institutional capacity for PA management;
- ➔ Build conservation awareness, constituencies and extension activities on conservation issues;
- ➔ Train local stakeholders including beneficiaries and FD staff in conservation management and income generation, raise awareness among stakeholders and develop PA facilities;
- ➔ Develop conservation and visitor facilities within the Park;
- ➔ Create tree resources in adjacent agricultural and village areas on participatory conservation and benefits sharing basis and implement alternative income generation activities for sustainable livelihoods;
- ➔ Convert existing short-rotation plantations of exotic species to naturally regenerated areas by gradually opening the canopy, and enrichment plantations of indigenous species in identified gaps, if required; and
- ➔ Provide alternative income generation opportunities for key stakeholders.

Major challenges expected in achieving the management objectives include encroachment of forest lands and illegal removal of forest produce (mainly timber and fuel wood) are two main challenges facing the Park. Other important challenges include biotic pressure by labor employed by Tea Estates, hunting and poaching, transboundary problems, flood and erosion, grasslands degradation, traffic movement on roads and rail lines, demarcation of PA boundaries, lack of funds, lack of trained professionals, inadequate staffing and infrastructure, monoculture, man-animal conflicts, etc.

The proposed framework activities will be undertaken under the following seven strategic programs developed for a sustainable Park:

1. Habitat Protection Programs: Main objective of this program is to provide adequate protection to the Park for the conservation of its constituent biodiversity. Main activities to be carried out to achieve this objective include updating forest cover and interface landscape maps; demarcation of Park boundaries and management zones; control of illegal felling, forest fires and poaching; and stopping encroachment of the Park lands.

Reconnaisance surveys followed by detailed surveys of identified areas will be conducted for verifying actual ground situation. New mapping will be completed during the Plan implementation and will include

relevant landscapes within a 3 km wide interface landscape zone outside of existing/proposed boundaries of the Park in order to provide a spatial context for coordination of regional landscape elements and forests. All the peripheral boundaries of the notified Park area will be identified, surveyed and marked on the ground. The boundaries of proposed management zones will be defined, mapped and identified on the ground during the Plan implementation period. Posts and/or other markers will be put in place at all important turning points and will be labeled and maintained regularly. Signboards of appropriate design will be placed at important locations.

Effective protection against illicit felling, poaching, forest fires, forest grazing and forest land encroachment will be provided by FD staff by gainfully associating local stakeholders. In view of limited area of the Park, patrolling on foot by local stakeholders and FD staff will be done regularly. Forest Villagers from Magurchara and Lawachara will particularly be helpful in forest protection efforts through joint patrol and intelligence sharing. Co-management agreements will be signed with main stakeholders at different levels and all co-management activities in the Park will involve local stakeholders, FD field staff and NGOs. A conflict resolution mechanism will be established as part of co-management council/committee because Park level conflicts may arise due to forest extraction, forest land encroachment, forest land disputes, forest offences, forest grazing and local level politics.

In case of organized smuggling an effective checking of tree felling and poaching will require concerted efforts from FD by using modern equipments, arms and ammunition (guns, revolvers, etc.), and transport facilities to combat organized smugglers and poachers. This also may require setting up special protection force by augmenting the presence of FD field staff, if necessary backed by BDR staff. In such cases inter-agency coordination will be necessary for successful efforts and control measures. Communication network will be strengthened by installing a radio communication network and by mobilizing more walky talkies, mobile telephones and vehicles. Adequate rewards will be provided to those FD field staff and local stakeholders who will perform exemplary biodiversity protection duties.

2. Management Programs: Main objectives of this program are to maintain ecological succession in constituent forests by providing effective protection against biotic interference; to develop natural forests and plantations as good habitat favoring wildlife; to conserve the forest resources including the constituent biodiversity; and to establish appropriate co-management methods and practices through stakeholders' consultation and active participation. The long-term management aim of maintaining the maximum possible area under forest cover along with its constituent biodiversity in the best possible condition will be achieved by zoning the Park area and surrounding landscape such that i) the areas of highest conservation value (forests and/or old plantations) are protected, regenerated and managed towards natural forest composition and structure, particularly in the core zone, ii) the areas used to provide benefits to local people through sustainable use of forests are defined, and high impact activity areas, mainly as interface landscape zone. The core zone will have the highest conservation value followed by interface landscape zones which of course are important for biotic life; these two broad zones will further be subdivided into specific sub-zones as discussed below.

All of the total notified area of the Park is designated as the core zone, which is sub-divided into 5 sub-zones (ecosystem sub-zone, habitat management sub-zone, sustainable use sub-zone, village use sub-zone and intensive use sub-zone). All the well stocked areas are covered under the ecosystem sub-zone, where main management objective is to protect and maintain remaining vegetation in good stocking and encourage natural regeneration to gradually bring back natural forests. More than half (57%) of the notified Park has been designated as ecosystem management sub-zone covering existing forests/plantations areas with good biodiversity value. Forest management in this sub-zone will focus on conserving the remaining natural forests and bringing back natural regeneration wherever possible. This will be achieved by providing protection (against illicit removals of forest produce, encroachment, poaching, fires and grazing) through co-management practices and encouraging natural processes for regeneration and rehabilitation of forests. Canopy manipulation (gradual opening of top canopy through selective removals) will be carried out in extensive monoculture of teak and other exotics in order to create more favorable habitat for wildlife by encouraging natural regeneration and enrichment planting of indigenous trees, shrubs, herbs and palatable grasses. Subsidiary silvicultural operations will be carried out whenever necessary to encourage natural regeneration. Habitat management sub-zone will be subject to management/manipulation of habitat for key wildlife species through selective management interventions. Habitat improvement works including rehabilitation of degraded areas, enrichment planting of fruit bearing species and palatable grasses, replacement of exotics by gradual canopy opening, maintenance of glades and water holes, soil/water conservation in identified micro-watersheds and eradication of weeds will be taken up.

Enrichment plantations will be taken up in those areas where natural regeneration is not coming up due to lack of regenerative rootstock.

Nearly one-quarter of the notified Park area is designated as sustainable use sub-zone comprising forests/plantations which can sustainably be used by local people by entering into participatory conservation and benefits sharing agreements. Short and long rotation plantations including those raised under FSP as buffer plantations will be managed under benefit sharing agreements. However, these plantations will not be clearfelled but instead be managed under selection felling (mainly of exotic species) so that the area can be naturally regenerated to be ultimately included over the period in core zone as mixed forests. The traditional use of assigned forests for betel leaf cultivation by forest villagers of Magurchara and Lawachara is included in this zone. The habitations and cultivations with respect to Forest Villages (Magurchara and Lawachara) are included in village use sub-zone. Such areas existing at the time of Park notification will be delineated with permanent markers. The existing inhabitants will be registered and further in-migration will be discouraged. As important stakeholders, the Forest Villagers will be engaged in co-management activities with formal co-management agreements signed with FD. Intensive use sub-zones will incorporate the relatively small areas required for administrative buildings and staff quarters, visitor accommodation and other facilities.

Interface landscape zone will focus on the surrounding landscape helpful in protecting and conserving the core zone and creating congenial habitat for wildlife including protecting and maintaining wildlife corridors. Depending upon the uses to which different areas are used and managed, this zone is further categorized into 3 specific sub-zone: support sub-zones, transportation corridor sub-zones and Tea Estate sub-zones.

The present residents of the villages (situated within and on the periphery of the Park: Magurchara, Lawachara, Dolobari and Bhagmara) will continue to use forests/plantations sustainably as per the co-management agreements to be signed with FD. The first of three identified support sub-zones consists of 67 ha of short rotation plantations (of acacia and eucalyptus) adjacent to the western edge of the proposed northward extension of the Park in Chautali Beat. The second support sub-zone consists of 19.5 ha of FD lands with secondary vegetation of grass and scrub, bordering the eastern edge of the Park, and ceded to the NGO HEED under a long-term agreement. This area will be brought under FSP plantations to be raised by associating local stakeholders with benefits sharing agreements. The third support sub-zone will comprise all the 16 identified villages where livelihoods programs will be implemented by using Landscape Development Fund (LDF).

Transportation corridors sub-zones will cover a rail line, a power transmission line and an asphalt-surfaced highway, all passing through the Park. FD will establish and maintain regular contacts with the concerned land owning agencies and departments (Bangladesh Railways, Power Development Board and Roads & Highways Department) in order to get their cooperation in preventing and limiting noise/chemical pollution and damage, and also minimizing the width of vegetation clearing during RoW maintenance. Strip plantations may be raised along rail lines and roads under FSP and other GOB funded schemes by involving local stakeholders under benefits sharing arrangements.

All the six Tea Estates (Fulbari, Khaichara, Jakchara, Gilachara, Noorjahan and Bharaura) surrounding the Park are typically very important part of the interface landscape zone of Lawachara Park. Some parts of these Tea Estates have so far not been brought under tea cultivation, and have over the period developed as unmanaged secondary vegetation. They provide additional wildlife and plant habitat as a transition zone between mixed forests/plantations and tea plantations. Small areas along Tea Estates have been converted to citrus, pineapple and banana plantations. This trend needs to be reversed back and Tea Estate authorities should be convinced by FD for developing secondary vegetation for providing additional habitat for wildlife. A large number of labor employed by the Tea Estates and their family members depend on Lawachara forests for meeting their livelihoods consumption needs. The unemployed villagers particularly from Fulbari, Jakchara and Khaichara Tea Estates get involved in illicit removals of fuelwood and timber from nearby forests. At times illicit fellers pass through adjoining Tea Estates (e.g. Jakchara, Gilachara) to fell trees inside the Park and also shade trees inside tea gardens. So joint efforts both from FD and Tea Estate authorities are needed for control of illicit felling. Livelihoods programs will be implemented for identified households of Tea Estate workers, who will be involved in the protection of adjoining forests.

3. Livelihoods Programs for Landscape Development: In the absence of any commercial harvesting inside the Park, additional benefits need to be mobilized through off-PA activities including alternative income generation activities and self-employment opportunities to local stakeholders. Main objective of

livelihood programs for landscape development is to establish proper linkages with appropriate livelihoods programs and other projects/initiatives that will reduce biotic pressure on forests. Up-scaling of skills will be taken up for generating value additions through capacity building of local stakeholders. LDF will be used to provide finance for the members of co-management groups and committees, and their federations will be encouraged to set up micro-enterprises, particularly forests-based, to generate value additions locally. The benefits from eco-tourism will also be ploughed back locally for the development of local communities and the Park. Networking with relevant NGOs acting in the landscape zones will be established for rendering rural development services to local stakeholders. The following production technologies were found suitable for their implementation in the interface landscape zones:

- ➔ Agricultural and Horticultural Crops (integrated homestead farming, cultivation of high value crops, village tree nursery, food processing and storage, marketing, etc.)
- ➔ Livestock Rearing (beef fattening, milch cow rearing, broiler/layer rearing, etc.)
- ➔ Fisheries (rice fish farming, fingerling rearing, crop polyculture, fish culture, etc.)
- ➔ Non-Timber Forest Products (NTFPs based technologies and enterprise development)

4. Facilities Development Programs: Main objective of this program is to develop necessary accommodation for FD staff and procure field equipments required for the management of the Park. The development of built facilities will be undertaken to support the Park administration during the Plan implementation period. Built facilities will be developed at Park Hqs. including the existing Lawachara Beat Office and BFRI facilities; rest stop/picnic area near Janakichara Nursery; Guard Bhagmara Camp near eastern Park boundary; and Chautali Beat Office. At each location, the design standards for both renovations and new construction will be based on sound environmental considerations. Existing forest roads and trails will be renovated and maintained regularly. Vehicles, field equipments and office equipments will be procured to support the development and administration programs.

5. Visitor Use and Visitor Management Programs: Regulated eco-tourism in the form of nature education and interpretation tours (as against commercial tourism) will be a main objective of visitor use and management programs. The potential of conservation tourism is high in Lawachara mainly due to its easy accessibility and so there is good scope for developing visitors facilities. A tourism region will be identified around the Park by linking with other local and regional attractions including Guest Houses, tribal villages, rolling landscapes, wetlands and tea gardens through forest roads and trails. Eco-guides to be identified amongst local communities and co-management groups/committees will be trained and employed for the guidance of eco-tourists. Brochurs, pamphlets, guide maps, hand outs, audiovisual aids, display boards will be developed for encouraging eco-tourism.

A network of nature and hiking trails of short, medium and long duration will be identified and developed for visitors movement through key natural and cultural features of interest (patches of high forests, betel leaf gardens, natural streams, cultural remnants, etc.). Priority will be given for developing existing foot paths and vehicle tracks in order to minimize creation of new paths and consequent vegetation clearances and soil erosion. Lawachara Beat Office and Shamoli FRH will be connected with nature trails as far as possible. Sign-posts with adequate information will be provided at main trail heads and printed material will be distributed to interested visitors for their conservation education and awareness.

The publicity of Park management activities will be improved through electronic and print media for propagating biodiversity conservation, environment, and wildlife and the cause of its habitat. Schools and colleges will be targeted (forming Sabuja Vahinis) for conservation education and building an informed wildlife constituency. Nature interpretation will, as educational activity, focus on revealing meaning and relationships of complex ecosystems and landscapes. Existing BFRI Laboratory/Office Building will be developed as a Nature Interpretation Centre, which will act as Environmental Education Centre.

A collaborative conservation strategy will be developed to provide mechanisms for improving inter-sectoral coordination and information sharing in order to maximize biodiversity conservation efforts. The concept of public-private partnership will be developed and implemented in soliciting the inputs/contributions from private sector for Park facilities development. Nature conservation partnerships will be designed to offer interested businesses a vehicle for contributing to long-term biodiversity conservation in a way that is transparent with low transaction costs, generates beneficial public image for the contributor and makes a long term difference in biodiversity conservation.

6. Conservation Research, Monitoring and Capacity Building: This program will focus on providing tools/mechanisms for a better understanding of the Park and its functions in sustainably managing forests and biodiversity. Keeping in view the funds scarcity for conservation research, appropriate collaboration and networking with relevant Bangladeshi research organizations will be established. Conservation research may include aspects such as diverse types of flora and fauna, status of endangered species, wildlife behavior, socio-economic issues, silvicultural aspects, applied biological research, ecological issues, man-animal conflicts, impact of anthropogenic pressures on natural systems, etc. The results/findings of research studies will be adequately disseminated for their proper utilization by FD field staff. Research dissemination and use methods will be standardized and circulated among FD staff. Useful research outputs will be included in annual development plans of FD for their field implementation.

The following set of core indicators has been designed by following the guidelines contained in the USAID's Performance Monitoring Plan:

- ➔ Indicator 6.2d : Declining incidence in illegal logging in the forests of Lawachara
- ➔ Indicator 6b : Increased production of natural resources in targeted areas
- ➔ Indicator 6c : Increased biodiversity in targeted areas of the PA

Benchmark information base will be developed for measuring and comparing the volume of timber loss (cubic meter/ha), and natural regeneration and biodiversity status for assessing effectiveness of project interventions during the Project period. A critical review of the long-term habitat management strategy based on a detailed inventory of biodiversity will be taken up during the final year of implementation of the Plan. Park management practices will accordingly be adjusted based on the findings of review.

As a part of Plan implementation a good coordination with related organizations in Asia and elsewhere will be developed. Cross-country exchange visits and training will be arranged to learn from relevant experiences from similar projects being implemented in different Asian countries. A working group will be supported under NSP for preparing and disseminating co-management best practices and lessons learned. Potential organizations for establishing and maintaining professional contacts may include FAO (Bangkok office), RECOFTC (Bangkok), ICIMOD (Kathmandu), WII (Dehra Dun), CIFOR (Bogor), etc.

There is great necessity of imparting conservation training to the FD field staff responsible for managing Lawachara Park. FD presently does not have any specialized capacity for imparting PA management training, although adequate forestry training infrastructure has developed under different donor funded projects. Of many forestry subjects only one paper relates to wildlife management being taught to cadre officers at Forest Academy, Chittagong. Other subordinate FD staff do not receive any significant training on PA management, although wildlife management is one of the many taught subjects. There is lack of faculty, particularly on in-situ conservation at ecosystem and landscape levels by involving stakeholders. Some forest officers have undergone overseas training on wildlife and PA management but are presently working outside WNCC, thereby under-utilizing their expertise. An exhaustive conservation training plan, covering both in-country and overseas training, will be developed under NSP and implemented over the project period. A training strategy dealing with both quality and quantity of conservation training including refresher and orientation training will form part of the training plan.

The existing Wildlife (Preservation) (Amendment) Act, 1974 is under revision process by a committee comprising of FD officers. The revision process will be expedited and completed after taking relevant inputs from renowned legal and environmental experts and stakeholders. It will be ensured that the revised Act is compatible with relevant international conventions and agreements signed by the Government of Bangladesh.

7. Administration and Budget: Main objectives under this program are to ensure that technical and administrative staff required to manage the Park effectively are posted and adequate financial organizations systems are in place. It is recommended to implement the approved organogram by operationalizing newly created wildlife division and posting of approved technical and management staff for each PA. Lawachara Park will be an independent operational unit with greater decentralized authority for decision-making with an assigned ACF who will have required administrative and financial powers. The duties and responsibilities of the designated staff have been defined in the Plan.

The existing financial organization systems are adequate and appropriate in most areas but need a detailed review in order to identify specific areas of financial strengthening in future. For example, under the existing budget codes neither there is any specific budget code for PA head (the WNCC is created in 2001 only whereas the budget codes were designed much earlier) nor separate budget allocations are made for operational funds exclusively for the management of wildlife and PAs. This system needs to be implemented as soon as possible in order to ensure a certain required level of annual financial stability for *in-situ* biodiversity conservation in the PAs managed under the WNCC.

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VOLUME 1

MANAGEMENT PLANS

PART I

ASSESSING THE PRESENT SITUATION-FINDINGS AND ISSUES

1. BACKGROUND

Participatory forestry projects, supported by donors, have been implemented in Bangladesh on a large scale since 1981 when a community forestry project was taken up by Forest Department (FD) with the financial support from Asian Development Bank (ADB). Sectoral forestry development projects such as Forestry Sector Project (FSP) have been implemented with a major policy shift in favor of a participatory management of the country's forests (Figure 1) and protected areas (Figure 2). Local people and communities participated in developing, protecting and managing forests/plantations in lieu of usufructury rights granted as per participatory benefit sharing agreements (PBSAs) signed between user groups (of participants) and land owning agencies (such as FD in case of forest land). The Nishorgo Program of FD aims to protect and conserve the forests and biodiversity of the country's protected areas (PAs) by building gainful partnerships between FD and main stakeholders based on mutual trust and shared roles and responsibilities for biodiversity conservation and sustainable use.

The country's PAs have been an intimate interspersion of human habitations and cultivation through them with traditional dependency on neighboring forests for their livelihood in a largely agrarian economy. In addition to development pressures on forest land, the traditional dependence of local communities on the forests has historically been an important aspect of forests management in the country. As a result, the biodiversity conservation priorities cannot be set in isolation from local forest resource use and development. Anthropogenic pressures including increased commercial extraction of forest produce, and forest land encroachment for habitations and agriculture, brought by manifold increase in human and cattle population, led to widespread shrinkage and degradation of PAs in Bangladesh. Illegal removals from the forests have increased off late, thereby jeopardizing the very existence of biodiversity in some of the PAs. This has adversely affected the local people and communities as well as the conservation status of wildlife habitat. In the process the livelihood patterns of natural resources dependent people are affected adversely.

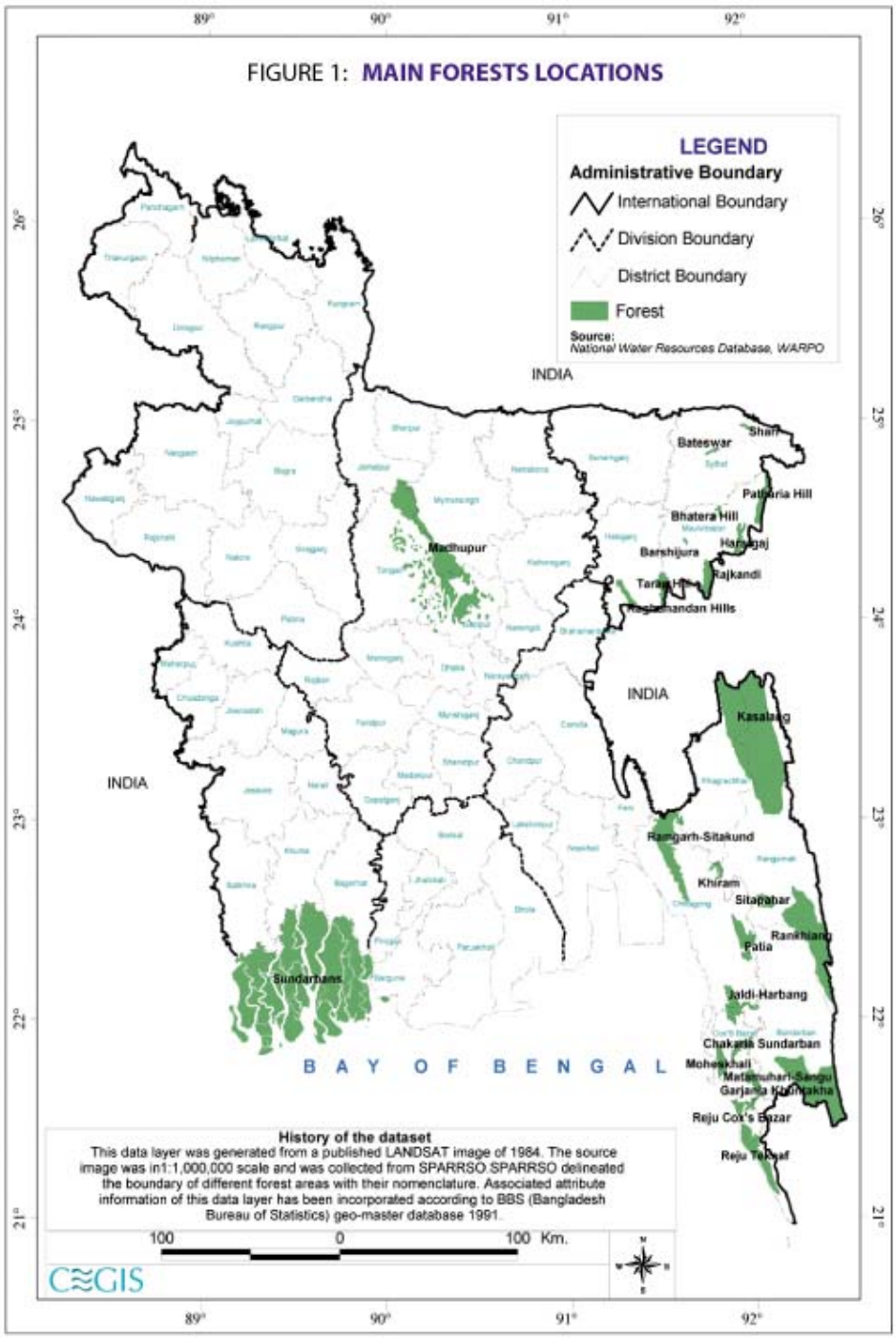
A basic principal of PA management is that every PA should have a management plan. Management plan guides and controls the management of PA resources, the uses of the area, and the development of facilities needed to support that management and use; it facilitates all development activities in an area (MacKinnon et al. 1986). Participatory management plans were prepared for two PAs covered under the conservation area management component of FSP. Although these management plans prescribed a list of management activities to be carried out in two PAs, they required updating in view of a co-management approach being adopted under the Nishorgo Support Project (NSP).

The NSP is a project of the FD, Ministry of Environment & Forest, funded by USAID and implemented by International Resources Group (IRG). The project is supporting a broad Nishorgo Program of FD, which is a comprehensive effort to improve the management of country's protected areas being managed by FD. The Nishorgo Program, which focuses on all the PAs (Wildlife Sanctuaries, National Parks, Safari Parks and Game Reserves) of FD, aims to protect and conserve country's forests and biodiversity for future generations.

A draft management plan, prepared (2000) for Lawachara NP under FSP by following an ecosystem approach, could not be approved as it was deemed to be incomplete and insufficiently prescriptive. This 5-year plan, a revision of the draft Plan prepared under FSP, is prepared by following a co-management approach, encompassing relevant ecosystems and socio-institutional systems in core and interface landscape zones. A FD structure for management plans has been followed by including descriptive information in Part I and prescriptive details in Part II of the Plan. Main objectives of the Plan have been presented in Chapter 1 of Part II. This plan will be implemented mainly by FD and the project staff but would also be useful to all the stakeholders including local participants, NGOs, planners, policy-makers and researchers.

A participatory and process-oriented approach was followed in the development of this Plan. The proposed contents, structure and outline for this plan were first circulated and discussed with senior FD officials. A first draft was developed and presented to senior FD officials at Ban Bhaban. A revised draft Plan was developed and circulated among the FD officials for their written comments. Participatory discussions continued in the meantime with the field staff of FD and NSP, and members of co-management councils/committees and user groups. An updated draft prepared after incorporating written comments from FD staff and suggestions made by councils/committees was presented in a planning workshop held at Ban Bhaban for second round of feedback from FD officials. A revised version, prepared after incorporating suggestions made in the planning workshop was subsequently circulated

among the senior officials of FD. The draft Plan was finally presented in a meeting held at Ban Bhaban for final review prior to submission for Government approval. The final draft incorporates all the suggestions made in this meeting.



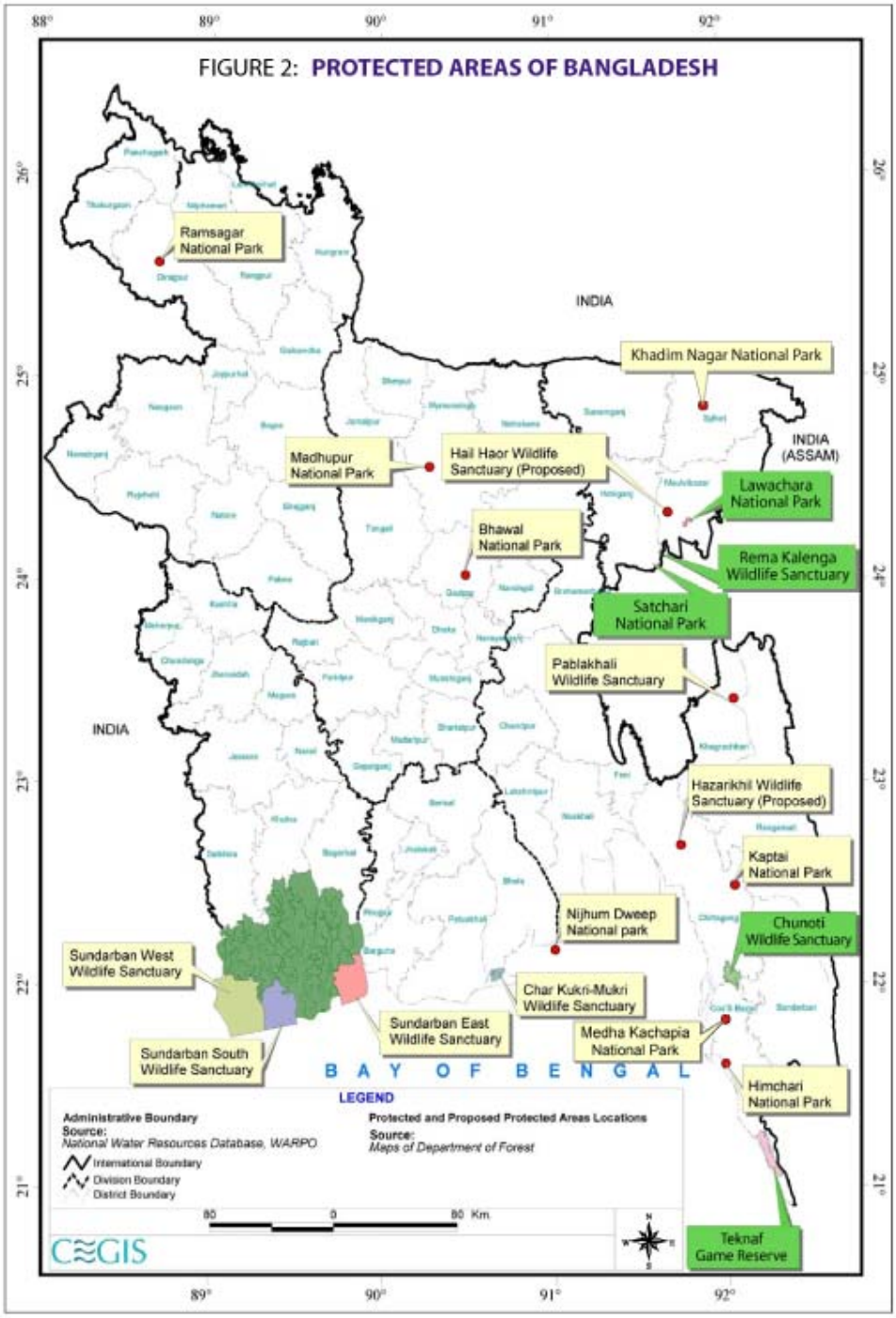


FIGURE 2: PROTECTED AREAS OF BANGLADESH
Ramsagar National Park
INDIA
Khadim Nagar National Park
INDIA (ASSAM)
Madhupur National Park
Hail Haor Wildlife Sanctuary (Proposed)
Lawachara National Park
Bhawal National Park
Rema Kalenga Wildlife Sanctuary
Satchari National Park
Pablakhali Wildlife Sanctuary
INDIA
Hazarikhil Wildlife Sanctuary (Proposed)
Kaptai National Park
Nijhum Dweep National park
Chunoti Wildlife Sanctuary
Sundarban West Wildlife Sanctuary
Char Kukri-Mukri Wildlife Sanctuary
Sundarban East Wildlife Sanctuary
Medha Kachapia National Park
Sundarban South Wildlife Sanctuary
B A Y O F B E N G A L
Himchari National Park
Teknaf Game Reserve
LEGEND
Administrative Boundary
Source:
National Water Resources Database, WARPO
International Boundary
Division Boundary
District Boundary
Protected and Proposed Protected Areas Locations
Source:
Maps of Department of Forest
80 0 80 Km
CEGIS
88° 89° 90° 91° 92°
26° 25° 24° 23° 22° 21°

2. INTRODUCTION

At the heart of Nishorgo Program is a focus on building partnerships between the FD and key local, and national stakeholders, who can assist in the conservation efforts for a PA. An effective implementation of the Nishorgo Program will help conserve biodiversity through facility development, capacity building, and gainful partnerships with stakeholders. Under its partnership with the Government of Bangladesh (GOB), the USAID, Bangladesh is providing targeted technical support to main aspects of the Nishorgo Program. The NSP works closely with the FD and key conservation stakeholders to develop and implement a co-management strategy to help conserve the country's PAs where relevant partnerships for PA conservation are essential. The Project is working at five initial pilot sites: Lawachara National Park, Rema-Kelinga Wildlife Sanctuary, proposed Satchuri National Park, Teknaf Game Reserve and Chunoti Wildlife Sanctuary, of which the first three PAs (Figure 3) are located in Sylhet Forest Division.

The Plan provides for an overall five year framework for developing and managing the Lawachara NP of Sylhet division under Nishorgo Program. Planned development interventions under FSP, NSP and other GOB schemes are included in the Plan along with other relevant activities necessary for the development of the Park. The stakeholders consultations on the draft Plan were held with public representatives (local MP, chairman and members of Union Parishads and Poursabha), FD field staff, BDR, potential members of user groups and co-management committees, village elites and leaders, journalists, NGOs, tribal leaders and forest villagers, saw mill owners, timber traders, mahaldars, etc. Main focus of forest management under this Plan will be on conservation of forests and constituent biodiversity resources, sustainable use of specified areas where this can help to achieve conservation on a broader scale, and involvement of local people and other key stakeholders in the PA management.

Part I of the Plan assesses the present situation (provides a description of the Park, an assessment of biodiversity, resources protection and management, human interactions, forest resources use patterns, interface landscape situation, past biodiversity management and practices, etc) with a documentation of main findings and issues. Additional information on the regional/national biophysical and socio-economic scenario can be found in the documents listed under References. Part II of the Plan recommends strategic programs and priorities (comprises prescriptions for future development and management of the Park with detailed guidelines) for a sustainable National Park. The Plan, as a guide to development interventions, will be useful for the PA managers, planners, decision-makers, researchers, donors and other stakeholders including local forests dependent communities.

The scope, timing and relative emphasis on specific activities may be modified by the Park managers on the basis of experience, success and progress as the Plan is implemented. The overall levels of inputs indicated under each activity will be maintained to the extent possible in order to ensure reasonable success in management implementation. However, it is important to have sufficient flexibility needed for making required modifications and adjustments to management activities within the limits set by overall goals and objectives. Hence, although five year schedules of activities and inputs are presented, it is recommended that needed changes in timing, inputs and outputs will be reflected in annual workplans to be prepared by Park managers every year and approved by.

The Management Plan is based on a co-management approach comprising, i) protection and conservation of all remaining ecosystems including natural forests and constituent biodiversity in the Park, ii) conversion of monocultures of exotic tree species into natural and man made regeneration of indigenous species by gradually opening the canopy, iii) identification of interface landscape and development of co-management agreements (and linking PA conservation with benefit sharing arrangements) with key stakeholders to reduce ongoing habitat damage by helping them achieve sustainable livelihoods through participatory forest use and alternative income generation activities, and iv) provision of support to better administration and management of the Park including capacity development, infrastructure, training, and wider extension and communication.

2.1 Location and Constitution

Lawachara NP (in Kamalganj Upzila of Maulvibazar District) is located nearly 160 km northeast of Dhaka and approximately 60 km south of Sylhet city. It lies between 24030' – 24032' N and 91037' – 91047' E and is nearly eight km east of Srimongal, on way to Kamalganj. The NP and proposed extension comprise forests of southern and eastern parts of West Bhanugach Reserve Forest (RF) within Lawachara, Chautali

and Kalachara Beats of Maulvibazar Range. The NP was notified (a copy annexed) in 1996 as per the Wildlife (Preservation) (Amendment) Act, 1974, with a total forest area of 1250 ha. In addition to the notified area, a proposed extension of 281 ha (incorporates the remaining old plantations in West Bhanugach RF) is also included in the Plan keeping in view the addition of habitat for biodiversity value and population viability of main forest-dwelling wildlife species. The proposed extension incorporates most of the remaining plantations in West Bhanugach RF that are greater than 25 years of age as recommended in the Forestry Master Plan (GOB, 1992).

2.2 Access

Bangladesh Railway serves well as the Park falls very near to the main railway line running through the forest division (Figure 4). Due to its well connectivity, the Park is very attractive for eco-tourism, particularly for the people of large urban centers such as Dhaka. Lawachara NP, representing the accessible hill forests of Sylhet forest division, is well connected by good roads, which also provide easy access to the nearest national/international airport at Sylhet. The Park is crossed by a paved road and railway line linking the towns of Sreemongal (nearly 8 km to the west of the south-western Park boundary) and Kamalganj (nearly 2 km to the east of the eastern Park boundary). Traffic inside Lawachara NP include mainly motor vehicles and trains. A power transmission line largely parallels the highway corridor. These transportation corridors and traffic movements are important considerations in the Park management because i) traffic noise damages/disturbes wildlife, ii) the cleared rights-of-way are potential barriers to wildlife movements, iii) the cleared rights-of-way provide easy access to illicit fellers, and iv) the highways provide easy access to visitors to the Park.

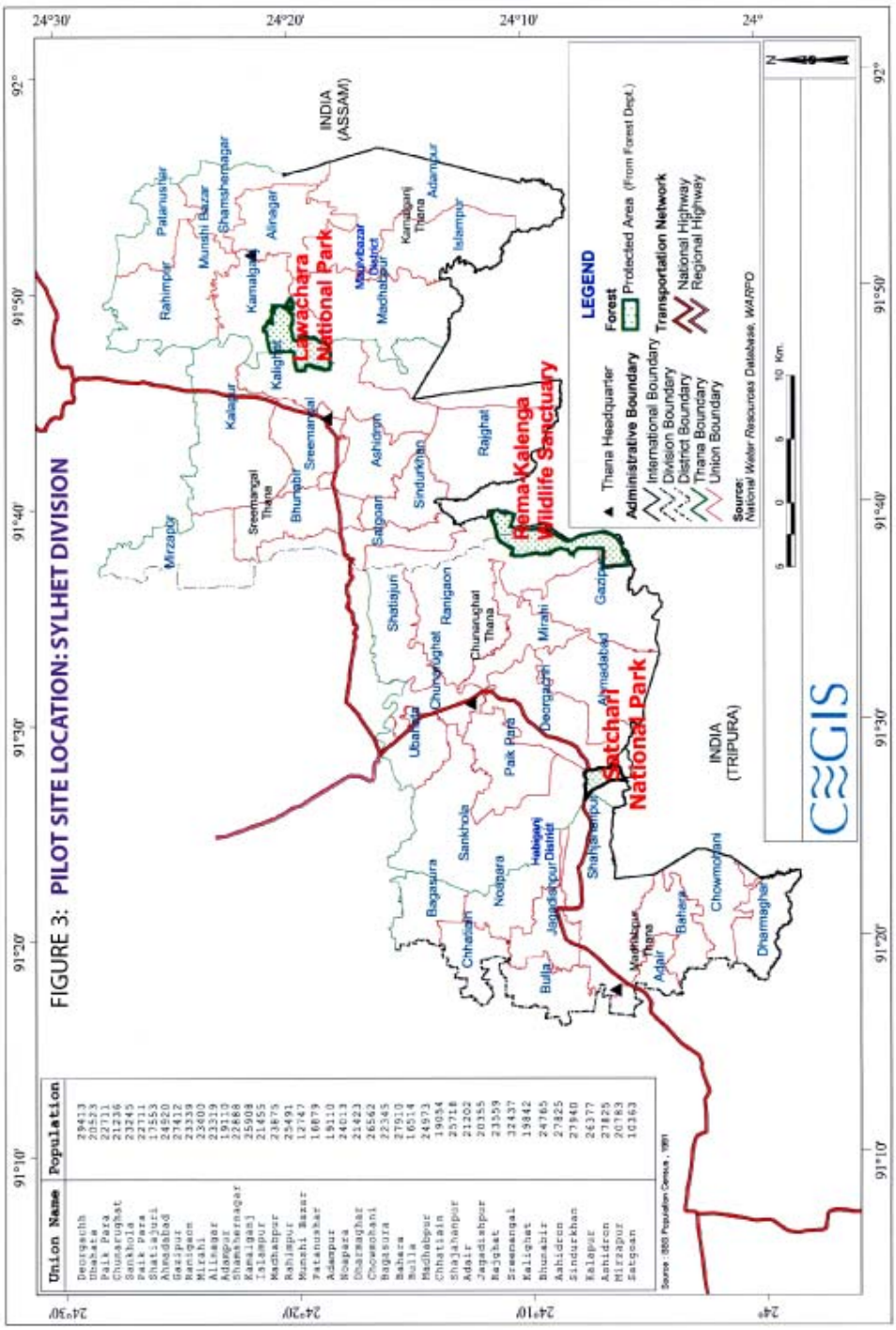


FIGURE 3: PILOT SITE LOCATION: SYLHET DIVISION
INDIA (ASSAM)
INDIA (TRIPURA)
Lawachara National Park
Rema-Kalenga Wildlife Sanctuary
Satchari National Park
LEGEND
Forest
Protected Area (From Forest Dept.)
Thana Headquarter
Administrative Boundary
International Boundary
Division Boundary
District Boundary
Thana Boundary
Union Boundary
Transportation Network
National Highway
Regional Highway
Source: National Water Resources Database, WARPO
CEGIS
Union Name | Population
Source: 1991 Population Census, 1991

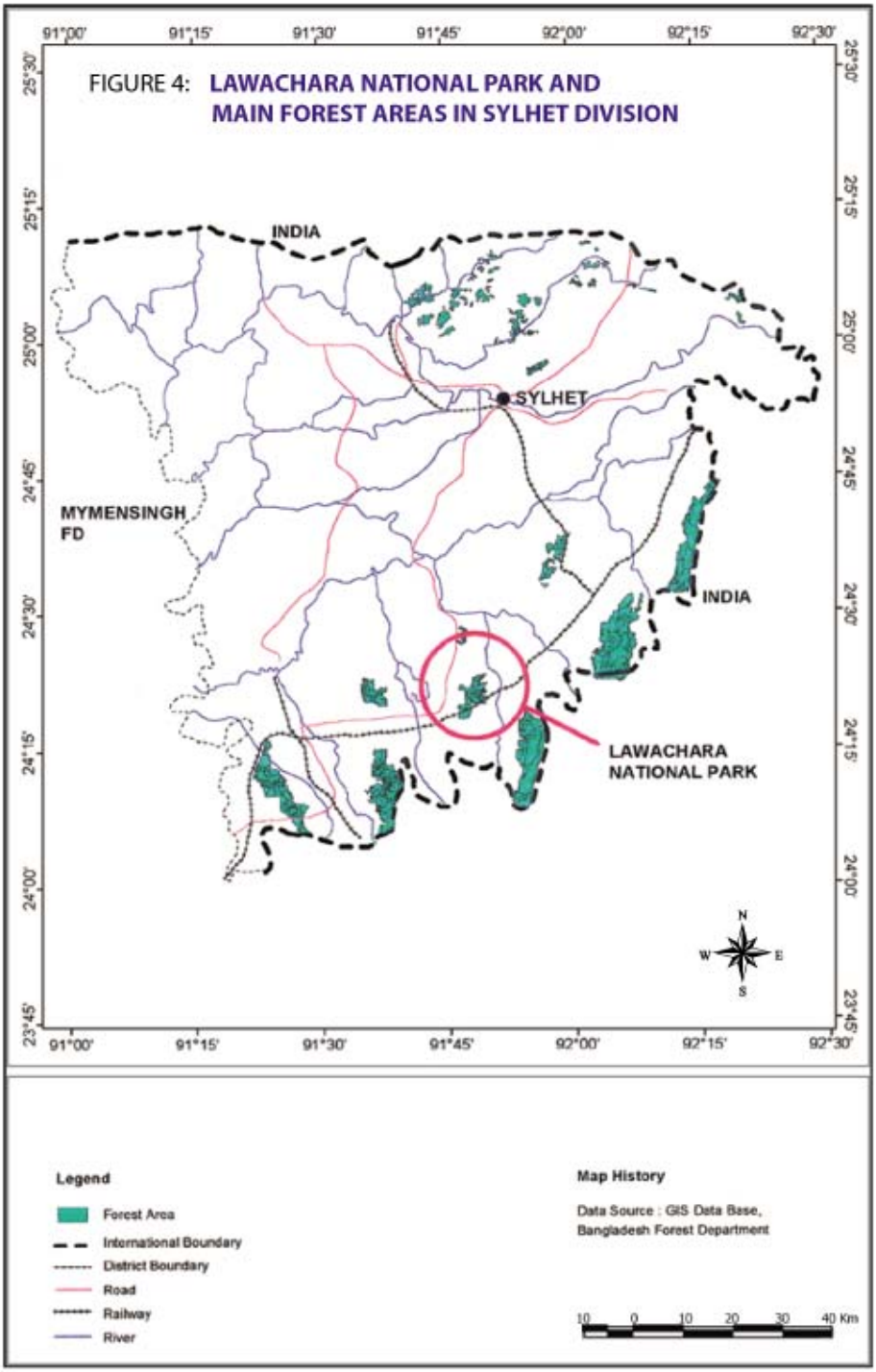


FIGURE 4: LAWACHARA NATIONAL PARK AND MAIN FOREST AREAS IN SYLHET DIVISION
INDIA
SYLHET
MYMENSINGH FD
INDIA
LAWACHARA NATIONAL PARK
N
W
E
S
91°00'
91°15'
91°30'
91°45'
92°00'
92°15'
92°30'
25°30'
25°15'
25°00'
24°45'
24°30'
24°15'
24°00'
23°45'
Legend
Forest Area
International Boundary
District Boundary
Road
Railway
River
Map History
Data Source : GIS Data Base, Bangladesh Forest Department
10 0 10 20 30 40 Km

3. BIODIVERSITY CONSERVATION ATTRIBUTES

3.1 Statement of Biodiversity Significance

The forests of Lawachara Park are biologically very rich, located as they are on the high rainfall bio-geographic zone with evergreen and semi-evergreen forests. The Park represents several features of the bio-diversity of north-eastern subcontinent, which is one of the mega biodiversity region with many floral endemic species. Many important rivers including Surma and Kushiara flow through Sylhet forest division, forming fertile floodplains with enhanced economic activity and high population density. The Park is home to Khasia tribe with their traditional lifestyle dependent on natural resources including forests for their forests-based livelihood. Forest Villages (Lawachara and Magurchara) of Khasia tribe were historically established within West Bhanugach RF (now part of which is covered under the Park) to ensure a regular labor supply for forestry activities including harvesting and raising plantations. Dolubari village inhabited by Tipra tribe is situated on the periphery of Lawachara Park.

The forests of Park are important in regulating water flows and checking soil erosion. Indeed the conservation of biodiversity within the Park is very important as the forests form important catchments and were so designated historically as head water reserves for many rivers and numerous water bodies. They are part of a network of transnational watersheds of Sulhet with intense forests-water interactions that have regional implications. In addition to providing a sanctuary to wildlife, these forests also may in future form water sanctuaries required for conservation of water and soil, and play an important role in carbon sequestration. The protection and conservation of these forests are particularly important in view of significant loss of natural forests in the country in general and Sylhet division in particular.

3.2 Biodiversity Conservation Values

Socio-economic values of the Park are important because a number of communities including ethnic minorities reside within and around the forests on which they depend for their livelihood opportunities. Biological values include providing shelter to biodiversity comprising important flora and fauna, habitat connectivity, presence of threatened and endemic species, and improving degrading habitat. Main ecological functions are catchment conservation of several rivers and water bodies (haors, beels, ponds, etc.), control of soil erosion, ecological security, irrigation and agricultural production, carbon sink and environmental amelioration. The Park provides significant scope for wildlife education and research, nature interpretation and conservation awareness. It represents a fragile landscape with a very rich biodiversity, which if not timely conserved, may be lost for future generations. The Park also is a potential source of eco-tourism, aesthetic values, dense high forests, historical and cultural values, scenic beauty and ethnic diversity. Finally many conservation values of the Park are global, regional and national but also with local implications.

3.3 Wildlife Conservation

Special protection measures were contemplated quite early for the preservation of elephants under Bengal Elephant Preservation Act, 1879. Subsequently the Wildlife Birds & Animal Protection Act, 1912 provided for the preservation of wildlife in Bengal through protection of many species of birds and animals, particularly during breeding season. The promulgation of Bangladesh Wildlife (Preservation) Order in 1973 was followed next year by the enactment of Bangladesh Wildlife (Preservation) (Amendment) Act, 1974. A Wildlife Advisory Board was set up for performing such functions as the Government may assign to it. The Act provided a sound legal basis for the preservation of wildlife in Bangladesh but needs updating in view of national and international changes that have taken place over the period. Accordingly the NSP would provide support to FD in the draft Act finalization process as recommended in Part II of the Plan. Both *in-situ* and *ex-situ* conservation of wildlife were to be achieved by designating and managing PAs in representative zones. A new circle (Wildlife and Nature Conservation) was created in 2001 exclusively for looking after the affairs related to wildlife and nature conservation.

3.4 Forest Boundaries

The Park is part of West Bhanugach RF, which was reserved in early nineteenth century by following the reservation process per the Forest Act 1878, the Assam Forest Manual 1898 and the Forest Act 1927. The settlements claims of local communities were settled and legal boundaries identified with names of forest

blocks, compartments, etc. Working Plans were prepared with topographical maps (1 inch to 1 mile or 1: 63,360) and specific recommendations for the maintenance of legal boundaries of forest blocks and compartments were given. The boundaries of forests could not, however, be maintained, as a result of which some forest areas have been brought under encroachment for cultivation and settlements. Although the Park was notified by the Government in 1996, no efforts have so far been made to physically demarcate the boundaries in the field. The situation got exacerbated with heavy biotic pressure on forests and large scale encroachment of forest land. As a result, these forests have become fragmented with reduced extent of suitable habitats and ensuing adverse effects on wildlife. This has adversely affected the ecological boundaries of Lawachara Park with limited wildlife corridors and breeding space.

3.5 Forest Geology, Rock and Soil

The low and rolling hills (Figure 5) of upper tertiary rocks of the Park are composed of upper tertiary rocks in which soft sandstone predominates. For example, the Park covers an area of low hills formed primarily from soft sandstone, and originally supporting a vegetation cover of mixed tropical evergreen forests (Alam, 1988).

A major portion of Sylhet forest division lies within the Surma-Kushiara floodplains, which are of alluvial origin, composed of clay and sand in varying proportions. This is a low lying area with smooth and broad ridges and basins, which are subject to deep flooding and the shallow basins (haors) may remain wet even during dry season. The area has been formed from the sediments brought down by rivers draining from neighbouring hills of India. The soils are heavy, silty loams and clays with strongly acidic in reaction.

A series of isolated low (nearly 150 m) and high (nearly 300 m) hills, derived from sandstones and shales, and extending north from India and interspersed with narrow floodplains of small rivers, are found in Sylhet forest division. They represent northern and eastern hills, interspersed with northern and eastern piedmont plains. The forest soils of Lawachara Park can be categorized as hill brown sandy loams with slight to strong acidity. They are shallow over sandstone bedrocks on high hills and accumulation of humas on the top of soil is small due mainly to rapid decomposition of debris under moist warm tropical conditions. West Bhanugach RF has well drained sandy loam soil with good humus but near nullahs and streams the soils are sandy.

3.6 Biophysical Situation

West Bhanugach RF originally supported mixed tropical evergreen and semi-evergreen forests, which over the period have been substantially altered due to heavy biotic interference and the plantations of exotic species established after clear-felling of natural vegetation. Encroachments of RF land has resulted in conversion of many low lying areas into paddy cultivation. As a result, the habitat has fragmented, adversely affecting the wildlife by restricting their movements through a barrier effect. However, at places good natural regrowth, particularly of ground flora and middle storey, has come up due to favorable climatic and edaphic conditions, thereby enhancing the Park's *in-situ* conservation values. Old plantations raised in the Park area have grown up in shape of tall multi-storied structure with regrowth of ground flora and a middle storey of naturally occurring species. Consequently, the vegetation in many areas of Lawachara has approached towards natural structure and species. The biophysical conditions of the Park are further described in detail in Chapter 4.

3.7 Micro-Climate

The climate of Lawachara Park is in general warm and humid but the weather is cool and pleasant during winter. The temperature varies on an average from minimum of 26.8 degrees in February to maximum of 36.1 degrees in June. The humidity is high in the Park throughout the year, with monthly average humidity varying from 74% in March to 89% in July. There is heavy dew during winter when rainfall is low. The water condensation is thus distributed throughout the year in different forms and greatly influences plants and wildlife. The area covered under the Park is one of the wettest in the country and so the rainfall is quite high with an annual average of 4,000 mm approximately, with maximum rainfall falling during June to September from South-West monsoon. Pre-monsoon Nor'westerly and cyclonic storms are accompanied by high speed winds and rains, which do considerable damage to property and trees.

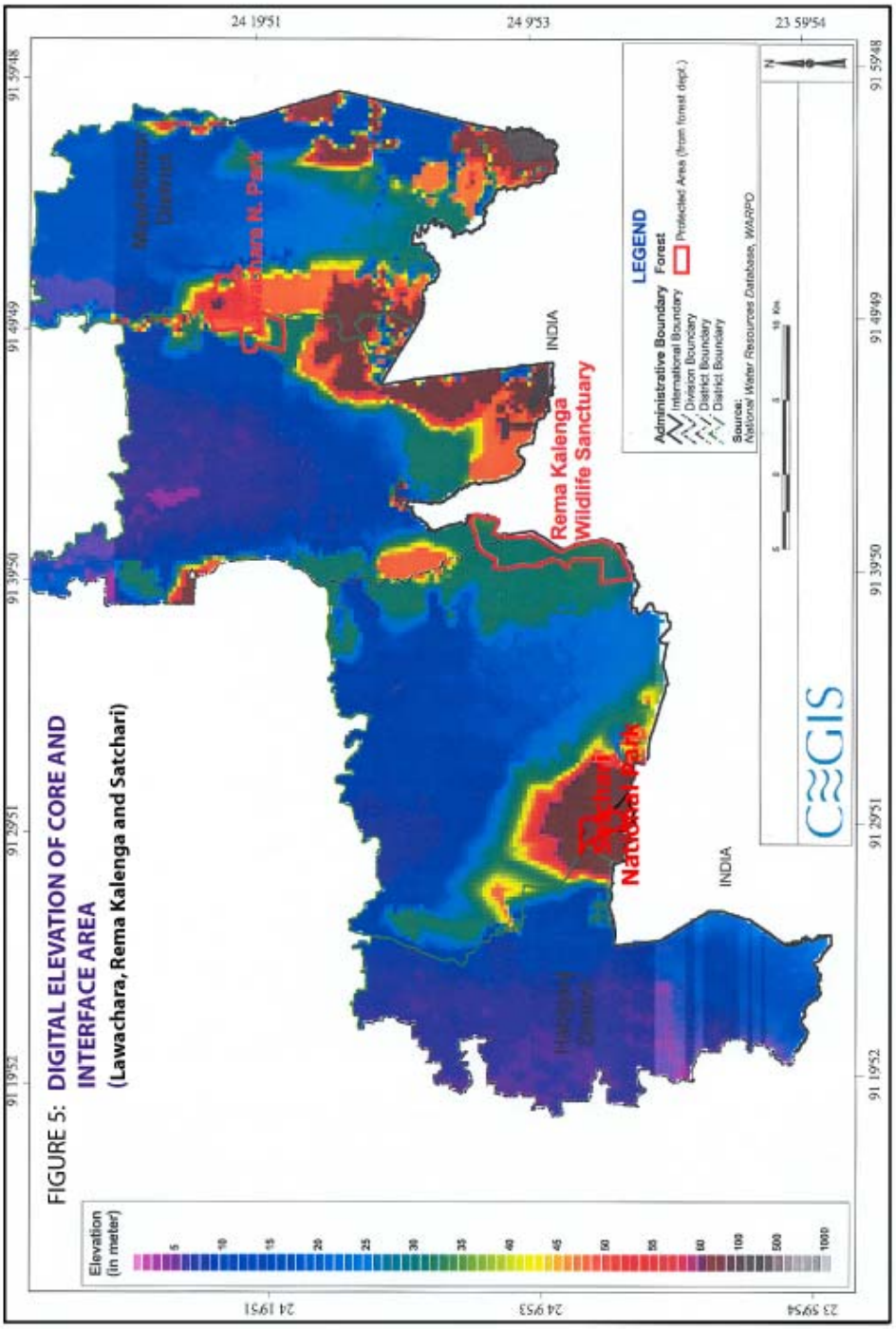


FIGURE 5: DIGITAL ELEVATION OF CORE AND INTERFACE AREA
(Lawachara, Rema Kalenga and Satchari)

4. BIODIVERSITY AND HABITAT

The conservation of biodiversity in each of the representative biogeographic zone of Bangladesh is a main objective of the establishment and management of PAs. Lawachara Park is categorized under the tropical evergreen and semi-evergreen biogeographic zone. The Park has also been shown under the Sylhet hills bio-ecological zone by the IUCN, Bangladesh. The influence of microclimatic and edaphic factors including rainfall, humidity, aspect, sunshine and soil is predominant on the forests of Lawachara.

4.1 Ecosystems Analysis

A community and the surrounding environment with which it interacts is referred to as an ecosystem. The Park and its interface landscape encompasses terrestrial, aquatic and forest ecosystems. A variety of plants, animals and micro-organisms, and the ecological processes that govern their functions are found in the Park. The forests of Lawachara NP are composed of mixed tropical evergreen and semi-evergreen plant species, characterized by high rainfall and a multi-tier vegetational assemblage of rich biodiversity. The predominant influence of edaphic and microclimatic factors including rainfall, humidity, sunshine, aspect and soils is seen in the development of Lawachara ecosystems.

The following six broad habitat types in Lawachara Park and its interface landscape are identified as:

i) high forests represented by the remaining patches of natural forests,
ii) plantations including the monoculture of exotics,
iii) grasslands and bamboos,
iv) wetlands,
v) Tea Estates, and
vi) cultivated fields.

The first three ecosystems being the largest in extent and also important from the Park management point of view. The cultivated fields (mainly of paddies) and grasslands, which harbour some mammals, ground birds and reptiles, get inundated during monsoon rains. The water bodies harbour important fish species, water birds and amphibians that are food to not only local communities but also hoolock and other wildlife. The following main components (fauna and flora including non-timber forest products) of biodiversity are described in order to have a better understanding of the habitat of Lawachara. Important land-uses and Tea Estates are described further in detail in Chapter 6 of Part I.

Although the results from many inventories of fauna and flora conducted earlier in Lawachara are included in Volunme 2 of this Plan, a new inventory will be conducted as suggested by FD. The planned biodiversity inventory study, for which adequate budget is earmarked under NSP, will identify composition and inter-relationships among fauna, flora and micro-organisms including food chain.

4.1.1 Forests

The forests (mainly mixed tropical evergreen and semi-evergreen forests) of Sylhet forest division including the forest areas covered under the Park were reserved in early nineteenth century. Before reservation many forests were cleared for jhum (shifting cultivation), after which secondary vegetation developed over the period. Presently the Park has few patches of natural forests, and the plantations raised earlier by converting high forests of great biodiversity value. Large deciduous trees are mixed with evergreen smaller trees and bamboos. The top canopy includes *Artocarpus chaplasha*, *Dipterocarpus turbinatus*, *Elaeocarpus floribundaas*, *Dillenia pentagyna*, *Castanopsis tribuloides*, etc. The shrub species comprise of *Adhatoda zeylanica*, *Carea arborea* and others, whereas bamboos species are *Bambusa tulda*, *Bambusa polymorpha*, *Bambusa longispiculata*, etc, and Saccharum, Daemonorops, Thysanolaena as main grass species. A number of fodder and fruit bearing plants occur naturally in the Park. Forest fires in summer have adversely affected the natural forest regeneration in the Park.

The natural forests of West Bhanugach RF, now part of of Lawachara NP, were converted by raising long rotation plantations (of teak, mahogany, garjan, karai, sal, gamari, shiso, toon, pynkado, agar, jarul, cham, jam, etc) taken up since 1922 for production forestry (Figure 6). Most of the original forests have been removed and the conservation value of the Park currently stems mainly from old plantations, which have

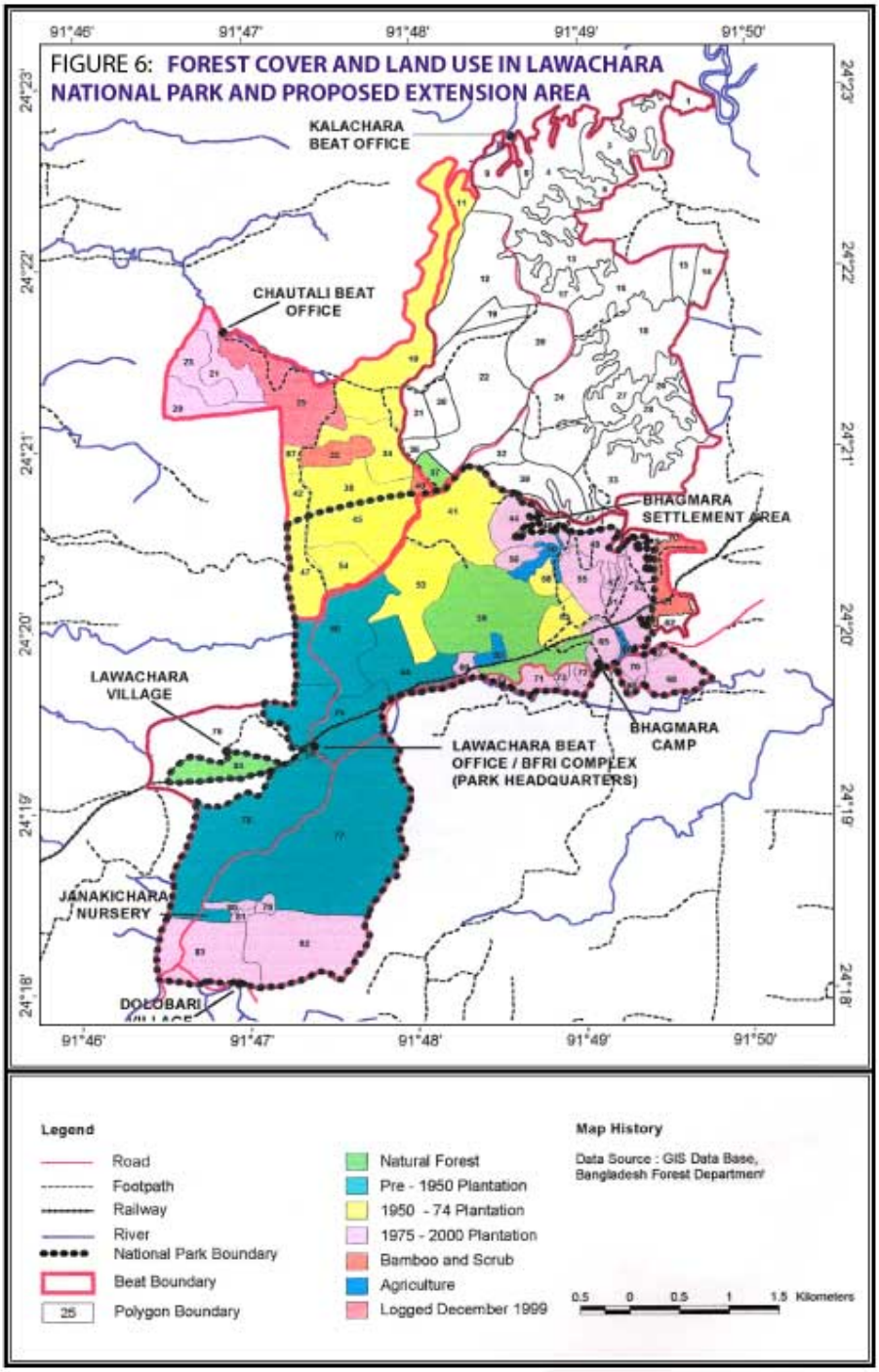
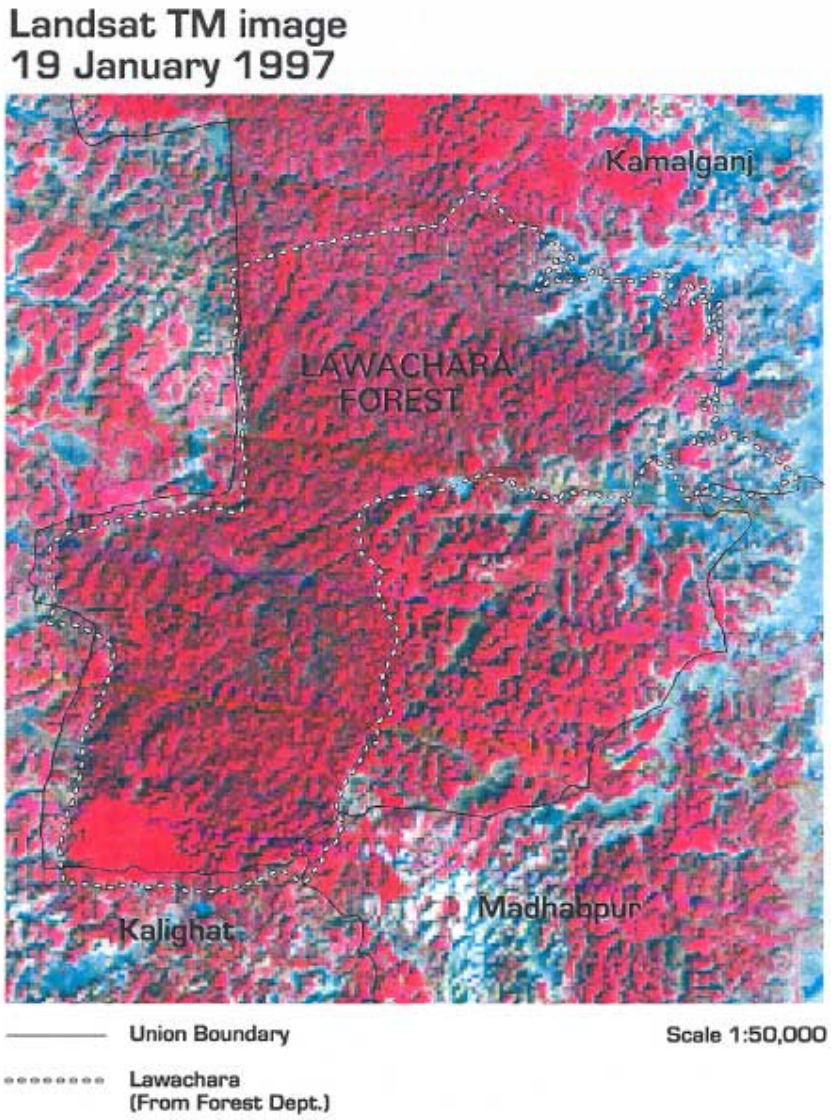


FIGURE 6: FOREST COVER AND LAND USE IN LAWACHARA NATIONAL PARK AND PROPOSED EXTENSION AREA
KALACHARA BEAT OFFICE
CHAUTALI BEAT OFFICE
BHAGMARA SETTLEMENT AREA
LAWACHARA VILLAGE
BHAGMARA CAMP
LAWACHARA BEAT OFFICE / BFRI COMPLEX (PARK HEADQUARTERS)
JANAKICHARA NURSERY
DOLUBARI
91°46'
91°47'
91°48'
91°49'
91°50'
24°23'
24°22'
24°21'
24°20'
24°19'
24°18'
Legend
Road
Footpath
Railway
River
National Park Boundary
Beat Boundary
35 Polygon Boundary
Natural Forest
Pre - 1950 Plantation
1950 - 74 Plantation
1975 - 2000 Plantation
Bamboo and Scrub
Agriculture
Logged December 1999
Map History
Data Source : GIS Data Base, Bangladesh Forest Department
0.5 0 0.5 1 1.5 Kilometers

FIGURE 7: **FOREST OF LAWACHARA**



developed a tall, multi-storied structure. The area represents the most accessible hill forests (Figure 7) in Sylhet forest division, and its biodiversity conservation and eco-tourism values have long been recognized. In the oldest of these areas the vegetation cover has taken on the structure of natural forest. On review of the old compartment history files of West Bhanugach block, it can be concluded that the natural regeneration in different compartments was still good (in sixties) with dense undergrowth in mixed irregular top canopy. Therefore, it can be concluded that the conversion of high biodiversity value natural forests was not justified in view of traumatic disturbances to the forest ecosystem brought by clearfelling of natural forests and followed by plantation activities. In fact, the name of the Park itself indicates its significance as a watershed of local streams as *chera* in local language means a stream.

An estimated 483 ha of plantations over 50 years of age are included within the Park, representing 40% of the total notified area. Much of the remainder of the area (244 ha, or nearly 20% of the notified area), and the proposed extension area are covered by mixed plantations of more than 50 years of age (Table 4.1). Some remnant patches of original high forests, including an 8.6 ha unlogged BFRI research plot, remain

scattered and are a good source of seedling origin natural regeneration. This includes nearly 130 ha of natural forest used for betel-leaf cultivation by ethnic minorities.

Table 4.1 Forest and land use cover in Lawachara National Park and proposed extension area

Cover Type	Notified Area		Proposed Extension		Total	
	Area (ha)	Percent	Area (ha)	Percent	Area (ha)	%
Natural forest[1]	0.0	0.0	0.0	0.00	0.0	0.0
Long-rotation plantation[2]						
- 1920s-30s	363.2	29.7	0.0	0.00	363.2	24.2
- 1940s	119.4	9.8	0.0	0.00	119.4	7.9
- 1950s	120.7	9.9	16.1	5.7	136.8	9.1
- 1960s	122.8	10.1	142.7	50.8	265.5	17.8
- 1970s	0.0	0.0	30.5	10.9	30.5	2.0
- 1980s	4.7	0.4	0.0	0.0	4.7	0.3
- 1990s	120.0	9.8	0.0	0.0	120.0	8.0
- 2000	0.0	0.0	61.8	22.0	61.8	4.1
Short-rotation plantation[3]	170.7	14.0	0.0	0.0	170.7	11.4
Failed plantation	0.0	0.0	16.3	5.8	16.3	1.1
Bamboo plantation	17.8	1.5	4.0	1.4	21.8	1.4
Cane	3.4	0.3	0.0	0.0	3.4	0.2
Forest Village	129.8	10.6	0.0	0.0	129.8	8.6
Agriculture	18.5	1.5	0.0	0.0	18.5	1.2
Forest Research Institute area	11.3	0.9	8.6	3.1	19.9	1.3
FD Beat Offices and Camps	4.0	0.3	1.0	0.4	5.0	0.3
Transportation/utility corridors	14.8	1.2	0.0	0.0	14.8	1.0
Total	1221.2	100	281.0	100	1502.2	100

Source : Forest Department

[1]much of the 129.8 ha designated as Forest Village is natural forest modified for betel leaf cultivation (lower limbs and undergrowth removed). An additional 8.6 ha designated as FRI area in the proposed extension is mature natural forest.

[2]long-rotation plantations are primarily teak (*Tectona grandis*) and jarul (*Lagerstroemia speciosa*), with chapalish (*Artocarpus chaplasha*), kadam (*Anthocephalus chinensis*) and other species, including natural regrowth.

[3]short-rotation species include moluccana (*Albizia (Paraserianthes) falcataria*), eucalyptus (*Eucalyptus* spp.), akashmoni (*Acacia auriculiformis*), mangium (*Acacia mangium*) and kadam (*Anthocephalus chinensis*).

4.1.2 Fauna

A number of animal species (mammals, birds, reptiles and amphibians), both forest-dwelling and wetland-associated species, of different genera and families are found in the forests of Sylhet forest division. Lawachara NP and adjoining West Bhanugach RF are home to avifauna of 237 species (representing nearly one-third of the country's known bird species) dependent on good forest undergrowth and cover. Although large mammals such as tigers, leopards, bears, wild dogs and sambar have disappeared from the Park due to habitat degradation and hunting. However, viable populations of many small and medium-sized mammal species that can survive in limited forest areas and/or disturbed or secondary habitats (e.g., jackals, small cats, barking deer, wild pigs, etc.) are found in the remaining disturbed and fragmented habitat of the Park. A rich diversity of other faunal groups such as reptiles, vertebrates, gibbons, langurs, hanumans, fishes and amphibians is present. Aquatic species including turtles and frogs are found in water bodies. Hoolock gibbon is used as a key species for the development and implementation of forest management and conservation measures in Lawachara.

4.1.3 Water Bodies

Sylhet forest division, characterized by high rainfall and a large amount of water drained from the surrounding hills, comprises a valley fed by two main rivers, Surma and Kusiyara. In the absence of adequate steep gradient required to carry huge monsoon rainfall, the water gets collected in depressions, locally known as *haors*. The water recedes during dry season, enabling local people to cultivate the remainder land with winter crops. The level of swamps is, however, being raised gradually due to siltation.

The Surma passes through Sylhet city and joins the Meghna river further south. There are a number of other small rivers such as Khaway, Dholai and Manu (and thier tributaries), and shallow depressions (e.g. *haors*), which are wetlands providing marshy sanctuaries to migratory birds and livelihood to local fishermen. They provide good habitat, drainage and drinking water source for the wild animals and local people. The rivers possess main characteristics of a flat alluvial country as the current is sluggish, the course tortuous and the bottom muddy. The waters are surcharged with materials brought from surrounding hills during monsoon rains and a large portion of the silt is deposited in the immediate neigbourhood of the streams. Lawachara NP lies between the Dholai river on the east, the Manu river on the north, and the road from Moulvibazar to Srimongal on the west.

A number of sandy-bedded streams and nallahs pass through the Park and so aquatic habitats associated with forest cover and riparian (streamside) vegetation and animal species are important part of overall habitat composition. The Park forms the catchment of a number of small streams, locally known as *cheras*. In most cases the catchment areas of each *chera* constituted a bamboo working coupe (*mahal*) under Working Plan and so named after the name of concerned *chera*. The ridge dividing the *chera* valley was taken usually as the *mahal* boundary. So the watershed line of each *chera* has been taken as the boundary of the mahal. If *cheras* had big valleys, the *chera* itself is taken as mahal boundary by naming it as right or left bank.

4.1.4 Non-Timber Forest Products (NTFPs)

The role of NTFPs in providing livelihoods, employment and income to forest dependent communities has been recognized, particularly with international surge on rural poverty alleviation, biodiversity conservation and co-management of forests by empowering local communities. Traditionally NTFPs play an important role in sustaining livelihoods of rural poor and forest dwellers in forest areas of Sylhet. Rural communities depend on forest foods such as honey, mushrooms, fruits, nuts, tubers, leaves and numerous other forest products. They collect a variety of NTFPs including honey, creepers, grass, fruits, nuts, tubers, leaves, bark, bamboo, canes, medicinal plants, wild animals, etc.

Medicinal plants collected from natural forests often form the main resource base for traditional medicine and health practices. A majority of rural population in the country depends on traditional medicines as allopathic medicines are expensive and not easily available in the countryside. Local biodiversity, trees, shrubs, herbs, grasses, animal products and minerals form a major resource base of these traditions. Local people depend on Kabirajs (local doctor), who prescribe traditional medicines based on their experiences. There is increasing demand for herbal medicines in urban areas as well due to their curative properties and no harmful side effects.

Usufructury rights in terms of both timber and non-timber products are granted to local communities through Participatory Benefit Sharing Agreements (PBSAs) under FSP. A regular flow of benefits from NTFPs can be a good source of livelihood, employment and income to local people. However, sustainable management of forests and the Park are necessary for managing NTFPs sustainably. As commercial harvesting is not practiced in the Park, one of the multiple objectives of forest management should be the production of NTFPs and consequent employment and income generation to rural surplus labour through the collection stage to processing and sale.

Many NTFPs such as roots, seeds, leaves and barks of medicinal trees can be harvested sustainably without adversely affecting forest regeneration (as cutting down a tree is not required). *In-situ* and *ex-situ* conservation of biodiversity of medicinal value is appropriate within the Park in view of heavy dependence of rural poor on medicinal plants for their primary health care. Some NTFPs collected by local people (e.g. sungrass) offer opportunities for self-employment if NTFPs based cottage and small-scale industries are promoted locally through co-management committees and their federations. They may be assisted (e.g. micro-level finance from landscape development fund and skill development training through partner NGOs) in establishing value addition units locally.

4.2 Biodiversity Utilization

Sylhet forest division is densly populated and a majority of population depend on agriculture for earning their livelihood. The forests of Sylhet division are not adequate in meeting a huge demand of a predominantly agrarian population. Isolated hill forests of Lawachara Park are surrounded by large population residing in peripheral villages, towns and Tea Estates. Although no commercial harvesting is

done by FD in the Park, the forests are under tremendous biotic pressure for forest produce and forest land for cultivation mainly by local people but also from the people from neighbouring towns and Tea Estate labourers. In addition to timber and fuelwood collected by local people for meeting agricultural demands and boat construction, a number of NTFPs are collected by them, mainly for subsistence consumption. Bamboo, cane and sungrass (thatch for roof construction) are important furniture and house building material. Although the hunting of wildlife is prohibited, local tribes sometimes hunt for meeting their consumption demands for meat. Even surrounding urban population use the Park for earning their livelihood through commercial sale of illicitely felled timber and fuelwood. Although the relatively easy accessibility of the Park is a source of easy access to visitors to the Park, it also provides scope for illicit removal of forest produce from the forests and encroachment of forest land. Therefore, the protection of forests and wildlife against smuggling and poaching, and encroachment of forest land pose a big challenge both for the FD staff and other stakeholders.

Important local markets for forest produce (mainly timber and fuelwood) from the forests of Lawachara include Sylhet, Sunamganj, Maulvibazar, Madhabpur, Habiganj and Srimangal. Easy accessibility of forests through roads and railways has greatly facilitated the transport of forest produce (including timber and fuelwood). The demand for forest produce far exceeds their supply from the forests of Sylhet due to heavy population density. The predominantly agrarian economy of local people puts a heavy demand on forest produce including timber for agricultural implements and boat construction. A large part of the demand for forest produce is met by homesteads, which in addition to meeting the subsistence needs of local farmers are an important source of meeting demand-supply gap. Sylhet forest division is main source of supply of bamboo, cane and murta from the government forests. However, the supply of forest produce from the government forests is declining due mainly to deforestation and shrinking forest lands. Other NTFPs that are harvested and can be marketed include vines, medicinal plants, grasses, fodder and mulch. Illicitely harvested timber and fuelwood are also marketed in nearby towns and markets.

5. ASSESSMENT OF BIODIVERSITY MANAGEMENT PRACTICES

5.1 Forest Management Systems

The forests of West Bhanugach RF, a large part of which is now covered under Lawachara Park, were declared as RFs during early nineteenth century. West Bhanugach RF was divided into 8 compartments. By and large the catchment area of each existing stream (*chera*) was designated as a forest block. This illustrates that the concept of watershed management was adopted at an early stage of managing the hill forests, which are now part of the Park. These forests have been subjected to unrestricted biotic interference; shifting cultivation, grazing and forest fires being the most prominent. Initially individual trees used to be sold based on permits issued by FD. The purchase contract system based on a minimum guaranteed royalty was introduced during 1924-25 under which the purchaser was allowed to fell any tree over and above 6 feet girth. The system of marking trees (by a responsible officer of FD) before felling was introduced in 1930-31. As the traders objected, the marking system had to be replaced next year by coupe (*mahal*) system of timber harvesting based on fee-cum-royalty. Bamboo working in the RF was regulated in order to avoid excessive extraction of immature bamboo clumps/culms in designated areas and compartments (that were opened for bamboo harvesting over a four year felling cycle).

The first Working Scheme, prepared for Sylhet forest division (for the period 1935-38), prescribed plantations of teak, jarul, gamar, cham, toon and garjan in West Bhanugach RF. The first Working Plan (Das, 1938-47) recommended three Working Circles (Timber A & B, Firewood A & B, and Bamboo) and many parts of the RF were included under Timber Working Circle (WC) managed under selection-cum-improvement silvicultural system in view of the hilly terrain. The RF was divided into blocks and compartments under the two Working Schemes (prepared for the periods 1950-54 and 1959-65) for their silvicultural management under selection-cum-improvement (harvesting of selected trees for timber based on exploitable girth) and clearfelling-cum-artificial (conversion of existing forests by clearfelling followed by raising plantations) regeneration methods. As a result, many natural forest area in the RF were clearfelled and planted with teak, jarul and garjan.

A revised Working Plan was prepared by Chowdhury (for the period 1963 – 1983) recommending five Working Circles for managing the forests of Sylhet division. Unfortunately the selection-cum-improvement WC, which was a very appropriate system of silvicultural management for the hill forests covered under the Park, was abolished in this plan. Given good rainfall and rich forest soils, the natural regeneration of the hill forests would have been encouraged by checking biotic pressure. The clearfelling-cum-artificial regeneration WC was split up in two WCs in order to accommodate the plantations of long and short rotation plantations. The hill forests covered under the present day Lawachera NP were allocated under long rotation WC wherein annual coupes were marked for clearfelling followed by the plantations of long rotation trees species such as teak, sal, chapalish, garjan and jarul.

The plantations of malakana (*Paraserianthes falcataria*) were introduced in 1974 in many RFs of Sylhet forest division in order to ensure a regular supply of short rotation (10-15 years) pulpwood material for Sylhet Pulp and Paper Mill. The plantations continued to be raised in West Bhanugach RFs and with increased focus on plantation forestry, the recommendations for conversion of natural forests and raising of plantations continued under the Management Plans of Balmforth and Howlader (1988-97) and Choudhury (1991-2001) till the declararion of Lawachara NP in 1996.

5.2 Wildlife Management

The management plans of Balmforth and Howlader (1988-97) and Chowdhury (1991/92-2000/01) provided for preservation working circle for the management of PAs of Sylhet forest division. Although the main prescription of stopping commercial fellings in the PAs was implemented, other recommended wildlife management practices could not be improved due mainly to paucity of funds. The plans also recommended to prepare separate schemes/plans for the management of PAs. Accordingly separate Management Plans were prepared for Lawachara and Rema-Kalenga by Rosario (1997), and Salter and Alam (2001) but the same could neither be approved nor implemented.

5.3 Habitat Protection

The forests of West Bhanugach were subject to indiscriminate felling prior to their reservation in early nineteenth century. The forests were brought under scientific management during British rule when FD was established in 1865 and the Forest Acts of 1878 and 1927 were implemented. The hill forests were declared as RFs by following due reservation procedures. As a result, the legal status of these forests got enhanced and the protection of habitat against illicit felling, encroachment, forest fires and grazing was organized by FD staff. The provisions of Wildlife (Amendment) (Preservation) Act, 1974 provided further protection to the Park and its constituent wildlife after gazetting the Park.

Participatory forestry is being implemented in Sylhet forest division under FSP. The buffer plantations raised around the Park (in the interface landscape zones of the Park) are protected by the participants, organized into user groups, who get usufructury benefits from the harvests as per the guidelines of FSP. The Park areas are approachable by jeeps, bicycles and foot, and this easy accessibility available to huge local population (combined with fertile soil and suitable topography) have contributed to encroachment of forests lands, over-exploitation of forest produce and degradation of habitat. A large labour force working in Tea Estates derive forest produce from nearby forests resulting in vegetation degradation. A close proximity of the forests to international borders gives rise to transnational protection problems which require international coordination between the Forest Departments of Bangladesh and the neighbouring Indian states.

5.4 Eco-Tourism

The easy accessibility of Lawachara Park from Sylhet and Dhaka through air, rail and road networks makes the Park very attractive for eco-tourism, particularly to urban dwellers. A large number of tourists visit, particularly easily accessible parts of Lawachara to have a feel of luxuriant vegetation of evergreen forests and good landscape of the Park with rolling hills and interspersed valleys. However, chartered eco-tours on the pattern of Sundarbans have not been yet organized in Lawachara. But with increased facilities for visitors it can be anticipated that the number of eco-tourists will increase manifold in future.

5.5 Management Practices for Non-Timber Forest Products

Forest management practices in Sylhet have in past focused mainly on timber management due mainly to its commercial value. The approach of forest management laid more emphasis on the development of major forest products such as timber whereas NTFPs received relatively low priority by treating them as bye-products. This is evident from the terminology, minor forest produce (MFP) given to all the forest products other than timber and fuelwood (which are termed as major forest products). As a result, the management of NTFPs did not receive its due importance. NTFPs cover a broad spectrum of biomass obtained from leaves, flowers, fruits, seeds, stems, roots and barks from different tree species, shrubs, herbs and wild animals for meeting human needs for food shelter, clothing and other items for local use and income generation. Many of these NTFPs are collected by primary collectors for their subsistence consumption but also for cash sale locally. Largely food and medicinal value of the products for which they are used as raw material determined the degree of commercialization of NTFPs. The extent and use-patterns of many NTFPs have remained inadequately known in the absence of any scientific survey.

Destructive harvesting practices were applied by private traders in the collection of many NTFPs, whose collection and trade were taken up as an un-organized sector. The adverse impact of unscientific and destructive exploitation practices adopted by some private collectors inside easily accessible forests has not been investigated. With dwindling forests many NTFPs have become extinct and the symbiotic relationship that existed in past between forest dwellers including tribals is disturbed, leading to further deforestation and loss of NTFPs. Clearfelling, jhum, encroachment and forest degradation without adequate replenishment through natural and artificial regeneration, has reduced the availability of NTFPs considerably in many forests of Sylhet.

Some NTFPs in past used to be leased out to private sector based on fixed royalty payment to Government. Although primary collectors including forest dwellers and tribals did the collection of NTFPs from forests, the lessees got the rights for their procurement and marketing. The disposal of some NTFPs (e.g. sungrass), based on auctions of forest coupes (locally known as *mahals*), was done to private sector on payment of fixed royalty. In such cases the primary collectors sold the collected NTFPs to the designated agents of lessee (locally known as *mahaldar*). Both of these systems of disposing NTFPs favor over-

exploitation of forests and NTFPs without adequate consideration for the sustainability of forest resources or the livelihhods of the local forest dependent communities. The royalty and revenue generated from the sale of NTFPs have not been ploughed back for their sustainable management and development. Except a scheme on the plantations of bamboo, cane and murta funded by the GOB, no significant efforts have been taken up in past by the FD for the regeneration of NTFPs yielding species. There are some other NTFPs, which do not fall under the above category, and their trade is free from FD restrictions. Local collectors including tribals sell such NTFPs in local weekly markets (*hats*), sometimes on barter basis.

There is a lack of appropriate policies, harvesting rules and regulations to the management, harvesting and development of many NTFPs. Whatever harvesting rules are existing for some NTFPs such as bamboo and canes do not get implemented in the absence of adequate funds and field supervision. There are no organized marketing institutions, which can support the primary collectors of NTFPs. Adequate research has not been taken up for the promotion, management and development, harvesting and utilization of NTFPs. Hill forests managed under clearfelling system have reduced biodiversity and inadequate regeneration of NTFPs bearing species. Although many NTFPs yielding species can be well integrated in the FD plantation program through inter-planting and under-planting, no such efforts have been made in past while undertaking plantation programs, which focused mainly on few commercially important species such as teak (*Techtona grandis*) and gamar (*Gmelina arborea*).

The role of NTFPs in rural livelihoods, biodiversity conservation, poverty alleviation, household food security, nutrition and local employment generation is being increasingly recognized. However, in Bangladesh inadequate attention has been given to NTFPs, particularly with respect to their sustainable management, regeneration, collection, processing, value addition and marketing.

5.6 Conservation Research, Monitoring and Training

There is neither any wildlife research staff nor research facility (e.g. laboratory) for the the Park. Similarly there is no established monitoring mechanism presently for assessing the health status of wildlife and biodiversity. The assessment of regeneration or degeneration of forests is necessary for which a suitable monitoring mechanism need to be put in place for better management.

Although no special wildlife in-country training of FD staff has been organized, some officers have been trained overseas in wildlife and PA management. Wildlife management is one of the several subjects being taught during the regular forestry training imparted to cadre officers at Forest Academy, Chittagong. There is a need for organizing special training (in-country and overseas) courses on protected area management, co-management of PAs, legal aspects of PA management, capture of wildlife, census operations, captive breeding, etc. Such topics should be included in regular syllabus prepared for training of FD staff.

5.7 Administrative Set Up

Under the overall charge of the CCF, a wildlife and nature conservation circle (with CF as head and assisted by a staff officer of DCF rank) operates with six field level DFOs as approved by the Govt. of Bangladesh. Of the six DFOs, four are to be in-charge of Wildlife Management & Nature Conservation (WMNC) Divisions with HQs at Chittagong, Sylhet, Khulna and Dhaka. However, of the four designated DFOs, only two (at Chittagong and Khulna) are in position presently. There is a need of immediately posting a DFO for the PAs of Sylhet forest division as per the approved organogram. They should be well assisted with adequate staff including trained ACFs posted at each PA level within a Wildlife Division.

6. INTERFACE LANDSCAPE SITUATION

6.1 Landscape Approach

The Plan has adopted a landscape approach of Park management by focusing on an appropriate spatial scale (Figure 8) to integrate relevant habitat/forest system, ecosystem and relevant social/institutional system. It is an holistic approach taking into account factors that impinge on the management of Lawachara Park in the context of a broader spatial scale. The landscape is taken as a planning and development unit for an integrated management of the Park in order to address the needs of households and co-management activities in the context of a broader economic, natural resource and socio-institutional environment of Lawachara. It provides a framework to manage the Park for multiple uses by addressing interactions between local economy, stakeholders and natural resource base of the Park.

Landscape management of Lawachara Park would entail biodiversity conservation by linking surrounding ecosystems and human systems. It helps restore ecological processes both within the Park and in surrounding landscapes by accounting presence and needs of local inhabitants. It promotes active involvement of main stakeholders in Park management and biodiversity conservation. However, the boundaries of an identified integrated system (the spatial scale) need to be kept within manageable limits after assessing field specific situation. The structure and conditions of surrounding landscape must be accounted for in the Park management.

6.2 Interface Landscape of Lawachara Park

Interface landscape exercises influence around the boundaries of the Park. A number of villages and tea estates fall within the zone of influence of Lawachara NP. The Park is intimately surrounded by a number of villages, towns, cultivated fields and Tea Estates. The Lawachara NP is bordered on the north, west, south and south-east largely by Tea Estates whereas a part of the eastern boundary (nearly 1 km.) is bordered by FD lands (mainly grasslands) under long-term lease to HEED Bangladesh (a health and participatory development NGO). Most of the north-eastern boundary of the Park and proposed extension are bordered by FD lands under Kalachara Beat. Most of the local population including ethnic minorities, who depend on agriculture for their livelihood, depend on nearby forests for meeting their consumption needs for forest produce. A gas pipeline recently laid out by UNOCAL passes through the Park.

The name of Lawachara NP is derived from one of the two forest villages (Lawachara and Magurchara), which are inhabited by Khasia ethnic minority. These villages were established by FD in 1940s mainly to ensure a regular supply of labour for raising plantations. The villagers of both Magurchara (nearly 40 households) and Lawachara (nearly 23 households) grow betel vines on forests earmarked for them by FD *in lieu* of the supply of labour for forest protection and plantation activities. They also meet their subsistence consumption needs for fuelwood and timber for constructions from these forests. In addition to 16 identified villages (see Chapter 6), a number of Tea Estates are located around the NP and the labourers, many of them migrants from other densely populated districts such as Noakhali and Commilla, depend on the neighbouring forests for forest produce but also for cultivation of paddy through encroachment of forest land. The conversion of forest land into paddy land is extensive along the adjacent eastern boundary of Kalachara Beat and along nearly 1 km of the Park boundary.

The area used for betel leaf production by Lawachara forest village is an enclave within a larger area used by BFRI for silvicultural research. The boundary between the Park and this BFRI area is nearly 2 km. in legth. It is anticipated that BFRI research will be coordinated with FD, and this area will remain under forest cover. Small areas of the western part of Kalachara Beat (17.2 ha of 1965 teak plantation, 8.6 ha of BFRI natural forest plot) are included in the proposed extension of Lawachara NP. The remaining FD lands in Kalachara Beat are primarily under short-rotation plantations, which form effective buffer against other land uses.

6.3 Tea Estates

There are 4 Tea Estates (Fulbari, Khaichara, Jakchara and Gilachara) bordering the Park and 2 neighbouring Tea Estates (Noorjahan and Bharaura), which have substantial impacts on the forests covered under the Park (see Figure 9). Some parts of adjoining Tea Estates have not so far been brought under tea cultivation and have over the period developed unmanaged secondary vegetation, which provide additional

wildlife and plant habitat as a transition zone between mixed forests/plantations and tea gardens. Small areas along Tea Estates have been converted to citrus, pineapple and banana plantations by individual families. The trend of converting secondary vegetation areas into monocultures has not been good for wildlife as it adversely affected their additional habitat comprising secondary vegetation.

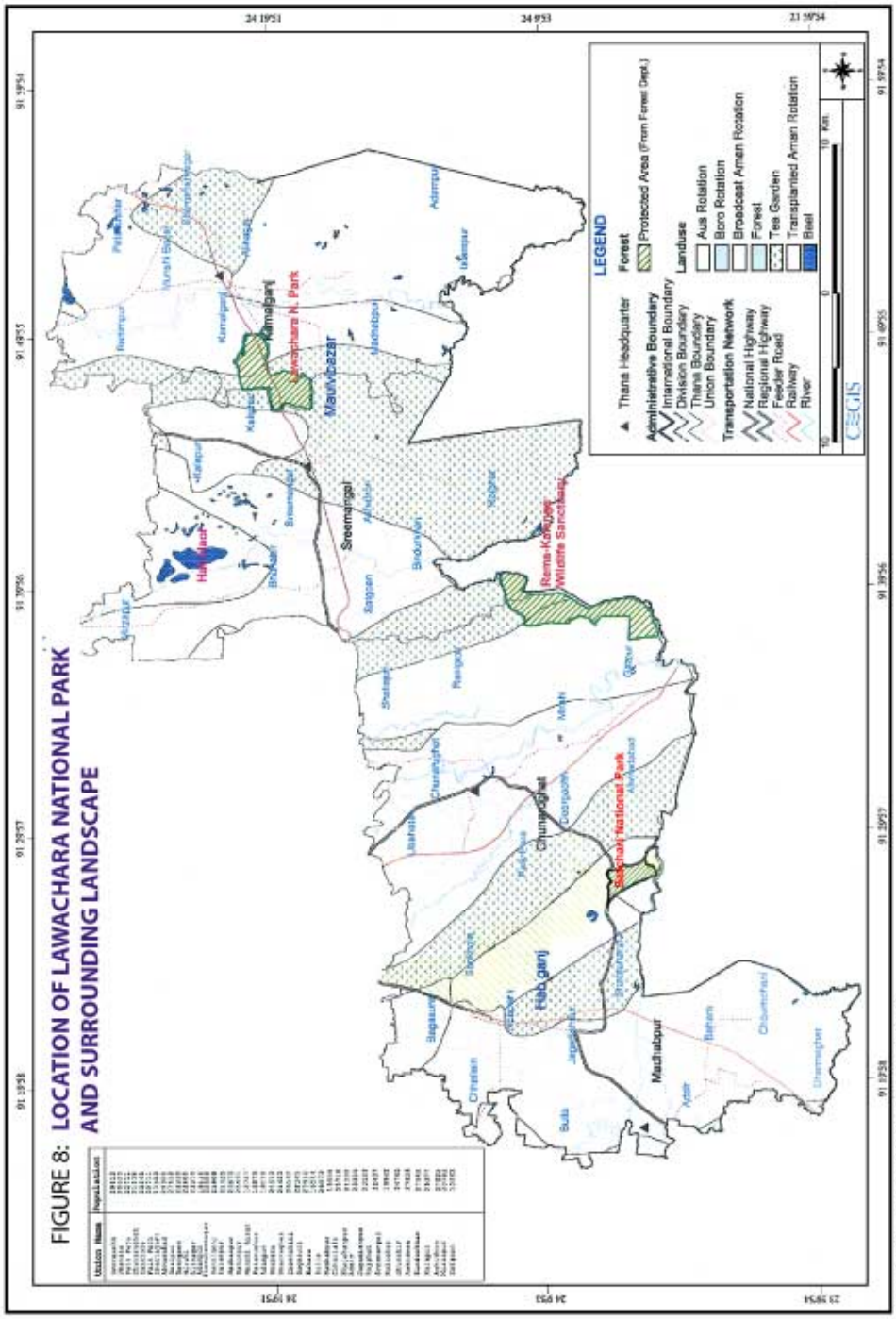
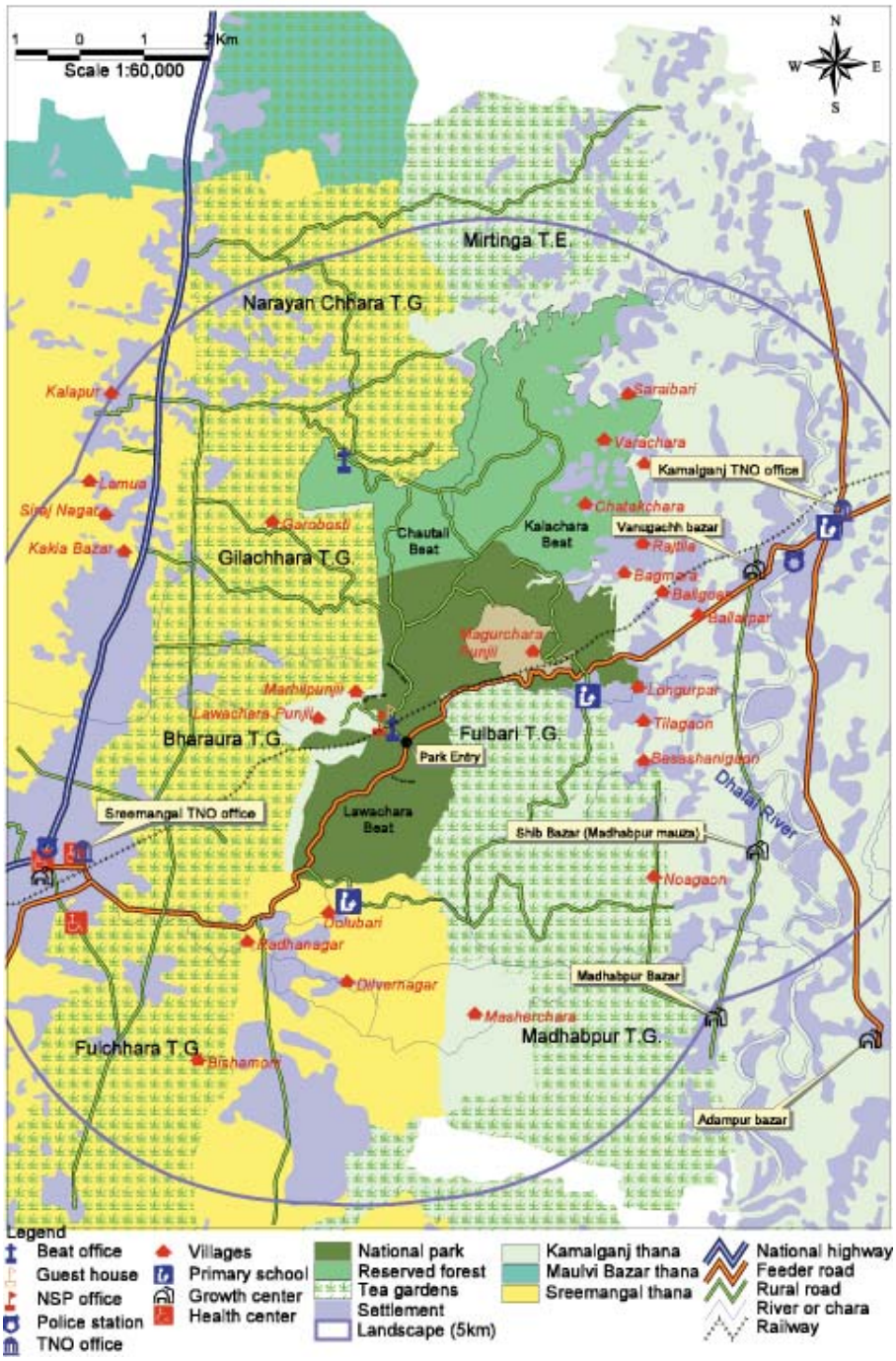


FIGURE 9: **LANDSCAPE OF LAWACHARA NATIONAL PARK**



A large number of labour employed by the Tea Estates and their family members depend on the forests for meeting livelihood consumption needs. The unemployed villagers from Fulbari, Jakchara and Khaichara Tea Estates are particularly involved in fuelwood collection and illicit felling. Huge amount of labor required for managing Tea Estates gives rise to tremendous pressure on nearby forests for fuelwood, fodder, timber and other forest products. Shade tree species such as *Albizzia lebbec* are planted inside the tea plantations for providing shade to tea bushes. Sometimes illicit fellers pass through adjoining Tea Estates (e.g. Bharuara, Jakchara and Gilachara) to fell trees inside the Park (Figure 9) and transport routes but also shade trees inside the estates. This means joint efforts are required from FD staff and estate managers for controlling illicit felling.

Some of the poor families of Tea Estate workers may be involved in protecting the forests covered under the Park. User groups can be formed and money from landscape development fund (LDF) can be used in development activities. But this will require a policy decision from the Tea Employers Association, Chittagong, who will issue suitable instructions to Tea Estates management. The FD will approach the Chairman of Tea Employers Association to issue such instructions to the identified 6 Tea Estates authorities.

Exploratory drilling for natural gas on Tea Estate lands adjacent to Lawachara NP has indicated that an extensive gas-bearing structure underlies the Park. An intense fire resulting from a drilling accident in 1997 jumped across the highway and railroad line and burned an estimated 8 ha of natural forest used for betel leaf cultivation adjacent to Magurchara village. Fortunately this drilling was subsequently stopped. Any future proposals for pipeline construction or other infrastructure development will need to be rerouted well outside of the Park in order to avoid habitat loss during construction and operation.

6.4 Forest Villages

Two recognized Forest Villages, Magurchara Punji (40 households) and Lawachara Punji (23 households) inhabited by khasia ethnic minority and located within the core zone, were established by FD in 1950's under an agreement signed between the FD and the representatives of the tribal community. Three acres of forest lands was assigned to each household (presently a household has 8-10 family members) for the practice of betel leaf cultivation and in turn they provided voluntary labor required for FD activities including nursery, plantations and protection of forests. They continue to practice betel leaf cultivation for which they plant betel cuttings near trees and start harvesting betel leaves after three years upto 25-30 years. Betel vines are grown on the trees which are lopped every year. Mulching is practiced by using cleaning and weeding materials and no fertilizer is added. Each forest village has a chief (locally known as Mantri), who looks after the interests of his community and maintains a close liaison with FD. Of the two forest villages, Magurchara is comparatively more developed due mainly to its location (it is situated on the Srimangol-Kamalganj Highway) and the money received by the villagers as compensation to the damage done by the gas fire.

6.5 Interface Villages

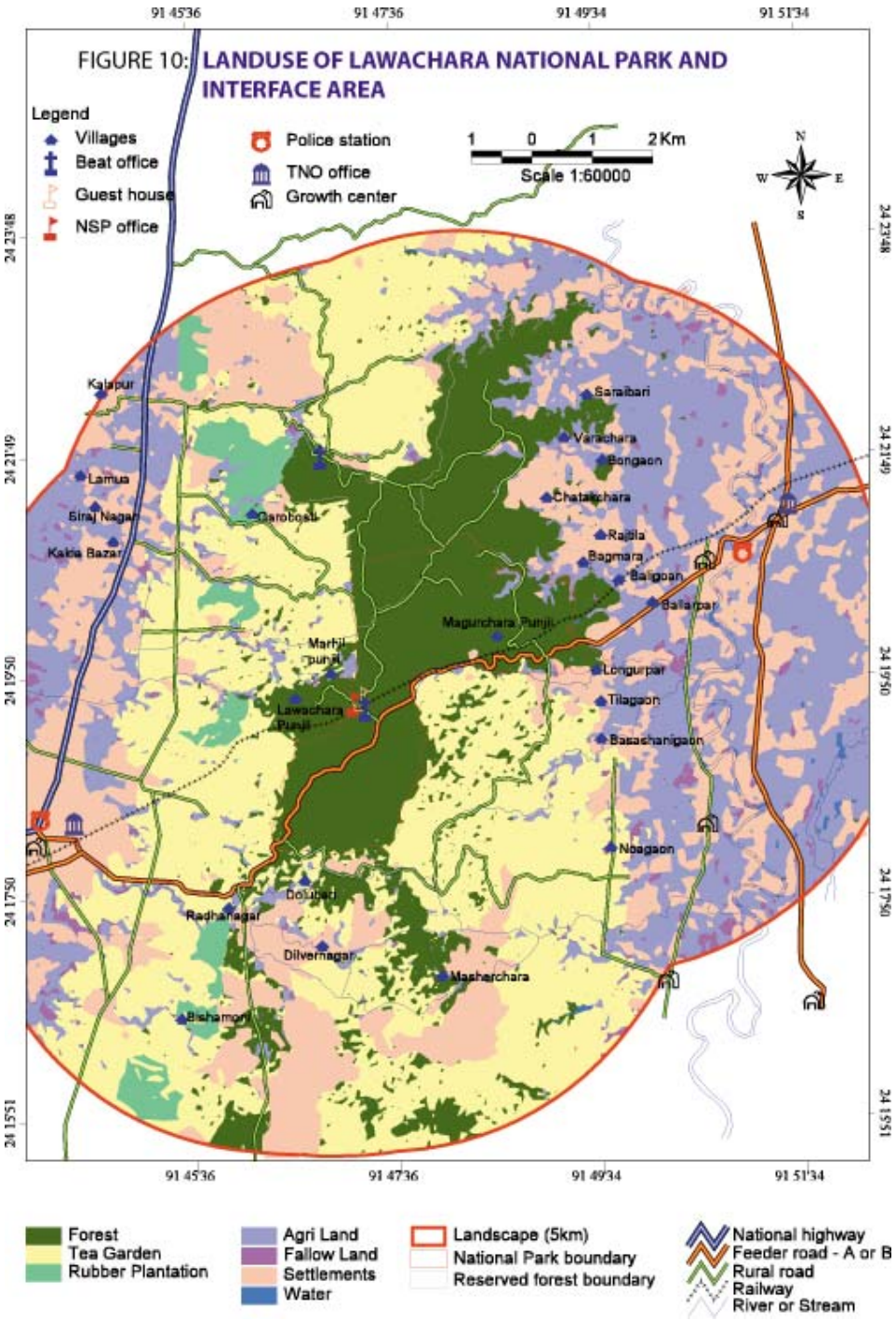
In addition to 2 Forest Villages, a total of 16 villages (Figure 10) have been identified having varied stakes in the forests, through RRA/PRA carried by NACOM (2004) during May-July 2004. These villages lie within 1 km. of the Park boundary; 4 villages (Baligaon-300 households, Bagmara-300 households, Rashtila-171 households and Chatakchara-61 households) are just at the outskirt of the Park. Of the 18 villages, 6 villages (Bagmara, Magurchara, Lawachara, Baligaon, Dolubari-84 households and Biranpur-300 households) have been identified as having major stakes, another 6 villages (Botertol slum, Rashtila, Saraibari-190 households, Veerachara-118 households and Radhanagar-325 households) with moderate level of stakes and the remaining 6 villages (Langurpur-92 households, Ballarpur-61 households, Noagaon, Tilagaon, Bhasaniganj and Bongaon-47 households) with minor level of stakes in the forests covered under the Park. Local people from Lawachara, Magurchara, Dolubari and Birainpur are involved mainly in fuelwood collection, whereas people from Bagmara, Radhanagar, Rashtila, Baligaon, Verachara and Chatakchara are involved in illicit felling.

6.6 Assessment of Stakeholders

Three main categories of stakeholders (primary, secondary and institutional) have been identified by NACOM (2004) through RRA/PRA carried out in Lawachara Park. A total of 15 primary stakeholders are involved directly with the extraction of forest produce whereas 4 secondary stakeholders exert influences indirectly on the forests covered under the Park. The institutional stakeholders (FD, NGOs, Union Parishads and Gram Sarkar, Banks, BDR and Police) are involved with the development and administration activities around the Park. Main NGOs presently operating around the Park include HEED, ASA, BRAC, Grameen Bank, CARITAS and IRPK.

Primary stakeholders include fuelwood collector, illegal timber feller, bamboo collector, house building material collector, vegetable collector, honey collector, sungrass collector, forest land encroacher, betel leaf cultivator, fodder collector, cultivator, visitors, bark collector, hunter and fruit collector. Most of the primary stakeholders from the neighbouring villages are poor who earn their livelihoods by carrying out

forest based activities. Fuelwood collectors, illegal timber fellers and betel leaf cultivators have major stakes in the forests.



Secondary stakeholders who are linked with forest-based activities through utilization and trade include timber trader, sawmill owner, brickfield owner and furniture shop owner. There are 10-12 licensed timber traders (Mohaldars) in Srimangal and 15-20 in Bhanugach bazaar. As per the PRA report (NACOM, 2004) a total of 9 sawmills in Kamalganj area and 12 sawmills in Srimangal were in operation in 2004. A number of furniture shops (nearly 30 and 25 shops in and around Bhanugach bazaar and Srimangal respectively) use sawn timber from the sawmills. Both timber and fuelwood are collected locally and then transported by roads and railways. There are 7 brickfields near Kamalganj and Srimangal and fuelwood is used in initiating fires for coal operated brickfields.

PART II

RECOMMENDING STRATEGIC PROGRAMS FOR A SUSTAINABLE PROTECTED AREA SYSTEM

1. PLAN OBJECTIVES AND CHALLENGES

1.1 Objectives of Management

The Plan focuses on protecting and conserving the rich biodiversity of the Park in accordance with sound principles of sustainable environmental and socio-economic development and the Forest Policy of 1994. Main long-term management aim is to maintain the maximum possible area under forest cover, and to maintain this forest and its constituent biodiversity in the best possible condition. Main objectives of the Plan are as follows:

- ➔ To develop and implement a co-management model that will ensure long-term protection and conservation of biodiversity within the Park, while permitting sustainable use in designated zones by local people as key stakeholders.
- ➔ To conserve the biodiversity of the Park by following landscape approach based on building partnerships with all the stakeholders and sharing benefits with local communities and key stakeholders.
- ➔ To refine and strengthen the policy, operational, infrastructural and institutional capacity framework for PA management
- ➔ To conserve and maintain viable wildlife population including endangered, threatened, endemic and rare species of plants and animals
- ➔ To restore and maintain as far as possible the floral, faunal, physical attributes and productivity of the forest eco-systems
- ➔ To encourage private tree growing
- ➔ To encourage eco-tourism in suitable zones and develop visitor amenities
- ➔ To implement income generation activities for sustainable livelihood development and enhance skills of local stakeholders required for reducing rural poverty

1.2 Framework Activities

Main framework activities to be undertaken for achieving the above-stated objectives include amongst others:

- ➔ Survey, demarcate and mark the Park boundaries;
- ➔ Develop a co-management model and relevant policy guidelines, and establish co-management agreements linking PA conservation with benefits sharing arrangements with key stakeholders;
- ➔ Survey biodiversity resources;
- ➔ Strengthen FD institutional capacity for PA management;
- ➔ Build conservation awareness, constituencies and extension activities on conservation issues;
- ➔ Train local stakeholders including beneficiaries and FD staff in conservation management and income generation, raise awareness among stakeholders and develop PA facilities;
- ➔ Develop conservation and visitor facilities within the Park;
- ➔ Create tree resources in adjacent agricultural and village areas on participatory conservation and benefits sharing basis and implement alternative income generation activities for sustainable livelihoods;
- ➔ Convert existing short-rotation plantations of exotic species to naturally regenerated areas by gradually opening the canopy, and enrichment plantations of indegeneous species in identified gaps, if required; and
- ➔ Provide alternative income generation opportunities for key stakeholders.

1.3 Challenges in Achieving Management Objectives

Encroachment of forest lands and illegal removal of forest produce (mainly timber and fuelwood) are two main challenges facing the Park. Other important challenges include biotic pressure by labor employed by Tea Estates, hunting and poaching, transboundary problems, flood and erosion, grasslands degradation, traffic movement on roads and rail lines, demarcation of PA boundaries, lack of funds, lack of trained professionals, inadequate staffing and infrastructure, monoculture, man-animal conflicts, etc.

Social Forestry Rules, 2004 providing for the sharing benefits from social forestry plantations will be helpful in sharing benefits with local communities. Similarly co-management agreements to be developed under NSP will help formalize sharing mechanisms and tools. Possible benefits for local communities may include income and forest biomass from the Park and interface zone, livelihood opportunities under NSP, ancillary economic activities when the Park serves as a pole of regional economic growth, and a voice in determining their own livelihoods.

2. SUSTAINABLE PROTECTED AREA MANAGEMENT SYSTEM

2.1 Protected Area Management : Emerging Priorities

In earlier stages of forests management in the country its main objective was production of wood, mainly timber. The value of other forest functions and services such as regulation of stream flow, source of biological diversity and sink for carbon content was neither adequately appreciated nor accounted for in forest management decisions. Consequently the management of forests was based on partial valuation of forest functions and services. With the promulgation of Forest Policy of 1994, the emphasis shifted from timber production to ecological requirements, conservation of biological diversity, meeting bonafide consumption needs of local people and other services from forests.

A forest ecosystem creates its own micro-climate that is an integrated result of meteorological processes and the conditions within the space occupied by the forest ecosystem. Success of natural forest management depends upon adequate site information, understanding of plant communities and local people, nutrient availability, regeneration, etc. Management of natural forests for generating products and services while maintaining their environmental roles and multiple functions is possible, but silviculturally complex. An important process responsible for the sustainability of forest ecosystems is the biogeochemical cycling of nutrients. The leaves, twigs, small branches and fruits make the litter falling on forest floor. The litter is decomposed by micro-organisms (bacteria, fungi), adding nutrients to forest soils for plant growth. Forest management should thus be part of biodiversity and land management strategy so that perennial vegetative cover is maintained. The management system should be perceived as husbandary of renewable forest resource with attention to the protection of conservation, recreational and other values.

2.2 Management Strategies

Consistent with the definition of a National Park under the Wildlife (Preservation) (Amendment) Act, 1974 and the need to establish gainful partnerships with key stakeholders based on sustainable use, the following management and development strategies have guided the development of this Management Plan, and of the management programs outlined in Part-II. The overall focus of management planning in the the PA is to manage it in as natural and undisturbed condition as possible, and to provide protection to their constituent biodiversity including wildlife population. However, such a management of Lawachara Park would by necessity require gainful partnerships with key stakeholders in view of their intimate interspersion with human habitations and cultivation in a largely agrarian economy with traditional dependency on neighbouring forests for livelihoods. Co-management approach within the parameters set by the NSP has, therefore, been adopted as described in detail in next section.

The maintenance and development of good quality forest cover with natural structure and composition, and the conservation of its constituent plant and animal biodiversity will guide the management of the Park. The management of Lawachara Park will focus on maintaining, and wherever necessary developing, natural forests with its constituent biodiversity. Hunting of wildlife and commercial felling from forests will not be allowed in keeping with the provisions of the Wildlife (Preservation) (Amendment) Act, 1974 applicable for National Parks and Sanctuary. However, subsidiary silvicultural operations required for natural forests regeneration will be carried out keeping in view of specific requirements of habitat management. Similarly sustainable use practices will be allowed by local people/stakeholders particularly in buffer areas based on co-management agreements specifying roles and responsibilities for stakeholders partnerships. As far as possible subsistence use will be gradually shifted to interface landscape zones and no new settlement or in-migration will be permitted within the core areas. Visitor use for outdoor recreation, research and educational purposes will be encouraged in designated areas.

Boundaries of Lawachara Park will be surveyed, demarcated and maintained regularly. Specific zones will be designated for achieving different management objectives. Within the Park a management zone is an area of specific management category, distinguishable on account of its management objectives. Zonation will help achieve different management objectives by applying suitable management strategies and operations in each identified zone. Zone programs, prepared for each identified zone with specific management objectives and strategies, will be implemented over the plan period of five years. Some management strategies may be common to two or more zones and so will be detailed in the relevant zones. Such strategies may be related to habitat improvement, restoration and protection. Detailed strategies along with management practices are described in detail in each identified zones in subsequent chapters.

2.3 Co-management Approach

Rural development efforts have so far either been inadequate or failed to take into account relevant linkages between conservation of PAs and welfare of local people. Not only they are getting less production and employment opportunities due to decreasing land fertility and reduced underground water tables but also degraded forests are not able to meet their bonafide consumption needs for forest produce. The consequent degradation of both public and private land-based resources has resulted in widespread deprivation and rural poverty among local people. A gainful association of such rural mass, achieved by establishing partnership mechanisms, is essential for sustainable management of the country's PAs. Co-management agreements are formal mechanisms for soliciting community interventions for the protection and conservation of PAs in lieu of identified benefits.

2.3.1. Co-management

Collaborative management – or co-management - is defined as a situation in which two or more social actors negotiate, define and guarantee amongst themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources. An equitable sharing of benefits and costs of PAs' protection and management among the stakeholders is, therefore, an important part of co-management approach. An effective linking of socio-economic and ecological incentives and biodiversity conservation will be instrumental in eliciting stakeholders' participation in this approach. For Bangladesh's PAs, relevant co-management actors will include the FD, as legal custodian of PAs, and the stakeholders that play important role in the conservation management. Co-management agreements are important for linking participatory benefit sharing arrangements to PA conservation and will help formalize symbiotic linkages.

2.3.2. Co-management Objective

The NSP is designed to assist in achievement of the primary objective of conservation of biodiversity within the PAs of Bangladesh. This overall objective is to be achieved through support to the FD and key stakeholders in protecting, rehabilitating, conserving and sustainably managing biodiversity of the PAs by building partnerships based on shared rights and responsibilities.

The Project is expected to contribute significantly to sustainable economic growth in remote rural areas with a high proportion of relatively poor groups. The economic interventions to be proposed will include sustainable benefits for co-management participants deriving from participatory conservation and benefits sharing agreements to be signed with locally organized groups of participants.

2.3.3. Co-management Councils and Committees

A two-tier institutional structure (Co-management council and co-management committee) for sustainable PA co-management will be adopted. The council will have a broad-based structure, drawing people from different strata of the community from an identified landscape (see guidelines issued by GOB as annexed).

A co-management committee, responsible for overall management of a PA, will consist of maximum19 members (ideally 15), elected by the co-management council following a structured guideline that will contain the number of people to be elected from each representative category, their election procedures and the tasks to be performed by the committee.

The Committee will have a Chairperson, Vice-Chairperson and a Member-Secretary. Half of the members of the committee will retire voluntarily every year and new members will be elected against the vacant posts (a member cannot be elected for two consecutive terms). Specific functions of the co-management council and committee will be specified. The existing Wildlife Advisory Board will be at the apex of the proposed councils and committees. Co-management councils/committees will have oversight role in Plan implementation.

2.3.4. Project Objectives

The NSP will work to achieve the following six separate but closely related objectives in support of the above-stated co-management objective:

- ➔ Develop a functional model for formalized co-management of PAs;

- ➔ Create alternative income generation opportunities for key local stakeholders associated with pilot co-managed PAs;
- ➔ Develop policies conducive to improved PA management and build constituencies to further these policy goals;
- ➔ Strengthen the institutional system and capacity of the FD and key stakeholders so that improvements co-management under the Project can be made permanent;
- ➔ Build or reinforce the infrastructure within PAs that enable better management and provision of visitor services at co-managed sites; and Design and implement a program of habitat management and restoration of pilot PAs.

2.3.5. Rationale for Benefit Sharing

Local communities are generally put to hardships after notification of a forest area as PA due mainly to curtailment of the flow of forest usufructs through strict regulation, and threats from wildlife to their life and property. Fragmentation of wildlife habitat due to loss of forest land has given rise to man-wildlife conflicts and a tenuous interface situation. Conservation-oriented management of PAs with strict restrictions on forest harvesting and enhanced patrolling have further excerbated their problems. Local people incur high opportunity costs in terms of foregone benefits, which they were deriving from the forests before the implementation of strict enforcement practices.

The local people, who were hitherto using forests for meeting their livelihood consumption needs, get deprived from forest-based benefits and so need to be compensated adequately for the loss of economic opportunities and wildlife damage to their life and property. This can be achieved by launching co-management projects such as Nishorgo Support Project and sharing the benefits with local people. So there is a strong case for compensating them by sharing benefit streams flowing through PAs and/or off-PAs alternative income generating (AIG) activities.

A sustainable partnership will require an equitable sharing of both benefits and costs. Due to widespread impoverishment of local people it is not expected that they will come forward in investing cash money in the conservation efforts of PAs. However, due to widespread unemployment and under-employment it is plausible to solicit their voluntary labour contribution in an effective protection and management of the PAs and also create self-employment opportunities through alternative income generation activities. This will not only help in instilling ownership feeling among the partners but will also help utilize surplus labour productively for efficient allocation of human and land resources for effective wildlife and habitat conservation.

2.3.6. Co-management Agreements

The stakeholders' rights (e.g. sharing of usufructs and revenue) and responsibilities (e.g. protection and conservation of biodiversity) need to be defined in co-management agreements. Easy access of stakeholders to PAs and protection measures against anthropogenic factors including illegal removals, encroachment, poaching and man-made fires should also be clarified. These agreements will play an important role in the protection and conservation of PAs as discussed in the next chapter.

2.3.7. Landscape Development Fund

Main focus of co-management is on equitably sharing roles and responsibilities by main stakeholders for biodiversity conservation in the Park. Benefits sharing from the harvests of plantations is a main mechanism for eliciting peoples' participation in participatory forestry and so the focus is on plantations as a part of production forestry. For instance, the harvests from plantations raised under FSP form seed money for Tree Farming Fund (10% of total proceeds from the harvests of plantations are earmarked as seed money for TFF). So with focus on biodiversity conservation the flow of benefits to local people is much less in co-management of PAs when compared to participatory forestry. This means that benefit stream need to be strengthened for which LDF is being designed for funding alternative income generating activities. An initial amount of USD 300,000/- is earmarked to be used as seed money. Operational guidelines for the LDF are currently under preparation.

2.4. Elements of a Sustainable Protected Area Management System

A study on assessment of the FD's institutional organization and capacity to manage the PA system of Bangladesh was completed under NSP with main objectives as i) identifying main elements of a sustainable PA system, ii) assessment of current status of PA management elements and finally iii) making

recommendations along with delivery mechanisms. Two broad elements identified were on institutional organization (management support systems), and training and capacity building. These two broad elements were further sub-divided into specific elements as below:

Institutional Organization - Management Support Systems:

- ➔ Organizational management
- ➔ Information management technology
- ➔ Spatial data management
- ➔ Financial organizational systems
- ➔ Institutional orientation to co-management
- ➔ Legal support
- ➔ Law inforcement
- ➔ Wildlife insurance
- ➔ Information, education and communication
- ➔ Research
- ➔ Monitoring and Evaluation
- ➔ Inter-sectoral conservation planning
- ➔ Public-private partnerships
- ➔ Sustainable financing

Training and Capacity Building:

- ➔ Staffing pattern
- ➔ Training facilities and capacity
- ➔ Training for professional specialist skills
- ➔ Integrated training for on-site PA field staff
- ➔ Integrated training for local community and other stakeholders

Some of the relevant aspects from the above-mentioned list are covered in this Plan.

3. HABITAT PROTECTION PROGRAMS

3.1 Objectives

Heavy biotic pressure brought by manifold increase in population, and agricultural and industrial demands have resulted in habitat degradation and loss of wildlife in the Park. Main objective of this program is to provide adequate protection to the Park for the conservation of its constituent biodiversity. Main activities to be carried out to achieve this objective will include i) updating forest cover and interface landscape maps, ii) demarcating the Park boundary, iii) controlling illegal removals from PAs, and iv) checking encroachment of the Park lands.

3.2 Updating of Existing Forest Cover and Landscape Maps

Detailed forest cover/landscape mapping for Lawachara NP (and adjoining forests of West Bhanugach RF) is available with FD based on 1996 satellite imagery and relevant FD records. This mapping is used in management zoning by identifying core zones and interface landscape zones, and also specific zones within the broad core and landscape zones. It is recommended to verify this zoning during the Management Plan implementation based on field visits and stakeholders assessments.

Reconnaissance surveys followed by detailed surveys of identified areas will be helpful in verifying actual ground situation. New mapping will be carried out during the Plan implementation and will include relevant landscapes within a 3 km wide interface landscape zone outside of existing/proposed Park boundaries in order to provide a spatial context for coordination of regional landscape elements and neighbouring forests. Mapping will be extended to include the Tea Estate and khas land portions of the landscape and will particularly focus on identifying remnant patches of natural vegetation and encroachments. Land-use and base maps will be prepared by acquiring latest satellite imageries (e.g. high resolution IKONOS or aerial images) for the Park. These maps may be standardized after comparing with the previous RIMS maps. Actual maps may be produced based on ground truthing by making use of differential GPS.

3.3 Boundary Demarcation

All the peripheral boundaries of the NP will be identified, surveyed and marked on the ground. The boundaries of different management zones will be defined, mapped and also be identified on the ground during the Plan implementation. The advantage of natural features (i.e. rivers, streams/*cheras*, ridge, roads, etc.) will be taken wherever possible while carrying out demarcation. Posts (e.g. concrete pillars, relevant guidelines for which are suggested in Volume 2) or other markers (wooden or iron pillers, trenches, mounds, etc.) will be put in place at all important and/or turning points and will be labeled. Sometimes boundary and markers are vulnerable to alteration due to human-interference or natural calamities such as floods. So a regular annual maintenance program will be necessary for boundary and pillar renovation and maintenance.

All the locations where primary access routes cross the Park's outer boundaries will be clearly marked with signs indicating the Park's name and summarizing key regulations in written text and symbols. Signboards will be of the following types: i) attractively designed, large wooden signboards where the Srimongal-Kamalganj Highway crosses the western and eastern boundaries of the Park; and ii) concrete slab signboards (of the type currently used to mark plantations) at all other locations. Signboards will be placed at the locations, i) highway crossing point, western Park boundary (wooden signboard); ii) highway crossing point, eastern Park boundary (wooden signboard); iii) railway crossing point, western Park boundary (concrete signboard); iv) railway crossing point, eastern Park boundary (concrete signboard); v) Lawachara-Kalachara forest road crossing point, northern Park boundary (concrete signboard); vi) Lawachara-Chautali forest road crossing point, northern Park boundary (concrete signboard); and vii) Chautali Beat Office.

3.3.1 Inconsistency in Park Boundaries and Forest Areas

The traditional traversing method is generally used for boundary demarcation based on Gazette Notification. This method does not employ Aerial Photographs for re-validation. Moreover the boundaries of the Park have not in general been delineated keeping in view permanent natural features such as

streams/rivers, roads and ridges. As a result, some inconsistencies creep in particularly with respect to boundaries and areas of the Park. Some human errors during plotting the traverses and mapping are also not ruled out. The field maps were used by RIMS to generate GIS databases (administrative boundary layers) through digitization. The notified area of Lawachara NP is 1250 ha as against the area (1221.2 ha) computed from the GIS data base of RIMS.
These problems can be solved either through traditional survey and mapping or else through DGPS guided survey using satellite technology. However, the traditional survey method may not produce desired accuracy and will indeed be costly in terms of time and manpower. So the DGPS survey, which may be accurate to sub-meter and would require limited manpower, may be employed for removing noted inconsistencies.

3.4 Control of Illicit Felling, Fires and Grazing

Effective protection against illicit felling, forest fires and grazing are necessary for the conservation of biodiversity and management of the Park.

3.4.1 Control of Illicit Felling

Illicit felling inside the Park will be checked through extensive joint patrolling (FD staff and local stakeholders) inside the forests, particularly the core areas. The villagers from Magurchara and Lawachara will particularly be helpful in forest protection efforts through patrol and intelligence sharing. Stakeholders' participation in controlling petty theft will be very helpful as being local people they are better informed about biotic pressure points and routes. In view of limited area of the Park, patrolling on foot by participants and FD field staff will regularly be done. In addition to controlling illicit felling, they will also check the boundaries of the Park and encroachment within the Park. The present practice of engaging helpers from nearby villages for forest protection has not proved successful and so will be discontinued. It will be essential to regulate illegal running of sawmills and furniture shops located nearby the Park. Guidelines may include that no sawmill should function within 10 km boundary of any PA. Wood-based industries without proper license should be stopped. Issuing transit permits by FD staff will also be checked and regulated keeping in view of biodiversity conservation in the Park.

An effective checking of organized smuggling of timber and poaching will require concerted efforts from FD by using modern equipments and transport facilities. In case of organized smuggling there may be need for sophisticated fire arms and ammunition and training to combat organized poachers and smugglers. It may be necessary to give one Revolver and/or Rifle to each ACF and DBBL guns to Beat Officer and FGs. This also may require setting up special protection force by augmenting the presence of FD field staff, if necessary backed up by local police and BDR officials. In such cases inter-agency coordination will be necessary for successful protection efforts and control measures. Similarly international coordination with north-eastern Indian states may be sought. Communication network particularly needs strengthening by installing a radio communication network and by mobilizing more walkies talkies, mobile telephones and vehicles. At least one four wheel jeep along with sufficient nos. of motor cycles will be provided for the use of the Park field staff. Each Beat would have at least one motor cycle.

Existing motorable roads will be maintained for easy movement of patrolling duties. But construction of new roads is not proposed as patrolling on foot will be more effective due to limited areas under the Park. Redeployment of FD field staff may be necessary depending upon the intensity of illicit felling in certain areas. Special incentives and amenities may be provided to the FD field staff posted in difficult areas (e.g. international border points). Adequate rewards will be provided to those field staff who perform exemplary protection duties. Similarly a group of local informers may be engaged based on payment of rewards to those local people whose information may lead to catching of smugglers. This may prove most effective against poaching of wild animals and theft of forest produce. A patrolling camp may be setup beside Kalapur Ansar Camp.

3.4.2 Control of Poaching

Poaching of wildlife inside the Park will be checked by FD field staff. Stakeholders' participation in controlling poaching will be very helpful; patrolling on foot by participants (particularly by villagers from Magurchara and Lawachara Forest Villages) and FD field staff will regularly be done. Special care will be taken during moon nights when incidences of poaching may increase due to better visibility. However, an effective checking of poaching by organized gangs will require concerted efforts from FD by using modern equipments and transport facilities. This also may require setting up special protection force, if necessary by involving local police and BDR officials. A public awareness program will be mounted through TV,

Radio, Video film, newspaper, magazines, brochures, etc. for generating awareness among local people for propagating the cause of wildlife and its habitat.

3.4.3 Regulations of Non-Timber Forest Products

NTFPs are presently collected from the Park indiscriminately by whosoever gets access. This collection process should be streamlined and entrusted to co-management committees (to be formed at different levels) who will be responsible for the collection of NTFPs under overall guidance of FD field staff. An assessment of availability of NTFPs will be done before allowing NTFPs collection by the members of co-management committees). This assessment will cover the regeneration status of NTFPs, time and methods of collection and limits of sustainable harvest. No collection of NTFPs will be allowed from Ecosystem Management Zone. The collection of bark and roots will not be allowed. Similarly felling and lopping of trees will also not be allowed. Fruits, seeds, leaves used by wildlife will not be collected. If possible, the processing of NTFPs will be done locally in order to get value addition and generate employment opportunities in the villages of interface landscape zones.

3.4.4 Control of Forest Fires

Control of forest fires will be done by involving local stakeholders. Existing paths/tracks will be used as fire lines as well and will be maintained so by cutting and control burning of grasses and debris twice a year (say in December and March/April). Existing patrolling paths will be cleaned every year before fire season. Additional fire lines will be created at strategic places including regeneration areas. Local people engaged in grazing and NTFPs collection will particularly be targeted for making them aware about forest fire control. Publicity and awareness material will be developed and put up at convenient places for making local people aware about the necessity of forest fire control. The watch towers, to be developed for tourists, will be used as fire watch tower as well. Similarly patrolling squads in association with local stakeholders also will guard against the forest fire. Communication network including walkie talkies will be used in forest fire control. Handy fire extinguishers and other fire fighting tools (e.g. fire beater, fire rake, fire shovel, brush hook) can also be kept at Beat/Camp HQs and other convenient places. A register of forest fire occurrences may be maintained for monitoring of fire incidences and assessing their adverse impacts.

3.4.5 Control of Forest Grazing

Villagers (including Forest Villagers and Tea Estate labourers) in and around the Park maintain cattle who invariably graze in forests. No grazing will be allowed in the Park except allowed by the concerned DFOs, particularly rotational grazing in plantation areas. Stakeholders will be convinced not let loose their cattle in forests and also control the cattle of other villagers while patrolling for illicit felling and poaching. However, cutting and carrying of grasses from some specified areas such as plantations may be allowed for stall feeding of cattle of stakeholders. In buffer areas silvi-pastoral models may be implemented and villagers may be provided such technologies (including seeds/slips) so that they can raise their fodder plantations on their private lands and other unutilized khas lands. Improved cultivation practices carried out with mechanical appliances including power tillers will reduce the need for draught animals. Similarly the breed of livestock may be improved in collaboration of Department of Livestock. A public campaign will be undertaken by holding public meetings and distributing leaflets to make the local people aware about adverse effects of grazing.

3.4.6 Control of Forest Land Encroachment

Survey and demarcation of the peripheral boundary of the Park will be done during the first year of Plan implementation when encroachment areas will also be identified and evicted, if possible after obtaining their voluntary consent.

3.4.7 Resolution of Man-Animal Conflicts

Wild animal depredation (e.g. monkeys, capped langur) may be a problem in fringe villages including Forest Villages and surrounding Tea Estates. They will be trained by FD staff and NGOs and the equipments (e.g. batteries) will be provided under the project for driving away wild animals. An awareness campaign will be launched for villagers and Tea Estate labourers. A provision is being made in the revised Wildlife Act for making compensation in case of wildlife depredation.

Currently no Wildlife Insurance Schemes for human-animal conflict (e.g. injury, death, property damage, crop damage, etc.) and no provision for damage compensation exist in FD. In some south Asian countries compensation schemes through wildlife insurance have developed as a mechanism to compensate the loss caused by the wildlife. Similarly the budget provisions are made for FD compensating the damage to private property and life by wildlife. The Wildlife Insurance and compensation for damage should be implemented in Bangladesh and be incorporated in the draft Wildlife Act.

3.5 Co-Management Agreements

The existing traditional use of forests for bonafide consumption inside the three PAs needs to be formalized through co-management agreements to be signed with groups of users. For example, there are forest villages established inside PAs (e.g. Lawachara and Magurchara forest villages in Lawachara NP) by allotting forest lands and have villagers' established rights for betel leaf cultivation and their responsibility in forest protection and labour supply for forestry works. Detailed discussions will be held with the users about their roles and responsibilities, and the type and quantity of benefits to be accrued to them on long-term basis in lieu of their current exploitative forest use to be foregone.

Under FSP the plantations (woodlots, strip plantations and agroforestry) are being raised in buffer areas of 7 PAs (including the 5 pilot PAs of NSP). Participants formed into user groups take responsibility for protecting and managing the plantations in lieu of usufructury benefits ensured through participatory benefit sharing agreements (PBSAs) signed between them and FD. These PBSAs will be valid (and so renamed as co-management agreements) under NSP as well. The participants will have responsibility for the protection of neighbouring natural forests in addition to the plantations assigned to them under FSP.

As per the Wildlife (Preservation) (Amendment) Act, 1974 no commercial harvesting is allowed inside the core areas and hence other relevant mechanisms of benefits flows to local communities need to be explored. Moreover, no regular plantations are planned to established in the core areas. This means that no benefits will flow from the harvests of either plantations or naturally occurring trees. Some enrichment plantations of indegeneous tree, shrubs, herbs and grass species will be taken up by gradually opening the top canopy through selectively felling of exotic trees that are not suitable for wildlife. It is envisaged that the enrichment plantations of indigenous species will over a period of time develop similar to natural stands of forests to be retained in future as a part of suitable habitat for wildlife.

An important source of benefits to local people could be from the sustainable harvesting of NTFPs from the forests of PAs. The forests of Sylhet are particularly rich in NTFPs, which may supply raw materials for NTFP-based village and cottage industries. Similarly some forest produce will be available as a bye-product of subsidiary silvicultural operations (SSOs) to be carried out for the improvement of wildlife habitat. Water yield as a result of habitat conservation can be an additional incentive to local people for agricultural purposes. A draft co-management agreement format applicable for the benefits sharing from natural forests (particularly from core areas of the Park) is developed.

The above-enumerated benefits may not be sufficient to motivate local people and so additional benefits need to be mobilized through off-PA activities including alternative income generating (AIGs) activities. The upscaling of skills by RDRS and CODEC will be helpful in generating value additions through capacity building of local people. Landscape Development Fund (LDF) will help provide finance for RMOs to set up micro-enterprises, offering self-employment opportunities to the skilled members. Benefits from eco-tourism can also be ploughed back for the development of local communities and PAs. The FD may countersign the benefit sharing agreement. A new co-management agreement format to be signed between RMOs and the implementing NGO is developed for the AIG activities to be carried out through LDF.

Existing traditional users from established Forest Villages (Lawachara and Magurchara) will in groups formalize their existing bonafide consumption use practices by signing a benefit sharing agreement to be signed between them and FD with the assistance of implementing NGO. The existing use areas will be marked and shown on maps of FD.

3.6 Protected Area Conflict Resolution and Management

Main sources of conflicts among local people around Lawachara Park relate to forest extraction, forest land encroachment and land disputes, forest offence cases, forest grazing, money lending, children and family affairs, local politics, etc. Some of these conflicts are resolved by local elites and public representatives (e.g. union parishad chairman and members, village leaders, local MP and Gram Sarkar). A large number

of forest offence cases have been registered by FD and are pending in local courts. Local community organizations such as Khasia Welfare Society, Dakshin Sylhet Adivasi Forum, Tripura Sanskritik Kendra and Abkash Tarun Sangha will be use ful in resolving local conflicts.

Co-management activities in the PA will involve local stakeholders, NGO staff and FD field staff. A PA conflict may arise due to misunderstanding or a disagreement between two or more parties engaged in PA management activities. This disagreement under NSP could be among the local stakeholders, NGO partners and FD field staff. PA conflicts may arise due to incompatibility of needs, and differing opinions, values, interests, actions and goals of the stakeholders. As elsewhere in many south Asian countries, natural forests are not only scarce and limited in Bangladesh but also with manifold increase in population the biotic pressure on forests within the PA is indeed high, thereby giving rise to possibilities of PA conflicts. Unlike the traditional forestry practiced in RFs, the chances of PA conflicts are more in co-management approach due to a number of actors involved.

3.6.1 PA Conflict Prevention

Challenges of co-existence should be realized by all the stakeholders of co-management in the PA. Conflict prevention is more important than PA conflict resolution. Developing coalitions, alliances, peace making, networking, and local experiences are essential in PA conflict prevention. Productive, peaceful and rewarding relationships and good understanding among the local stakeholders of NSP will help prevent PA conflicts. A coalition of positive interests need to be developed and managed in order to check PA conflicts. This will require a good understanding of each other, instilling democratic norms, identifying shared interests, fagging conflicting issues, respecting differences and diversity of thoughts and views, tolerance to differing cultures and traditions, and putting in place a mechanism for PA conflict prevention through dialogue. Representative leadership, transparency, accountability and inclusivity in decision-making of co-management committees, and a commitment to equity, empowering diverse local institutions and devolution of powers to local stakeholders can help prevent PA conflicts in co-management of the PA.

3.6.2 PA Conflict Resolution

In case a PA conflict cannot be prevented, its resolution is better than a conflict run its course. Identification of PA conflicts and the underlying reasons for such conflicts in co-management need to be done through field visits and close interactions with disputing parties by adopting participatory methods such as RRA/PRA, focus group discussions, diagnostic visits and stakeholders analyses. Proper PA conflict resolution tools and mechanisms need to be developed and FD field staff, NGOs and members of co-management committees imparted appropriate training. PA conflict resolution may require providing PA management alternatives, solidarity with co-management committees, combining innovative PA co-management practices with the traditional ones, being at peace with disputing parties, patience in dealing with local stakeholders, trust building among disputing parties, dialogue with stakeholders, humility and tolerance among FD field staff, establishing confidence building measures, and negotiated agreements with disputing parties.

Raising awareness of FD field staff, local stakeholders and NGO partners through training will be helpful in leaving aside their shell of prejudices, developing active listening habits and becoming aware of body language (the way people sit, their gestures and postures, eye contact, etc.). It will empower local stakeholders to be better able understand difficult issues and relevant challenges in NSP implementation. Efforts will be made to foster a local leadership culture that will support greater trust, communication and collaborative problem solving among disputing parties. Face to face interactions between disputing parties and use of communication tools such as audio-visuals will help establish a participatory process of PA conflict resolution based on dialogue and mutual trust. Building appropriate local institutions (e.g. regular meetings of co-management committees, and forming federations or umbrella groups and networks) as a platform for airing dissent and creating situations where local stakeholders can learn together are necessary for resolving PA conflicts.

Some of the following steps may help prevent and resolve PA conflicts:

- ➔ Self-sensitization of FD and NGO staff is important
- ➔ Learn from PA dependent communities instead of telling them as to what to do
- ➔ Using co-management tools to involve local stakeholders in the process of learning about PA use and management
- ➔ Appreciating and nurturing grounds of common interest on PA issues

- ➔ Generating recognition between individuals/user groups and underlining similarities of their aims and objectives on PA issues
- ➔ Establishing reliable information base on PA resources on which conflicts may be based
- ➔ Organizing short workshops and developing manuals on training on PA conflict resolution
- ➔ Conducting focus group discussions with co-management committees to build consensus on collective goals of co-management committees as against individual goals
- ➔ Raising questions on real PA issues, seeking options/suggestions from local stakeholders for co-management of the PA
- ➔ Developing, implementing and monitoring a plan of co-management action for the PA
- ➔ Follow up, networking and process documentation for future learning

3.6.3 PA Conflict Management

PA conflicts that cannot be resolved over a short period, need to be managed and transformed so as to enable their ultimate resolution in long-term. PA conflict management is particularly useful when the cost being incurred due to the conflict continuance is great for all stakeholders, deforestation issues are complex and building long-term relationships among the disputing parties is important for sustainable PA management. PA scenario planning may be adopted as a dialogue tool, and flexibility in responding to local stakeholders' needs and unfolding events is desirable. Dialogue between the disputing parties is necessary to build an on-going relationship, Influencers such as village leaders and elites on both sides of a PA conflict may help sustain such a dialogue.

A negotiated management of a PA conflict may involve i) acting as catalyst in making understanding among disputing parties, ii) focusing on a particular situation being faced by disputing parties, iii) informal efforts (Track II) by local leaders/elders that may complement/supplement formal efforts (Track I) of co-management committees, FD staff and NGOs, iv) collaborative approach to negotiations, v) taking adequate preparations before starting of formal negotiations, and vi) adopting appropriate negotiation skills/tools. In some cases the disputing parties locked in an endless tit-for-tat retribution cycle may need a third party to push or pull them into a PA conflict management process. Intervention efforts through a third party may in such cases involve negotiation, facilitation, mediation or arbitration.

In summary a typical PA conflict resolution/management process may involve:

- ➔ Develop and institutionalize a mechanism for interactions and discussions at a common platform (e.g. co-management committee meetings)
- ➔ Allow disputing parties to present their versions of facts at a forum conducted by a neutral third person
- ➔ Build trust and confidence among the members of local stakeholders through informal interactions, discussions and social gatherings
- ➔ Explore with each party main areas of common concern/understanding where a consensus could be reached and issues resolved through dialogue among disputing parties
- ➔ Leave out contentious PA issues initially. Flag areas of severe dissent where bridges need to be built
- ➔ Hold meetings with the representatives of both disputing parties to explore PA issues and bring about agreements among them
- ➔ Create a win-win situation for disputing parties by establishing a regular dialogue, patience listening, consulting with co-management committees to deflate potential PA conflicts and crises as they emerge. Seek solutions to the identified PA issues with tangible benefits to be shared equitably among disputing parties
- ➔ Develop and install confidence building measures before solving contentious issues and provide sufficient time for their implementation
- ➔ Attempt to resolve contentious PA issues by making use of local leadership. If needed outside help may be taken in the form of mediation, etc.
- ➔ Establishing a forum for maintaining a regular dialogue among disputing parties to review performance and discuss relevant issues of co-management of the PA
- ➔ Maintain a list of selected persons (e.g. villager leaders/elders) who can be available as facilitators/mediators.

PA conflict prevention (and/or resolution) through peaceful means is desirable and cost effective in long run than its continuation (or PA conflict resolution through violent means).

3.7 Summary of Main Prescriptions

Main prescriptions outlined under the above-developed protection programs are summarized (Table 3.1) with respect to indicative timing of each proposed activity and responsibility assigned.

Table 3.1 Summary of Main Prescriptions

Year	Main Activities	Main Outputs/Success Criteria	Responsibility
1	➢ Procuring modern equipments, vehicles, tools, imageries, etc.	Equipments & remote sensing products procured	FD/NSP
	➢ Reviewing the existing forest cover and land-use maps and updating them by using latest imageries/aerial photos and ground truthing	Updated maps prepared by RIMS	RIMS/FD
	➢ Establishing co-management committees and forming user groups	Co-management committees and user groups are in place	NSP/FD/ Stakeholders
	➢ Signing co-management and benefit sharing agreements	Co-management & benefit sharing agreements signed	FD/NSP/ Stakholders
	➢ Controlling poaching, forest land encroachment and illicit removals from the Park and checking forest grazing and fires by associating local stakeholders	Reduced level of biotic interference	Stakeholders/ FD/NSP
	➢ Providing incentives for good protection efforts and disincentives for poor protection	Good FD field staff and stakeholders rewarded	FD/NSP
	➢ Establish conflict resolution mechanisms through co-management committees	Conflict resolution mechanism in place	Stakeholders/ FD/NSP
2	➢ Delineating the boundaries of Park and management zones and putting pillars and markers	Boundaries delineated in field	FD/NSP
	➢ Maintaining a register of the Park boundaries and pillars, and conducting annual inspections by supervisory FD field staff	Register updated and inspections done	FD
	➢ Conducting regular meetings of co-management committees and user groups for providing effective protection against illicit felling, encroachment, forest grazing and fires	Reduced level of biotic interference	Stakeholders/ FD/NSP
	➢ Controlling poaching, forest land encroachment and illicit removals from the Park and checking forest grazing and fires by associating local stakeholders	Reduced level of biotic interference	Stakeholders/ FD/NSP
	➢ Providing incentives for good protection efforts and disincentives for poor protection	Good FD field staff and stakeholders rewarded	FD/NSP
	➢ Resolving forest conflicts	Certain no. of conflicts resolved	Stakeholders/ FD/NSP
3	➢ Maintaining a register of the Park boundaries and pillars, and conducting annual inspections by supervisory FD field staff	Register updated and inspections done	FD
	➢ Conducting regular meetings of co-management committees and user groups for providing effective protection against illicit felling, encroachment, forest grazing and fires	Reduced level of biotic interference	Stakeholders/ FD/NSP

	➢ Controlling poaching, forest land encroachment and illicit removals from the Park and checking forest grazing and fires by associating local stakeholders	Reduced level of biotic interference	Stakeholders/ FD/NSP
	➢ Providing incentives for good protection efforts and disincentives for poor protection	Good FD field staff and stakeholders rewarded	FD/NSP
	➢ Resolving forest conflicts	Certain no. of conflicts resolved	Stakeholders/ FD/NSP
4	➢ Maintaining a register of the Park boundaries and pillars, and conducting annual inspections by supervisory FD field staff	Register updated and inspections done	FD
	➢ Conducting regular meetings of co-management committees and user groups for providing effective protection against illicit felling, encroachment, forest grazing and fires	Reduced level of biotic interference	Stakeholders/ FD/NSP
	➢ Controlling poaching, forest land encroachment and illicit removals from the Park and checking forest grazing and fires by associating local stakeholders	Reduced level of biotic interference	Stakeholders/ FD/NSP
	➢ Providing incentives for good protection efforts and disincentives for poor protection	Good FD field staff and stakeholders rewarded	FD/NSP
	➢ Resolving forest conflicts	Certain no. of conflicts resolved	Stakeholders/ FD/NSP
5	➢ Maintaining a register of the Park boundaries and pillars, and conducting annual inspections by supervisory FD field staff	Register updated and inspections done	FD
	➢ Conducting regular meetings of co-management committees and user groups for providing effective protection against illicit felling, encroachment, forest grazing and fires	Reduced level of biotic interference	Stakeholders/ FD/NSP
	➢ Controlling poaching, forest land encroachment and illicit removals from the Park and checking forest grazing and fires by associating local stakeholders	Reduced level of biotic interference	Stakeholders/ FD/NSP
	➢ Providing incentives for good protection efforts and disincentives for poor protection	Good FD field staff and stakeholders rewarded	FD/NSP
	➢ Resolving forest conflicts	Certain no. of conflicts resolved	Stakeholders/ FD/NSP

4. MANAGEMENT PROGRAMS

4.1 Objectives

Main objectives of the management program are to i) maintain ecological succession in constituent forests by providing effective protection against biotic interference, ii) develop and maintain natural forests as good habitat favouring wildlife, iii) conserve the forest resources including the constituent biodiversity, and iv) establish co-management practices through stakeholders' consultations and active participation.

4.2 Landscape Management Zoning

Land-use within the Park and surrounding landscape will be managed based on sound co-management principles and practices. The general approach is to permit existing levels of land-use where these are manageable by means of zoning, and/or where they do not result in major adverse or irreversible environmental impacts. This includes the majority of existing and expected land-uses with some controls on location and use intensity.

Landscape management zoning is useful in implementing relevant management practices in different areas of the Park based on management objectives to be achieved spatially. The Park is, therefore, divided into two broad zones (core zone and interface landscape zone, each subdivided further into specific sub-zones) based on existing forests, landscape elements and management objectives as below. The proposed management follows internationally accepted management zoning principles (MacKinnon and MacKinnon, 1986) applied to a PA. It provides a basic spatial framework for protecting the areas of highest conservation value (old plantations and natural vegetation), for limiting the spatial extent of high impact activities (administrative and services and transportation facilities), and for designating areas used to provide benefits to local people. Illegal removals and commercial harvests will be checked and stopped in order to achieve the objectives of Park management.

The long-term management aim of maintaining the maximum possible area under forest cover along with its constituent biodiversity in the best possible condition will be achieved by zoning the Park area and surrounding landscape such that i) the areas of highest conservation value (forests and/or old plantations) are protected, regenerated and managed towards natural forest composition and structure, particularly in the core zone, ii) the areas used to provide benefits to local people through sustainable use of forests are defined, and high impact activity areas, mainly as interface landscape zone. The core zone will have the highest conservation value followed by interface landscape zone which of course are important for biotic life ; these two broad zones are further subdivided into specific sub-zones as discussed below.

4.3 Core Zone

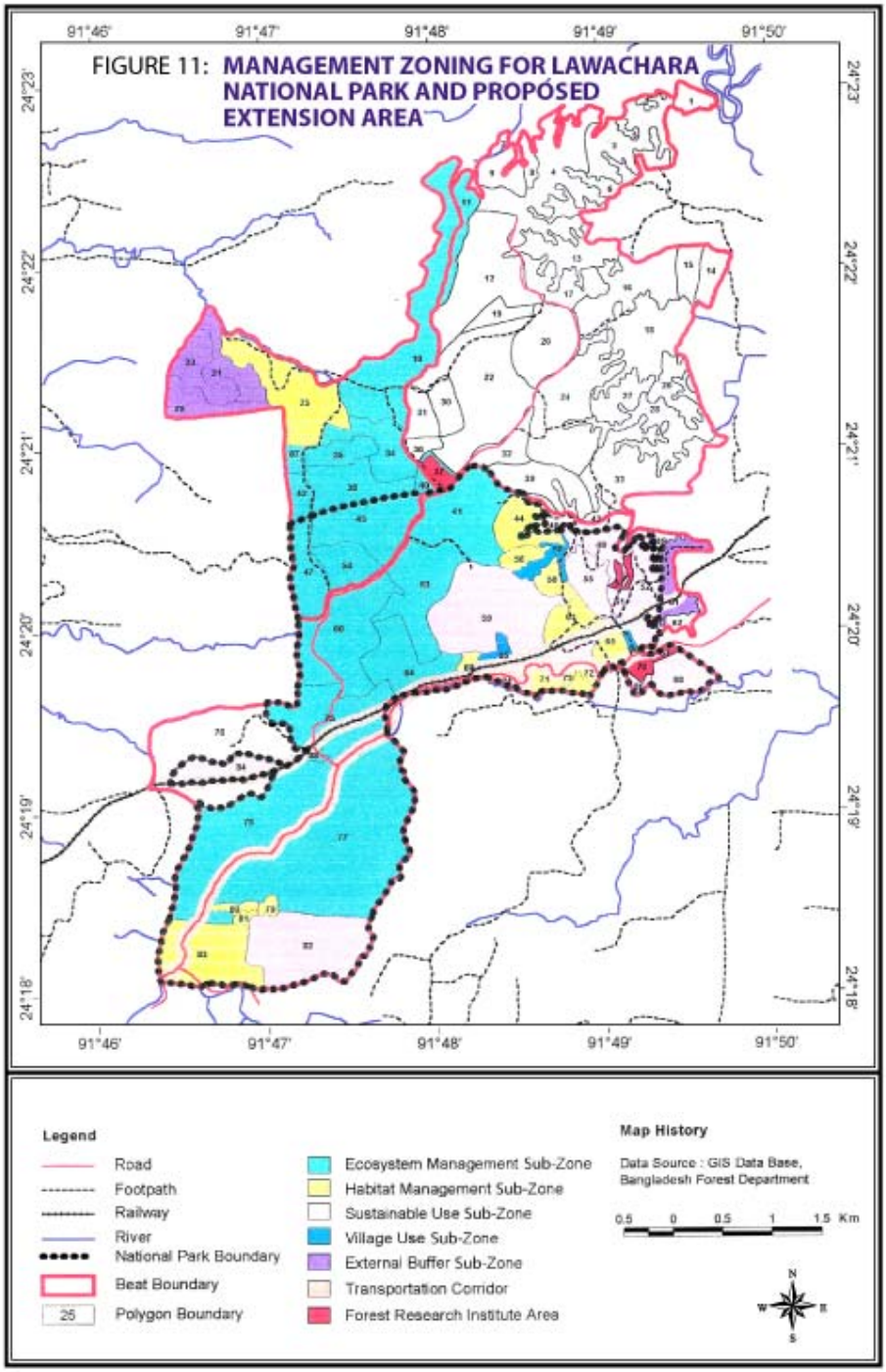
Almost all of the total notified area of Lawachara NP (which has the highest conservation value) is designated as the core zone, which is sub-divided further into Ecosystem Sub-zone, Habitat Management sub-Zone, Village Use sub-Zone, Sustainable Use sub-Zone and Intensive Use sub-Zone (Figure 11). All the well stocked areas with wildlife of the Park are covered under the core zone, where management objective is to protect and maintain remaining vegetation in good stocking and encourage natural regeneration to gradually bring back natural forests.

4.3.1 Ecosystem Management Sub-zone

Ecosystem management sub-zone is constituted to preserve constituent forests in as near natural conditions as possible by providing an effective protection against all forms of biotic interference and maintaining natural course of ecological succession. So main management aim in Ecosystem Management Sub-zone is long-term protection of existing vegetation including remaining natural forests and mixed plantations, and rehabilitation toward natural forest habitat. More than half (57%) of the notified Park area has been designated as Ecosystem management sub-zone covering existing forest/plantations areas with good biodiversity value. The proposed extension to incorporate most of Chautali Beat will also be managed primarily as Ecosystem Management Sub-zone.

Forests management in this sub-zone will focus on conserving the remaining natural forests and bringing back natural vegetation (composition and structure) wherever possible. This will be achieved by providing

protection (against illicit removals of forest produce, encroachment, grazing and fire) and encouraging natural processes for regeneration and rehabilitation of forests. Extensive monoculture of teak and other exotic species need canopy manipulation in order to create more favorable habitat for wildlife by encouraging natural regeneration and enrichment planting of indigenous trees, shrubs, herbs and palatable grasses. Subsidiary silvicultural operations will be carried out whenever necessary to encourage natural vegetation. Effective protection against biotic pressure (illicit felling, forest fire and grazing) will allow natural processes of regeneration in degraded forest areas.



Co-management practices will be implemented (through associated co-management councils/committees to be formed at different levels) in strengthening protection efforts against illicit felling, forest fires and forest grazing. In lieu of reduced removals by the local communities from the Ecosystem Sub-zone, they will be provided alternative means from interface landscape zone and other alternative income generation activities for sustainable livelihoods. The visitor use of the Ecosystem Management Sub-zone will be regulated and only low impact tourist activities will be allowed in terms of hiking and wildlife watching. High impact visitor activities such as motorized transport and group pick-nicks will not be allowed.

The protection efforts will be facilitated through communication outreach activities, public awareness, stakeholders' access to interface landscape zones in meeting their subsistence requirements but also enhanced enforcement by FD particularly in combating organized smuggling by outsiders. Local people will be convinced not to send their cattle for forest grazing by associated user groups. For example, the villagers from Dolubari will be engaged in alternative income generation activities for sustainable livelihoods in order to wean them away from illegal harvesting from the nearby forests. However, only sustainable use of selected NTFPs such as bamboo, grasses, canes and medicinal plants for bonafide consumption will be allowed *in lieu* of their increased protection efforts for the core zone. Control of forest fires will be through community efforts but forest fire lines will be established in order to check spread of forest fires. Controlled burning will be used as a management tool particularly in moist forest areas of the Park. Fire lines will be created and maintained in forest fire prone areas.

Subsidiary silvicultural operations will be carried out for encouraging natural regeneration of indigenous species. Gradual opening of top canopy through selective removal (leaving any indigenous tree) may be taken up in the areas having exotic plantations (e.g. maloccana, teak, etc.) to create favorable conditions for natural regeneration to be established over a period. However, dead and hollow trees will not be removed as they provide shelter/nest to wildlife. Reduced impact logging methods (e.g. vine-cutting prior to felling, directional felling, non-mechanized skidding and hauling) will be employed during harvesting in order to minimize damage to natural growth and wildlife. Similarly the area under planted canes (nearly 20 ha has been planted with canes) will gradually be reduced through harvesting followed by planting of local herbs and shrubs. The present practice of under-planting of canes by clear-felling ground vegetation in forested areas will be discontinued. Enrichment plantations of fruit bearing species for wildlife including wide crown fruit species and palatable grasses will be taken up in those forest areas where adequate regenerative rootstock may not exist. A list of framework species (defined as native species that grow rapidly, shade out weeds and attract seed-dispersing wildlife) suitable for plantations is given in Volume 2.

4.3.2 Habitat Management Sub-zone

This sub-zone is constituted to manage/manipulate the habitat for wildlife management and conserve forests and other critical habitats. Habitat management sub-zone, as a part of the core zone, will comprise approximately 14% of the total notified area of the Park and nearly 22% of the proposed Park extension. Main management objective in this sub-zone will be to improve forest habitat for key wildlife species through selective management interventions while preserving and increasing the diversity and interspersion of habitat. For example, appropriate subsidiary silvicultural operations required for improving habitat for wildlife will be carried out. Habitat improvement works including rehabilitation of degraded forest areas, enrichment planting of fruit bearing shrubs and trees and palatable grasses, thinning of plantations, maintenance of glades and waterholes, replacement of exotics by gradual canopy opening, eradication of weeds from glades and wetlands, soil and water conservation, watershed development, etc. will be taken up. Gradual opening of top canopy in exotic plantations will be taken up mainly to replace exotic species and encourage natural regeneration to come up and get established. Enrichment plantations will be taken in those areas where natural regeneration is not coming up due to lack of rootstock. Main factors responsible for habitat degradation will be identified by holding stakeholders' consultations. Protection against the identified causal factors including illicit felling, forest fires and grazing, encroachment and poaching will be given by involving all the stakeholders. The collection of NTFPs from this zone will be regulated in consultation with stakeholders. Salvage of dead, dying and diseased trees will be done after leaving some dead trees suitable for wildlife nesting, etc.

The Habitat Management Sub-zone within the Park will comprise the following two main areas. A 57 ha block of mature plantations of *moluccana*, *eucalyptus* and *acacia* (with under-planting of some cane and bamboo) bordered to the north with the Ecosystem Sub-zone and located at the far southern end of the Park. This area will be gradually brought under management by selectively (say in groups or strips) removing top canopy of exotic species in order to encourage natural regeneration of indigenous species.

But there will not be clear felling of the area as it will seriously disturb the forest ecosystem. Minimum damage should be done to natural growth and ecosystem during harvesting by adopting low impact felling techniques. The present practice of under-planting canes by clear-felling ground vegetation in forested areas will be discontinued. Enrichment plantations of native fruit bearing tree species and palatable grasses will be taken up in those areas where natural regeneration is not coming up due to lack of sufficient rootstock. Habitat Suitability Model developed for hoolock gibbons (Volume 2) will be used both to provide a guide to species selection for replanting and to evaluate the success of habitat establishment. This area may be brought under Ecosystem Sub-zone once natural regeneration is established after converting all exotic plantations either through assisted natural regeneration or enrichment plantations.

Another area of 98 ha of long rotation plantations, located along the eastern edge of the Ecosystem Management Sub-zone and Village Use Sub-zone, and bordered to the east by Sustainable Use Sub-zone will be part of Habitat Management Sub-zone. This area will also be gradually converted to mixed forests by encouraging natural regeneration through selective felling (of exotic species) done for opening canopy and enrichment plantations of indigenous species and palatable grasses. An area of 62 ha of long rotation plantations, which was logged in 1999, will be planted with indigenous species to form as a part of Habitat Management Sub-zone in the proposed Park extension. Over a period this area will also be included under Ecosystem Management Sub-zone after its return to natural forest cover and structure.

4.3.2.1 Habitat Improvement Works

Different habitat improvement activities to be carried out in this sub-zone are further explained as below.

4.3.2.1.1. Canopy Opening in Monoculture

This operation will be done mainly in Habitat Management Sub-zone but also on a limited scale in the patches of Ecosystem Sub-zone where monoculture of exotics occur. There are patches of pure teak and maloccana plantations along with mixed plantations of other species such as eucalyptus and acacia. These plantations are not favoured by wildlife as it inhibits bushy undergrowth and middle storey to provide food and shelter for wild animals. Suitable areas of monoculture will be identified for gradual (say 20 ha each year) canopy opening in teak and other exotic plantations based on the following guidelines:

- **i)** Dense teak and exotic plantations will be taken up for marking the trees, whose removal will open the canopy for natural regeneration to come up.
- **ii)** Canopy opening will be done in small but irregular plots of say 2-4 ha, staggered to minimize disturbance to wildlife and its habitat. Mosaic pattern of opening provides better ground light penetration for getting good natural regeneration.
- **iii)** No canopy opening will be undertaken near water bodies including *cheras* in order to avoid erosion.
- **iv)** At least 150-200 trees will be retained along with all the natural regeneration and advance growth.
- **v)** Marking of trees will be done after monsoon rains are over and felling operations completed by February.
- **vi)** Teak and eucalyptus (being strong coppicers) stumps will be battered after felling in order to discourage coppicing. Any upcoming coppices of exotics will be removed subsequently.
- **vii)** The first year after the felling will be devoted for obtaining natural regeneration. Suitable gaps will be identified for raising enrichment plantations (see below) of indigenous fruit bearing shrubs and trees, and palatable grasses during the second year.

4.3.2.1.2. Enrichment Plantations

Enrichment plantations will be taken up in degraded areas of the core zone. Additionally enrichment plantations will be done after canopy is opened in monoculture of exotics. Planting (spacing 2.5m x 2.5m) of indigenous shrub and tree species including wide crown species may be taken up in alternate rows whereas fruit tree species (not more than 10% of total stock) may be planted sporadically. Maintenance operations including weeding and casuality replacement will be taken up in subsequent years. The plantations will be protected against fire and grazing at least for three years. Some suitable species for plantations include siris, sisoo, simul, chikrasi, jarul, chalta, amla, bahera, ficus species, jackfruit, bamboo. Palatable grasses for fodder plantations will include *Typha angustifolia, Alpimia nigra, Themeda arundinacea, Saccharum arundinaceum, Sacharum longisetosum, Sacharum narenga, Sacharum hookeri, Phragmites karka, Arundo donax, Impreta cylinder, Sacharum spontaneum, Cymbopogan flexuosus* and

Setaria palmafolia. Planting of wide crown trees such as chapalish and artocarpus will particularly be suitable for arboreal fauna including hoolock. A plantation journal will be maintained for each of the enrichment plantation. Nurseries will be raised well in advance. Maintenance operations including weeding and cleaning will be taken for three years after raising enrichment plantations. Beating up operations will be taken only during the first year. Plantations of species attractive to butterflies, bees and other pollinator insects will be included in the planting species mix. No PBSAs will be signed inside core zone. However, if any agreement is to be signed for protection, the same will be entered with a co-management committee.

4.3.2.1.3. Canopy Manipulation for Congenial Wildlife Habitat

Removal of congestion is required for easy movement of wildlife. So canopy of plantations will be manipulated properly to create congenial habitat for wildlife. Two canopy manipulations say at 5th and 10th year of plantations can be taken up.

4.3.2.1.4. Development of Grasslands

Existing grasslands will be maintained. Grasslands will be further developed by taking up grass plantations along with other tree species as a part of enrichment plantations. Plantations of palatable grasses will be taken up in blank patches. They will be protected against grazing and forest fires by involving all stakeholders. Suitable grass species for planting include *Typha angustifolia, Alpimia nigra, Themeda arundinacea, Saccharum arundinaceum, Sacharum longisetosum, Sacharum narenga, Sacharum hookeri, Phragmites karka, Arundo donax, Impreta cylinder, Sacharum spontaneum, Cymbopogan flexuosus* and *Setaria palmafolia*.

4.3.2.1.5. Maintenance of Waterbodies

This operation is applicable to the entire core zone. A number of natural waterbodies are present in the Park and they will be maintained for use of wildlife and also local people. An inventory of existing waterbodies and a list of wildlife using different waterbodies will be developed. Desiltation, cleaning and repairing may be necessary in those waterbodies where soil erosion has taken place. Biomass removed during cleaning may be handed over to local people. Stakeholders' participation may be ensured in maintenance of waterbodies by developing fisheries on sharing basis. Plantation of shrubs and vegetables may be taken up around waterbodies by involving local stakeholders. Unauthorized fishing, hunting, cattle grazing and contamination of water should be checked by involving local people as a part of co-management activities.

4.3.2.1.6. Maintenance of Special Habitats

Areas rich in NTFPs including medicinal plants, orchids and other threatened species will be given special attention. Breeding sites of any animal and any other site (e.g. burrow) harboured by nocturnal animal will be protected and maintained.

Over-storey trees with twisted boles, furrowed bark or natural cavities will be retained (say 3-5 nos./ha) to provide shelter to snakes, etc. Snags (hollow, dry, partially/fully dead standing trees, at least 1.5m in height and with a minimum of 20cm diameter at breast height) will be retained (say 3-5 nos./ha) for use by birds, small mammals and other life forms such as bacteria and fungi. Fruit and NTFPs bearing trees will also be retained.

4.3.2.2 Habitat Restoration Works

Degraded habitats within the habitat management zone will be restored naturally by carrying out low capital but labour intensive land-based restoration activities in identified micro-watersheds.

4.3.2.2.1. Watershed Management

Micro-watersheds will be identified for carrying out habitat management practices within the natural boundaries of a drainage area by developing biophysical and human resources for the socio-economic welfare of local people. The micro-watershed will provide a context for a gainful participation of local people by taking on board the diversity of forests and human resources. Appropriate land husbandary practices in such watersheds will focus on *in-situ* moisture conservation based on the percolation of water under-ground. This will enable the natural regeneration of indigenous vegetation, soil conservation and enhancement of moisture regime. Low input land husbandary technologies (e.g. half moon trenches, contour furrows, staggered trenches, mulhing, hedgerows, small check dams, impounding pits, small tanks,

soil barriers and traps, diversions ditches, etc.) which can be implemented by local stakeholders will be more sustainable when compared to large water harvesting structures and engineering works requiring high capital inputs.

4.3.2.2.2. Eco-restoration

Good rainfall, incident radiation and soil are some of the favourable factors that are present in the Park forests for natural regeneration. Therefore, natural regeneration comes up rather well in the forests but do not get established due mainly to biotic pressure. The protection against biotic factors will be taken up before low-input oriented land husbandry practices can be implemented for facilitating eco-restoration process, necessary for the rehabilitation of forests and local people. Degraded forests with recoverable rootstock will be restored through community protection by establishing suitable mechanisms under the proposed co-management approach. Degraded forests with inadequate rootstock shall be taken for assisted natural regeneration for recovering remaining rootstock and enrichment planting.

Natural regeneration and succession in this zone will be encouraged by carrying out eco-restoration activities in identified micro-watersheds. Soil and water conservation measures including stabilization of land slips and control of erosion of stream/chera banks will be taken up in identified areas. This will allow the existing rootstock to be recovered by enlisting active participation of local stakeholders in the protection of forests and implementation of low-input forests management and land husbandry practices. Over the period the woody vegetation cover will extend and gradually thin out the primary succession vegetation such as weeds and grasses. Given protection against illicit felling and burning, the plant succession will progress over a period towards semi-evergreen forests. The enrichment plantations of indigenous shrub and tree species (e.g. chapalish, chikrassi, toon, karoi, garjan, dhakijam, pynkado, gamar, albizzia, kadam, etc.) can be taken up in the identified degraded and barren areas that do not have rootstock.

4.3.3 Village Use Sub-zone

The habitations and cultivation (with respect to Lawachara and Magurchara Forest Villages) that are included within the notified Park area are included in this Sub-zone. Such areas existing at the time of notification will be delineated with permanent markers. Similarly the existing inhabitants will be registered and further in-migration will be discouraged. As important stakeholders, the villagers from the villages will be engaged in co-management activities with formal co-management agreements signed with FD.

4.3.4 Sustainable Use Sub-zone

Approximately 26% (319 ha) of the notified Park area is designated as sustainable use sub-zone. This sub-zone comprises forests/plantations within the Park, which can be used by local people on a sustainable use basis. The first category of such forest areas are natural forest areas surrounding Lawachara and Magurchara Forest Villages, where the local ethnic communities grow betel leaf vines but the forests still retain their biodiversity value. The second category of areas under this sub-zone comprise short-rotation and recent long-rotation plantations, which may be assigned to local communities (e.g. living in Dolubari village) for meeting their bonafide consumption needs for fuelwood, timber, NTFPs and other products.

Forest Villagers of Lawachara and Magurchara have been allowed by FD to practice vetel leaf vine cultivation on the natural forests assigned (1.2 ha for each family) to them for the purpose *in lieu* of their regular labour supply for forestry works. Over a period these villagers have modified the structure of natural forests to suit vetel leaf cultivation by removal of lower tree limbs to provide additional trunk substrate for betel vines and by removal of under-storey.

This type of traditional forest use, continued since these Forest Villages were set up, will be allowed to continue but will be formalized by signing co-management agreements with clear roles and responsibilities. Their assigned areas will be delineated (40 households x 1.2 per household = 48 ha) and excess forest area (available RIMS land use mapping suggests that the area currently used around Magurchara village is 108 ha) be merged with the Habitat Management sub-zone in such a way that the assigned area be contiguous to village site and the remaining area merged. It may be possible to shift some betel cultivation eastward into short rotation plantations (currently zoned as sustainable sub-zone). Betel leaf cultivation around Lawachara forest village occurs in an outlying section of the Park, within a large block of forest/plantations under BFRI control. The villagers will be responsible for the protection of the Park and also be encouraged to conserve biodiversity and raise medicinal and other NTFP bearing plants.

Short and long rotation plantations including those raised under FSP (as buffer zone plantations) will be brought under the proposed benefit sharing agreements. The participants will, in addition to the protection of plantations, be responsible for providing biodiversity protection to the PA's core zone. These plantations will not be clear-felled but instead be managed under selection felling (mainly of exotic species) so that the area can be naturally regenerated to be ultimately as a mixed forest over a period of time. In such a case the existing participants will be well compensated through off-PA alternative income generation activities to be carried out for sustainable livelihoods. Accordingly to RIMS measurements of plantation area included in Sustainable Use Sub-zone (189 ha) and estimates of area requirements under benefit sharing agreement (72 ha at Bhagmara village and 75 ha at Dolubari village), nearly 42 ha forest area may be included to habitat management zone.

4.3.5 Intensive Use Sub-zone

Intensive Use Sub-zone incorporates the relatively small areas required for administrative buildings and staff quarters, visitor accommodations and other facilities. Administrative buildings (Park Hqs, Lawachara Beat Office, BFRI facilities, etc.), Park staff quarters, visitor facilities (Samoli Rest House and an Environmental Education Centre) and other infrastructure facilities are included in this zone. Future facility development will be based on environmentally friendly guidelines and green management principles as presented in Volume 2 of the Plan. Adverse environmental impacts of infrastructure development will be minimized by carrying out Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) before taking up design, construction and operation building works (see Volume for the guidelines on IEE and EIA). Green management will ensure that designs, materials and construction works are compatible with the natural background; that water, air and solid waste pollution is checked; and that other adverse environmental impacts are avoided or minimized during construction and operation.

The following four Intensive Use Sub-zones have been identified in Lawachara NP:

1. This intensive zone incorporates the existing Lawachara Beat Office facilities, Samoli Forest Rest House and BFRI infrastructure (staff accommodation and nurseries). Park Headquarters, comprising of a Park Office, Park staff quarters, and an Environmental Education Centre will be developed in this zone.

2. A forest rest stop/picnic area will be developed nearly 800 m beyond the south-western Park entrance, consisting of two covered picnic shelters and washrooms. This area incorporates existing FD nursery facilities and staff accommodation.

3. Bhagmara Guard Camp, located along the highway near the eastern boundary of the Park, and consisting of staff accommodation.

4. Chautali Beat Office complex, assuming that as proposed the remainder of Chautali Beat is added to the Park area.

Detailed guidelines for facilities development are discussed in the next Chapter.

4.4 Interface Landscape Zone

Interface landscape zone will focus on the surrounding landscape helpful in protecting and conserving the core zone and creating congenial habitat for wildlife including protecting and maintaining wildlife corridors. As opportunities for receiving tangible benefits from the conservation-oriented management of the core zone are very less, off-core zone livelihood opportunities (see Chapter 5) will be provided to the local stakeholders in the surrounding landscape. Subsistence consumption needs of local people for fuelwood, NTFPs and timber will be met by entering into co-management agreements. Though interface landscape zone will have comparatively less conservation value, they will play an important role in supporting the biodiversity conservation in the core zone. Interface landscape zone is further categorized into three specific sub-zones (support sub-zone, transportation corridors sub-zone and tea estate sub-zone) depending upon the uses to which different areas are used and managed. Interface landscape zone supports the protection of biodiversity in the core zone and so can also be termed as support zone or buffer zone.

However, the word buffer has a negative connotation of buffering something good by something bad and so has not been used in this Plan.

4.4.1 Buffer Reserve Sub-zone

The present residents of the villages (situated within and on the periphery of the Park: Dolubari, Magurchara and Lawachara) will continue to use forests and plantation resources sustainably within the Park area as per the co-management agreements to be signed with FD. The present subsistence harvest of wood (say from strip plantations) and NTFPs (grazing, fodder, bamboo, canes, etc.) by non-residents is expected to continue, particularly in peripheral areas. However, consumptive use by non-residents will be gradually shifted, to the extent possible, to support zones on FD lands outside of but adjacent to the Park boundary. Three such support zones have been identified.

The first of three identified support zones consists of 67 ha of short rotation plantations (of acacia and eucalyptus) adjacent to the western edge of the proposed northward extension of the Park in Chautali Beat. These plantations will be brought under co-management agreements in order to alleviate harvest pressures from adjacent settled areas as evident by heavy, commercial harvest of fuelwood and bamboos from long-rotation plantations throughout Chautali Beat. Co-management in this Sub-zone will focus on providing a reliable and legitimate source of wood and non-wood products for local poor resident to the north and west of the Park by managing these plantations based on selection felling.

The second support sub-zone consists of 19.5 ha of FD lands (with scrub, sungrass, short rotation plantations and paddy fields), bordering the eastern edge of the Park, and ceded to the NGO HEED under a long-term agreement. This area may be brought under plantations of suitable tree species to be raised under FSP after signing PCBSAs (Participatory Conservation and Benefit Sharing Agreements) in order to alleviate use pressures coming from the settled area between the Park boundary and Kamalganj to the east.

The third support sub-zone will comprise all the remaining areas of the RF where buffer plantations will be taken up by following FSP guidelines. But the TFF will be managed by co-management committee. It is recommended that all the 3 Beats (Lawachara, Kalachara and Lawachara) covering entire West Bhanugach RF will be managed under one Range with Park Headquarters in Kamal Ganj Upojila (near HEED Office on the eastern park boundary).

4.4.2 Transportation Corridors Sub-zone

The following three linear corridors, traversing the Park in a generally east-west direction, are part of interface landscape zone as transportation corridors:

- ➔ A rail line (bed width 4 m, total cleared RoW averaging 10 m) constructed and managed by Bangladesh Railways;
- ➔ A power transmission line (total cleared RoW averaging 10 m); and
- ➔ An asphalt-surfaced highway (surfaced width 3.5 m, total cleared RoW averaging 10 m) constructed and maintained by the Roads and Highways Department.

Although the RoWs are not under the direct Park management authority, the management will take proper initiatives in developing the necessary communication channels and agreements with the operators of these facilities in order to get their cooperation in preventing and limiting noise and chemical pollution and by minimizing the width of vegetation clearing during RoW maintenance. For example, the Roads and Highways Department will not only provide to FD staff free access to Park but also help regulate traffic in order to avoid damage to wildlife and vegetation.

The current grazing by cattle, particularly between Magurchara village and eastern boundary of the Park, will be allowed but monitored to check any habitat damage. The livestock grazing will not be permitted along the railway lines and transmission lines, except that environmentally sound harvesting of fodder on cut and carry basis will be permitted within the existing RoWs.

The management, harvesting and replanting of strip plantations along the rail line RoW will continue near to sustainable use and village use sub-zones in coordination with Park management authorities. However, only selective felling of existing strip plantations will be permitted near ecosystem and habitat management sub-zones in consultation with local stakeholders.

An expansion of transportation and power transmission facilities is not foreseen in near future. In case of any such proposal arising in long-term, it will be subject to a rigorous environmental assessment taking

due regard of the conservation management programmes included in this Plan and the intent and purpose of a PA under relevant legislation.

4.4.3 Tea Estate Sub-zone

The labourers and their families residing the Tea Estate lands in proximity to the Park use sungrass, bamboo, fuelwood, small timber and fodder from the unused Tea Estate lands (situated mainly to the south, west and north of the Park). The availability of these forest products from Tea Estate lands is gradually reducing in view of the government policy (which requires that more than 50% of leased estate lands be planted under tea) and the Estate management programs (which emphasize planting cash crops such as rubber and pineapples on unused lands), which result in reduction of area under secondary vegetation and consequent biotic pressure on neighbouring forests. This biotic pressure will be reduced by encouraging the growth of vegetation (through assisted natural regeneration and enrichment planting techniques) and for meeting the needs of local people living on Tea Estates, and also of wildlife. The establishment of cash crops such as pineapple and rubber plantations will be discouraged in favour of tree and horticultural crops. This will require a regular dialogue with Tea Estate management during the implementation period of the Plan in order to coordinate sound land-use management along the Park/Tea Estate boundaries (including enrichment plantations to be taken up by FD staff based on co-management agreements to be signed with local labourers).

4.5 Zonal Boundaries and Management Objectives

Main management objectives under each zone (Figure 10) are summarized in Table 4.1 as below:

Table 4.1 Management Zoning for Lawachara National Park

Management Zone	Main Management Objective	Area
CORE ZONE		
Ecosystem Management Sub-zone	➢ long-term protection and rehabilitation of forest cover (long-rotation plantations >25 years old)	699.9 ha (+218.2 ha in proposed extension)
Habitat Management Sub-zone	➢ restoration and manipulation of habitat for selected wildlife species, incorporating selected areas of short-rotation plantation, and recently felled long-rotation plantation	165.4 ha (+61.8 ha in proposed extension)
Village Use Sub-zone	➢ housing, agricultural fields (primarily paddy) and homestead woodlots associated with Magurchara and Lawachara Forest Villages	18.5 ha
Sustainable Use Sub-zone	➢ sustainable use of plantations, primarily at the periphery of the existing Park and its proposed extension, and of natural forest managed for betel leaf cultivation	318.6 ha
Intensive Use Sub-zone	➢ site management around administrative buildings and built visitor facilities	4 ha (+1 ha in proposed extension)
INTERFACE LANDSCAPE ZONE		
Transportation Corridor Sub-zone	➢ right-of-way management along the Srimongal-Kamalgonj highway and railroad within the Park, and the largely parallel power transmission line	14.8 ha (5.4 ha of highway, 4.0 ha of railroad, 5.4 ha of power line RoW)
Support Sub-zone	➢ sustainable use of plantations and natural vegetation on FD lands adjacent to the Park, where such use can reduce pressure on the Park's resources ➢ 16 villages where livelihood programs will be implemented by using LDF	86.6 ha (+ area surrounding 16 villages)
Tea Estate Lands Sub-zone	➢ sustainable use of forest and secondary vegetation on Tea Estate lands bordering the Park	to be determined

Boundaries of intensive use sub-zone and transportation corridor sub-zone will be identified by permanent physical features such as streams, roads, rail lines, hillocks, settlements/villages, etc. But the boundaries of ecosystem management sub-zone, habitat management sub-zone, sustainable use subzone and village use

sub-zone will be marked with posts having legible inscriptions in Bangla for easy differentiation. One corner of each use area will be marked by a concrete signboard indicating the management regime and the identification of user group responsible for co-management of the forest area. The Park staff will explain the system to local stakeholders for their wide acceptance and publicity.

The boundaries of agricultural encroachment at Bhagmara village and of betel cultivation areas at Lawachara and Magurchara villages of Lawachara NP will be surveyed and marked using posts.

4.6 Summary of Main Prescriptions

Main prescriptions outlined under the above-developed management programs in Core and Landscape Zones are summarized in Tables 4.2 and 4.3 with respect to timing of each proposed activity and responsibility assigned.

4.6.1 Summary of Main Prescriptions in Core Zones

Main prescriptions outlined under the above-developed management programs in Core Zone are summarized in Table 4.2 with respect to timing of each proposed activity and responsibility assigned.

Table 4.2 Summary of Main Prescriptions in Core Zone

Year	Zones	Main Activities	Main Outputs/ Success Criteria	Responsibility
1	Ecosystem Management Sub-zone	➢ Protecting forests and other biodiversity against biotic interference (illicit removals, poaching, land encroachment, forest grazing, fires, etc.)	Reduced level of biotic interference including illicit felling	Stakeholders/ FD/NSP
		➢ Carrying out subsidiary silvicultural operations required for encouraging natural regeneration (including gradual canopy opening in exotic monoculture and enrichment planting in identified gaps without rootstock)	Natural regeneration established	FD
	Habitat Management Sub-zone	➢ Carrying out silvicultural operations for improving habitat for wildlife	Enhanced wildlife	FD
		➢ Carrying out subsidiary silvicultural operations required for encouraging natural regeneration (including gradual canopy opening in exotic monoculture and enrichment planting in identified gaps without existing rootstock)	Natural regeneration established	FD
		➢ Implementing habitat improvement works (canopy manipulation, grassland development, special habitats maintainance, waterbodies maintainance, etc.)	Improved habitat	FD
		➢ Implementing habitat restoration works (identification f micro-watersheds, watershed management, eco-restoration activities including soil/water conservation and other low input land husbandry practices)	Rehabilitated habitat	FD
	Sustainable Use Sub-zone	➢ Delineating the forest land assigned to Forest Villagers of Lawachara and Magurchara for raising betel leaves	Forest use areas delineated on ground and maps	FD/Forest Villagers
		➢ Involving Forest Villagers in forest protection, and in income generation activities by using LDF	Forests regenerated & Villagers' income enhanced	FD/Forest Villagers/NSP

		➢ Motivating Forest Villagers to adopt biodiversity friendly betel leaves growing practices	Cleaning of forest floor stopped	FD/Forest Villagers/NSP
	Village Use Sub-zone	➢ Signing benefit sharing agreements with the villagers of peripheral villages such as Dolubari and Bhagmara for protecting nearby plantations and associating them in LDF funded activities	Income of villagers enhanced and forests protected	FD/Forest Villagers/NSP
	Intensive Use Sub-zone	➢ Delineating the habitation land assigned to Forest Villagers of Lawachara and Magurchara at the time of notification	Habitations delineated on ground and maps	FD/Forest Villagers
		➢ Existing FD buildings maintained by following environmental friendly guidelines	FD buildings maintained	FD
2	Ecosystem Management Sub-zone	➢ Protecting forests and other biodiversity against biotic interference (illicit removals, poaching, land encroachment, forest grazing, fires, etc.)	Reduced level of biotic interference including illicit felling	Stakeholders/ FD/NSP
	Habitat Management Sub-zone	➢ Carrying out subsidiary silvicultural operations required for encouraging natural regeneration (including gradual canopy opening in exotic monoculture and enrichment planting in identified gaps without rootstock)	Natural regeneration established	FD
		➢ Carrying out silvicultural operations for improving habitat for wildlife	Enhanced wildlife	FD
		➢ Carrying out subsidiary silvicultural operations required for encouraging natural regeneration (including gradual canopy opening in exotic monoculture and enrichment planting in identified gaps without existing rootstock)	Natural regeneration established	FD
		➢ Implementing habitat improvement works (canopy manipulation, grassland development, special habitats maintainance, waterbodies maintainance, etc.)	Improved habitat	FD
		➢ Implementing habitat restoration works (identification f micro-watersheds, watershed management, eco-restoration activities including soil/water conservation and other low input land husbandry practices)	Rehabilitated habitat	FD
	Sustainable Use Sub-zone	➢ Forest Villagers continue to involved in forest protection, and in income generation activities by using LDF	Forest Villagers' income enhanced	FD/Forest Villagers
		➢ Encourage Forest Villagers to adopt biodiversity friendly betel leaves growing practices	Cleaning of forest floor stopped	FD/Forest Villagers
	Village Use Sub-zone	➢ With the villagers of peripheral villages such as Dolubari and Bhagmara continue protecting nearby plantations and core areas by associating them in LDF funded activities	Income of villagers enhanced and plantations and core protected	FD/Forest Villagers/NSP

	Intensive Use Sub-zone	➢ No new habitations by Forest Villagers of Lawachara and Magurchara are allowed	New habitations stopped	FD/Forest Villagers/NSP
		➢ Proposed FD buildings are developed by following environmental friendly guidelines	Buildings are constructed	FD
3	Ecosystem Management Sub-zone	➢ Protecting forests and other biodiversity against biotic interference (illicit removals, poaching, land encroachment, forest grazing, fires, etc.)	Reduced level of biotic interference including illicit felling	Stakeholders/ FD/NSP
	Habitat Management Sub-zone	➢ Carrying out subsidiary silvicultural operations required for encouraging natural regeneration (including gradual canopy opening in exotic monoculture and enrichment planting in identified gaps without rootstock)	Natural regeneration established	FD
		➢ Carrying out silvicultural operations for improving habitat for wildlife	Enhanced wildlife	FD
		➢ Carrying out subsidiary silvicultural operations required for encouraging natural regeneration (including gradual canopy opening in exotic monoculture and enrichment planting in identified gaps without existing rootstock)	Natural regeneration established	FD
		➢ Implementing habitat improvement works (canopy manipulation, grassland development, special habitats maintainance, waterbodies maintainance, etc.)	Improved habitat	FD
	Sustainable Use Sub-zone	➢ Implementing habitat restoration works (identification f micro-watersheds, watershed management, eco-restoration activities including soil/water conservation and other low input land husbandry practices)	Rehabilitated habitat	FD
		➢ Continue involving Forest Villagers in forest protection, and in income generation activities by using LDF	Forest Villagers' income enhanced	FD/Forest Villagers
		➢ Continue motivating Forest Villagers to adopt biodiversity friendly betel leaves growing practices	Cleaning of forest floor stopped	FD/Forest Villagers/NSP
	Village Use Sub-zone	➢ Villagers of peripheral villages such as Dolubari and Bhagmara continue protecting nearby plantations	Plantations protected	FD/Villagers /NSP
	Intensive Use Sub-zone	➢ Keeping a vigil that the Forest Villagers of Lawachara and Magurchara do not add more habitations	Convinced Forest Villagers	FD/NSP/ Forest Villagers
		➢ FD buildings are maintained by following environmental friendly guidelines	Better maintained FD buildings	FD
4	Ecosystem Management Sub-zone	➢ Protecting forests and other biodiversity against biotic interference (illicit removals, poaching, land encroachment, forest grazing, fires, etc.)	Reduced level of biotic interference including illicit felling	Stakeholders/ FD/NSP

	Habitat Management Sub-zone	➢ Carrying out subsidiary silvicultural operations required for encouraging natural regeneration (including gradual canopy opening in exotic monoculture and enrichment planting in identified gaps without rootstock)	Natural regeneration established	FD
		➢ Carrying out silvicultural operations for improving habitat for wildlife	Enhanced wildlife	FD
		➢ Carrying out subsidiary silvicultural operations required for encouraging natural regeneration (including gradual canopy opening in exotic monoculture and enrichment planting in identified gaps without existing rootstock)	Natural regeneration established	FD
		➢ Implementing habitat improvement works (canopy manipulation, grassland development, special habitats maintainance, waterbodies maintainance, etc.)	Improved habitat	FD
	Sustainable Use Sub-zone	➢ Implementing habitat restoration works (identification f micro-watersheds, watershed management, eco-restoration activities including soil/water conservation and other low input land husbandry practices)	Rehabilitated habitat	FD
		➢ Continue involving Forest Villagers in forest protection, and in income generation activities by using LDF	Forest Villagers' income enhanced	FD/Forest Villagers
	Village Use Sub-zone	➢ Continue motivating Forest Villagers to adopt biodiversity friendly betel leaves growing practices	Cleaning of forest floor stopped	FD/Forest Villagers/NSP
		➢ Villagers of peripheral villages such as Dolubari and Bhagmara continue protecting nearby plantations	Plantations protected	FD/Villagers /NSP
	Intensive Use Sub-zone	➢ Keeping a vigil that the Forest Villagers of Lawachara and Magurchara do not add more habitations	Convinced Forest Villagers	FD/NSP/ Forest Villagers
		➢ FD buildings are maintained by following environmental friendly guidelines	Better maintained FD buildings	FD
5	Ecosystem Management Sub-zone	➢ Protecting forests and other biodiversity against biotic interference (illicit removals, poaching, land encroachment, forest grazing, fires, etc.)	Reduced level of biotic interference including illicit felling	Stakeholders/ FD/NSP
		➢ Carrying out subsidiary silvicultural operations required for encouraging natural regeneration (including gradual canopy opening in exotic monoculture and enrichment planting in identified gaps without rootstock)	Natural regeneration established	FD
		➢ Carrying out silvicultural operations for	Enhanced wildlife	FD

	Habitat Management Sub-zone	improving habitat for wildlife ➢ Carrying out subsidiary silvicultural operations required for encouraging natural regeneration (including gradual canopy opening in exotic monoculture and enrichment planting in identified gaps without existing rootstock)	Natural regeneration established	FD
		➢ Implementing habitat improvement works (canopy manipulation, grassland development, special habitats maintainance, waterbodies maintainance, etc.)	Improved habitat	FD
	Sustainable Use Sub-zone	➢ Implementing habitat restoration works (identification f micro-watersheds, watershed management, eco-restoration activities including soil/water conservation and other low input land husbandry practices)	Rehabilitated habitat	FD
		➢ Continue involving Forest Villagers in forest protection, and in income generation activities by using LDF	Forest Villagers' income enhanced	FD/Forest Villagers
		➢ Continue motivating Forest Villagers to adopt biodiversity friendly betel leaves growing practices	Cleaning of forest floor stopped	FD/Forest Villagers/NSP
	Village Use Sub-zone	➢ Villagers of peripheral villages such as Dolubari and Bhagmara continue protecting nearby plantations	Plantations protected	FD/Villagers /NSP
	Intensive Use Sub-zone	➢ Keeping a vigil that the Forest Villagers of Lawachara and Magurchara do not add more habitations	Convinced Forest Villagers	FD/NSP/ Forest Villagers
		➢ FD buildings are maintained by following environmental friendly guidelines	Better maintained FD buildings	FD

4.6.2 Summary of Main Prescriptions in Landscape Zone

Main prescriptions outlined under the above-developed management programs in Landscape Zones are summarized in Table 4.3 with respect to timing of each proposed activity and responsibility assigned.

Table 4.3 Summary of Main Prescriptions in Landscape Zone

Year	Zones	Main Activities	Main Outputs/ Success Criteria	Responsibility
1	Support Sub-zones	➢ Short rotation plantations in Chautali Beat brought under co-management	Agreements signed	FD/ Stakeholders
		➢ 16 identified villages are grouped for LDF activities in lieu of their forest protection efforts	Groups formed	FD/NSP/ Stakeholders
		➢ Vacant FD lands brought under woodlots under FSP	Woodlots established & Protected	FD/FSP
	Transport Corridors Sub-zones	➢ Establishing communication channels with the land owning agencies (LGED, Railways)	Land Owning Agencies	FD/Land Owning Agencies

	Tea Estate Sub-zones	➢ Planting strip plantations along roads and railway lines ➢ Establishing contacts with Tea Employers Association, Chittagong and the Management Authorities of 6 identified Tea Estates ➢ Encouraging the Management Authorities of Tea Estates to bring vacant land under plantations for the benefits of local people and also wildlife ➢ Motivate Tea Estate workers and if possible involve them in income generation activities	contacted Survey completed and Nurseries developed Instructions issued by the Association to Tea Estate management Area under plantations enhanced Groups of workers formed	FD/FSP FD/NSP Tea Estates/ FD/NSP Tea Estates/ FD/NSP
2	Support Sub-zones Transport Corridors Sub-zones Tea Estate Sub-zones	➢ Short rotation plantations in Chautali Beat protected under co-management ➢ Remaining vacant FD lands brought under woodlots under FSP ➢ Villagers from the 16 identified villages start LDF funded activities in lieu of their forest protection efforts ➢ Maintaining communication channels with the land owning agencies (LGED, Railways) ➢ Planting and managing strip plantations along roads and railway lines ➢ Maintaining regular contacts with Tea Employers Association, Chittagong and the Management Authorities of 6 identified Tea Estates ➢ Pursue the Management Authorities of Tea Estates to bring vacant land under plantations for the benefits of local people and also wildlife ➢ Involve Tea Estate workers in income generation activities	Plantations protected Woodlots established Income of the villagers enhanced Regular contacts established Strip plantations protected Better coordination established between FD and Tea Estate Management Vacant land brought under plantations Groups of workers formed and motivated	FD/ Stakeholders FD/FSP NSP/FD/ Stakeholders FD/Land Owning Agencies FD/FSP FD/Tea Estate Management FD/NSP/ Tea Estate Management NSP/FD/Workers/Tea Estate Management
3, 4 and 5	Support Sub-zones Transport	➢ Continue protecting short rotation plantations in Chautali Beat ➢ 16 identified villages continue to be covered under LDF in lieu of their forest protection efforts ➢ Woodlots raised on vacant FD lands continue to be protected ➢ Continuing good communication with the land owning agencies (LGED, Railways)	Plantations protected Villagers' income enhanced and forests protected Protected woodlots Land Owning Agencies	FD/ Stakeholders NSP/FD/ Stakeholders FD/FSP FD/NSP/Land Owning Agencies

	Corridors Sub-zones Tea Estate Sub-zones	➢ Protecting strip plantations along roads and railway lines ➢ Continuing regular contacts with Tea Employers Association, Chittagong and the Management Authorities of 6 identified Tea Estates ➢ Management Authorities of Tea Estates continue to bring vacant land under plantations for the benefits of local people and also wildlife ➢ Tea Estate workers continue to be involved in income generation and protection activities	convinced Strip plantations protected Better coordination established Vacant land planted Groups of workers with enhanced income	FD/FSP FD/NSP/ Tea Estate Management Tea Estate Management NSP/FD/ Workers/Tea Estate Management

5. LIVELIHOODS PROGRAMS FOR LANDSCAPE DEVELOPMENT

5.1 Objectives

As per the Wildlife (Preservation) (Amendment) Act, 1974 no commercial harvesting is allowed inside the Park and so minimum benefits (mainly from NTFPs, which may not be sufficient to motivate local people) will flow from the core areas in absence of any timber harvests. So other relevant mechanisms of benefits flows to local communities need to be explored. Additional benefits need to be mobilized through off-PA activities including alternative income generation activities and self-employment.

Main objective of livelihood programs for landscape development is to develop appropriate linkages with appropriate livelihood programs and other projects/initiatives that will reduce biotic pressure on forests by providing alternative livelihood opportunities to poor stakeholders living both within and outside of the Park. Up-scaling of skills will be taken up for generating value additions through capacity building of local people. Landscape Development Fund (LDF) will be used to provide finance for the members of user groups and co-management committees and their federations will be encouraged to set up micro-enterprises to generate value additions locally. The benefits from eco-tourism may also be ploughed back for the development of local communities and the Park. The program will be focused mainly in the identified interface landscape zones (see Chapter 6 of Part I and Chapter 4 of Part II) but also in the Village Use Zone of the broad Core Zone. Networking with relevant NGOs acting in the area will be established for rendering rural development services to user groups/

5.2 Production Technologies

Appropriate production technologies, which may be implemented as a part of off-PA development interventions were identified based on field investigations done by the partner NGO, RDRS. The following production technologies are proposed by RDRS to be implemented mainly in the interface landscape zone of the Park:

5.2.1 Agricultural and Horticultural Crops

The following production technologies are proposed:

- ➔ Integrated homestead farming
- ➔ Cultivation of high value crops
- ➔ Village tree nursery
- ➔ Food processing and marketing

Integrated Homestead Farming

Many villagers on fringes of the Park (in interface landscape zone) practice subsistence farming (low input and low output) on their homesteads (small yard, backyard ditch, etc.). Inter-dependency among the various components of the production technology package can be designed to maximize output, which can be used for household consumption and surplus being sold for buying non-agricultural daily necessities. This will provide livelihood security and enhance their income by creating livelihood assets and self-employment opportunities. Diversification of production possibilities will help avert production risks and reduce vulnerability of livelihood during natural calamities. Possible components of such an integrated production technology package may include vegetables (on open fields, machans, dykes and other unutilized places around houses), cash crops, horticultural and tree nursery, poultry rearing , cow rearing (local improved breed with crossing for fattening), fish culture (in micro-ponds), duck-cum-fish culture (in family ponds), pigeon farming (six pairs of pigeon reared as scavengers) and apiculture (domesticated wild bees). Complementary off-farm activities may include food processing (threshing, winnowing, drying, grading, husking, etc.) food preservation, and other cottage and small scale value addition activities.

Cultivation of High Value Crops

High value crops have more nutritive value, high price and demand. But this production technology is suitable to those farmers who have cultivable land and can make a minimum investment. Suitable high value crops for the PA include tomato, potato, fine rice, papaya, ginger, turmeric, yard long bean, leafy

vegetables, aroids, chilly, beetle leaf, maize. Guava, banana, jackfruit, pineapple, etc. Some vegetables can now be grown all year round and so fetch more prices during off-season.

Village Nursery

Many private nurseries have grown up in cities and town for meeting the demand for quality seedlings and seeds of horticultural, vegetables and tree species. Village nurseries to be developed by local people having some land will be encouraged to meet the local demand for quality seedlings and seeds. Technical and logistic support will be arranged to prospective farmers. Seedlings to be raised in village nursery will be as per local preferences which may include timber, fruit, vegetable, flower, fuelwood, fodder, medicinal and other NTFPs bearing species. Orchid culture is particularly suitable for Lawachara.

Nursery planning activities will be started at least one year in advance with proper attention on i) collection, processing and storage of seeds, ii) testing, certification and distribution of quality seeds, iii) training and awareness on improved nursery techniques and inputs, iv) seed orchards, v) water source and watering regime, vi) nursery management intensity and technical supervision, vii) culling, root coiling and fibrous root development, viii) standardization of nursery techniques, ix) improved transportation of seedlings from nursery to planting sites.

Food Processing

Simple food processing and preservation techniques will be explained to local people for creating value addition locally and providing self-employment opportunities. For example, pickles of mango, lemon and jackfruit can be made locally for households nutrition and cash sale.

5.2.2 Livestock Rearing

Livestock-poultry sub-sector is an important part of agriculture sector and cattle rearing with focus on milch cow rearing is particularly suitable for poor people residing within and outside the Park. The following livestock rearing technologies are found suitable for their implementation in and around the PA :

- ➔ Beef fattening
- ➔ Milch cow rearing
- ➔ Broiler/Layer rearing

Beef fattening can be achieved within a short period (3-12 months) by using a local improved breed cow with crossing hybrid. Milk provides a balanced diet by meeting the required demands of nutrition. So at least one milch cow of a locally improved bred or crossbred cow with average milk production of liters/day can be targeted for the identified households. The poultry industry has developed near cities and towns for meeting huge demand within a short time as a supplement of animal protein. Females are particularly suitable for carrying out broiler/layer rearing activities carried out in households.

5.2.3 Fisheries

The following production technologies were identified for the fishery sector:

- ➔ Rice fish farming
- ➔ Fingerling rearing
- ➔ Carp polyculture
- ➔ Fish culture

Broadly three main methods of fishery would involve capture fishery, culture fishery and dry fishery activities.

5.3 Non-Timber Forest Products (NTFPs)

Short-term production objectives of NTFPs management will be linked with long-term biodiversity conservation objectives in order to create personal stakes among the members of co-management committees. Although a general perception is that the peoples' share in final harvests for timber (e.g. benefits from final harvests of plantations under FSP) is the main incentive for their participation, poor

communities particularly tribals may value a regular flow of NTFPs more than a distant one-time share from final harvests of trees. The flow of NTFPs from the natural forests of Sylhet will start from the first year of co-management activities; their volume and composition increasing gradually as the Park is provided an effective protection against biotic interference. The importance of NTFPs depends on a number of factors including use value, barter (exchange) value, market demand, accessibility to markets, storage and perishibility.

An important objective of NSP is to create stakes among local stakeholders for biodiversity conservation by ensuring adequate benefits to them from the Park and off-PA based income generation activities. In the forests being managed for biodiversity conservation in the Park, this objective can be achieved by facilitating close linkages with the livelihoods of local stakeholders and NTFPs development. The backward and forward linkages of NTFPs based production technologies is substantial in the Park. However, a long-term NTFPs management policy focusing on the access of co-management committees, liberalization of government restrictions on storage and transport (e.g. transit permit), dissemination of relevant information about marketing is necessary. The development of such a policy will be based on an exhaustive survey of NTFPs (extent, distribution, threatened species, regeneration and enrichment, collection and use-patterns, illicit removals, present and sustainable level of extraction, local needs and community dependence, processing and value addition opportunities, ethnobotany, indigenous knowledge base, local stakeholders, markets and marketing channels, forward and backward linkages, export and trade).

The timing of various agricultural operations and NTFPs management and collection activities are generally complementary. This means that appropriate management practices can be locally adopted in order to provide year-round employment and income to local unemployed villagers, thereby reducing the severity of rural poverty, particularly during the agriculture lean season. For example, the agriculture lean season could best be made use by the members of co-management committees for the collection, harvesting, processing and marketing of NTFPs. In addition to the benefits from NTFPs, forest management interventions such as pruning and cleaning would enhance the flow of intermittent benefits. The NTFPs based activities are more suitable for the rural poor including tribal women and children due to specific characteristics of NTFPs management such as labor-intensive (for instance, the collection and primary processing of bamboo and canes requires substantial labor), simple technologies (many times the collection techniques are inherited and handicrafts made by employing family skills) , easy accessibility and benefits to poor, seasonal collection, supplementary income to forest dwellers and household activities with low volume. However, a number of NTFP yielding trees (e.g. medicinal plants) are distributed dispersely and the collection of some NTFPs is to be completed within a short period. This may hamper an intensive management and collection, particularly in the absence of a designated organization responsible for the collection and marketing of NTFPs.

NTFPs based forest management within the Park is ecologically and economically sustainable provided extraction levels are maintained below the maximum sustainable yield by adopting appropriate silvicultural systems and management practices. Indeed sustainable management of NTFPs demands a sustainable management of forests as mother resource. A sustainable level of harvesting is a pre-requisite for socio-ecological security. This is necessary to meet the needs of the present generation without compromising the ability of future generations to meet their own needs for NTFPs. Enrichment planting of NTFPs bearing shrub and tree species (e.g. bamboo, cane, medicinal plants, etc.) will be taken up in identified gaps within the Park by associating members of co-management committees. Bamboo, canes and many medicinal shrubs and herbs can be planted and managed as an understorey without adversely affecting forests with trees in top canopy. Mature bamboo clumps need to be intensively managed, failing which they may hamper the growth of both natural and artificial regeneration. A regular working of bamboo will allow local people to get intermittent yield and alternative income generation. Depending on site conditions, the first harvest of clumps is available from year 5 to 7 based on usual cutting rules to be followed meticulously. Based on a usual cutting cycle of 3 years the harvested clumps will be ready for subsequent harvests every 3 years until the clump flowers.

A number of cane based industries are located at Sylhet. Canes are harvested manually and permits are issued by the FD staff for the collection of canes from the government forests. Canes are pulled down, trimmed and bundled for transporting for transporting to local collection centers as headloads or through bamboo rafts in waterways. These are subsequently transported to markets through boats and trucks. Royalties are collected at forest check gates as length of collected canes. Sun dried canes are bent by using blowtorch after they are split manually. Can grows well in areas having well drained, deep, moist and

alluvial soil. Ripe fruits are collected, crushed and soaked in water for a week before they are sown in mother beds. Seedlings with 2-3 leaves are pricked out to polybegs after 4-5 months. One year seedlings are planted at a spacing of either 4m x 4m or 5m x 5m. Under planting of canes is particularly suitable in homesteads having multiple stories of vegetation.

A variety of medicinal plants occur naturally in Sylhet due mainly to fertile land resources and favorable climate conditions. Primary collectors collect medicinal plants as per the requirements of local traders who are the main suppliers to big dealers and drug manufacturers. Drug manufacturing processes have been indigenously developed for a number of species such as *Rauwolfia serpentina, Datura fastousa, Allium sativum, Tinospora cordifolia, Occimum gratissimu, Vinca rosea, Berberis aristata,* lemon grass, *Andrographis paniculata, Centella asiatica* and *Cinchona succirubra*. There is a need for developing similar processes for other medicinal plants. Extensive training on the management of medicinal plants will be imparted to FD field staff and NGOs. Members of co-management committees will be encouraged to take up homestead plantations of medicinal species.

Table 5.1 Candidate Management Practices for Non-Timber Forest Products

Sl. No.	Functions	Potential Management Practices
1	Production/Regeneration	Manage the PA's forests for sustainable development of NTFPs. Protect forests by associating local stakeholders. Take enrichment planting of NTFPs yielding species in identified blanks.
2	Collection/Harvesting	Harvest/collect NTFPs sustainably by employing members of beneficiary groups. Use better harvesting tools and equipments. Impart training and skill development to beneficiary groups in improved harvesting/collection techniques.
3	Pre-processing	Train the groups in primary processing activities including storing, sorting, cleaning and drying. Help establish primary collection centres for storage after primary processing. Provide better pre-processing tools and equipments to group members.
4	Self-consumption	Awareness training. Basic storage facilities.
5	Marketing of unprocessed NTFPs	Provide useful information on use patterns, market channels, prices, demand, etc.
6	Storage and Processing	Provide relevant technology, training, finance, quality control, etc.
7	Marketing of processed NTFPs	Conduct a market assessment and develop a marketing strategy. Linkages with centres of production and marketing. Financing for storage, transport and marketing.

The collection, processing and marketing practices for NTFPs to be adopted by user groups need to be such as to enable them earn their subsistence living regularly. Development of NTFPs through user groups can be taken up by using LDF and rural credits. Poor harvesting practices for NTFPs will lead to waste and unsustainable practices. Raw materials (e.g. medicinal plants), which are to be kept after harvesting need to be dried and stored properly in order to prevent any quality deterioration. Some NTFPs including honey, grasses and bamboo can be processed at local level (i.e. user groups). Federations of user groups may establish processing-cum-marketing units (e.g. handicrafts, mats, broom, honey, etc.) locally by pooling their resources. These will not only help in accessing better harvesting tools and equipments but will also help in marketing of processed NTFPs at remunerative prices. The FD may not NTFPs into auctions and leases. Instead, the responsibility for primary collection, storage, processing and marketing can be given to user groups and co-management committees. This will help in biodiversity conservation through consumers of NTFPs becoming their primary producers with livelihood opportunities in terms of NTFPs based products, employment and income generation.

The parameters for ensuring a good quality for different NTFPs are variable. For example, medicinal and aromatic plants graded based on the contents of principles present in the collected NTFPs. Similarly

bamboo and honey are graded according to the size and colour respectively. Moreover, the technologies for grading, processing and storage depend upon market needs and nature of NTFPs. Factors responsible for quality deterioration (of perishable NTFPs such as honey and fishes) through contamination with air, moisture and dust should be eliminated before storing the collected NTFPs.

5.4 Enterprise Development

A study of pre-assessment of enterprise development around the PA completed under another USAID supported project (JOBS) suggested both the primary and secondary sectors. Primary sectors for potential development around the PA include handicrafts (cane, bamboo and murta), nursery development, food processing (pickle, jam, jelly), weaving (handloom, sewing) and natural dye processing, and bee keeping. Secondary sectors include herbal tea (basak, chamomile, shefali) cultivation and processing, medicinal plantations and processing, essential oil processing, buffer plantations, orchid cultivation and floriculture, eco-tourism and nature-based healing homes development. Priority sectors such as bamboo and canes, nursery and natural dye processing may initially be taken up for enterprise development.

Bamboo and canes occur naturally in the forests of Sylhet and used widely by local people in a variety of ways (making household articles, furniture, domestic utensils, house constructions, rafters, batons, binding material and handicrafts) and provide employment and livelihood to a large number of rural poor. In addition, bamboo are major source of raw material for pulp and paper industry. Nevertheless the supply of bamboo and canes from natural forests has declined due mainly to clear felling of natural forests and monoculture of commercial species.

Cane (rattan) is a climbing plant that produces flexible stems used for making handicrafts, furniture, domestic utensils, house constructions and binding material. Its products have export markets as fine quality finished products can be made with a variety of designs. The skills and artisanship for making handicrafts are learnt by local people from one generation to another. Bamboo and cane based cottage industries and enterprises will a good source of wage and self-employment in Sylhet areas. Unlike bamboo, no formal rules have been developed for cane harvesting for which permits by FD are issued after collecting royalty. Canes of adequate length are harvested manually by local people for their own use but also sold in bundles to local traders. Villagers sell sometimes standing crop of bamboo and canes from their homesteads based on stumpage prices. Selection-cum-Improvement silvicultural system is more suitable for the management of natural forests having bamboo and canes as middle story vegetation.

A well planned marketing of NTFPs can be a means for employment and income generation by optimizing the values of NTFPs and ensuring the distribution of enhanced benefits among the participants. The role of marketing is in creating better linkages between the NTFPs management, processing and end-use. Proper marketing can reinforce sustainable management of NTFPs by indicating the kind of products and raw materials required. The NTFPs markets, which are essentially local, exhibit seasonal behavioral patterns because NTFPs production is seasonal in character. The local merchants and intermediaries many times deprive tribals and poor a fair price for their collected NTFPs. There is a wide gap between the NTFPs prices received by the primary collectors and that of final products. So there is a need for rationalizing the marketing system in order to narrow down the wide price differences. The quality of NTFPs as raw material is influenced by post harvesting handling, processing and storage conditions.

The development of NTFPs based enterprises may be hampered due to a number of factors. Lack of adequate facilities for processing and storage will result in losses, especially for perishable NTFPs. Other constraints include limited availability of finance and uncertain markets. Government restrictions on the transit and movement of some of the collected NTFPs (in terms of transit permits to be issued by FD) discourage the collectors for their collection and sale. If the collected NTFPs are processed at local level then the value added (e.g. broom making, cane processing, leaf collection for puffed and parched rice, basket making, handicrafts making, etc.) can be retained locally thereby generating forward and backward linkages for socio-economic development. However, poor infrastructure, natural calamities, poor skills, poverty and illiteracy among local people may be hindrance in setting up small enterprises for making finished products in the absence of adequate government support. The processing of some NTFPs may require an access to secondary processing industries and regular markets. Therefore, there is a need for establishing proper linkages between the primary collectors, processing units and markets.

Traditional knowledge about medicinal plants and animals should be documented in view of their contemporary relevance. Revitalization of folk traditions on medicinal plants holds a real potential for self-reliance of rural people on primary health care. In-situ conservation of biodiversity of use in traditional

medicine should be encouraged by delineating medicinal plants conservation areas to conserve cross-sections of diverse eco-systems having potential for medicinal plants and animal species, and their genetic diversity.

5.5 Summary of Main Prescriptions

Main prescriptions outlined under the above-developed protection programs are summarized in Table 5.2 as below:

Table 5.2 Summary of Main Prescriptions

Year	Main Activities	Main Outputs/Success Criteria	Responsibility
1	➢ Conducting reconnaissance surveys and demand-supply assessment	Demand-supply situation assessed	NSP
	➢ Identifying a list of feasible production technologies	Feasible production technologies identified	NSP/ Stakeholders
	➢ Holding discussions with local stakeholders on feasible production technologies	Stakeholders' consultations held	NSP/FD/ Stakeholders
	➢ Finalizing a short list of candidate production technologies	Short list of production technologies finalized	NSP/FD/ Stakeholders
	➢ Identifying and selecting master trainers	Master trainers identified	NSP
	➢ Preparing training material on the finalized production technologies	Training materials prepared	NSP
	➢ Designing demonstration centres for proven technologies	Design of demonstration centres completed	NSP
	➢ Identifying farmers training schools	Farmers training schools identified	NSP
	➢ Finalizing preparations for imparting training to local stakeholders	Preparations for training completed	NSP/FD/ Stakeholders
	➢ Finalizing operational guidelines for LDF	LDF operational guidelines finalized	NSP/FD/ Stakeholders
2	➢ List of feasible production technologies refined based on the first year experiences	List of production technologies refined	NSP/ Stakeholders
	➢ Continue holding discussions with local stakeholders on feasible production technologies	Stakeholders' consultations continued	NSP/FD/ Stakeholders
	➢ Short list of candidate production technologies refined based on the first year experiences	Short list of production technologies refined	NSP/FD/ Stakeholders
	➢ Finalizing training material on the finalized production technologies	Training materials finalized	NSP
	➢ Establishing demonstration centres for proven technologies and arranging for stakeholders visits	Demonstration centres established	NSP

Year	Main Activities	Main Outputs/Success Criteria	Responsibility
	➢ Establishing farmers training schools and arranging for stakeholders visits	Farmers training schools established	NSP
	➢ Imparting training to local stakeholders	Training to groups imparted	NSP/FD/ Stakeholders
	➢ Training in simple storing and processing technologies	Stakeholders trained	NSP/ Stakeholders
	➢ Encouraging low-input small scale and cottage industries	Stakeholders encouraged	NSP/ Stakeholders
	➢ Conducting enterprise development assessment	Enterprise development studied	NSP
3	➢ Continue holding discussions with local stakeholders on selected production technologies	Stakeholders' consultations continued	NSP/FD/ Stakeholders
	➢ Training material on the finalized production technologies reviewed based on the project experiences	Training materials reviewed	NSP
	➢ Demonstration centres for proven technologies improved based on the project experiences	Demonstration centres improved	NSP
	➢ Upgrading farmers training schools based on the project experiences	Farmers training schools upgraded	NSP
	➢ Continue imparting training to local stakeholders	Training to groups continued	NSP/FD/ Stakeholders
	➢ Helping in developing market linkages	Market linkages established	NSP/Federations
	➢ Training on small enterprise development	Stakeholders trained	NSP/Federations
4	➢ Continue holding discussions with local stakeholders on selected production technologies	Stakeholders' consultations continued	NSP/FD/ Stakeholders
	➢ Continue arranging visits to demonstration centres	Demonstration centres visited	NSP
	➢ Continue arranging training in farmers training schools	Training in Farmers training schools continued	NSP
	➢ Continue imparting training to local stakeholders	Training to groups continued	NSP/FD/ Stakeholders
	➢ Helping in enterprise development	Small enterprises establihsed	NSP/Federations
5	➢ Continue holding discussions with local stakeholders on selected production technologies	-Stakeholders' consultations continued	NSP/FD/ Stakeholders
	➢ Continue arranging visits to demonstration centres	Demonstration centres visited	NSP
	➢ Continue arranging training in farmers training schools	Training in Farmers training schools continued	NSP

Year	Main Activities	Main Outputs/Success Criteria	Responsibility
	➢ Continuing with enterprise development and market assistance activities	Enterprise development continued	NSP/Federations

6. FACILITIES DEVELOPMENT PROGRAMS

During the implementation of the Management Plan the development of Park facilities will be undertaken to support the long-term administration. In addition to built facilities, the Facilities Development Programs will focus on the procurement of transport and other equipments required for the implementation of proposed management programmes.

6.1 Objective

Main objective of this program is to develop necessary facilities including accommodation and procure filed equipments for FD field staff responsible for the management of PA.

6.2 Built Facilities

The development of built facilities will proceed in a well-planned and phased manner that is appropriate to a Park setting, in order to ensure that they do not negatively impact the area's natural resources or ecotourism potential. Existing FD and BFRI facilities will be fully utilised and incorporated in Park management where these can be renovated on a cost-effective basis. Built facilities will be concentrated in four areas: i) Park Headquarters (incorporating the existing Lawachara Beat Office and some BFRI facilities); ii) a rest stop/picnic area located at the Janakichara Nursery, on the main access road; iii) a Guard Camp located on the main access road, near the eastern Park boundary (current Bhagmara Camp); and, iv) Chautali Beat Office (assuming the Park is extended as proposed).

Built facilities requirements during the Management Plan period are summarised in Tables 6.1 and 6.2.

Table 6. 1 Built facilities development in Lawachara National Park: use of existing facilities

Location	Facility (current use)	Use during Plan Period	Action Required
Park Headquarters Complex (near eastern Park boundary, in front of HEED Office)	Samoli Resthouse (3 bedrooms, 3 bathrooms, 1 storeroom, 1 dining room, 1 sitting room, and covered verandah). Building footprint ~195 m^2. Detached cook's quarters and driver's/ attendant's rooms.	Resthouse	➢ regular maintenance
	Beat Officer's Quarters (3 bedrooms, 2 bathrooms, 1 sitting room, 1 kitchen). Building footprint ~80 m^2.	Forester's Quarters	➢ renovations to improve rainwater drainage and cross ventilation ➢ installation of water supply and electricity hookup ➢ repainting and regular maintenance
	BFRI Quarters (2 bedrooms, 1 bathroom, 1 sitting room, 1 kitchen). Building footprint ~75 m^2.	BFRI use	➢ general renovation/repairs ➢ installation of water supply and electricity hookup ➢ repainting and regular maintenance
	Wildlife Training Centre (1 large and 2 small offices, 1 bathroom, 1 kitchen). Building footprint ~125 m^2.	Park Office (office space for OIC, Ranger and Forester)	➢ general renovation/repairs ➢ installation of water supply, electricity hookup and telephone ➢ repainting and regular maintenance ➢ construction of walkway from access road
	Beat Office	none	➢ remove (not repairable)
	Guard Quarters (3 buildings)	none	➢ remove (not repairable) ➢ replace with suitable quarters for 2 guards
	Forestry School Barracks	none	➢ remove (not repairable)

Location	Facility (current use)	Use during Plan Period	Action Required
Park Headquarters	Staff Quarters (2 bedrooms, 2 bathrooms, 1 sitting room, 1 kitchen). Building footprint ~80 m^2.	Environmental Education Officer's Quarters	➢ general renovation/repairs ➢ installation of water supply ➢ repainting and regular maintenance
	Laboratory/Office Building (3 offices, 1 large and 1 small work room, 1 toilet, 1 garage/store, 2 covered verandahs, 2 open verandahs/patios). Building footprint ~250 m^2.	Environmental Education Centre (including BFRI use of outer offices, if required)	➢ general renovation/repairs ➢ installation of water supply ➢ repainting and regular maintenance
	Guard Quarters	BFRI use	➢ not applicable
	Nurseries (2 locations)	BFRI use	➢ not applicable
Janakichara	Hilltop Viewpoint (octagonal, roofed shelter, total footprint ~50 m^2).	Hilltop Viewpoint/Picnic Shelter	➢ general renovation/repairs ➢ repainting and regular maintenance
	Wildlife Enclosure (half-walled, roofed structure on concrete base; total footprint ~60 m^2)	Picnic Shelter	➢ general cleanup and renovation/repairs ➢ removal of wire mesh and adjacent outdoor barbed wire enclosure ➢ installation of picnic tables ➢ repainting and regular maintenance
	Public Toilet	none	➢ remove and replace with appropriate public toilet facilities
	Mali Quarters (4)	none	➢ remove and replace with appropriate quarters
	Nursery	nursery for framework and enrichment planting species	➢ regular maintenance
Bhagmara Guard Camp	Single Guard Quarters (2 bedrooms, 1 bathroom, 1 kitchen). Building footprint ~55 m^2.	Forester's Quarters	➢ installation of water supply and electricity hookup ➢ repainting and regular maintenance
	Double Guard Quarters (each with 2 bedrooms, 1 bathroom, 1 kitchen). Building footprint ~125 m^2.	Guard Quarters (2)	➢ as above
Chautali Beat Office (applicable only if Park is extended to include remainder of Chautali Beat)	Beat Office/Residence	none	➢ remove and replace with appropriate office and quarters
	Guard Quarters (3)	none	➢ remove and replace with appropriate quarters

Table 6.2 Built facilities development in Lawachara National Park: new facilities

Location	Facility and use during Plan period	Action Required
Park Headquarters (Head Quarter near the eastern Park boundary, in front of HEED Office)	ACF's Quarters (1, area ~120 m^2)	➢ site selection ➢ design and construction ➢ installation of water supply and electricity hookup ➢ regular maintenance
	Ranger's Quarters (1, area ~100 m^2)	➢ as above
	Guard's Quarters (2, each ~60 m^2)	➢ as above
Park Headquarters	-no new facilities required	➢ not applicable
Janakichara	Nature Information Center Forester's Quarters (1, area ~80 m^2)	➢ site selection ➢ design and construction ➢ installation of water supply and electricity hookup ➢ regular maintenance
	Guard's Quarters (2, each ~60 m^2)	➢ as above
	Plantation Mali's Quarters (2, each ~40 m^2)	➢ as above
	Public Toilet	➢ as above
Bhagmara Guard Camp	Plantation Mali's Quarters (1, area ~40 m^2)	➢ site selection ➢ design and construction ➢ installation of water supply and electricity hookup ➢ regular maintenance
Chautali Beat Office (applicable only if Park is extended to include remainder of Chautali Beat)	Forester's Quarters (1, area ~80 m^2)	➢ site selection ➢ design and construction ➢ installation of water supply and electricity hookup ➢ regular maintenance
	Guard's Quarters (2, each ~60 m^2)	➢ as above
	Plantation Mali's Quarters (1, area ~40 m^2)	➢ as above

All built facility requirements at Park Headquarters, except for senior staff and Forest Guard's quarters, should be satisfied through the use of existing buildings. Renovations, and a regular schedule of maintenance, will be initiated during the first year of the Plan. New constructions will be initiated during the second year of the Management Plan. At the Janakichara Nursery/Rest Stop/Picnic Area, existing visitor facilities will be renovated to provide two covered picnic shelters and an adjacent outside picnic area. The existing toilet will be removed and replaced with a new facility. The nursery will be retained for production of seedlings required for habitat management, and new quarters will be constructed for the Park staff and nursery workers stationed at this location. Guard quarters at the Bhagmara Camp will be renovated to provide electricity and piped water, and will be repainted and maintained on a regular basis. Conversion of the Chautali Beat Office to Park use will require construction of all new staff quarters if the remainder of Chautali Beat is added to the Park area, as proposed.

At each location, design standards for both renovations and new construction will be based on the "Guidelines for Conservation Area Facilities Development" (Tecsult, 2001) as provided in Volume 2. A regular schedule of maintenance and upkeep will be maintained and all irreparable or unused buildings will be removed. Renovation and construction work will be completed at Park Headquarters as a matter of priority.

6.3 Forest Roads and Trails

Access to the Park Headquarters, rest stop/picnic area and Bhagmara Guard Camp is currently provided by all-weather access roads which do not require upgrading. Access roads between sites at Park Headquarters (*i.e.*, between the main office/accommodation complex, the Resthouse and proposed Environmental

Education Centre) will require periodic manual maintenance, but are currently built to sufficient standards for anticipated traffic loads. All other roads within the Park will be permanently closed to 4-wheeled vehicles. Unsurfaced forest trails (former logging tracks) link Park Headquarters/Lawachara Beat Office with the Chautali and Kalachara Beat Offices to the north. But these trails have not been maintained and several culverts would need to be replaced to restore easy vehicle access.

Restoration of these trails would provide quick and easy vehicle access to the northern parts of the Park (and its proposed extension) for Park management staff. But these would also provide unimpeded public access, thereby potentially increasing the severity and spatial extent of management problems. Due to the nature of the terrain, techniques commonly used to block public use of access roads (*e.g.*, barriers, locked gates) could easily be circumvented, and do not provide an effective solution to the potential problems of improved public access. Additionally most access by Park staff is currently and will continue to be by foot and motorcycle, and the distances involved are short (5 km from Park Headquarters to the Chautali Beat Office, 3.5 km to the northern boundary of the Park along the road to Kalachara Beat Office). Foot patrols are much more effective than vehicle patrols and so the trails linking the Lawachara, Chautali and Kalachara Beat Offices will be maintained for foot and motorcycle access, but not for access by vehicles with four wheels. These trails will be incrementally narrowed to an average width of approximately 2 m, through replanting bypass areas and permitting ingress of undergrowth.

Numerous other foot trails have been developed throughout the Park mainly at the time of plantation establishment, and linking settled areas within and on the periphery of the Park with subsistence use areas. Some of these, particularly those that tie in with the main road and trail access system described above, could also be used as nature trails. However, only existing trails will be renovated and maintained as nature walks and trails during the first five years and new trails will be laid out only during the subsequent years after assessing their potential and use. Reconnaisance surveys will be taken up to select trails which pass through diverse habitats and landscapes of interest. The trail selection and development will be taken up with specific objectives: i) to demonstrate the importance of biodiversity conservation to visitors and policy makers, ii) to make outing and hiking for observing the beauty of the Park, iii) to learn interesting things about the local environment, ecology, culture and wildlife, iv) to raise public awareness for biodiversity conservation and wildlife management. Each trail will be marked on the ground and base map and adequate information will be provided in shape of sign boards (at entry/start point) and also through printed materials including brochures. Some minimum visitor amenities such as resting places, rest rooms, waste disposal bins and hides may be provided along the identified trails. Adequate provisions should be made for the renovation and maintenance of these public utilities.

6.4 Field Equipments

Vehicles, field equipment and office equipment will be needed to support the management and administration programs. Double-cab pickups will be provided for the ACF/OIC. In addition two 100 cc motorcycles will be provided for use at Park Headquarters, and one each at Janakichara Nursery/Rest Stop/Picnic Area, Bhagmara Camp and the Chautali Beat Office. Two walkie-talkies will be provided for use at Park Headquarters, and one each at Janakichara Nursery/Rest Stop/Picnic Area, Bhagmara Camp and the Chautali Beat Office. These will be suitable for communication among these sites and between all sites and the Maulvibazar Range Office. Compasses, binoculars, GPS-units and other field equipment will be provided as required for support of the Park management programs.

6.5 Office Equipments

Office equipment (telephone, computer), furniture (desks, filing cabinets *etc.*) and supplies will be provided as required for use at Park Headquarters and the Chautali Beat Office. Similarly all necessary equipment and supplies for development and operation of the Environmental Education Centre will be provided. Specific requirements will be detailed in conjunction with the development of environmental education and other visitor use programmes.

6.6 Summary of Main Prescriptions

Main prescriptions outlined under the above-developed protection programs are already summarized in Tables 6.1 and 6.2.

7. VISITOR USE AND VISITOR MANAGEMENT PROGRAMS

7.1 Objectives

Regulated eco-tourism in the form of nature education and interpretation tours (as against commercial tourism) will be a main objective of visitor use and management programs. This will help promote biodiversity conservation and educate the visitors as enlightened nature tourists. Socio-economic benefits of eco-tourism will be accrued to local people through forward and backward linkages.

7.2 Conservation Tourism

The potential of conservation tourism is high in Lawachara due to its easy accessibility. So a number of facilities can be developed for visitos' use.

7.2.1 Identification of Tourism Areas

A tourism region will be identified around the Park by linking with other local and regional attractions including Guest Houses, tribal villages, rolling landscapes, wetlands and tea gardens through forest roads and trails. Adequate care will be taken to preserve the local traditions and culture of tribals by avoiding intrusive, exploitative and commercial behavior while implementing visitor program. Existing roads and trails will be renovated for easy movement in tourism zone. Initially tourists will use their own transport but a regular vehicular arrangement by FD on payment basis may be considered subsequently. Elephant ride may also be considered by FD as many tourists may be interested to have a close look of nature from elephant back. Initially FRH will provide accommodation to tourists. But when the number of tourists increase local enterprenuers on the fringes (in interface landscape zone) of the Park may be encouraged to set up nature camps, lodges, dormitories, huts and cottages for tourists. Eco-guides to be identified amongst local communities will be employed for the guidance of eco-tourists.

Brochurs, pamphlets, guide maps, hand outs, audiovisual aids, display boards will be developed at convenient points. Mass Communication Officer of FD and Communication Specialist of NSP will provide help in launching publicity program. Local youths/naturalists preferably from the co-management communities will be encouraged to act as eco-guides and nature interpreters. They will be trained as eco-guides by organizing a series of training workshops on communication and interpretation skills (including on what to speak, how to speak, presentation skills, body language assessment, team building exercises, etc.). Main message in these workshop will be on spreading conservation awareness among the visitors. Binoculars and books on ornithology may be provided to tourists on rent. They may also provide catering facilities at tourist accommodation places.

Nature camps (of -2 days duration) may be organized at places of interest within the Park for students and youths for learning by experience and discussions on biodiversity conservation issues. Camp accommodation will be provided in temporary tents to be established near sites of interest. Local NGOs and naturalists may help in establishing nature camps.

7.2.2 Facility Development

The proposed facilities to be developed in the Park are described in detail as below:

7.2.2.1 Use Types and Facilities

Only Samoli FRH (under the control of DFO, Sylhet) is available for night halts inside the Lawachara Park. The use of this FRH for general visitors is restricted as its occupation is very busy mainly by senior government personnel. However, longer-term visitors can get accommodation outside the Park area in the Guest Houses maintained by Tea Board (earlier under DFID), Tea Research Institute and HEED. In addition, reasonable hotel accommodation is available at Srimongal. Publicity and information materials having basic information about the Park will be provided to visitors by means of fixed signs, brochures, leaflets, printed guides, etc. at key road access points. Some of the possible points are the Janakichara Nursery near the southwestern entrance to the Park, Bhagmara camp near the eastern entrance to the Park and at the Park HQ Office. An Environmental Education Centre to be established at the Lawachara Beat Office/BFRI complex will serve as nature interpretation centre (NIC) with update information. Suitably trained staff will be posted at all of these locations with adequate information and publicity material about

the Park's importance and facilities. Additional training on public relations and visitors management will be provided to the Park staff.

7.2.2.2 Nature and Hiking Trails

A network of nature trails will be developed for visitors movement on foot and bicycle traversing key natural and cultural features of interest (e.g. patches of high forests, betel leaf gardens, cultural remnants, natural streams/cheras, religious places). The Samoli FRH will be connected with nature trails as far as possible. Priority will be given to develop existing foot paths and vehicle tracks as far as possible in order to minimize creation of new paths and consequent vegetation clearances and soil erosion. The Environmental Education Centre will be connected by one such trail for visitor access.

The following three existing nature trails have been identified initially and mapped (Figure 12):

1. **Short Trail (nearly 1 km with half an hour walk):** The trail starts at Chloroform tree near Samoli FRH and ends at the same point after traversing a loop with part brick soling and part kacha tack. The trail covers good forests of lohakat, chapalish, jarul, teak, kadam, etc. and one may encounter macaques, holloooks and birds appearing on these trees.
2. **Medium Trail (nearly 2 km with one hour walk):** The trail starts from the Lawachara Beat Office (near Samoli FRH) and ends at the same point after traversing a loop with katcha track. Tall trees of lohakat, jarul, chapalish, raktan and teak are worth seeing along the trail.
3. **Long Trail (nearly 5 km with three hours walk):** The trail starts at the entrance road of Magurchara Forest Village (Khasia Punji) and ends at Samoli FRH after traversing a long loop with katch track. A major part of the trail is plain but some elevated areas and streams (cheras) are encountered while walking along the trail. In addition to tall trees of chapalish, lohakat, jarul, kadam and teak the plantations of exotics such as eucalyptus, acacia and malakana are worth noticing. Macaques, hoolloks and birds (myna, ghungu, dhanesh) may be observed while walking along the trail.

The following guidelines/standards will be followed while designing, developing and maintaining the nature trails in future.

- ➔ Existing trails will be renovated by using local hard soil materials (e.g. laterite soils from nearby forest areas) in order to maintain them in as natural condition as possible;
- ➔ Renovation of trails will be done by maintaining minimum necessary surface area and vegetation clearances will be limited wherever possible for easy access;
- ➔ Sign-posts with adequate information will be provided at main trail heads and printed materials will be distributed by the staff to interested visitors for their education and awareness. A list of dos and don'ts for visitors will also be prepared and made available at visit places;
- ➔ Hygenic conditions will be maintained and simple toilets and litter disposal facilities will be provided at key points; and
- ➔ Motor traffic will not be allowed.

Self-guided trails with adequate information/interpretation will help bring visitors close to nature and provide aesthetic sense. In long-term these visitors will be future ambassadors of biodiversity conservation. A leveled sketch map, depicting significant natural features along the trail, will be posted at the starting point.

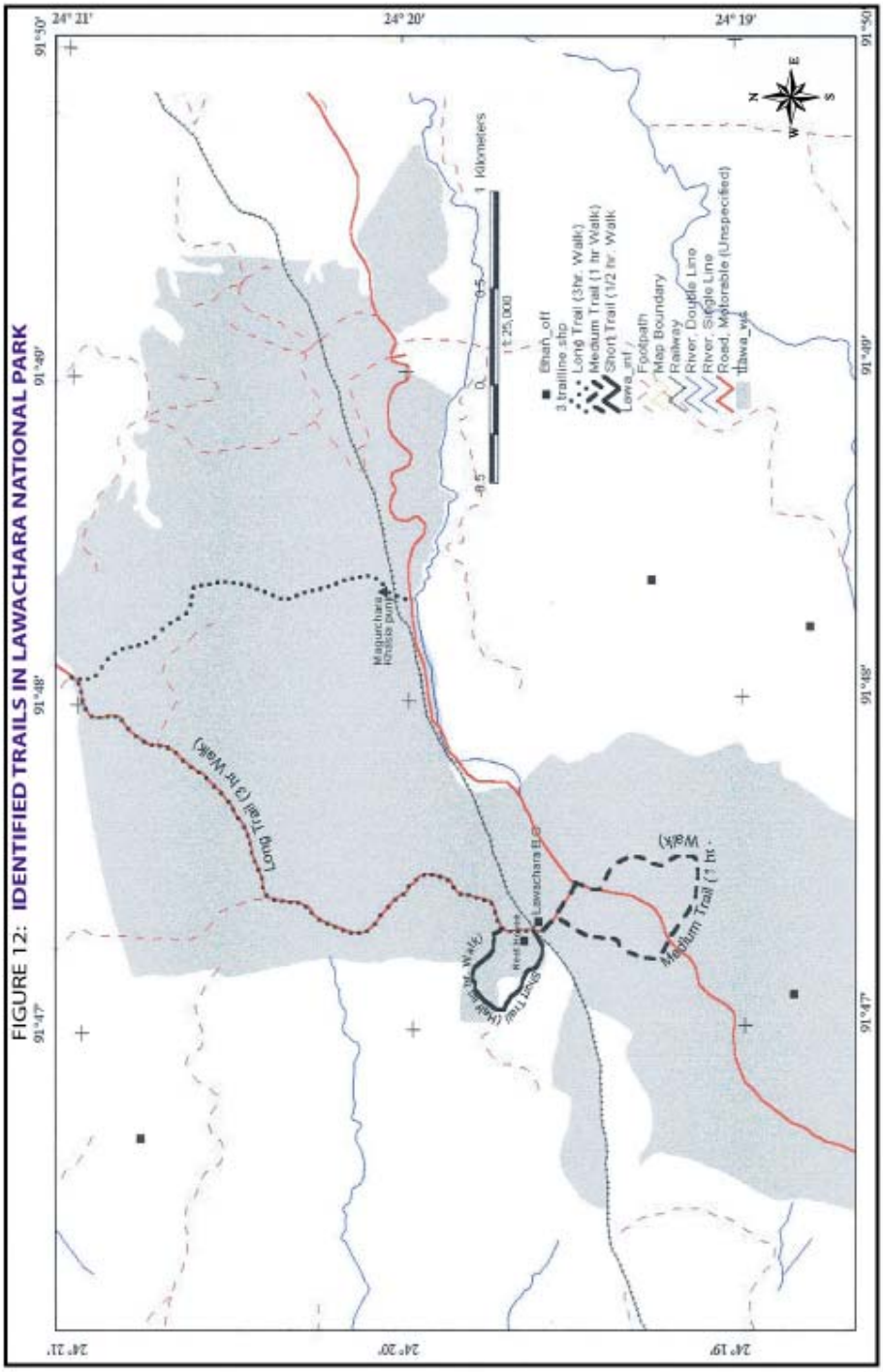
7.2.2.3 Picnic Facilities

Basic picnic facilities such as sheltered and outdoor tables, simple toilets and litter disposal buckets/boxes will be provided (for visitors in small groups) at the Janakichara Nursery, adjacent to the main access road through the Park. The Janakichara Nursery will be improved by leveling the seedling beds and small rest sheds, and will be open for visitors. However, the use of loudspeakers, amplifiers and other activities that could affect the use and enjoyment of the area by others will not be permitted inside the Park.

7.2.2.4 Community-Based Tourism

Guided tourism will be developed over a period of time by involving unemployed youth members/naturalists of co-management committees as eco-guides. They will be trained on eco-tourism including animal signals and calls, bird identification, biotic influences, local culture, etc. They will be

involved in the management of eco-tourism in order to create stakes among them. Involvement of user groups will be sought in developing community-based tourism. Co-management committee will be involved in eco-tourism activities and also share revenue from park entry fees and sale of brochure, shirts, etc.



7.2.2.5 Regulation of Eco-Tourism

Eco-tourism will be restricted to specific areas identified for the purpose. The movement of vehicles and tourists will be regulated within the identified tourists paths for which physical barriers and check posts will be established at appropriate places and manned by adequate staff to regulate the traffic into the core zone. Tourists will be allowed during day time only and all the visitors must leave the core zone by sun set.

No night driving will be allowed and entry hours will be specified. Similarly the Park may be closed during rainy season. Slow driving (say 25 km/hour) will be allowed for motor vehicles and blowing of horns will not be permitted. Wlidlife will not be chased and food from outside will not be allowed. Litting of fire will not be allowed during excursions. Dogs and pets will not be allowed. Empty canes, tins and polythene will not be allowed. The ACF incharge of PA will regularly get feed back from his field staff about the tourists through periodic reports and briefings.

7.3 Conservation Education, Awareness and Interpretation

The publicity of the Park management activities will be improved for propagating the biodiversity conservation, environment, and wildlife and the cause of its habitat. Electronic and print media (TV, Radio, Videos, newspaper, magazines, brochures, etc.) will be employed for this purpose. Schools and colleges will be targeted for conservation education and building an informed wildlife constituency. Conducting talks, essays writing and competition will be included in neighbouring schools as a part of publicity campaign. Sabuja Vahinis (Green Brigades) will be formed and trained in nearby schools and madarsas. Professional publicity and communication personnel will be invited for such tasks. Communication strategy as developed under NSP and FSP will be implemented. Efforts will be undertaken to improve relations and communications between the FD field staff and the media.

7.3.1 Interpretative Media for Tourist Education

Nature interpretation will, as an educational activity, focus on revealing meaning and relationships of complex ecosystems and landscapes. Public awareness of the laws related to wildlife will be enhanced and prosecutions under the laws will be publicized. Nature Interpretation Centres will be developed (at least one) in the Park at accessible place (say at PA HQ). Landscape features of the Park will be depicted in pictorial forms including topographical and biodiversity patterns. Depending upon the availability of resources a sound and light program can be added for explaining to visitors. Local exhibits, murals, dioramas, specimen of plants and wildlife, trophies and photographs may be added. Socio-cultural traditions/features (handicrafts, uniforms, dances, tools, furniture, ornaments, carvings, etc.) of local people including tribals may be added with proper leveling and description.

Appropriate signages will be used for the benefits of tourists in finding their ways without any enquiry. These signages may be i) directional signages showing the way to different places, ii) cautional signages indicating about prohibitory acts, iii) orientational signages helping in tourists orientation and iv) interpretive signages kept at conspicuous places to help interpret strategic themes and issues.

7.3.2 Environmental Education

Existing BFRI Laboratory/Office Building at Park Headquarters will be converted as an Environmental Education Centre by renovating with minor modifications. This building will be developed as a Nature Interpretation Centre (NIC), the design and development of which will be assigned to a professional organization. It will consist of walk-through displays, audio-visuals, explainatory printed materials, items of historical and conservation significance, computer interactive media, etc. A video film on wildlife and its habitat and cultural aspects may be developed for showing to visitors at NIC. Other relevant topics may include ecological processes at work in the Park, wildlife behavioural ecology, conservation history, role of local people in conservation, man-wildlife conflicts, etc. A library will be developed at NIC with books, magazines and journals relating to biodiversity, wildlife, environment and forestry.

7.4 Intersectoral Conservation Planning

Many times other sectors, particularly land-based sectors, have profound effects (both negative and positive) on the management of PAs. Therefore, the FD needs to establish clear linkages and programs for collaborative conservation planning with other relevant agencies/institutions both within and outside the country. A collaborative conservation strategy should be developed to provide mechanisms for improving inter-sectoral coordination and information sharing to maximize biodiversity conservation efforts.

7.5 Conservation Partnerships

The concept of public-private partnership will be applied in soliciting the inputs/contributions from private sector for the facilities development in Lawachara NP. It has been shown in many countries that nature conservation progresses rapidly when leading members of the private sector perceive nature conservation

as good for the economic well being of the country. Nature conservation partnerships can be designed to offer interested businesses a vehicle for contributing to long-term forest conservation in a way that is transparent with low transaction costs, generates beneficial public image for the contributor and makes a long-term difference in forest conservation.

A well designed Partnerships program may be implemented in the following ways:

1. It may help improve livelihoods of local people around the PA by building a strong and mutually self-interested relationship with the local communities. Such a relationship may be formalized by signing co-management agreements under which community representatives maintain joint responsibility for protection with FD, and in return receive benefits generated from the Park or provided by NSP. Contributors can support community needs for improved health and sanitation, womens' empowerment and livelihoods improvements.

2. Contributors can help create visitor facilities including educational exhibits, public utilities, sitting areas and other visitor amenities by making donations in lieu of recognition on appropriate plaques at Park level to attest to their contribution.

3. Contributors may support/co-finance NSP's communication and outreach efforts by help organizing events such as Earth Day, Nishorgo Day, Wildlife Week, etc.

4. NSP may offer an opportunity to potential contributors to license the Nishorgo logo and name for use in creating and selling nature-based products and souvinor including postcards and Tishirts with wildlife pictures. The receipts from the licensing program may be ploughed back either for local community development and/or improved PA management.

5. Private businesses located in the interface landscape zone (e.g Tea Estates) will be rewarded for their Park-friendly behabiour/activities. For example, those businesses supporting PA conservation may be given right to use the, "Certified Nishorgo-Friendly" level.

7.6 Summary of Main Prescriptions

Main prescriptions outlined under the above-developed protection programs are summarized in Table 7.1 as below:

Table 7.1 Summary of Main Prescriptions

Year	Main Activities	Main Outputs/Success Criteria	Responsibility
1	➢ Identifying tourism areas within the Park	Possible tourism areas identified	FD
	➢ Designing and developing basic picnic facilities for tourists	Minimum tourist facilities are in place	FD/NSP
	➢ Identifying suitable sites for nature camps	Possible sites for 1-2 days nature camps identified	FD/NSP
	➢ Designing and preparing publicity materials including pamphlets, brochures and maps	Publicity material developed	NSP/FD
	➢ Identifying and training eco-guides	Eco-guides identified and trained	NSP
	➢ Developing and propagating conservation awareness and education through electronic and print media	Conservation awareness program developed	NSP/FD
	➢ Identifying and motivating students and volunteers (Sabuj Vahini) for biodiversity conservation	Number of schools identified and students motivated	NSP/FD
			FD

Year	Main Activities	Main Outputs/Success Criteria	Responsibility
	➢ Identifying an existing building for establishing Nature Interpretation Centre	Building for NIC selected	FD/NSP
	➢ Identifying and mapping existing nature and hiking trails	Existing trails mapped	FD
	➢ Establishing regular contacts with relevant ministries and departments for inter-sectoral conservation planning	Relevant ministries and departments contacted	NSP
	➢ Developing a policy on public-private conservation partnership	Public-Private partnership policy drafted	
2	➢ Tourism areas shown on maps and brochures	Tourism areas notified	FD
	➢ Regulating tourism within the Park	Tourism regulated	FD
	➢ Developing basic picnic facilities for tourists	Tourist facilities are developed	FD/NSP
	➢ Developing suitable sites for nature camps	Possible sites for 1-2 days nature camps developed	FD/NSP
	➢ Preparing publicity materials including pamphlets, brochures and maps	Publicity material development completed	NSP/FD
	➢ Training eco-guides	Panel of possible Eco-guides trained	NSP
	➢ Propagating conservation awareness and education through electronic and print media	Conservation awareness propagated	NSP/FD
	➢ Motivating students and volunteers (Sabuj Vahini) for biodiversity conservation	Number of students motivated	NSP/FD
	➢ Establishing Nature Interpretation Centre (NIC)	NIC established	FD
	➢ Developing existing nature and hiking trails	Existing trails developed	FD/NSP
	➢ Holding meetings with relevant ministries and departments for integrating Nishorgo Program with other sectoral programs	Relevant ministries and departments pursued	FD
	➢ Approving a policy on public-private conservation partnership	Public-Private partnership policy approved	FD/MOEF/ NSP
3, 4 and 5	➢ Regulating tourism within the Park	Tourism regulated	FD
	➢ Continuing to develop picnic facilities for tourists	Tourist facilities are developed	FD
	➢ Maintaining suitable sites for nature camps	Possible sites for 1-2 days nature camps maintained	FD/NSP
	➢ Continuing to distribute publicity	Publicity material development	FD/NSP

Year	Main Activities	Main Outputs/Success Criteria	Responsibility
	materials including pamphlets, brochures and maps	distributed	
	➢ Maintaining the panel on eco-guides	Panel of possible Eco-guides maintained	NSP
	➢ Continue propagating conservation awareness and education through electronic and print media	Conservation awareness propagated	NSP/FD
	➢ Continue motivating students and volunteers (Sabuj Vahini) for biodiversity conservation	Number of students motivated	NSP/FD
	➢ Maintaining Nature Interpretation Centre (NIC)	NIC maintained	FD/NSP
	➢ Developing new nature and hiking trails	New nature trails developed	FD
	➢ Continue liaisoning with relevant ministries and departments for integrating Nishorgo Program with other sectoral programs	Relevant ministries and departments pursued	FD/MOEF/ NSP
	➢ Approving a policy on public-private conservation partnership	Public-Private partnership policy approved	FD/MOEF/ NSP

8. CONSERVATION RESEARCH, MONITORING AND CAPACITY BUILDING PROGRAMS

8.1 Objectives

Conservation research, monitoring and capacity are tools/mechanisms for a better understanding of PAs and their functions in order to sustainable manage forests and biodiversity. A research, monitoring and capacity building program will be developed with main objectives i) to better understand the Park's biodiversity resources, ecosystem and landscape environment, ii) to establish a baseline listing of all flora and fauna species for assessing their current abundance, distribution, and functional relationship among biotic communities iii) to develop quantitative population estimates for selected key species (hoolock gibbons), and develop detailed information on their current distribution and habitat use, iv) identify and map key patches of remnant forests and other critical habitats, v) to identify priority research and monitoring topics to help guide the development of Park's management program, and vi) to gradually reduce the extent and degree of uncertainty while taking the Park management decisions.

8.2 Conservation Research

Presently conservation research is not being undertaken by FD and there is no funding source earmarked for carrying out such research. It is, therefore, necessary to establish linkages with related research organization such as FRI, BARC and relevant Universities and NGOs. In view of scarcity of funding for conservation research, adequate collaboration and networking with other relevant research organizations is necessary.

Conservation research may include aspects such as diverse types of flora and fauna, status of endangered species, wildlife behavior, socio-economic issues, silvicultural aspects, man-animal conflicts, impact of anthropogenic pressures on natural systems, etc. Applied research relating to management aspects of the Park will be given priority by FD over academic studies, which may be conducted by Universities and research institutes.

8.2.1 Applied Socio-economic Research

Management driven studies for conservation research will be taken up on priority basis. In the absence of research laboratories, pure research will be not be taken by FD (and so would be left to other research institutes).

Possible topics of investigation may include the institutional development and financial sustainability of co-management committees to be formed at different levels and their federations, impacts and dependence of local people including Tea Estate labourers on habitat, ethnic knowledge on local biodiversity, impacts of human activities on natural habitats, forward and backward linkages of eco-tourism, sustainable collection, harvesting, storage and processing and marketing of NTFPs (means of multiplication), impacts of NTFPs on local economy, collection of NTFPs by the members of co-management committees. Many of these studies will be carried out through action research and by associating the stakeholders. Prioritization of research topics will be decided in a Workshop in which key persons from FD and other stakeholders will participate. A computerized data base and retrieval system will be established.

8.2.2 Applied Biological Research

Suitable benchmarks are needed for measuring diversity and to monitor the status of indicator/flagship/threatened species of flora and fauna. Some relevant topics of biological research may include wildlife-population viability analyses, population dynamics and feeding behaviour, wildlife habitat/niche use behabiour, wildlife distribution patterns, wildlife seasonal variability and movements, and wildlife health and diseases.

Population viability analyses will be taken up to ensure that considerations of minimum population size and population dynamics are taken into account while formulating appropriate habitat management strategy. The needs of species that are dependent on specific habitats (e.g. streamside areas) or specific components (e.g. standing and fallen dead trees) will also be studied for site-specific habitat management. Poaching and illegal wildlife trade will be studied.

8.2.3 Silvicultural Research

Main topics of silvicultural research may include impact of forest grazing and fires on forest regeneration and wildlife (e.g. grazing intensity-how far cattle grazing be allowed), canopy manipulation for improvement of habitat through natural regeneration, habitat improvement through enrichment and under plantings, and monitoring of floristic composition and structure. Main research findings from different silvicultural studies carried out by BFRI will be reviewed in order to draw relevant inferences and frame appropriate recommendations for managing forests in ecosystem zones and habitat management zones. Further research will be required on the effects of selected silvicultural and forest management practices on forest growth, structure and species composition, regeneration of NTFPs bearing plant species, sustainable collection and harvesting of NTFPs,

8.2.4 Ecological Research

Main topics of ecological research will include identification of fragile habitats and ecosystems, environmental impact studies, water bodies studies, assess the contribution of PAs in water yield and conservation, impacts of forest grazing and fires on natural regeneration and wildlife, impacts of habitat changes and eco-tourism on wildlife.

8.2.5 Baseline Surveys

Existing literature on resources surveys and research will be reviewed before taking up further studies on additional assessments. The inputs from baseline surveys (for example, current population levels, distribution and habitat use) will be used in refinement and application of habitat management and monitoring.

8.2.6 Conservation Research Dissemination and Utilization

Adequate dissemination and utilization of the results/findings of research studies are very important. Pure research done for academic purposes will find less acceptability by FD and so poor dissemination among the field staff. Research dissemination and use methods may be standardized and circulated among FD staff. Useful research outputs will be included in annual development plans of FD for their implementation.

8.3 Conservation Monitoring

A well developed technique for conservation monitoring in multi-species management scenario is to select one or more key or representative species, and to ensure that habitat suitability for this species or a group of species is retained. Main species considered for purposes of macro-level habitat management while implementing this Management Plan in Lawachara NP is the hoolock gibbon representing fruit-bearing species requiring mature, continuous tree cover with a variety of forest types including plantations and regenerating forest areas. The long-term aim will be to maximize gains in quantity and quality of habitat, and quality for these and associated species. Habitat Suitability Index (HSI) models have been developed (see Volume 2) for each of these species (Tecsult, 2001) and will form the basis for decisions on how to manage the Park's forest cover for no net loss of habitat and constituent biodiversity.

A detailed assessment of WNCC/PA data needs will be undertaken before putting an appropriate MIS for PAs as a part of existing RIMS which will be strengthened by including MIS in addition to existing GIS.

Performance Monitoring Plan (USAID, 2003) contains guidelines for designing and implementing different levels of indicators (parameters) and intermediate results (IR) developed to track project performances and to assess project success with respect to project objectives. Within the scope of PMP the following set of core indicators has been designed by Nasim (2004) by following the USAID's guidelines:

- ➔ Indicator 6.2d : Declining incidence in illegal logging in the forests of PA
- ➔ Indicator 6b : Increased production of natural resources in targeted areas of the PA
- ➔ Indicator 6c : Increased biodiversity in targeted areas of the PA

A detailed methodology for establishing benchmark data and measuring the volume of timber loss (cubic meter/ha) during the Project period will be used in using the indicator 6.2d for assessing effectiveness of project interventions in controlling unauthorized logging in the sampled forest patches in the Park. A survey of natural regeneration (density of seedlings and saplings per ha) in the forests of Park will be taken with respect to the indicator 6b. This will be complemented by photo monitoring technique, focusing on changes in plant height as a visual evidence of success of NSP interventions. Forest dwelling bird species will be used for assessing biodiversity status with respect to the indicator 6c. A simple procedure of sighting and counting (either population or nests) the indicator bird species using the forests as their habitat will be employed by associating local stakeholders in identified transect walks. Benchmark measurements will be taken to establish initial set of values which will act as reference for future comparison with subsequent measurements taken periodically for assessing impacts of project interventions.

A critical review of the long-term habitat management strategy based on a detailed inventory of biodiversity will be taken up during the final year of implementation of this Plan. Park management practices will accordingly be adjusted.

8.4 Regional Coordination

As a part of NSP implementation a good coordination with related organizations in Asia and elsewhere will be developed. Cross-country exchange visits and training will be arranged to learn from relevant experiences from similar projects being implemented in different Asian countries. Under NSP a working group will be supported for preparing disseminating co-management best practices and lessons learned. Potential organizations for maintaining professional contacts include regional FAO office (Bangkok), RECOFTC (Bangkok), Wildlife Institute of India (Dehra Dun), ICIMOD (Kathmandu), CIFOR (Bogor, Indonesia), etc.

8.5 Conservation Training

Of the total 378 positions (of which only 105 are technical staff) allocated to WNCC, only 259 staff are in position. Although there are 42 positions allocated to WMNC Division, Sylhet, its operation is still to be made functional. This means that the existing territorial staff continue to manage the Park based mainly on traditional forest management practices. There is great necessity of imparting conservation training to the FD field staff responsible for managing the PA. FD does not have any specialized capacity for imparting PA management training. Of the many forestry subjects only one paper relates to wildlife management being taught to cadre officers at Forest Academy, Chittagong. Other subordinate staff do not receive any significant training on PA management, although wildlife management is one of the many taught subjects. There is a lack of permanent faculty on in-situ conservation at ecosystem and landscape levels by involving local communities. However, some forest officers haven undergone overseas training on wildlife and PA management. Unfortunately many of them are working outside WNCC, thereby under-utilizing their expertise.

Other stakeholders including the beneficiaries and NGO staff also need conservation training. An exhaustive conservation training plan, covering both in-country and overseas training, will be developed under NSP and implemented over the project period. A training strategy dealing with both quality and quantity of training including refresher and orientation training courses will form part of the training plan. Significant progress has been achieved in overseas training during the current year when one senior officer was sent to US for short-term training and two ACFs were sent for long-term training at Wildlife Institute of India. Similar training programs will be conducted in future as well.

Adequate training infrastructure has been developed within FD under different donor funded projects including World Bank funded FRMP. Under the present cumbersome appointment procedures it may not be possible to recruit permanent staff in FD training institutes. So networking with other training and research institutes such as BFRI and IFESCU will be necessary.

A training needs assessment for participatory PA management was conducted under FSP (TECSULT, 2000). A provisional list of professional specialist skill is presented as below from the study (Art et al, 2004) conducted under NSP:

- ➔ Strategic and Adaptive PA Management Planning
- ➔ Information Technology (MIS)/Spatial Data Management (GIS)

- ➔ Communication Hardware Technology
- ➔ Information, Education and Communication (IEC)/Visitor Services
- ➔ Public Outreach and Extension
- ➔ Community Relations : Conflict Management and Resolution
- ➔ Community Support : Livelihoods Improvement
- ➔ Environment and Wildlife Law/Legal Support
- ➔ Law Enforcement
- ➔ Financial Management Accounting
- ➔ Wildlife Insurance and Compensation
- ➔ Co-management of PAs
- ➔ Conservation Biology
- ➔ Ecological and Biodiversity Inventory and Research
- ➔ Habitat Management of Rehabilitation Applied Research
- ➔ Wildlife Management, Rehabilitation and Species Recovery
- ➔ Socio-economic Research
- ➔ Gender and Ethnic Diversity
- ➔ Leadership Training and Decentralized Management

8.6 Conservations Acts and International Conventions

The existing Wildlife (Preservation) (Amendment) Act, 1974 is now under revision process by a committee of FD officers. The revision process should be expedited and completed after taking inputs from renowned legal experts and relevant stakeholders. This means that the draft Act will be subject to public scrutiny before it is finalized and finally gazetted. It should be ensured that the revised Act is compatible with relevant international conventions and agreements signed by the Government of Bangladesh.

8.7 Summary of Main Prescriptions

Main prescriptions outlined under the above-developed protection programs are summarized in Table 8.1 as below:

Table 8.1 Summary of Main Prescriptions

Year	Main Activities	Main Outputs/Success Criteria	Responsibility
1	➢ Identifying possible conservation topics for taking up research studies	A list of research topics prepared	NSP/FD
	➢ Holding stakeholders consultations on the proposed list of identified research topics	A short list prepared after stakeholders consultations	NSP/FD/ Stakeholders
	➢ Identifying and networking with interested national organizations for conducting selected research studies	Interested research organizations contacted	NSP/FD
	➢ Developing a set of indicators for conservation monitoring	A set of indicators selected after consultations	NSP/FD
	➢ Collecting and developing benchmark data/information base with respect to core indicators	Benchmark surveys completed	NSP
	➢ Identifying regional and international organizations for networking and cross-learning	Relevant regional organizations contacted	NSP/FD
	➢ Preparing an overseas and in-country training plan for imparting training to all stakeholders	Conservation training plan finalized	NSP/FD
	➢ Finalizing the draft Wildlife Act	Draft Wildlife Act finalized and submitted to MOEF	FD/NSP

2	➢ Prioritizing the identified research topics	Priority list finalized after stakeholders consultations	NSP/FD/ Stakeholders
	➢ Developing ToRs and arranging budget for priority research studies	ToRs ready with required budget	FD/NSP
	➢ Contracting interested national organizations for conducting selected research studies	Interested research organizations contracted	NSP/FD
	➢ Collecting and developing follow up data/information base with respect to core indicators	Follow up surveys completed	NSP
	➢ Maintaining regular contacts with regional and international organizations for networking and cross-learning	Contacts with regional organizations maintained	NSP/FD
	➢ Implementing overseas and in-country training plan for imparting training to all stakeholders	Training plan implemented	NSP/FD
	➢ Approving the draft Wildlife Act	Draft Wildlife Act submitted to Ministry of Law and other related ministries	FD
3, 4 and 5	➢ Implementing conservation research studies on the identified research topics	Priority research studies completed	NSP/FD
	➢ Disseminating and using research findings	FD and NSP staff use research findings	FD/NSP
	➢ Continue follow up data/information base with respect to core indicators	Follow up surveys completed	NSP/FD
	➢ Maintaining regular contacts with regional and international organizations for networking and cross-learning	Contacts with regional organizations maintained	NSP/FD
	➢ Implementing overseas and in-country training plan for imparting training to all stakeholders	Training plan implemented	FD
	➢ Approving the draft Wildlife Act	Draft Wildlife Act gazetted after Parliament approval	FD

9. ADMINISTRATION AND BUDGET PROGRAMS

9.1 Objectives

Main objective of administration program is to ensure that technical and administrative staff required to manage the Park effectively are approved, developed and posted. Improvements in financial organizational systems will aim for the financial sustainability for the PAs.

9.2 Administrative Set Up

As per the approved organogram a Wildlife Management and Nature Conservation Division is to manage the PAs within an overall supervision of Wildlife and Nature Conservation Circle (with a total of 378 staff) and each PA will be managed by an ACF/FR who will be assisted by 1 DR/Fr and 3 FG/Boatman. It is recommended to implement the approved organogram by creating functional Divisions and posting the field staff for each PA. Each PA will be an operational unit with greater decentralized authority for decision-making with an assigned ACF.

Presently the Lawachara NP is managed under the existing Maulvibazar Range of Sylhet forest division. Lawachara Beat and part of Chautali Beat cover the Park areas. The Park is currently managed within the overall administrative and management structure of Sylhet forest division. But a separate wildlife management & nature conservation division has been approved as per the new organogram. It is recommended that the newly approved division be operationalized (the divisional HQ may be located at Moulvibazar, and be made responsible for the management of Lawachara NP, Rema-Kalenga WS and the proposed Satchury NP) and adequate administrative and management structure be put in place as per the approved organogram. This means that a separate division for wildlife management and nature conservation be established along with approved technical and management staff and adequate infrastructure be put in place. The HQ of ACF and Park be at Lawachara (the existing Beat Office will be converted to Park HQ).

9.3 Staffing Pattern

Under the approved organogram a separate division for wildlife management and nature conservation is to be made functional for managing the two declared PAs and the proposed Satchury of Sylhet. A staff strength of 34 is approved for the division, including technical staff (one ACF, one DR/Fr and three FG/Boatman).

The Park will be an independent management and administrative unit, headed by an ACF. He will have all the administrative and financial powers, which are currently exercised by the concerned Range Officer. Deputy Range Officer, as provided in the approved organogram will function as an attached officer to the ACF, providing assistance as and when required.

Three trained Forest Gaurds as sanctioned per the approved organogram will be in Charge of Bhagmara Camp, Chautali Camp and Janakichara Nursery. Over a time the staffing at the three places will be strengthened by posting trained Forester at Bhagmara Camp, Chautali Camp and Janakichara Nursery. In addition, many co-management activities will be carried out in association with the stakeholders and related co-management committees. Participants will have greater role in interface landscape zone.

9.4 Duties and Responsibilities

The Park will be managed by an ACF under the overall charge of DFO who will be work under the guidance of Conservator of Forest (Wildlife & Nature Conservation Circle).

Main responsibilities (as per the approved organogram) of CF will i) be responsible for overall administration of the Wildlife and Nature Conservation Circle; ii) supervise and coordinate all the matters related to wildlife protection and management of PAs, ecological critical areas, critical watersheds, wetlands of international importance, and environmental management under Wildlife Preservation Act and other Ordinance, Rules and Regulations and Directives issued by the government from time to time; iii) be responsible to take necessary measures and efforts to fulfill national obligations towards wildlife, biodiversity and other forestry and environmental related international treaties, protocols and conventions

endorsed by the government; iv) be responsible for completion of all works within the budget provision of the Circle and distribution of funds within his budget grant among the Divisions under him; v) be responsible for all correspondences relating to wildlife management from time to time; vi) identify and draw up plans and programme for ex-situ and in-situ conservation for botanical/baldha gardens and PAs; vii) be responsible for taking programme related to conservation and management of PAs. Supervision of environmental management and nature conservation functions outside the PAs; viii) be responsible for drawing up programme for monitoring, survey and research in the PAs in relation to wildlife and biological diversity; ix) ensure the preservation of biodiversity, conservation of gene pool, germ plasm and the natural heritage of the nation; x) be responsible for preparation of budget and revised budget of his circle; xi) be responsible for appointment, promoting, disciplinary action, disposal of appeal cases, writing of ACRs of staff falling within his administrative powers; xii) be responsible for administration and ensuring execution of all functions in the forest division under him as per Policy, Acts, Ordinance, Rules and Regulations and Directives issued by the government from time to time; xiii) be responsible for providing proper executive and operational guidelines to the field staff of the Wildlife & Nature Conservation Divisions. Exercise control and supervision on the Divisions under his jurisdiction; ivx) be responsible for preparation of development/ annual programme related to conservation of biodiversity and eco-tourism; vx) be responsible for preparation and annual inspection of divisional offices within his jurisdiction; vix) be responsible for proper execution of all development programmes within his circle; viix) be responsible for auditing of Divisional accounts and according financial and technical sanctions within his powers; viiix) be responsible for drawing and disbursing in respective offices as well as submission of accounts to the Accountant General; ixx) be responsible for inter-Divisional transfer and posting of Class III and IV staff within the Circle except the staff of his own office; and xx) be responsible for the preparation of preliminary management plan report of the Forest Divisions under his jurisdiction.

As per the approved organogram the DFO (WM & NC), Sylhet Division will i) be responsible for overall administration, management and protection of the resources of the Division and supervise, manage and control over the matters related to biodiversity, wildlife and environmental management. Strict and effective enforcement of laws, rules and regulations related to protection of wildlife including migratory birds and other amphibians and reptiles; ii) be responsible for drawing and disbursing of fund within the division; iii) be responsible for conservation and management of PAs, ecologically critical areas, critical watersheds and wetlands under his jurisdiction with the use of participatory resource management and conservation principles; iv) be responsible for appointment of employees of the Division falling within his powers and dealing with all matters relating to establishment including writing of ACRs of subordinate officers/staff; v) be responsible for transferring and posting of all subordinate staff within the Division except the staff of his own staff; vi) be responsible for preparation of annual budget and revised budget of the Division; vii) be responsible for exercise of powers given under Forest Act (Amendment), Bangladesh Wildlife (Preservation) (Amendment) Act and various Acts and Rules thereunder; viii) be responsible for annual and initiation of programs/activities for habitat improvement within his jurisdiction; ix) be responsible for annual and periodical inspection of PAs and other offices (Range, Beats) under him; x) be responsible for management and in-situ conservation of PAs and execution of all development programme within the jurisdiction of his Division; xi) be Principal Accounting Officer of his Division; xii) be responsible for all types of construction of within his jurisdiction; xiii) be responsible for motivational/contact/public relation and publicity functions within the Division; and xiv) any other responsibility assigned by the CCF/DCCF/CF.

The ACF as officer in Charge for Lawachara NP will directly report to the DFO, Wildlife and Nature Conservation Division. He will be responsible for administration, budget, planning, protection, coordination and implementation of management plan and co-management activities for Lawachara Park. He will maintain liaison with other related government departments and local NGOs for smooth implementation of co-management activities. He will maintain a close liaison with the territorial staff of Sylhet division particularly in protection of forests and wildlife of the PA.

The following responsibilities for ACF as officer in Charge are as per the approved organogram; he/she will i) be responsible for over all administration of the PAs, Range Office and Beat Offices within his jurisdiction; ii) be responsible for exercise of powers given under various Acts and Rules thereunder; iii) help DFO in conducting smooth administration of the Division in which they are posted; iv) help DFO in the matter of all types of construction in the Division; v) help DFO in the matter of maintenance of discipline of the Division; vi) help DFO in the matter of raising plantation and nursery for habitat improvement within his jurisdiction; vii) help DFO in the matter of execution of development programme related to protected area management and wildlife conservation within his jurisdiction; viii) help DFO in

the matter of checking theft and pilferage of forest produces and wildlife; ix) help DFO in the matter of checking encroachment of forest areas; x) facilitating and catalyzing linkages for livelihood programs in the identified landscape zones; xi) maintain close liaison with FD staff responsible for the management of neighbouring forests and social forestry plantations; and x) any other duties assigned by the CF/DFO.

He will be assisted by a Deputy Range Officer (in discharging his duties effectively), who will be responsible for the management of field staff, park budget and protection. He will reside at Park HQ and be de facto Deputy Officer-in-Charge responsible for all Park related matters.

The Forester in Charge of a Beat will be responsible for all the field management activities under his Beat and will be assisted by a FG/Plantation Mali in discharging his duties satisfactorily. Adequate support staff (e.g. clerks, etc.) will be provided for budgetary and administrative management. The present regulatory management systems will gradually be changed to collaborative management systems. Under the co-management approach the participants and resource management organizations will have defined functions in park management.

9.5 Staff Amenities

The existing Lawachara Beat Office will be the HQ of ACF to be posted exclusively for managing Lawachara NP. He will be provided official residence at Lawachara along with other technical staff. If the Park is expanded to include the remainder of Chautali Beat as proposed, the Chautali Beat office will be upgraded and included under Park management.

9.6 Financial Systems

The existing financial organization systems are adequate and appropriate in most areas but needs a detailed review in order to identify specific areas of financial strengthening in future. For example, under the existing budget codes neither there is any specific budget code for PA head (the WNCC is created in 2001 only whereas the budget codes were designed quite early) nor separate budget is allocated for WNCC for PA management. In many countries separate allocations are made for operational funds exclusively for the management of PAs and wildlife. This system needs to be implemented in Bangladesh in order to ensure a certain required level of annual financial stability for in-situ biodiversity conservation in the PAs managed under the WNCC. The funds flow to PA management need to be augmented by retaining and ploughing back a part (say 20%) of the total revenues generated from the PAs. Eco-tourism activities and entry fees for the PA will be a good source of revenue in future.

10. THE BUDGET

The budget requirements for the implementation of Lawachara Management Plan are projected based on the information gathered from FD field offices and official documents.

10.1 Input Requirements and Indicative Cost Estimates

This proposed schedule of inputs and costs is based on the major input requirements identified in Part II of the Plan. It is intended as both a summary of the major inputs required during the five year life of the Plan, and as a guide to further detailed costing by FD staff charged with its implementation. Costs shown are subject to revision during the Plan implementation period.

Table 10.1 Input Requirements and Indicative Cost Estimates for Strategic Programs

Strategic Programs	Unit	Quantity/ Year						Unit Cost '000 Taka	Total Cost '000 Taka	Notes
		Y1	Y2	Y3	Y4	Y5	Total			
1. Habitat Protection Programs										
1.1 Updating of Land Use/Forest Cover Map	ha	4000					4000		200	note 1
1.2 Boundary Demarcation										
1.2.1 signboards	nos	10	15				25	3	75	note 2
1.2.2 outer and zonal boundary posts	km	25	25				50	5	250	note 3
1.3 Formation of groups and signing of participatory conservation and benefit sharing agreements by user groups	User groups (@20 partici-pants/ group)	20	20	10			50	2	100	
1.4 Formalization of co-management councils/committees	lump sum								20	
1.5 Control of illicit felling, poaching, encroachment, forest fires and grazing by user groups and patrolling groups	lump sum								500	note 4
1.6 Communication networks: maintenance of walki talkies, mobile telephones, etc.	lump sum								150	
1.7 Provision of arms and ammunition for control of organized smugglers	lump sum								200	
1.8 Rewards/Incentives for biodiversity protection efforts by FD staff & local stakeholders	lump sum								75	
1.9 Resolution of forest conflicts	no. of meet-ings	30	25	20	20	15	110	1	110	note 5
2. Management Programs										
2.1 Landscape Management Zoning	1589						1589			note 6
2.2 Core Zones Management										
2.2.1 Protecting forests and other biodiversity	ha	4000	4000	4000	4000	4000	4000			note 7
2.2.2 Canopy opening and enrichment planting	ha	40	60	100	60	40	300	8.8	2640	note 8

Strategic Programs	Unit	Quantity/ Year						Unit Cost '000 Taka	Total Cost '000 Taka	Notes
		Y1	Y2	Y3	Y4	Y5	Total			
2.2.3 Replanting framework species	ha	62					62	24	1488	note 9
2.2.4 Short-rotation plantation (woodlot) management	ha		10	30	10		50	10	500	note 10
2.2.5 Habitat improvement works	ha	20	50	100	50	7.2	227.2	15	3408	note 11
2.2.6 Habitat restoration works	ha	20	50	100	50	7.2	227.2	10	2272	note 11
2.2.7 Renovations of existing water bodies	No.	8					8	100	800	note 11
2.3 Interface Landscape Zones Management										
2.3.1 Sustainable Use Sub-Zones	ha						319			
2.3.2 Delineating the forest land assigned to Forest Villagers for betel leaves growing	ha	76					76	0.3	22.8	
2.3.3 Delineating short rotation plantations and assigning to local groups	ha	100	100	43.4			243.4	0.3	73.02	
2.3.4 Motivating Forest Villagers for biodiversity friendly betel leaves growing	HH	63	63	63	63	63	63	0.2	12.6	
2.3.5 Signing PCBSAs with Forest Villagers	HH	20	23	20			63	0.2	12.6	
2.3.6 Village Use Sub-Zones										
2.3.7 Delineating the habitation of Forest Villagers (Magrurchara and Lawachara)	HH	23	20	20			63	0.3	18.9	
2.3.8 Intensive Use Sub-Zones										
2.3.9 Maintaining renovating existing FD buildings	m2	50	70	30	10		160	7	1120	
2.3.10 Support Sub-Zones										
2.3.11 Managing existing plantations and natural vegetation	ha	87	87	87	87	87	435	1	435	
2.3.12 Forming groups and implementing livelihood programs for 16 identified villages	No. of villages	6	5	5			16	2	32	note 12
2.3.13 Transport Corridors Sub-Zone	ha						14.8			note 13
2.3.14 Liaisoning with Land Owning Agencies	lump sum								10	
2.3.15 Raising strip plantations along roads and railway lines	Km.		2	2	1		5	32	160	
2.3.16 Tea Estate Sub-Zones										note 14
2.3.17 Liaisoning with Tea Employers Association	lump sum								15	
2.3.18 Forming user groups of Tea Estate workers	lump sum								60	

Strategic Programs	Unit	Quantity/ Year						Unit Cost '000 Taka	Total Cost '000 Taka	Notes
		Y1	Y2	Y3	Y4	Y5	Total			
3. Livelihoods Programs										
3.1 Selecting priority production technologies	lump sum								15	
3.1.1 Conducting reconnaissance surveys and demand-supply assessment	lump sum								30	
3.1.2 Identifying a list of feasible production technologies based on demand – supply assessment	lump sum								5	
3.1.3 Stakeholders' Consultations on the proposed production technologies	lump sum								25	
3.2 Developing demonstration Centers										
3.2.1 Developing identified fields as demonstration centers	HH	50	50	100	50	50	300	3	900	
4. Facility Development Programs										
4.1 Facilities and Infrastructure										
4.1.1 Headquarters (Lawachara Beat Office)										
4.1.2 Conversion of Beat Officer's Quarters to Forester's Quarters	m^2	80					80	7	560	
4.1.3 conversion of Wildlife Scout Quarters to Forest Department Quarters	m^2	40					40	7	280	
4.1.4 Conversion of Beat Office to Park Office	m^2	125					125	7	875	
4.1.5 Demolition and removal of derelict buildings	lump sum								50	
4.1.6 Construction of ACF's Quarters	m^2	120					120	12.5	1500	
4.1.7 Construction of DFO Office at Moulvibazar	m^2	250					250	12.5	3125	
4.1.8 Construction of DFO residence	m^2	120					120	12.5	1500	
4.1.9 Garage (2 at Moulvibazar)	m^2	25					25	12.5	312.5	
4.1.10 Renovation of Forest Bangloa (1)	m^2	60					60	7	420	
4.1.11 Animal Recovery shed	m^2	100					100	5	500	
4.1.1.6 Construction of Dy. Ranger's Quarters	m^2	100					100	12.5	1250	
4.1.12 Construction of Guard's Quarters (2, each ~60 m^2)	m^2	120					120	12.5	1500	
4.1.13 Headquarters (BFRI Complex)										
4.1.14 Conversion of BFRI Staff Quarters to FD staff Quarters	m^2	80					80	7	560	
4.1.15 Conversion of BFRI Laboratory/Office Building to Environmental Education Centre	m^2		250				250	7	1750	
4. 2 Janakichara Nursery										
4.2.1 Renovation of Hilltop Viewpoint	m^2		50				50	7	350	

Strategic Programs	Unit	Quantity/ Year						Unit Cost '000 Taka	Total Cost '000 Taka	Notes
		Y1	Y2	Y3	Y4	Y5	Total			
4.2.2 Conversion of Wildlife Enclosure to Picnic Shelter	m^2		60				60	7	420	
4.2.3 Removal of derelict buildings	lump sum								50	
4.2.4 Construction of Forester's Quarters	m^2		80				80	12.5	1000	
4.2.5 Construction of Guard's Quarters (2, each ~60 m^2)	m^2		120				120	12.5	1500	
4.2.6 Construction of Plantation Mali's Quarters (2, each ~40 m^2)	m^2		80				80	12.5	1000	
4.2.7 Construction of Public Toilet	m^2		10				10	12.5	125	
4.3 Bhagmara Camp										
4.3.1 Renovation of Single Guard Quarters	m^2		55				55	7	385	
4.3.2 Renovation of Double Guard Quarters	m^2		125				125	7	875	
4.3.3 Construction of Plantation Mali's Quarters	m^2		40				40	12.5	500	
4.4 Chautali Camp										
4.4.1 Removal of derelict buildings	lump sum								50	
4.4.2 Construction of Forester's Quarters	m^2		80				80	12.5	1000	
4.4.3 Construction of Guard's Quarters (2, each ~60 m^2)	m^2		120				120	12.5	1500	
4.4.4 Construction of Plantation Mali's Quarters	m^2		40				40	12.5	500	
4.5 Vehicles										
4.5.1 Double-cab pickups	nos	1					1	2500	2500	
4.5.2 100 cc motorcycles	nos	5					5	130	650	
4.5.3 Student hut/Dormitory	m^2	150					150	12.5	1875	
4.5.4 Dormitory/Barrack for staff	m^2	300					300	7	2100	
4.6 Equipment										
4.6.1 Office equipment	misc	40%	60%				100%	100	100	
4.6.2 Field equipment	misc	40%	60%				100%	200	200	
5. Visitor Use and Visitor Management Programs										
5.1 Nature Interpretation Centre	m^2	100					100	12.5	1250	
5.2 Nature trails	km	0	5	5	5	0	15	8	120	
5.3 Identifying suitable sites for Nature Camps		2					2	2	4	
5.4 Toilets/Restrooms	no.	1	1	1			3	75	225	
5.5 Resting Facility	no.		2				2	100	200	
5.6 Trash cans	no.	5	3	2			10	1.5	15	
5.7 Identifying & training eco-guides	no.	5					5	5	25	
5.8 Preparing publicity materials	no.	9000	7000	5000	3000	1000	25000	0.015	375	
5.9 Motivating Sabuj Vahinis	no.	500	400	300	200	100	15000	0.025	375	

Strategic Programs	Unit	Quantity/ Year						Unit Cost '000 Taka	Total Cost '000 Taka	Notes
		Y1	Y2	Y3	Y4	Y5	Total			
5.10 Film making (audio-visuals) for NIC	no.	1					1	300	300	
6. Conservation Research, Monitoring and Capacity Building Programs										
6.1 Conservation Research										
6.1.1 Floral and faunal inventories	m-m	2	2				4	30	120	
6.1.2 Research studies	m-m	4	3	3			10	75	750	
6.2 Conservation Monitoring										
6.2.1 Biodiversity health monitoring	m-m	12	2	2	2	2	20	30	600	
6.2.2 Socio-economic monitoring	m-m	4	1	1	1	1	8	30	240	
6.3 Conservation Capacity Building										
6.3.1 Overseas study tours (1 DFO, 1 ACF, 1 Forest Ranger)	m-m						2.5	200	500	
6.3.2 Overseas training (2 PG Diploma in Park Management)	m-m	20					20		800	note 15
6.3.3 In-country training (ACF (1), Forest Ranger (1), Deputy Forest Ranger (1), Foresters (4), Forest Guards (8), NGO staff (3)	m-m	11					11	12	132	note 16
6.3.4 In-country training of members of user groups and co-management committees	no.	40	50	50	40	40	220	1	220	
6.3.5 Overseas tour of user groups	No.	25	25				50	20	1000	note 17
7. Administration and Budget Programs										
7.1 Staffing										
-DCF (1)	m-m	12	12	12	12	12	60	10	600	
- ACF (1)	m-m	12	12	12	12	12	60	5	300	
- Forest Ranger/Deputy Forest Ranger (1)	m-m	12	12	12	12	12	60	3	180	
- Foresters (3)	m-m	36	36	36	36	36	180	2.5	450	
- Forest Guards (3)	m-m	36	36	36	36	36	180	2	360	
- Plantation Malis (3)	m-m	36	36	36	36	36	180	2	360	
7.2 Operating Costs										
- support staff, utilities, vehicle fuel and upkeep, *etc.*	months	12	12	12	12	12	60	10	600	

Notes:

1 based on an area of 1589 ha for the Park, proposed extension and landscape zones including a ~2400 ha in a 1 km wide surrounding area. Mapping to be produced by RIMS based on 1996 satellite imagery (more recent IKONOS, if available), updated Forest Department plantation records, ground-truthing by Park staff, and socio-economic surveys.

2 based on number of signboards to be placed at main access points and elsewhere along the Park boundary (estimated 10) and to designate participatory use areas (estimated 15).

3 calculated based on boundary length.

4 estimated mainly for paid patrols by community groups. Vehicles and other equipments are covered under facility development programs

5 estimated expenses for conducting village level meetings for conflict resolution

6 cost for landscape management zoning (based on an area of 1589 ha for the Park, proposed extension and support zones) is covered under item 1.1

7 cost of protection is covered under item 1(Habit Protection Programs)

8 based on the approximate area that may be subject to selective felling or other silvicultural treatment.
9 based on an area of 62 ha of long-rotation plantation in the proposed Park extension which was logged in December 1999. This area will be replanted with indigenous species and managed for a rapid return to forest cover.
10 estimated based on current area of plantations.
11 rough estimates for a number of site specific activities as listed in the text; the funds requirements will be precisely estimated after inspecting the sites.
12 costs are covered under livelihoods programs (Chapter 5 of Part II).
13 strip plantations (being raised under buffer zone planting of FSP) will be used for raising linear plantations in Transport Corridor Zones
14 Tea Estate workers will be covered under livelihoods programs as covered under Chapter 5 of Part II.
15 costs per PG Diploma are calculated as travel costs (US$450 or Tk 27,000) plus tuition fee (US$5000 or Taka 300,000) plus living costs and miscellaneous (Tk 7,200/month).
16 based on training duration of 5 weeks for ACF, 3 weeks for Forest Ranger/Deputy Forest Ranger and 2 weeks for Forester/Plantation Malis/Forest Gaurds/NGOs
17 members of user groups will visit nearby West Bengal by making bus journeys from Dhaka to Kolkata to north Bengal.

10.2 Budget Revision

The budget estimates as presented in the above-stated Section 11.1 are based on the information gathered from FD field offices and are subject to variations depending upon the site locations and actual work periods. It is recommended to prepare annual plans with revised budgets taking into consideration work sites and availability of labour.

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VOLUME 2

S U P P O R T M A T E R I A L

1. NOTIFICATION

The following is an unofficial translation of the original notification in Bangla.

Government of the People's Republic of Bangladesh
Ministry of Environment and Forests
Section – III

No. PBM(S-3)7/96/367

Date: July 07, 1996 A.D.
Asharh 23, 1403 B.S.

Notification

In exercise of the powers conferred by Article 23(3) of the Bangladesh Wild Life (Preservation) Order, 1973 (President's Order No. 23 of 1973), as amended by the Wild Life (Preservation) (Amendment) Act, 1974, (Act XVII of 1974), the Government is pleased to declare 1250 hectares of forests of the Bhanugachh Reserved Forest under Kamalgonj Upazila of Moulavi Bazar District, as described in the Schedule below, as Lawachhara National Park with effect from the date of publication of this notification in the Gazette.

Schedule

Mouza: West Bhanugachh Reserved Forest.

Land within the area of Block 3 and Block 4 mentioned in the Gazette Notification No. 328 (R) dated January 20, 1917 and the Gazette Notification No. 960(R) dated July 21, 1921.

The "FD" marked pillar, situated at the southwest corner of West Bhanugachh Reserved Forest at the junction of Balishira Hill Mouza (Block No. 3), Bharaura Tea Garden Mouza and West Bhanugachh Reserved Forest Mouza at the following bearings and distances from the 11 km marked mile pillar of the Srimangal-Bhanugachh Road of the Roads and Highways Department, has been deemed to be the No. 1 Station.

Station "A" = 11 km marked mile pillar

Bearing	Distance (in chains)
Station A – B = 64° 0′	2.04
Station B – C = 38° 0′	1.97
Station C – D = 18° 0′	1.56
Station D – No. 1 Station = 327° 0′	4.25

South: The line marked from the above-mentioned No. 1 Station, at the bearing 89° 0′ at the distance of 91.20 chains, to the No. 2 Station (which is marked as the northern boundary of Balishira Hill Mouza and Noorjahan Tea Estate Mouza and the southern boundary of West Bhanugachh Reserved Forest).

East: The line reaching the No. 49 Station of the Srimangal-Bhanugachh Road of the Roads and Highways Department, at the following bearings and distances, running in zigzag form towards the north over the boundary line between the West Bhanugachh Reserved Forest and Fulbari T.E. Mouzas starting from the above-mentioned No. 2 Station.

Bearing	Distance (in chains)
1°30′	3.60
40°0′	1.80
80°30′	2.40
29°0′	4.00
55°30′	4.10

Bearing	Distance (in chains)
39°0´	2.40
332°0´	3.90
252°0´	2.00
79°0´	2.80
360°0´	3.20
10°0´	1.60
46°0´	2.80
14°0´	4.00
346°0´	4.20
55°0´	2.40
95°0´	4.10
38°30´	5.80
22°0´	5.50
17°30´	3.20
328°0´	2.50
303°30´	2.20
3°30´	5.60
137°0´	3.50
58°0´	2.00
347°30´	5.80
57°0´	2.80
334°0´	4.80
42°0´	2.80
20°0´	2.80
54°0´	2.20
333°0´	3.00
12°0´	2.20
62°0´	1.80
13°0´	2.80
15°0´	2.40
293°0´	4.00
346°30´	6.60
306°30´	5.60
354°0´	5.50
329°30´	5.00
18°0´	4.85
304°0´	3.20
329°0´	3.00
309°0´	2.90
328°30´	5.40
59°0´	9.20
73°30´	15.20
78°30´	14.00

Thereafter the boundary line leaves the railway line and reaches No. 60 Station towards the southeast at the following bearings and distances:

Bearing	Distance (in chains)
115°30´	5.60
136°00´	3.90
109°0´	24.00
44°0´	5.60
92°0´	10.00
102°30´	10.80

Thereafter the boundary line runs towards the northeast, at the bearing of 27° 30´ at the distance of 13.40 chains, and again reaches the No. 61 Station of the Srimangal-Bhanugachh Road of the Roads and

Highways Department. Thereafter it reaches the No. 63 Station following the said road at the following bearings and distances:

Bearing	Distance (in chains)
30°0´	6.40
87°30´	5.60

Thereafter the boundary line reaches the No. 64 Station towards the southeast corner at the bearing 153° 0´ at the distance of 16.80 chains and from there it reaches the No. 72 Station towards the east at the following bearings and distances:

Bearing	Distance (in chains)
54°0´	8.87
28°30´	6.20
104°0´	5.20
75°30´	7.20
89°0´	4.20
76°0´	6.00
46°30´	3.20
66°30´	4.00

Thereafter the boundary line reaches the No. 73 Station towards the northeast at the bearing 15° 30´ at the distance of 2.85 chains, and from there it travels further northwest and reaches No. 76 Station, *i.e.*, the road of the Roads and Highways Department starting from Srimangal towards Bhanugachh.

Bearing	Distance (in chains)
257°0´	5.60
237°30´	4.30
257°0´	8.20

Thereafter, the boundary line reaches the No. 84 Station towards the northeast and north at the following bearings and distances:

Bearing	Distance (in chains)
25°0´	4.80
68°0´	6.00
18°0´	4.80
65°0´	2.00
2°30´	50.80

North: The boundary line reaches from the above-mentioned No. 84 Station to the No. 91 Station at the following bearings and distances:

Bearing	Distance (in chains)
281°30´	8.80
247°0´	2.60
207°0´	10.80
295°0´	3.90
32°0´	4.40
301°0´	80.60
263°0´	84.50

West: From the above-mentioned No. 91 Station, the boundary line reaches the No. 102 Station, *i.e.*, the railway line from Srimangal towards Bhanugachh, at the following bearings and distances:

Bearing	Distance (in chains)
176°0´	38.00
179°0´	19.20
171°0´	21.60
182°0´	20.00
187°30´	13.60
269°30´	11.70
173°0´	7.20
95°0´	10.00
179°0´	10.20
130°0´	5.20
83°0´	5.60
320°30´	9.20
268°0´	17.00
249°0´	12.40
294°0´	17.60
221°0´	13.20
183°3´	8.80
91°0´	34.80
80°0´	9.00
70°0´	8.20

Thereafter the boundary line reaches the No. 117 Station at the following bearings and distances:

Bearing	Distance (in chains)
182°– 0´	4.00
218°– 0´	9.25
294°– 0´	5.00
240°– 0´	14.50
273°– 30´	12.00

The boundary line thereafter passes towards the southwest through the boundary line between the Bharaura T.E. Mouza and West Bhanugachh Reserved Forest and reaches the “FD” marked pillar at the No. 1 Station, *i.e.,* the station from where it first started, at the following bearings and distances:

Bearing	Distance (in chains)
191°0´	8.00
192°0´	12.00
194°0´	2.40
195°30´	13.20
197°0´	6.60
195°0´	8.60
192°0´	15.20
187°30´	27.50

By order of the President

(Ahbab Ahmed)
Additional Secretary (In Charge)

2. USEFUL GLOSSARY

Biodiversity: The variety of life and its processes including complexity of species, communities, genepools and ecological functions (USDA Forest Service 1993).

Den tree: A standing live tree with cavity in branches or in the bole in use or having potential for use by wildlife.

Keystone species: Animals or plants which by virtue of their presence or absence alter the structure of a community.

Limiting factor: The environmental influence through which the toleration limit of an organism is first reached, which acts as the immediate restriction in one or more of its functions or activities or in its geographic distribution.

Pinch period: A season during which either food or water or both are minimal in their quantity, quality or distribution, causing stress in animal populations.

Riparian zone: An area identified by the presence of vegetation that requires free or unbound water or conditions more moist than normally found in the area.

Sensitive site: A site vulnerable to rapid change in its biological attributes or physical character in the face of management activity or resource uses either due to its small size or due to existing species/communities, which are tolerant to change or are exacting in their habitat requirements or fragile rock/soil formation.

Stand: Plant communities, particularly of trees, sufficiently uniform in composition, constitution, age, spatial arrangement or condition to be distinguishable from adjacent communities.

Succession stage: A stage or recognizable condition of a plant community which occurs during its development from bare ground to climax.

Influence zone: The extent of area outside the legal boundaries over which local villagers have a traditional PA based forests based dependency and/or over which significant wildlife damage occurs.

3. LIST OF WILDLIFE SPECIES

3.1 PART ONE: BIRD SPECIES REPORTED FROM LAWACHARA FOREST AREA

The following list is based on:

Thompson, P.M. and D.L. Johnson. 1999. *Checklist of birds recorded at 19 sites in Bangladesh.* Updated to 1 February 1999. Unpublished MS.

Frequency/abundance categories are defined as:

rare (1-5): number of sightings of rare species since 1977, where known
rare: 5+ sightings since 1977; unlikely to be seen during a visit
uncommon: a fair chance of being seen on a single visit
common: can expect to be seen on a single visit
abundant: seen on every visit; usually many seen

Nomenclature follows:

Inskipp, T., N. Lindsey and W. Duckworth. 1996. *An annotated checklist of the birds of the Oriental Region.* Oriental Bird Club, Sandy, U.K.

Common name	Scientific name	Status
White-cheeked Partridge	*Arborophila atrogularis*	Uncommon
Red Junglefowl	*Gallus gallus*	Common
Kalij Pheasant	*Lophura leucomelanos*	Uncommon
Speckled Piculet	*Picumnus innominatus*	Uncommon
White-browed Piculet	*Sasia ochracea*	Uncommon
Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*	Rare
Fulvous-breasted Woodpecker	*Dendrocopos macei*	Rare
Rufous Woodpecker	*Celeus brachyurus*	Common
Lesser Yellownape	*Picus chlorolophus*	Common
Greater Yellownape	*Picus flavinucha*	Common
Grey-headed Woodpecker	*Picus canus*	Common
Himalayan Flameback (Goldenback)	*Dinopium shorii*	rare (1)
Greater Flameback (Goldenback)	*Chrysocolaptes lucidus*	common
Lineated Barbet	*Megalaima lineata*	common
Blue-throated Barbet	*Megalaima asiatica*	common
Blue-eared Barbet	*Megalaima australis*	uncommon
Coppersmith Barbet	*Megalaima haemacephala*	rare
Oriental Pied Hornbill	*Anthracoceros albirostris*	uncommon
Great Hornbill	*Buceros bicornis*	rare (1)
Common Hoopoe	*Upupa epops*	rare
Red-headed Trogon	*Harpactes erythrocephalus*	uncommon
Indian Roller	*Coracias benghalensis*	rare
Dollarbird	*Eurystomus orientalis*	rare
Common Kingfisher	*Alcedo atthis*	uncommon
Oriental Dwarf Kingfisher	*Ceyx erithacus*	rare (2)
White-throated Kingfisher	*Halcyon smyrnensis*	uncommon
Blue-bearded Bee-eater	*Nyctyornis athertoni*	uncommon
Blue-tailed Bee-eater	*Merops philippinus*	rare
Chestnut-headed Bee-eater	*Merops leschenaulti*	common
Pied Cuckoo	*Oxylophus jacobinus*	rare
Chestnut-winged Cuckoo	*Clamator coromandus*	rare
Large Hawk Cuckoo	*Hierococcyx sparverioides*	rare (5)
Common Hawk Cuckoo	*Cuculus varius*	rare
Indian Cuckoo	*Cuculus micropterus*	uncommon
Eurasian Cuckoo	*Cuculus canorus*	rare

Common name	Scientific name	Status
Oriental Cuckoo	*Cuculus saturatus*	rare (1)
Lesser Cuckoo	*Cuculus poliocephalus*	rare (1)
Banded Bay Cuckoo	*Cacomantis sonneratii*	uncommon
Plaintive Cuckoo	*Cacomantis merulinus*	uncommon
Asian Emerald Cuckoo	*Chrysococcyx maculatus*	rare
Violet Cuckoo	*Chrysococcyx xanthorhynchus*	rare (3)
Drongo Cuckoo	*Surniculus lugubris*	common
Asian Koel	*Eudynamys scolopacea*	rare
Green-billed Malkoha	*Phaenicophaeus tristis*	common
Greater Coucal	*Centropus sinensis*	uncommon
Lesser Coucal	*Centropus bengalensis*	uncommon
Vernal Hanging Parrot	*Loriculus vernalis*	rare
Rose-ringed Parakeet	*Psittacula krameri*	rare
Blossom-headed Parakeet	*Psittacula roseata*	rare
Red-breasted Parakeet	*Psittacula alexandri*	common
Asian Palm Swift	*Cypsiurus balasiensis*	uncommon
House Swift	*Apus affinis*	rare
Oriental Scops Owl	*Otus sunia*	common
Collared Scops Owl	*Otus bakkamoena*	common
Spot-bellied Eagle Owl	*Bubo nipalensis*	rare (1)
Dusky Eagle Owl	*Bubo coromandus*	rare (1)
Brown Fish Owl	*Ketupa zeylonensis*	rare (2)
Brown Wood Owl	*Strix leptogrammica*	rare (1)
Asian Barred Owlet	*Glaucidium cuculoides*	common
Jungle Owlet	*Glaucidium radiatum*	uncommon
Spotted Owlet	*Athene brama*	uncommon
Brown Hawk Owl	*Ninox scutulata*	common
Grey Nightjar	*Caprimulgus indicus*	rare (1)
Large-tailed Nightjar	*Caprimulgus macrurus*	common
Pale-capped Pigeon	*Columba punicea*	rare (3)
Oriental Turtle Dove	*Streptopelia orientalis*	common
Spotted Dove	*Streptopelia chinensis*	uncommon
Emerald Dove	*Chalcophaps indica*	common
Orange-breasted Green Pigeon	*Treron bicincta*	rare
Pompadour Green Pigeon	*Treron pompadora*	common
Thick-billed Green Pigeon	*Treron curvirostra*	uncommon
Yellow-footed Green Pigeon	*Treron phoenicoptera*	uncommon
Pin-tailed Green Pigeon	*Treron apicauda*	rare (1)
Green Imperial Pigeon	*Ducula aenea*	rare
White-breasted Waterhen	*Amaurornis phoenicurus*	rare
Wood Snipe	*Gallinago nemoricola*	rare (1)
Jerdon's (Blyth's) Baza	*Aviceda jerdoni*	rare
Black Baza	*Aviceda leuphotes*	uncommon
Oriental Honey-buzzard	*Pernis ptilorhyncus*	uncommon
Black (Pariah) Kite	*Milvus migrans*	rare
White-rumped Vulture	*Gyps bengalensis*	uncommon
Crested Serpent Eagle	*Spilornis cheela*	common
Eurasian Marsh Harrier	*Circus aeruginosus*	rare (1)
Pied Harrier	*Circus melanoleucos*	rare
Crested Goshawk	*Accipiter trivirgatus*	rare
Besra	*Accipiter virgatus*	rare
Eurasian Sparrowhawk	*Accipiter nisus*	rare
Common Buzzard	*Buteo buteo*	rare
Changeable Hawk Eagle	*Spizaetus cirrhatus*	uncommon
Little Egret	*Egretta garzetta*	rare
Grey Heron	*Ardea cinerea*	rare
Great Egret	*Casmerodeus albus*	rare
Indian Pond Heron	*Ardeola grayii*	uncommon

Common name	Scientific name	Status
Black-crowned Night Heron	*Nycticorax nycticorax*	rare
Malayan Night Heron (Tiger Bittern)	*Gorsachius melanolophus*	rare (3)
Asian Openbill	*Anastomus oscitans*	rare
Blue-naped Pitta	*Pitta nipalensis*	common
Blue Pitta	*Pitta cyanea*	rare (2)
Hooded Pitta	*Pitta sordida*	common
Silver-breasted Broadbill	*Serilophus lunatus*	uncommon
Asian Fairy Bluebird	*Irena puella*	common
Blue-winged Leafbird	*Chloropsis cochinchinensis*	uncommon
Golden-fronted Leafbird	*Chloropsis aurifrons*	common
Rufous-tailed Shrike	*Lanius isabellinus*	rare (1)
Brown Shrike	*Lanius cristatus*	uncommon
Long-tailed Shrike	*Lanius schach*	uncommon
Grey-backed Shrike	*Lanius tephronotus*	common
Red-billed Blue Magpie	*Urocissa erythrorhyncha*	rare (1)
Common Green Magpie	*Cissa chinensis*	uncommon
Rufous Treepie	*Dendrocitta vagabunda*	rare
Grey Treepie	*Dendrocitta formosae*	common
Large-billed (Jungle) Crow	*Corvus macrorhynchos*	uncommon
Ashy Woodswallow	*Artamus fuscus*	uncommon
Black-naped Oriole	*Oriolus chinensis*	rare
Black-hooded Oriole	*Oriolus xanthornus*	abundant
Maroon Oriole	*Oriolus traillii*	uncommon
Large Cuckooshrike	*Coracina macei*	uncommon
Black-winged Cuckooshrike	*Coracina melaschistos*	common
Rosy Minivet	*Pericrocotus roseus*	common
Brown-rumped (Swinhoe's) Minivet	*Pericrocotus cantonensis*	rare
Small Minivet	*Pericrocotus cinnamomeus*	rare (2)
Long-tailed Minivet	*Pericrocotus ethologus*	rare
Scarlet Minivet	*Pericrocotus flammeus*	common
Bar-winged Flycatcher-shrike	*Hemipus picatus*	common
White-throated Fantail	*Rhipidura albicollis*	rare (1)
Black Drongo	*Dicrurus macrocercus*	rare
Ashy Drongo	*Dicrurus leucocephalus*	common
Crow-billed Drongo	*Dicrurus annectans*	rare (1)
Bronzed Drongo	*Dicrurus aeneus*	common
Lesser Racket-tailed Drongo	*Dicrurus remifer*	common
Spangled (Hair-crested) Drongo	*Dicrurus hottentottus*	common
Greater Racket-tailed Drongo	*Dicrurus paradiseus*	common
Black-naped Monarch	*Hypothymis azurea*	abundant
Asian Paradise-flycatcher	*Terpsiphone paradisi*	uncommon
Common Iora	*Aegithina tiphia*	common
Large Woodshrike	*Tephrodornis gularis*	common
Common Woodshrike	*Tephrodornis pondicerianus*	rare
Blue Whistling Thrush	*Myophonus caeruleus*	rare
Orange-headed Thrush	*Zoothera citrina*	uncommon
Dark-sided Thrush	*Zoothera marginata*	rare (1)
Black-breasted Thrush	*Turdus dissimilis*	rare
Grey-winged Blackbird	*Turdus boulboul*	rare (2)
Eyebrowed Thrush	*Turdus obscurus*	rare (3)
Dark-throated Thrush	*Turdus ruficollis*	rare
Lesser Shortwing	*Brachypteryx leucophrys*	rare
White-browed Shortwing	*Brachypteryx montana*	rare (2)
Red-throated Flycatcher	*Ficedula parva*	common
Snowy-browed Flycatcher	*Ficedula hyperythra*	uncommon
Little Pied Flycatcher	*Ficedula westermanni*	uncommon
Slaty-blue Flycatcher	*Ficedula tricolor*	rare (1)
Sapphire Flycatcher	*Ficedula sapphira*	rare (2)

Common name	Scientific name	Status
Verditer Flycatcher	*Eumyias thalassina*	uncommon
Small Niltava	*Niltava macgrigoriae*	rare (1)
Rufous-bellied Niltava	*Niltava sundara*	rare (1)
Pale-chinned (Brook's) Flycatcher	*Cyornis poliogenys*	common
Pale Blue Flycatcher	*Cyornis unicolor*	rare (1)
Blue-throated Flycatcher	*Cyornis rubeculoides*	rare (3)
Tickell's Blue Flycatcher	*Cyornis tickelliae*	rare (3)
Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	common
Indian Blue Robin	*Luscinia brunnea*	rare (1)
Rufous-breasted Bush Robin	*Tarsiger hyperythrus*	rare (1)
Oriental Magpie Robin	*Copsychus saularis*	common
White-rumped Shama	*Copsychus malabaricus*	common
White-capped Water Redstart	*Chaimarrornis leucocephalus*	rare (1)
White-tailed Robin	*Myiomela leucura*	uncommon
Black-backed Forktail	*Enicurus immaculatus*	uncommon
White-crowned Forktail	*Enicurus leschenaulti*	rare (1)
Common Stonechat	*Saxicola torquata*	rare
Grey Bushchat	*Saxicola ferrea*	rare (1)
Asian Glossy Starling	*Aponis panayensis*	rare (1)
Chestnut-tailed Starling	*Sturnus malabaricus*	common
Asian Pied Starling	*Sturnus contra*	rare
Common Myna	*Acridotheres tristis*	rare
Jungle Myna	*Acridotheres fuscus*	uncommon
Hill Myna	*Gracula religiosa*	common
Velvet-fronted Nuthatch	*Sitta frontalis*	uncommon
Barn Swallow	*Hirundo rustica*	common
Wire-tailed Swallow	*Hirundo smithii*	rare (1)
Red-rumped Swallow	*Hirundo daurica*	rare
Black-headed Bulbul	*Pycnonotus atriceps*	uncommon
Black-crested Bulbul	*Pycnonotus melanicterus*	common
Red-whiskered Bulbul	*Pycnonotus jocosus*	abundant
Red-vented Bulbul	*Pycnonotus cafer*	common
White-throated Bulbul	*Alophoixus flaveolus*	common
Olive Bulbul	*Iole viridescens*	uncommon
Ashy Bulbul	*Hemixos flavula*	common
Rufescent Prinia	*Prinia rufescens*	rare (1)
Grey-breasted Prinia	*Prinia hodgsonii*	uncommon
Oriental White-eye	*Zosterops palpebrosus*	common
Chestnut-headed Tesia	*Tesia castaneocoronata*	rare (1)
Slaty-bellied Tesia	*Tesia olivea*	rare (1)
Grey-bellied Tesia	*Tesia cyaniventer*	common
Asian Stubtail	*Urosphena squameiceps*	rare (1)
Common Tailorbird	*Orthotomus sutorius*	common
Dark-necked Tailorbird	*Orthotomus atrogularis*	rare
Common Chiffchaff	*Phylloscopus collybita*	rare
Dusky Warbler	*Phylloscopus fuscatus*	rare
Tickell's Leaf Warbler	*Phylloscopus affinis*	rare
Inornate (Yellow-browed) Warbler	*Phylloscopus inornatus*	common
Greenish Warbler	*Phylloscopus trochiloides*	common
Western Crowned Warbler	*Phylloscopus occipitalis*	uncommon
Blyth's Leaf Warbler	*Phylloscopus reguloides*	common
Yellow-vented Warbler	*Phylloscopus cantator*	uncommon
Golden-spectacled Warbler	*Seicercus burkii*	common
Grey-hooded Warbler	*Seicercus xanthoschistus*	rare (2)
White-spectacled Warbler	*Seicercus affinis*	rare (2)
Lesser Necklaced Laughingthrush	*Garrulax monileger*	uncommon
Greater Necklaced Laughingthrush	*Garrulax pectoralis*	common
Rufous-necked Laughingthrush	*Garrulax ruficollis*	rare

Common name	Scientific name	Status
Abbott's Babbler	*Malacocincla abbotti*	common
Buff-breasted Babbler	*Pellorneum tickelli*	uncommon
Spot-throated Babbler	*Pellorneum albiventre*	rare (2)
Marsh Babbler	*Pellorneum palustre*	rare (1)
Puff-throated (Spotted) Babbler	*Pellorneum ruficeps*	common
Large Scimitar Babbler	*Pomatorhinus hypoleucos*	rare
White-browed Scimitar Babbler	*Pomatorhinus schisticeps*	uncommon
Rufous-fronted Babbler	*Stachyris rufifrons*	uncommon
Grey-throated Babbler	*Stachyris nigriceps*	common
Striped Tit Babbler	*Macronous gularis*	abundant
Brown-cheeked Fulvetta (Quaker Babbler)	*Alcippe poioicephala*	common
Nepal Fulvetta	*Alcippe nipalensis*	common
Long-tailed Sibia	*Heterophasia picaoides*	rare (2)
White-bellied Yuhina	*Yuhina zantholeuca*	common
Greater Rufous-headed Parrotbill	*Paradoxornis ruficeps*	rare (1)
Rufous-winged Bushlark	*Mirafra assamica*	rare
Thick-billed Flowerpecker	*Dicaeum agile*	rare (4)
Yellow-vented Flowerpecker	*Dicaeum chrysorreum*	uncommon
Yellow-bellied Flowerpecker	*Dicaeum melanoxanthum*	rare (2)
Pale-billed (Tickell's) Flowerpecker	*Dicaeum erythrorhynchos*	common
Plain Flowerpecker	*Dicaeum concolor*	uncommon
Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	abundant
Ruby-cheeked Sunbird	*Anthreptes singalensis*	common
Purple-throated Sunbird	*Nectarinia sperata*	common
Purple Sunbird	*Nectarinia asiatica*	rare
Mrs Gould's Sunbird	*Aethopyga gouldiae*	rare (1)
Green-tailed Sunbird	*Aethopyga nipalensis*	rare (1)
Crimson Sunbird	*Aethopyga siparaja*	common
Little Spiderhunter	*Arachnothera longirostra*	abundant
Forest Wagtail	*Dendronanthus indicus*	uncommon
Olive-backed Pipit	*Anthus hodgsoni*	common
White-rumped Munia	*Lonchura striata*	uncommon
Scaly-breasted Munia	*Lonchura punctulata*	uncommon

3.2 PART TWO: MAMMAL SPECIES REPORTED FROM LAWACHARA FOREST AREA

The list of mammals is based on the following sources:

1. Ahsan, M.F. 1995. Human impact on 2 forests of Bangladesh: a preliminary case study. *International Wildlife Management Congress*: 368-372.

2. Feeroz, M.M., M.A. Islam and M.M. Kabir. 1994. Food and feeding behaviour of hoolock gibbon (*Hylobates hoolock*), capped langur (*Presbytis pileata*) and pigtailed macaque (*Macaca nemestrina*) of Lawachara. *Bangladesh J. Zool*. 22(2):123-132.

3. Khan, M.A.R. 1982. On the distribution of the mammalian fauna of Bangladesh. Pages 560-575, *in:* Proc. of the Second *National Forestry Conference*, Bangladesh-1982. Dhaka, Bangladesh, 21-26 January 1982.

4. Leech, J. and S.S. Ali. 1997. *Extended Natural Resources Survey: Part IV – plant and animal species lists.* GoB/WB Forest Resources Management Project, Technical Assistance Component. Mandala Agricultural Development Corporation, Dhaka, Bangladesh. Note: species list derived from RIMS database.

5. Lockwood, I. 1998. Bangladesh's declining forest habitat. *Sanctuary Asia* XVIII: 22-33.

6. Siddiqui, N.A. and M. Faizuddin. 1981. Distribution and population status of some mammals in Bangladesh. *Bano Biggyan Patrika* 10 (1 and 2):1-6.

7. Thompson, P.M. and D.L. Johnson. 1996. Birdwatching areas. Lawachara Forest and Srimangal area, Bangladesh. *Oriental Bird Club Bulletin* Number 24:25-29.

8. Information from local Forest Department staff, May-December 1999.

9. Information from local villagers May-December 1999.

10. Observations by the FSP Biodiversity Conservation and Management Specialists, May-December 1999.

Common name	***Scientific name***	**Source**	**Remarks**
Slow Loris	*Nycticebus coucang*	(2,4,5)	
Pig-tailed Macaque	***Macaca nemestrina***	(2,4,5,7,10)	
Rhesus Macaque	*Macaca mulatta*	(2,4,5,6)	
Assamese Macaque	*Macaca assamensis*	(5,6,7)	
Capped Langur	*Presbytis pileatus*	(2,4,6,7,10)	
Phayre's Leaf-monkey	*Presbytis phayrei*	(2,5,6,7)	
Hoolock Gibbon	***Hylobates hoolock***	(2,4,5,6,7,8,9,10)	
Jackal	*Canis aureus*	(1,8)	
Wild Dog	*Cuon alpinus*	(9)	extirpated
Sloth Bear and/or Himalayan Black Bear	*Melursus ursinus* *Ursus thibetanus*	(9)	extirpated
Yellow-throated Marten	*Martes flavigula*	(7)	
Tiger	*Panthera tigris*	(9)	extirpated
Leopard	*Panthera pardus*	(3,9)	extirpated
Fishing Cat	*Felix viverrina*	(7)	
Leopard Cat	*Felix bengalensis*	(7)	
Wild Pig	*Sus scrofa*	(6,9)	
Sambar	*Cervus unicolor*	(9)	extirpated
Barking Deer	*Muntiacus muntjac*	(1,6,8,9)	
Indian Giant Squirrel	*Ratufa indica*	(4,10)	

This list is incomplete and additional survey work is required. Based on previously reported occurrence in the evergreen and semi-evergreen forests of Sylhet (*e.g.*, Khan 1982) and information from villagers one or more representatives of the following families also can be expected:

- ➔ Talpidae (moles)
- ➔ Soricidae (shrews)
- ➔ Pteropodidae (old world fruit bats)
- ➔ Emballonuridae (sheath-tailed bats)
- ➔ Vespertillionidae (evening bats)
- ➔ Manidae (pangolins)
- ➔ Tupaidae (tree shrews)
- ➔ Viverridae (civets)
- ➔ Herpestidae (mongooses)
- ➔ Pteromyidae (flying squirrels)
- ➔ Muridae (rats and mice)
- ➔ Hystricidae (porcupines)
- ➔ Leporidae (hares)

3.3 PART THREE: REPTILE AND AMPHIBIAN SPECIES REPORTED FROM LAWACHARA FOREST AREA

The list of herptiles is based on the following sources:

1. Leech, J. and S.S. Ali. 1997. *Extended Natural Resources Survey: Part IV – plant and animal species lists.* GoB/WB Forest Resources Management Project, Technical Assistance Component. Mandala Agricultural Development Corporation, Dhaka, Bangladesh. *Note:* species list derived from RIMS database.

2. Information from local villagers May-December 1999.

Common name	Scientific name	Source	Remarks
Reptiles			
Wall Lizard	***Gekko gecko***	(1)	
House Lizard	*Hemidactylus brookii*	(1)	
Common Skink	*Mabuya carinata*	(1)	
Agama (?)	***Oriocalotes paulus***	(1)	
Monitor Lizard	*Varanus* sp.	(2)	
Python	*Python* sp.	(2)	
Amphibians			
Common Toad	*Bufo melanostictus*	(1)	
Skipper Frog	*Rana cyanophlyctis*	(1)	
Bull Frog	*Rana tigrina*	(1)	
Tree Frog	*Rhacophorus leucomystax*	(1)	

This list is very incomplete and additional survey work is required.

4. FRAMEWORK TREE SPECIES

The framework species method of forest restoration was first developed in the late 1980's in Queensland, Australia, where planting just 20-30 carefully selected "framework" tree species resulted in rapidly regenerating forests, accumulating up to 80 tree species, within 6-10 years. The method relies on selecting tree species that: i) are fast-growing with dense spreading crowns that rapidly shade out competing weeds and ii) are attractive to seed-dispersing wildlife, especially birds and bats. In addition, framework species must be easy to propagate in nurseries. High quality seedlings of 20-30 framework tree species, 5-60 cm tall (30 cm for the fastest growing species) are planted 1.6 – 1.8 m apart at the beginning of the rainy season. Weeds are vigorously controlled and fertilizer is sometimes added, but after 2-3 rainy seasons the canopy closes, the forest becomes self-sustaining and no further maintenance is required. Once the "framework" of a forest has been re-established, the other components of the ecosystem can return naturally (Elliott et al. 1998).

The following have been identified as potentially suitable "framework" species for use in forest restoration and enrichment planting in Lawachara National Park. The list comprises species that are known to occur in Lawachara (see preceding List of Plant Species) or elsewhere in Sylhet forests (as listed by Alam 1988), and that satisfy the above criteria. The list includes but is not limited to trees (and some climbers) that belong to one of the three major groups of framework species identified by Elliott *et al*. (1998), as follows:

- Figs (Moraceae). Many *Ficus* species produce figs within a year or two after planting and hence are excellent framework species. Some species are natural colonisers of deforested areas. Birds attracted to feed in fig trees transport in the seeds of other forest trees, adding species to the regenerating forest.

- Legumes (Leguminosae). Because of their nitrogen-fixing properties, many leguminous trees have high growth rates on degraded sites. Flowers and seeds are attractive to wildlife.

- Oaks and chestnuts (Fagaceae). These species cast dense shade, thus inhibiting weed growth, and produce nutritious nuts which attract seed-dispersing wildlife.

The following list is not intended to be comprehensive and can be added to based on the criteria outlined above.

Species indicated in **bold** may be available from BFRI or other nurseries. Wild seed collection will be required for other species.

Family	Species
Moraceae	***Artocarpus lacucha***
Euphorbiaceae	*Bischofia javanica*
Rhizophoraceae	*Carallia brachiata*
Leguminosae	*Cassia fistula*
	Cassia siamea
Fagaceae	*Castanopsis indica*
	Castanopsis tribuloides
Dilleniaceae	*Dillenia pentagyna*
Elaeocarpaceae	*Elaeocarpus* spp.
Juglandaceae	*Engelhardtia spicata*
Ternstroemiaceae	*Eurya acuminata*
Moraceae	*Ficus benghalensis*
	Ficus benjamina
	Ficus comosa
	Ficus hispida
	Ficus infectoria
	Ficus racemosa
	Ficus religiosa

Family	Species
	Ficus rumphii
	Ficus semicordata
Verbenaceae	***Gmelina arborea***
Euphorbiaceae	*Macaranga* spp.
	Mallotus spp.
Magnoliaceae	***Michelia champaca***
Fagaceae	*Quercus* spp.
Theaceae	*Schima wallichii*
Moraceae	*Streblus asper*
Myrtaceae	*Syzygium fruticosum*
	Syzygium grande
Verbenaceae	*Vitex* spp.
Leguminosae	*Xylia dolabriformis*

REFERENCES

Alam, M.K. 1988. *Annotated check list of the woody flora of Sylhet forests.* Bulletin 5, Plant Taxonomy Series, Forest Research Institute, Chittagong.

Elliott, S., D. Blakesley and V. Anusarnsunthorn (eds.). 1998. *Forests for the future: growing and planting native trees for restoring forest ecosystems.* Forest Restoration Research Unit/The British Council, Chiang Mai University, Thailand.

5. LIST OF PLANT SPECIES

The following list of plant species reported from the Lawachara Forest area is based on the following sources:

1. Leech, J. and S.S. Ali. 1997. *Extended Natural Resources Survey: Part IV – plant and animal species lists.* GoB/WB Forest Resources Management Project, Technical Assistance Component. Mandala Agricultural Development Corporation, Dhaka, Bangladesh.

Note: species list is derived from RIMS database, as follows:

Number of Sample Points: 6
Number of Plots: 18

Sample Point	Longitude D M S	Latitude D M S
245	91 49 0	24 20 30
250	91 48 20	24 21 0
253	91 46 40	24 18 30
255	91 47 20	24 18 30
270	91 47 40	24 19 10
280	91 48 0	24 20 0

2. Feeroz, M.M., M.A. Islam and M.M. Kabir. 1994. Food and feeding behaviour of hoolock gibbon (*Hylobates hoolock*), capped langur (*Presbytis pileata*) and pigtailed macaque (*Macaca nemestrina*) of Lawachara. *Bangladesh J. Zool.* 22(2):123-132.

3. Islam, M.A. and M.M. Feeroz. 1992. Ecology of hoolock gibbon of Bangladesh. *Primates* 33(4):451-464.

Scientific Name	**Source**[1]	**Status**[2]
Acacia chinensis	(2)	
Acacia falcataria	(2)	
Acacia mangium	(1)	17
Acacia moniliformis	(1)	11
Acanthus ilicifolius	(1)	17
Actinodaphne angustifolia	(1)	39
Ageratum conyzoides	(1)	17
Albizia moluccana	(1)	22
Allophyllus cobbe	(2)	
Alpinia malaccensis	(1)	78
Alsophila sp.	(3)	
Alstonia scholaris	(1,2)	6
Amoora wallichii	(1,2)	22
Amorphophallus companulatus	(1)	22
Amorphophallus dubius	(1)	17
Anthocephalus cadamba	(1)	17
Anthocephalus chinensis	(2)	
Aphanamixis polystachya	(1)	56
Aquilaria agallocha	(1,2,3)	17
Ardisia solanacea	(1)	17

Scientific Name	Source[1]	Status[2]
Artocarpus chaplasha	(1,2,3)	56
Artocarpus lacucha (lakoocha)	(1,2)	72
Axonopus compressus	(1)	61
Azadirachta indica	(1)	6
Baccaurea sapida	(2)	
Bambusa tulda	(1,3)	17
Belamcanda chinensis	(1)	6
Blumea lacera	(1)	6
Bursera serrata	(1,2)	22
Calamus tenuis	(1)	11
Callicarpa arborea	(1)	50
Canna indica	(1)	6
Carallia brachiata	(2)	
Cassia fistula	(1,2)	17
Cassia siamea	(1)	17
Cassia sophera	(1)	6
Cassia tora	(1)	17
Castanopsis indica	(2)	
Castanopsis tribuloides	(2)	
Chromolaena odorata	(1)	50
Cinnamomum sp.	(2)	
Clerodendrum viscosum	(1)	78
Coccinia cordifolia	(1)	33
Colocasia esculenta	(1)	17
Colocasia nymphaefolia	(1)	22
Commelina benghalensis	(1)	39
Connarus paniculatus	(2)	
Cordia sp.	(2)	
Curcuma aromatica	(1)	17
Cuscuta reflexa	(1)	6
Dalbergia rimosa	(1)	39
Dendrocalamus giganteus	(1)	11
Digitaria granularis	(1)	22
Dillenia pentagyna	2,3	
Dioscorea bulbifera	(1)	67
Dipterocarpus turbinatus	(1)	33
Dracaena spicata	(1)	11
Entada sp.	(2)	
Eucalyptus camaldulensis	(1)	28
Eugenia fruticosa	(1)	33
Eugenia jambolana	(1)	11
Eupatorium odoratum	(1,2,3)	17
Ficus benghalensis	(1,2)	17
Ficus benjamina	(2)	
Ficus comosa	(2)	
Ficus hispida	(2)	
Ficus infectoria	(1)	22
Ficus racemosa	(2)	
Ficus religiosa	(2)	
Ficus rumphii	(2)	
Ficus semicordata	(1)	83
Firmiana colorata	(1)	22
Garcinia cowa	(2,4)	
Geodorum sp.	(3)	

Scientific Name	Source[1]	Status[2]
Gmelina arborea	(1,2,3)	33
Grewia asiatica	(2)	
Hedyotis scandens	(1)	6
Heterophragma adenophyllum	(1)	17
Holarrhena antidysenterica	(1)	22
Hopea odorata	(3)	
Imperata cylindrica	(1)	17
Lagerstroemia speciosa	(1,2)	56
Lantana camara	(1)	39
Lauranthus sp.	(2)	
Lawsonia inermis	(1)	61
Leea crispa	(2)	
Litsea glutinosa	(1)	11
Mallotus sp.	(2)	
Mangifera sylvatica	(2)	
Melastoma malabathrica	(1)	17
Melilotus indica	(1)	17
Melocanna baccifera	(1)	78
Memordia cochinchinensis	(1)	22
Mezoneuron enneaphyllum	(2)	
Mikania cordata	(1)	56
Mikania scandens	(1)	17
Mimosa pudica	(1)	39
Mucuna imbricata	(1)	6
Musa sapientum	(1)	17
Mussaenda roxburghii	(1)	89
Naravelia zeylanica	(1)	22
Oroxylum indicum	(2)	
Passiflora foetida	(1)	22
Phyllanthus embelica	(1,2)	17
Plumeria acutifolia	(1)	6
Polyalthia longifolia	(1)	17
Psilotrichum ferrugeneum	(1)	11
Pterospermum acerifolium	(1)	6
Pygeum sp.	(2)	
Quercus spp.	(3)	
Randia sp.	(2)	
Sacrolobus globosus	(1)	22
Sapium baccatum	(2)	
Sarcolobus globosus	(1)	6
Schima wallichii	(1)	28
Semecarpus anacardium	(2)	
Setaria italica	(1)	22
Shorea robusta	(1)	17
Smilax macrophylla	(2)	
Smilax roxburghiana	(1)	22
Sonneratia caseolaris[3]	(1)	17
Spatholobus sp.	(2)	
Spilanthes acmella	(1)	39
Stereospermum chelonioides	(1)	6
Stictocardia macalusoi	(1)	6
Streblus asper	(1)	28
Swietenia mahogoni	(1)	17
Swintonia floribunda	(1)	6
Syzygium cumini	(2)	

Scientific Name	Source[1]	Status[2]
Syzygium fruticosum	(1,2)	17
Syzygium grande	(1)	50
Syzygium jambos	(1)	72
Tapiria hirsuta	(1)	83
Taxus baccata	(1)	11
Tectona grandis	(1,2,3)	50
Terminalia arjuna	(1)	33
Terminalia belirica	(1,2)	11
Terminalia catappa	(2)	
Tetrameles nudiflora	(3)	
Thespesia lampas	(1)	72
Thunbergia grandiflora	(2)	
Toonia ciliata	(3)	
Trewia polycarpa	(1)	22
Vallaris solanacea	(1)	22
Vitex peduncularis	(1)	11
Xanthophyllum alatum	(1)	17
Xylia dolabriformis	(1)	17
Zanthoxylum rhetsa	(1)	6
Zizyphus rugosa	(1)	28

[1]nomenclature based on original sources.
[2]for species listed by Leech and Ali (1997), status refers to number of sample plots (N=18) where species was observed.
[3]believed to be listed in error due to confusion among common names.

6. GUIDELINES FOR FACILITY DEVELOPMENT

6.1 General Principles

As noted in the Introduction, these guidelines focus on the development of facilities for low volume ecotourism in existing conservation areas, and on the development of support facilities required for conservation area management. This approach implies no or low impacts on natural and cultural resources, based on the following underlying principles:

- ➔ Environmentally responsible design specifications, site planning and construction techniques; and,
- ➔ Ongoing monitoring and mitigation of impacts through environmental audits and other measures.

In combination these will require:

- ➔ Limiting the physical and ecological impacts of all facilities developments;
- ➔ Limiting the visual impacts of all facilities developments; and,
- ➔ Limiting the cultural impacts of all facilities developments.

General guidelines for limiting physical and ecological impacts are:

- ➔ Put the environment first;
- ➔ Know and follow existing environmental regulations;
- ➔ Conduct an environmental assessment for all new facilities proposals;
- ➔ Where possible, select development sites where natural vegetation cover has already been removed or disturbed;
- ➔ Avoid siting facilities in or near key wildlife habitats or other ecologically sensitive areas;
- ➔ Avoid any disturbance to aquatic habitats;
- ➔ Limit construction and working area footprint to the minimum necessary;
- ➔ Limit the use of machinery on site;
- ➔ Limit construction to the dry season;
- ➔ Specify and follow construction cleanup requirements;
- ➔ Rehabilitate/reclaim working areas disturbed during construction;
- ➔ Utilise applicable energy and water conservation technology and practices;
- ➔ Avoid all use of toxic materials, plastics, styrofoam and other persistent wastes;
- ➔ Ensure that all solid and liquid wastes are properly disposed of;
- ➔ Develop and deliver an education programme to avoid visitor impacts on vegetation and wildlife;
- ➔ Identify and deal with problems as they occur;
- ➔ Conduct regular environmental audits to track and mitigate erosion problems, changes in drainage patterns, changes in adjacent habitats and other evidence of site degradation; and,
- ➔ Develop and deliver an environmental awareness programme to all staff.

General guidelines for limiting visual impacts are:

- ➔ Cluster facilities in groups;
- ➔ Use natural materials and colours;
- ➔ Standardise exterior designs and finishes, and maintain a regular schedule of maintenance;
- ➔ Educate visitors in order to prevent graffiti and other damages to facilities;
- ➔ Use only locally occurring species for landscaping;
- ➔ Rehabilitate/reclaim disturbed areas, water catchment ponds *etc.* to natural contours and shapes;
- ➔ Screen support facilities (*e.g.*, generators, septic tanks, staff housing) from public view;
- ➔ Identify and deal with problems as they occur; and,
- ➔ Conduct regular environmental audits to track and mitigate evidence of littering and other negative visual impacts.

General guidelines for limiting cultural impacts are:

- ➔ Involve local communities in all aspects of conservation area management, including facilities development;
- ➔ Identify local community boundaries and use areas during the planning stage of facilities development;
- ➔ Respect facilities development and visitor restrictions requested by communities; and,
- ➔ Develop and deliver a cultural awareness programme to all staff and visitors.

Facilities also need to be cost-effective, but at the same time fit in with environmental and cultural aesthetics. General guidelines for achieving this balance are:

- ➔ Ensure that there is an existing demand or requirement, or reasonable expectation of such demand developing in the near future, before planning and developing any physical facility;
- ➔ Ensure that all facilities are relevant and appropriate to the management and visitor use of natural conservation areas;
- ➔ Utilise local architectural styles, and maximise the use of local materials and labor;
- ➔ Utilise and promote appropriate technologies in all facilities, including indigenous or locally developed energy and water conservation practices;
- ➔ Avoid use of expensive or inappropriate materials (*e.g.*, marble, terrazo, rare or exotic woods);
- ➔ Avoid live animal displays, which require a high level of expertise and are expensive to maintain properly, and may have negative impacts on biodiversity conservation; and,
- ➔ Provide an attractive, natural and safe environment for all visitors.

These principles and guidelines need to be followed, as applicable, during the planning, construction and operation of all conservation areas facilities.

6.2 FACILITY DEVELOPMENT GUIDELINES

Specific guidelines for each type of facility development anticipated in NSP-supported areas are provided below, in the following order:

6.2.1 Access Roads

6.2.1.1 Paved Access Roads

Paved (asphalt-surfaced) access roads pass through Lawachara National Park and immediately adjacent to Madhupur NP, Teknaf Game Reserve and Chunati Wildlife Sanctuary. These roads are variously the responsibility of RHD and LGED, but their proper use and maintenance within the conservation area context will require cooperation between RHD/LGED and FD staff to prevent unnecessary widening of the road rights of way, to minimise habitat loss, to control vehicle speeds and hence minimise wildlife road kills, and to minimise vehicle noise.

Guidelines for Paved Access Roads:

Do	Don't
➢ use asphalt or other hard surfacing only on access roads with high traffic volumes, used by heavy vehicles, or requiring constant access during the rainy season ➢ limit vegetation clearing during road maintenance to within 1 m of pavement ➢ conduct roadside vegetation clearing by hand only ➢ avoid use of chemicals in roadside vegetation management ➢ post speed limits and no littering signs ➢ limit use of horns to emergency situations ➢ maintain working contacts with other responsible agencies to ensure that all guidelines and restrictions are followed	➢ permit the routing of new road alignments through conservation areas, except as specifically required for conservation area management purposes ➢ permit the use of sand, gravel, fuelwood or any other material harvested from conservation areas to be used in road maintenance

6.2.1.2 Unpaved Access Roads

Unpaved access roads (including brick or aggregate-surfaced roads and earthen tracks) are located in or adjacent to all NSP-supported conservation areas. Some of these roads are the responsibility of LGED, and as above their proper use and maintenance within the conservation area context will require cooperation between LGED and FD staff. Others have been established to provide access to FD plantations, while still others appear to have been informally established along the route of existing foot and cart trails and are passable to vehicle traffic only during the dry season, if at all. However even these require management attention to ensure that improved but unwanted vehicle access to the interior of conservation areas is not inadvertently created.

Guidelines for Unpaved Access Roads:

Do	Don't
➢ use natural surfacing (herringbone brick, crushed gravel, earth), as appropriate to traffic levels, on interior access roads ➢ limit public access (using gates, barriers *etc.*) on roads created specifically for conservation area management purposes ➢ limit earthwork and vegetation clearing during road maintenance to within 1 m of road edge ➢ conduct roadside vegetation clearing by hand only ➢ avoid use of chemicals in roadside vegetation management ➢ immediately revegetate/stabilise bare areas created during road maintenance	➢ permit the routing of new road alignments through conservation areas, except as specifically required for conservation area management purposes ➢ permit the use of sand, gravel, fuelwood or any other material harvested from conservation areas to be used in road maintenance

Do	Don't
➢ limit access development and maintenance to single lane ➢ post signs indicating speed limits, no littering, and no use of horns except in emergency situations ➢ maintain working contacts with other responsible agencies to ensure that all guidelines and restrictions are followed	

6.2.1.3 Bridges and Culverts

Access roads into or through established conservation areas are primarily the responsibility of RHD or LGED. However, some forest roads and trails are the responsibility of neither of these agencies, and will need to be maintained by FD if their use is required either for patrolling or for visitor access. These roads are likely to be unsurfaced (or at most surfaced by herringbone brick) and hence adequate precautions against scouring and erosion will be required, particularly at stream crossings.

Guidelines for Bridges and Culverts:

Do	Don't
➢ maintain bridges and culverts sufficient to prevent washouts, and to keep key roads and trails passable ➢ where development of new access is required, design to minimise the number of watercourse crossings ➢ limit installation work to the dry season, utilising manual labor to the extent possible ➢ limit stream crossings to single lane ➢ minimise disturbance to stream banks and vegetation ➢ make adequate provision at culvert inlets and outlets and at bridge approaches and anchor points to minimise erosion ➢ periodically inspect all bridges and culverts and effect maintenance and repairs as necessary	➢ overdesign (*e.g.*, don't install a bridge designed for 4-wheel vehicle traffic where management access is by motorcycle and/or visitor access by foot) ➢ install any crossings that block stream flow (*e.g.*, log clusters with earth fill) ➢ operate any machinery in any watercourse during bridge or culvert installation ➢ permit ford crossings except where traffic levels are low, where water flow depths are <0.5 m, where approaches are low gradient with low (<1 m) bank heights, and where stream substrates are solid (gravel or rock)

6.2.2 Accommodation

6.2.2.1 Staff Accommodation

All NSP-supported conservation areas are managed under FD's system, which includes *in situ* accommodation for field staff (Range Officers, Beat Officers, Forest Guards, Plantation Malis) primarily clustered around Range and Beat Offices. This accommodation generally follows GoB space standards but there often are insufficient units for numbers of staff, and existing units generally are in poor repair. NSP planning completed to date indicates a need for new or renovated accommodation for all staff levels, including higher level officers (ACFs) newly posted to conservation areas.

Guidelines for Staff Accommodation:

Do	Don't
➢ provide staff housing and basic amenities (*e.g.*, electricity, running water) to a sufficient standard to ensure a positive effect on staff morale and efficiency. ➢ ensure that unused or underused buildings (*e.g.*, as constructed by FD's Wildlife Conservation and Management Project) are put to appropriate use, when otherwise suitable as specified below ➢ renovate and use existing buildings only if they will remain functional throughout at least a 5 year period ➢ remove all derelict buildings and reclaim sites ➢ ensure that building renovations, and new building designs and locations, are functionally and aesthetically appropriate ➢ make maximum use of local building and living technologies (*e.g.*,	➢ permit occupation of staff quarters by other than assigned staff and immediate family members ➢ permit unauthorised construction of outbuildings or other structures

Do	Don't
sanitary latrines, production and use of biogas, fuel efficient stoves, *etc.*) ➢ make maximum use of natural lighting and airflow in building design ➢ locate staff accommodation out of view of visitors/ visitor traffic flow ➢ implement a regular inspection and maintenance programme to ensure that all staff accommodation is kept in clean and habitable condition	

Suggested minimum area standards for staff accommodation:
ACFs: 120 m^2
Range Officers: 100 m^2 (200 m^2 when combined with office)
Beat Officers: 80 m^2 (120 m^2 when combined with office)
Forest Guards: 60 m^2
Plantation Malis: 40 m^2

All staff housing should include adequate living space, kitchen and toilet facilities, and access to clean water

6.2.2.2 Visitor Accommodation

All NSP-supported conservation areas currently provide limited on-site visitor accommodation in the form of Forest Department resthouses. These resthouses are intended primarily for the use of visiting FD staff, although they also are available for use by VIPs and other visitors. Accommodation is typically limited to 1-3 bedrooms, and a maximum of 6 persons. Cooking and cleaning services are provided by a resident caretaker.

Current planning for ecotourism-related facilities is based on the assumption that most ecotourism activities will be small scale and/or primarily day use, and no additional development of visitor accommodation within conservation areas is proposed. Should future use of conservation areas raise demand levels for overnight visitor accommodation, this would best be provided by Parjatan Corporation (*e.g.*, as per their most recent development in the Teknaf area) or the private sector (as per recent hotel developments in Cox's Bazar). Any such additional accommodation should be developed outside of conservation area boundaries.

Immediate needs in terms of FD inputs are for renovation of existing resthouses and construction of new facilities in priority areas.

Guidelines for Visitor Accommodation:

Do	Don't
➢ provide facilities primarily for the use of FD staff and others engaged in area management on a short-term or periodic basis ➢ renovate and use existing buildings only if they will remain functional throughout at least a 5 year period ➢ remove all derelict buildings and reclaim sites ➢ ensure that building renovations, and new building designs and locations, are functionally and aesthetically appropriate ➢ make maximum use of local building and living technologies (*e.g.*, sanitary latrines, production and use of biogas, fuel efficient stoves, *etc.*) ➢ use natural materials (*e.g.* wood, stone, brick) for exteriors, stairs and flooring. Avoid use of bare concrete and terrazzo ➢ use tile, wooden shingles and other natural materials for roofing. Avoid CI and plastic sheeting ➢ make maximum use of natural lighting and airflow in	➢ use visitor accommodation for other purposes (*e.g.*, staff housing) ➢ initiate construction unless adequate capital and maintenance funds are available

Do	Don't
building design ➢ implement a regular inspection and maintenance programme to ensure that all visitor accommodation is kept in clean and well-maintained condition	

Resthouses constructed by the Forest Department were previously based on wood-frame and siding construction, with airflow and cooling maximised by raising the structure on stilts and by appropriate placement of window openings. Recently constructed resthouses have all been concrete construction, with a utilitarian or futuristic design that is out of place in a natural setting, and with a finish that deteriorates and becomes unsightly very rapidly. In addition, generally little or no attention is paid to natural cooling and lighting. A return to previous design principles, using natural materials, and maximising the use of natural airflow and lighting, is required for newly constructed resthouses in conservation areas.

6.2.3 Landscaping

Landscaping is an important consideration in high public use areas, such as around conservation area offices, environmental education/visitor information centres, and picnic areas. It also includes reclamation and revegetation of earthworks such as tanks and roadways.

Guidelines for Landscaping:

Do	Don't
➢ minimise clearing of natural vegetation (and hence the need for landscaping) to the immediate vicinity of facilities ➢ use low maintenance landscaping designs ➢ mimic 'natural' vegetation structure (*e.g.*, layering, non-geometric planting patterns) ➢ use indigenous species to the extent possible ➢ incrementally replace exotic tree plantings (*e.g.*, eucalypts) along roadsides with indigenous species ➢ minimise fencing. Where fencing is necessary use natural materials (stone, wood, bamboo, living fencing) to the extent possible ➢ revegetate bare areas (*e.g.*, roadsides, tank margins) as soon as possible after completion of earthworks ➢ design artificial waterbodies (tanks, reservoirs *etc*.) to look as natural as possible. Use natural shoreline shapes and bank grades, and shoreline and bank revegetation. Avoid square or rectangular shapes, steep banks, and unvegetated areas	➢ use geometric planting designs (straight lines, squares, circles *etc*.) ➢ use elaborate planting designs ➢ use exotics ➢ use barbed wire fencing ➢ locate facilities in areas requiring felling of large trees, or clearing of extensive areas of natural vegetation and subsequent landscaping

6.2.4 Litter Collection

Litter collection facilities are required in all areas of high public use, including park/sanctuary offices, environmental education/visitor centres, and picnic areas.

Guidelines for Litter Collection Facilities:

Do	Don't
➢ provide litter collection facilities in all public contact and public use areas ➢ ensure that litter collection facilities are well sign-posted ➢ use natural materials and colors, at least for outer containers ➢ ensure that litter collection facilities are animal-proof and waterproof ➢ empty litter collection facilities on a regular basis (daily or as otherwise required) and dispose of at an established, preferably	➢ permit litter collection sites to become general dumping areas for domestic waste; confine use to conservation area visitors only

Do	Don't
offsite sanitary waste disposal facility ➢ ensure that final disposal of litter has no or low environmental impact ➢ implement a regular inspection and maintenance programme for all litter collection facilities ➢ ensure that disposal of organic litter such as leaves and other vegetation (*e.g.*, by burning, composting) has no visitor impact	

6.2.5 Observation Towers and Platforms

Towers and platforms provide points from which to observe wildlife, vegetation and scenery. However, they need to be properly sited with a specific purpose in mind. Also, as these facilities can be difficult and expensive to construct and maintain, they should be developed primarily where there is a reasonable expectation of at least moderate visitor use.

Guidelines for Observation Towers and Platforms:

Do	Don't
➢ for maximum field of view, locate observation towers and platforms on hilltops, or in open habitats (wetlands, meadows, forest edges) when in flat terrain ➢ ensure that there is an appropriate "point of interest" (*e.g.*, panoramic or scenic view, wildlife feeding area, variety of trees and other vegetation) ➢ where possible use a screened or concealed approach ➢ make the facility as inconspicuous as possible, using natural materials and colors. Avoid use of bright or gaudy colors ➢ orient to avoid views directly into the sun ➢ ensure that towers and platforms are safe for public use; this will require solid construction, adequate guard rails, caution signs, and frequent inspection and maintenance	➢ locate towers and platforms where public use will result in negative impacts on wildlife ➢ rely on observation towers as a means of policing illicit use of forest products, as they provide a very limited field of view in flat, densely wooded terrain (foot patrols are a much more effective means of controlling forest use)

6.2.6 Offices

Comfortable and functional office facilities for senior field staff are an essential requirement in every conservation area. Although these should not be large or elaborate, sufficient space and support facilities need to be provided to ensure efficient administration of each area. In some areas the park/sanctuary office will also function as the contact point at which visitors obtain information, and hence needs to be open and presentable to the public.

As all NSP-supported conservation areas are managed under FD's system, Range Offices and/or Beat Offices have already been established in or adjacent to each area. In general one of these locations can be selected to function as a main park/sanctuary office. However, existing buildings generally are in poor repair, and will need to be renovated or replaced as appropriate.

Guidelines for Offices:

Do	Don't
➢ provide facilities adequate for the use of all senior FD staff and others engaged in area management (*i.e.*, ACF, Range Officers, Beat Officers) ➢ in areas without other environmental education/ visitor information facilities, locate offices where they are easily accessible to the public, and clearly identify with appropriate signs ➢ utilise natural landscaping around all office buildings ➢ renovate and use existing buildings only if they will remain functional throughout at least a 5 year period ➢ remove all derelict buildings and reclaim sites ➢ ensure that building renovations, and new building designs and locations, are functionally and aesthetically appropriate ➢ use natural materials (*e.g.* wood, stone, brick) for exteriors, stairs and	➢ use security fencing; this gives the wrong message to the public ➢ initiate construction unless adequate capital and maintenance funds are available

Do	Don't
flooring. Avoid use of bare concrete and terrazzo, and of rugs or other unwashable flooring ➢ use tile, wooden shingles and other natural materials for roofing. Avoid CI and plastic sheeting ➢ make maximum use of natural lighting and airflow in building design ➢ implement a regular inspection and maintenance programme to ensure that all offices are kept in clean and well-maintained condition	

6.2.7 Picnic Areas

Available information on existing outdoor recreation demand/use patterns in Bangladesh suggests that picnicking is likely to be the main visitor use of conservation areas that are easily accessible by road. Several tens of thousands of visitors annually visit Bhawal National Park outside of Dhaka for just this purpose, and FD has gained significant experience in developing facilities to meet this demand. Among NSP-supported areas, Lawachara NP already is used by picnickers, and demand is likely to increase in future.

This activity often involves large groups travelling by bus, and may involve other activities (*e.g.*, the use of loudspeakers, and attraction of hawkers and concessionaires) that are not appropriate in a conservation area setting, and that impact the use and enjoyment of the area by others. Providing appropriate facilities, but at the same time maintaining adequate controls, presents a unique set of challenges to conservation area managers.

Guidelines for Picnic Areas:

Do	Don't
➢ provide information on picnic facilities at vehicle entrance points ➢ confine picnicking, including vehicle parking, to designated areas ➢ space facilities to achieve a balance between limiting the physical footprint and avoiding crowding ➢ wherever possible, locate picnic sites and parking in areas where natural vegetation cover has already been removed or disturbed ➢ use natural landscaping to prevent the development of bare/eroded areas. Rotate heavy use areas as necessary to allow ground vegetation to recover ➢ provide easy vehicle access appropriate to facilities location and spacing (*e.g.*, linear, branched or ring road design) and to prevent off-road driving ➢ develop appropriate signage and facilities ➢ provide adequate information on use restrictions (*e.g.*, no loudspeakers or amplified music; no collection of plants, fossils or other natural materials; no cutting of vegetation; no feeding or harassment of wildlife; no off-road vehicle use; no graffiti; no damage to facilities; no littering) ➢ train staff in visitor management, and control and supervise use of all designated sites ➢ provide adequate litter disposal facilities ➢ provide adequate drinking water facilities ➢ provide adequate toilet facilities and keep clean and in working order ➢ ensure that toilets and grey water disposal do not pollute surface or groundwater sources ➢ provide picnic shelters (providing shelter from rain and sun) and picnic tables as required. Use standard, sturdy designs, and maximise use of natural materials and natural color schemes appropriate to a conservation area setting ➢ provide fuelwood (*e.g.*, from harvest of plantations) ➢ control contractors and unauthorised concessionaires (*e.g.*, food sellers, animal rides, boat rentals *etc.*), and ensure that services provided are appropriate to the setting and public use programme ➢ provide access to simple nature trails and other interpretive facilities to broaden visitor experience ➢ develop a mechanism for obtaining and using visitor feedback ➢ keep all facilities clean and free of litter. Clean up all sites immediately after	➢ use security fencing; this gives the wrong message to the public ➢ develop picnic sites in or adjacent to key wildlife habitats, including natural wetlands ➢ initiate facilities construction unless adequate capital and maintenance funds are available

Do	Don't
use ➢ implement a regular inspection and maintenance programme	

6.2.8 Public Toilets

Toilet facilities are required in all areas of high public use, including park/sanctuary offices, environmental education/visitor centres, and picnic areas.

Guidelines for Public Toilets:

Do	Don't
➢ provide toilet facilities, including clean water, in all public contact and public use areas ➢ provide adequate signage to ensure that facilities are easy to find ➢ provide separate facilities for men and women ➢ keep toilets clean and in working order ➢ ensure that toilets and grey water disposal do not pollute surface or groundwater sources ➢ implement a regular inspection and maintenance programme	➢ develop facilities in or adjacent to key wildlife habitats, including natural wetlands ➢ initiate facilities construction unless adequate capital and maintenance funds are available

6.2.9 Signs and Markers

A well-designed sign system helps accomplish two main operational goals, providing an enjoyable and safe experience for all visitors, and helping to protect the land base and on-site facilities (Alberta Community Development 1993)

6.2.9.1 Boundary Signs and Markers

Clear and unambiguous marking of outer boundaries is a priority in all FSP-supported conservation areas, and will be one of the first steps in gaining effective management control. Participatory management and use areas, wherein local residents will have access to forest resources on a sustainable use basis, also need to be clearly marked.

Guidelines for Boundary Signs and Markers:

Do	Don't
➢ based on boundary descriptions in the conservation area notification, delineate and mark all outside boundaries at turning points and at maximum 200 m intervals along straight stretches ➢ delineate and mark all zonal boundaries ➢ ensure that the boundary marking system is as tamper-proof as possible, to prevent removal or shifting of boundary markers ➢ conduct periodic inspections to ensure that boundary marking remains intact ➢ develop, install and maintain sturdy, tamper-proof signboards at access points to external and zonal boundaries (trail and road crossings) giving the conservation area's name and summarising key use restrictions with symbols and in Bangla	➢ create wide cleared corridors along boundaries ➢ blaze trees along boundaries unless no other boundary marking option is feasible

6.2.9.2 Entrance Signs

Each of the NSP-supported conservation areas has one or more main entrance points, and these need to be clearly sign-posted. As they create the visitor's first impression of the conservation area, it is important that entrance signs be designed for both attractiveness and clarity.

Guidelines for Entrance Signs:

Do	Don't
➢ post a large entrance sign indicating the area's name, and readable from a moving vehicle, at the main road entrance or entrances of the conservation area ➢ post a large area sign/information board near the entrance sign, providing a simplified map of the site showing road and trail systems, and recreational and other facilities ➢ utilise natural materials and colors in sign construction	➢ clutter up the entrance with too many signs. Two large signs as indicated are better than a proliferation of small signs

6.2.9.3 Facility/Amenity Signs

Facility and amenity signs are necessary to let visitors know where they are, or how to get to where they want to go.

Guidelines for Facility/Amenity Signs:

Do	Don't
➢ identify each major facility accessible to the public (environmental education/visitor information centre, offices, picnic areas, toilets, water supply points) with a clear and unambiguous sign at the location entrance ➢ supplement these with directional signs (indicating direction and distance) as necessary ➢ utilise natural materials and colors in sign construction	➢ use too many signs

6.2.9.4 Trail Signs

Nature trails are likely to be developed in the NSP-supported protected area, and could also be developed to a limited extent in wildlife sanctuaries. Well-posted trails are a low cost, effective means of providing both recreation and environmental education to conservation area visitors.

Guidelines for Trail Signs:

Do	Don't
➢ provide a trail entrance sign, which identifies the trail head and provides the visitor with information on the trail name, length and walking time ➢ provide supplementary directional signs to orient the user at decision points (*e.g.*, forks in the trail) ➢ provide supplementary interpretive signs, providing information at points of interest, or keyed to a more comprehensive, written trail guide ➢ utilise natural materials and colors in sign construction	➢ use too many signs

Conservation area signs need to be both effective and quiet

"A sign system is effective when it allows visitors to move with safety and minimum confusion to their destination, as well as informing them of the site's facilities, opportunities, points of interest, and regulations. It is quiet when it accomplishes these objectives with minimum intrusion on the natural beauty of the area. In general, an effective and quiet system is composed of a variety of signs"
(Alberta Community Development 1993)

6.2.10 Trails

6.2.10.1 Nature Trails

As noted above, nature trails are likely to be developed in the three NSP-supported protected area, providing both recreation and environmental education to conservation area visitors. Care needs to be taken both to ensure visitor safety, and to avoid environmental impacts.

Guidelines for Nature Trails:

Do	Don't
➢ develop nature trails in areas of ecological interest, utilising existing trails to the extent possible ➢ vary trail lengths to cater to a variety of visitor interest levels and physical capabilities ➢ clearly mark all trails with identification and directional signs, and provide supplementary printed information ➢ provide guidelines on expected visitor behaviour (*e.g.*, no littering, no defacing of trees or rock faces, no collecting of plants or harassment of wildlife) ➢ provide litter disposal facilities along the trail ➢ ensure visitor safety, at least on longer trails, through a registration system and frequent patrols by conservation area staff ➢ minimise trail width and grooming (clearing of adjacent vegetation and maintenance of the trail surface) to the minimum necessary to maintain easy passage and to prevent erosion problems ➢ maintain natural surfacing and use natural erosion controls (live vegetation, plant debris, rock) to the extent possible ➢ monitor visitor use and develop a system for obtaining and using visitor feedback	➢ develop trails through key wildlife habitats, including natural wetlands ➢ clutter up the trail with too many signs ➢ permit motor vehicles, including motorcycles, on the nature trail system (except for motorcycles used by conservation area staff on patrol)

6.2.10.2 Patrol Trails

All NSP-supported conservation areas have existing road and trail systems that have been developed in conjunction with plantation establishment, that link settled areas, or that are used by local residents for access to forest resources. These also provide an access network that can be used by conservation areas staff for patrolling each area.

Guidelines for Patrol Trails:

Do	Don't
➢ develop a patrolling system which regularly covers all parts of the conservation area, utilising existing trails to the extent possible ➢ except as required for approved public access (*e.g.*, leading to main conservation area facilities) close minor roads and trails to all vehicles with four wheels or more ➢ maintain patrol trail system for foot or motorcycle access only ➢ minimise trail width and grooming (clearing of adjacent vegetation and maintenance of the trail surface) to the minimum necessary to maintain easy passage and to prevent erosion problems ➢ replant bypass areas and avoid future "braiding" of trails through wet areas ➢ maintain natural surfacing and use natural erosion controls (live vegetation, plant debris, rock) to the extent possible ➢ monitor use of patrol trails by local residents and illicit resource users	➢ develop trails through key wildlife habitats, including natural wetlands

6.2.11 Utility Corridors

Existing utility corridors in NSP-supported conservation areas are limited to power transmission and telephone lines, although future developments could conceivably include other linear facilities such as gas pipelines. When constructed through forested areas, such developments involve direct permanent loss of habitat, habitat fragmentation (*e.g.*, preventing arboreal species such as gibbons from crossing the cleared corridor), and major human and mechanical disturbances during the construction phase. They also require periodic inspection and maintenance which may include repeated clearing of regenerating woody

vegetation along the long, narrow strip occupied by the utility. These are important considerations in management of conservation areas, and negative impacts need to be minimised to the extent possible.

Guidelines for Utility Corridors:

Do	Don't
➢ zone existing utility corridors as designated use areas during conservation area management planning, and specify use conditions and limitations ➢ limit vegetation clearing to the immediate RoW ➢ conduct vegetation clearing by hand only ➢ maintain connectivity of vegetation cover wherever possible (*e.g.*, in shrub and lower canopy layers) to facilitate wildlife movements ➢ avoid use of chemicals in vegetation management ➢ maintain working contacts with agencies responsible for existing utilities to ensure that all guidelines and restrictions are followed	➢ permit the routing of new utility corridors through conservation areas, except as specifically required for conservation area management purposes ➢ develop new aerial facilities (*e.g.*, power and telephone lines) where buried lines are a viable option

7. GUIDELINES FOR ENVIRONMENTAL ANALYSES

The purpose of environmental analysis is to ensure that the forests/plantation management options under consideration are environmentally sound and sustainable and that the environmental consequences are recognized early and taken into account. The activity is designed I) to identify and assess the potential impacts of the activities proposed ;to be undertaken, aiming at regeneration of forests, ii) to assess the degree to which environmental safeguards are incorporated in the existing plans iii) to interpret and communicate the information about such impacts, and iv) to recommend appropriate measures for strengthening the environmental management in the plans.

The steps involved in environmental analysis could be detailed as below:

- ➔ List all activities envisaged in the plan,
- ➔ Identify their potential impacts,
- ➔ Predict the magnitude of potential impacts on physical and social environment,
- ➔ Evaluate, and interpret the significance, urgency and irreversibility of the impacts,
- ➔ Formulate the mitigatory strategies, and
- ➔ Communicate the results of environmental analysis.

Screening of activities is a process involving a quick run through the list of proposed activities that have significant potential adverse impacts. A check list of questions, providing basic; check of any disorder in the environmental components that could be associated with any activity of the plan, is drawn. Such questions could be as follows:

Land

- ➔ Will the activity alter the landscape character and visual quality
- ➔ Does the work involve excavation and earth moving and would lead to soil erosion
- ➔ Will the activity alter the fertility of the soil
- ➔ Will the activity lead to land pollution
- ➔ Is restoration of the site possible.

Water

- ➔ Will the activity affect the water table
- ➔ Will the activity alter the direction of ground water flow
- ➔ Will the activity pollute the surface and/or ground water
- ➔ Will the activity lead to flood/drought condition
- ➔ Is mitigation possible.

Air

- ➔ Will the activity generate gaseous emissions

- ➔ Will the activity generate particulate emission
- ➔ Will the activity lead to air pollution
- ➔ Are mitigation measures available.

Biota

- ➔ Is the activity compatible with ecological conditions of the area
- ➔ Will the activity have negative effect on floral and/or faunal diversity
- ➔ Will the activity adversely affect any function of the ecosystem (including mycorrhiza)
- ➔ Is itigation possible

Social

- ➔ Will the activity have impact on subsistence and/or commercial needs of the community
- ➔ Are mitigatory measures (alternative sources) available to the community
- ➔ Does the community agreed to such alternate arrangement.

Having determined the range of impacts associated with proposed activities it is crucial to determine the seriousness and magnitude of the identified impacts. The impact matrix provides a mix of negative and positive impacts of activities without providing any rating of their signifcance. This would decide whether the impacts are acceptable or would require mitigatory measures. The significance of the negative impacts is determined by asking the following questions.

- ➔ How importance is the impact in relation to others
- ➔ What proportion of the local population is affected by this impact
- ➔ How much important is the impact to the affected people
- ➔ How much importance is the impact to the affected people
- ➔ How much of a particular resources will be affected over which the effect will be felt
- ➔ How much area and time duration the impacts would affect.

The urgency of impact is the function of rate at which is significant problem will get worse if the negative impact is allowed, ;how quickly the natural system might deteriorate and how much time is available for it's stabilization or enhancement.

Whether the impact is negative or positive, direct or indirect, net of residual, long or short term, reversible or irreversible, is what would determine the ability to mitigate the effects of potential negative impacts of proposed activities. It is ultimately the outcome of decision on the magnitude of impact that would aid developing the mitigatory strategies.

The environmental analysis is expected to result in following outputs:

- ➔ Identification of positive and negative impacts on physical and social environment
- ➔ Suggestions for mitigatory measures; which might reduce or prevent the adverse impacts.
- ➔ Identification of the residual adverse impacts; which can not be mitigated
- ➔ Identification appropriate monitoring strategies to tract the impacts and provide; early warning system.
- ➔ Incorporation of environmental information related to the proposed activities into decision making process, and
- ➔ Selection of optimum alternatives.

8. HABITAT SUITABILITY INDEX MODELS AND EXAMPLE APPLICATIONS

PART ONE

MODEL DEVELOPMENT CONCEPTS AND PROCEDURES

1.0 INTRODUCTION

Two primate species –the hoolock gibbon and capped langur– have been selected as key species for use in the development and implementation of forest management and conservation measures during the Management Plan period. The hoolock gibbon represents fruit-eating species requiring mature, continuous tree cover, and the capped langur represents leaf-eating species that are able to utilise a variety of forest types, including plantations and regenerating forest areas.

Habitat Suitability Index (HSI) models have been developed for each of these species, and will form the basis for decisions on how to manage the Park's forest cover. This Annex describes the methodology used in developing and applying these models, and includes a description of the model rationale and mechanics for each species.

2.0 DEVELOPMENT OF HABITAT SUITABILITY INDEX MODELS

2.1 BACKGROUND

2.1.1 Habitat Suitability Modelling

HSI modelling was originally developed to assist resource planners in evaluating habitat management alternatives (USFWS 1981), and has now been widely applied in a variety of situations where a landscape scale assessment and predictive capability is required (*e.g.*, Verner *et al.* 1986; Irwin 1994; Roloff and Haufler 1997). The underlying assumption of the approach is that habitat quality can be assessed through mathematical combinations of habitat structure values, and consideration of the spatial arrangement of limiting factors.

Habitat suitability models describe, in quantitative terms, the relationship between habitat suitability for a given wildlife species and measurable habitat features or other environmental variables. The variables and their assigned values are selected on the basis of known habitat requirements, as described in the literature and/or as determined from field studies.

The modelling process permits the calculation of a species- and time-specific habitat suitability index (HSI) value for any given area, based on a combination of remotely sensed measurements of the component variables (*e.g.,* from aerial photographs, satellite imagery, forest cover maps) and field measurements. It also permits an assessment of how changes in the model variables (*e.g.,* as resulting from forest harvesting, plantation establishment, forest protection) affect habitat suitability of a given area for a given species.

The theoretical range of HSI values is from 0.0 (indicating no habitat value) to 1.0 (the best possible habitat). HSI values normally are calculated for circumscribed areas each having relatively uniform habitat conditions for the species in question, as measured by the model variables. These HSI values can be mapped to provide a spatial portrayal of habitat quality.

An additional feature of this approach is that it permits the incorporation of area measurements; multiplying the HSI value by area yields Habitat Units (HUs), which can be summed to obtain a measure of the habitat value of large, diverse areas within which a series of HSI and HU values have been calculated. This permits an evaluation of spatial changes in habitat availability over time, and/or in response to different management regimes.

2.1.2 Selection of Key Species

Lawachara National Park supports a broad diversity of plant and animal species. For example, 242 species of birds have been recorded in the area, and the total diversity of all life forms probably amounts to several thousand species.

Clearly, it is not possible to consider the habitat needs of each individual species in the development and implementation of forest management and conservation measures. In order to overcome this problem, habitat assessments and biodiversity monitoring generally focus on a limited number of species or species groups selected on the basis of defined criteria. Although there is no universal system, some of the more commonly used groupings and criteria are as follows (based on Burley and Gauld (1995), Heywood (1995) and other references):

Keystone species: species that play a major role in maintaining ecosystem structure and integrity. For example, figs can be viewed as keystone species given their overwhelming role in supporting primate and frugivorous bird communities, and the reciprocal role of wildlife in spreading seeds and ensuring the perpetuation of figs and other forest plants. Elephants have also been classified as keystone species, given their role in modifying and maintaining habitat structure.

Ecological indicator species: species that are adapted to (or predictably react to) specific environmental factors, and hence flag changes in biotic or abiotic conditions (*e.g.*, aquatic invertebrates that are sensitive to changes in water quality).

Guild representatives: species that represent groups of species with similar feeding or habitat use strategies (*e.g.*, the pied hornbill as a representative of fruit-eating birds).

Umbrella species: species whose occupancy area (in the case of plants) or home ranges (for animals) are large enough and/or habitat requirements broad enough, that an area managed for their long-term conservation will automatically include a variety of other species with smaller distributions or home ranges. Tigers, elephants, hornbills and other wide-ranging large mammals and birds are good examples of umbrella species.

Flagship species: species that are well known to the public, or otherwise evoke sympathy or recognition, and that can be used as "symbols" for conservation efforts. Elephants and other large mammals are examples of flagship species.

Threatened species: species that are threatened with extinction on a global or local basis (all species on IUCN's Red List (WCMC 1998)).

Economically important species: species that have economic, amenity or touristic value (*e.g.*, timber trees, medicinal plants, easily viewable wildlife).

In order to streamline the model development and application process, the number of species selected for HSI modelling in Lawachara National Park was limited to two –the hoolock gibbon and capped langur. A number of criteria were taken into account in selecting these species (Table 1a).

Table 1a
Criteria for selection of key species for HSI modelling (species selected)

Criterion	Degree to which criterion is fulfilled:	
	Hoolock gibbon	**Capped langur**
➢ species should be broadly representative of the range of habitat conditions that currently occur, or that are aimed for through management intervention	➢ represents mature evergreen and semi-evergreen forest cover with a full complement of fruiting trees	➢ represents mature semi-evergreen forest cover and earlier seral stages, including plantations under assisted regeneration to natural forest composition
➢ species should be "high profile", with demonstrable conservation value	➢ restricted world range; Bangladesh populations of high importance ➢ included on IUCN Red List as Data Deficient ➢ high interest species for ecotourism	➢ restricted world range; Bangladesh populations of high importance ➢ included on IUCN Red List as Vulnerable ➢ easily observable and photogenic
➢ habitat requirements (food, cover, space) should be well known	➢ published research studies available ➢ research locations include	➢ published research studies available ➢ research locations include

Criterion	Degree to which criterion is fulfilled:	
	Hoolock gibbon	**Capped langur**
	Lawachara NP	Lawachara NP
➢ populations should be amenable to relatively rapid and accurate periodic census for population monitoring	➢ census methodology already developed ➢ groups occupy fixed home ranges thus facilitating census	➢ census methodology already developed ➢ groups occupy fixed home ranges thus facilitating census
➢ populations should be viable in the long-term, within the available or potentially available habitat area	➢ population is isolated within West Bhanugach Reserved Forest with no potential for natural immigration or emigration ➢ long-term population viability needs to be determined (Population and Habitat Viability Analysis required)	➢ population is isolated within West Bhanugach Reserved Forest with little or no potential for natural immigration or emigration ➢ long-term population viability needs to be determined (Population and Habitat Viability Analysis required)
➢ the models developed should be applicable to other conservation areas	➢ not proposed for application in other NSP protected areas, but potentially applicable elsewhere in Bangladesh or other countries within the range	➢ also applied in Rema-Kalenga WS
Conclusion:	➢ selected as representative of species requiring mature evergreen or semi-evergreen forest and an abundance of fruiting trees	➢ selected as complementary to hoolock gibbon, effectively broadening the range of species covered to include those using degraded or early seral forest and forest edges

Table 1b
Criteria for selection of key species for HSI modelling (examples of species rejected)

Criterion	Degree to which criterion is fulfilled:	
	Barking deer	**Oriental pied hornbill**
➢ species should be broadly representative of the range of habitat conditions that currently occur, or that are aimed for through management intervention	➢ occupies a broad range of habitats in generally thickly wooded areas ➢ represents forest edge and species feeding in clearings and on forest floor	➢ represents evergreen and semi-evergreen forest cover with a full complement of fruiting trees
➢ species should be "high profile", with demonstrable conservation value	➢ widely distributed across South, Southeast and East Asia ➢ not included on IUCN Red List	➢ widely distributed across South and Southeast Asia ➢ easily observable ➢ not included on IUCN Red List
➢ habitat requirements (food, cover, space) should be well known	➢ habitat requirements generally known but not specifically determined within Bangladesh range	➢ habitat requirements generally known but not specifically determined within Bangladesh range
➢ populations should be amenable to relatively rapid and accurate periodic census for population monitoring	➢ secretive and not easily censused	➢ wide-ranging; cannot be reliably censused within a small fixed area such as Lawachara
➢ populations should be viable in the long-term, within the available or potentially available habitat area	➢ West Bhanugach Reserved Forest provides an important block of habitat, with natural immigration and emigration probably occurring through neighboring Tea Estates	➢ individuals are highly mobile and thus not restricted to West Bhanugach Reserved Forest ➢ population probably viable as long as sufficient forest patches remain
➢ the models developed should be applicable to other conservation areas	➢ not proposed for application in other NSP protected areas or elsewhere in Bangladesh	➢ not proposed for application in other NSP protected areas or elsewhere in Bangladesh
Conclusion:	➢ habitat use is generally too broad to be representative of	➢ mobility makes occurrence haphazard and thus not

Criterion	Degree to which criterion is fulfilled:	
	Barking deer	**Oriental pied hornbill**
	target habitat types (evergreen and semi-evergreen forests) ➢ requirements for dense cover and food at ground layer (fallen fruits, herbaceous vegetation) adequately covered by hoolock gibbon and capped langur HSI models and associated management measures	necessarily indicative of habitat quality ➢ requirements for an abundance of fruiting trees adequately covered by hoolock gibbon HSI model

Hoolock gibbons and capped langurs are both canopy dwellers. Selection of key species was limited to this habitat stratum based on the following assumptions:

1. That the main habitat management aim in the Park is to maintain the maximum extent of mature, closed canopy forest; and,
2. That if habitat is maintained for canopy dwellers, it will also be maintained for lower layers (mid-story and understory trees, shrub layer, forest floor), but that the converse is not necessarily true (*e.g.*, focussing on maintaining a shrub layer will not guarantee retention of a canopy layer).

These two species are considered to provide an adequate basis for ensuring that the main habitat management aim of maintaining the maximum possible area under forest cover, and of maintaining this forest and its constituent biodiversity in the best possible condition (Volume 1, Section 4.2.4.3), is fulfilled. On a broad scale, optimising habitat for hoolock gibbons and capped langurs will also maintain habitat for all other species requiring dense, mature evergreen and semi-evergreen forest cover (the original vegetation cover of the Park and surrounding area). By definition this includes all animal and plant species utilising living tree crown and trunk substrate. With appropriate management it will also include species dependent on dense undergrowth, snags (standing dead trees), natural forest openings (as created by fallen trees), fallen fruits, deadfall (fallen branches and trees) and litter (fallen leaves and dead herbaceous undergrowth); this will require preventing or minimising all disturbances (fire, grazing, removal of herbaceous or woody material) in developing or mature forest habitats.

Special consideration will also need to be given to aquatic and riparian habitats, which are present in the Park but are too limited to be incorporated in HSI model development. Given adequate protection from disturbance these habitats are expected to develop naturally and to support a full complement of plant and animals species, with the obvious exceptions (as for forest habitats) of any species that have already been lost.

2.2 MODEL DEVELOPMENT

The first step in HSI model development was a review of relevant field studies and other literature to identify what environmental features (variables) were the best predictors of habitat suitability for each key species. The background review and identification of key habitat factors focussed on the life requisites of food, cover and special habitat requirements such as space (minimum area) and juxtaposition of habitat components. In addition, a comprehensive literature review was conducted to determine the known effects of habitat change on each species, and what additional variables if any needed to be included in the models to account for disturbance factors.

In the HSI approach to habitat assessment, species-specific HSI values normally are calculated for defined areas or land units with uniform ecological conditions. Typically these areas are vegetation types or other habitat units derived from forest cover, biophysical or other ecological maps. The next step in model development was therefore a review and assessment of available mapping for the Park and surrounding area, in order to identify the land units within which the models would be applied.

The RIMS/GIS Database maintained by the Forest Department was assessed as being the best available descriptor of land units having uniform ecological conditions. This database, and associated mapping based on interpretation of SPOT multispectral satellite data, existing forest cover maps, topographic maps and FD plantation records (Figure 1), has the following features:

➔ It divides the whole of West Bhanugach Reserved Forest (including all of the National Park and

proposed extension) into polygons based on current vegetation cover (natural forest, long-rotation plantations, short-rotation plantations, bamboo, agriculture *etc.*);

- ➔ It provides an identification number and area measurement for each polygon; and (for plantation areas),
- ➔ It includes information on year of establishment and major species planted.

The final step in model development was to develop a standard table for assigning HSI values to each polygon type, based on a generic assessment of how well the vegetation cover and structure of each type

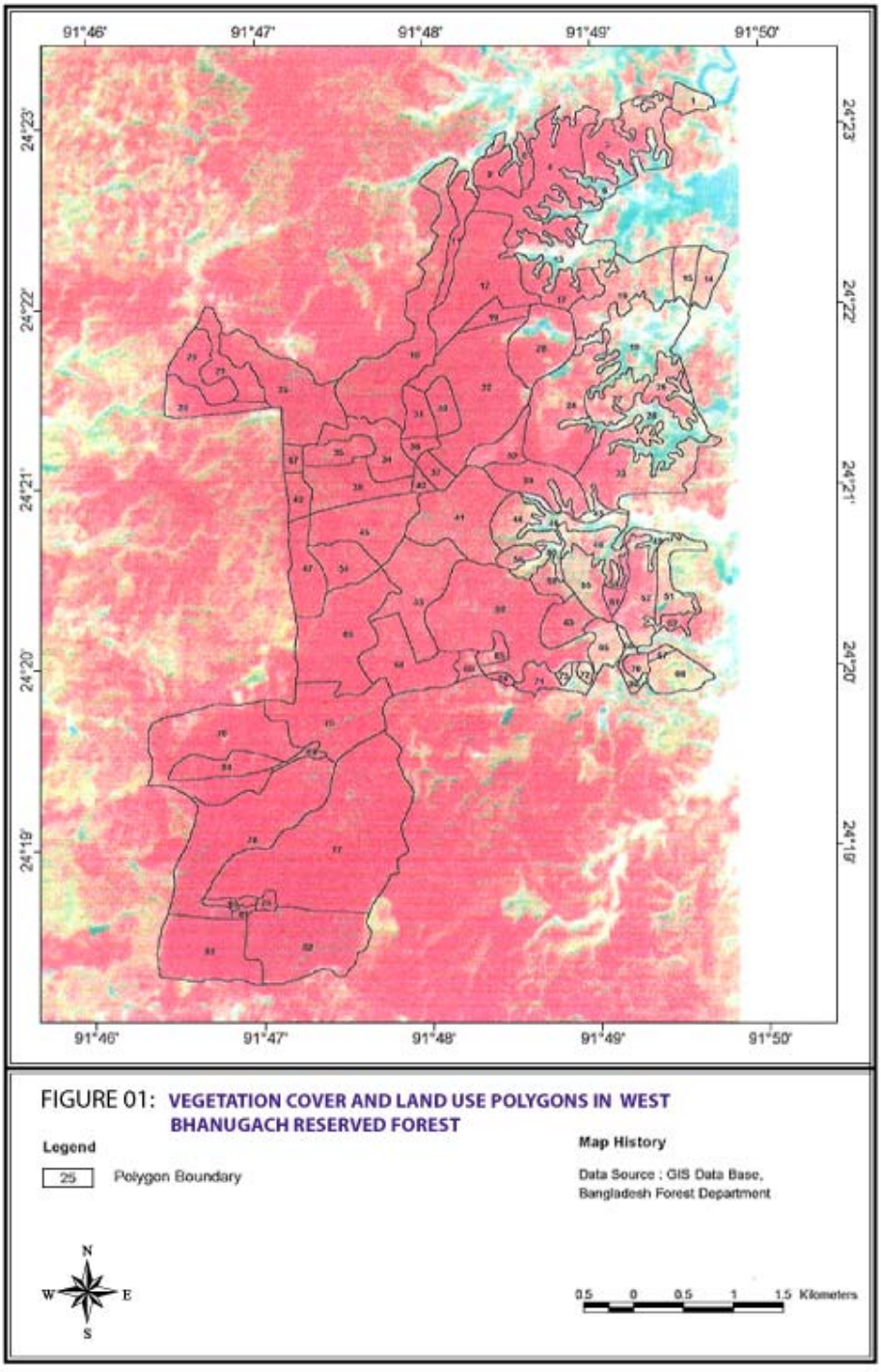

FIGURE 01: **VEGETATION COVER AND LAND USE POLYGONS IN WEST BHANUGACH RESERVED FOREST**

matches the habitat requirements of each species. For example, agricultural areas do not provide any of the habitat requirements of hoolock gibbons, and hence an HSI value of 0 was assigned to this polygon type. Conversely, natural high forest would be expected to provide the requisite food trees, sleeping trees and closed canopy required for travel, and an HSI value of 1.0 was therefore assigned to this polygon type. The HSI assignment tables are included under the individual model descriptions (Parts 2 and 3 of this Annex).

2.3 MODEL APPLICATION

For purposes of this example application the HSI models were applied to three scenarios:

- ➔ A "pre-development" scenario representing a recreation of conditions that would prevail had no plantation development or other human uses of forest occurred in the area (*i.e.*, if all of the area had remained covered by mature evergreen and semi-evergreen forest);
- ➔ A "current" scenario representing current area and type of forest cover, including plantations and other land uses, as determined from the RIMS database and limited field checking; and,
- ➔ A "Management Plan implementation" scenario representing area and type of forest cover that will be retained and/or developed under the management zoning and forest management schemes outlined in the current Management Plan.

For each scenario, total habitat value was determined by multiplying the area of each polygon by its assigned HSI value, and summing the resultant HU values. Additional details are provided under each model description.

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PART TWO

HOOLOCK GIBBON HABITAT SUITABILITY INDEX MODEL

1.0 INTRODUCTION

The hoolock or white-browed gibbon (*Hylobates hoolock*) occupies a very restricted world range, occurring only in eastern Bangladesh, eastern India, southern China and northern Myanmar (Prater 1971; Roonwal and Mohnot 1977). Its status within this range is rated as Data Deficient (*i.e.*, information is inadequate to make an assessment of risk of extinction based on distribution and/or population status, but future research may show that a threatened classification is appropriate) (WCMC 1998).

In Bangladesh hoolocks are found in the evergreen and semi-evergreen hill forests of Sylhet, Chittagong and Cox's Bazar Forest Divisions, and in the Chittagong Hill Tracts (Green 1978; Khan 1982; Wahab and Faizuddin 1984; Khan 1986; Islam and Feeroz 1992; Ahsan 1994). They may also occur in the far north of Mymensingh FD, along the international border with Indian Assam (Khan 1982), where the *sal* forests at the edge of the Garo Hills include an admixture of evergreen species (Alam 1995). Although common during the early part of this century, hoolocks are now considered to be endangered in Bangladesh (Husain 1992), due primarily to destruction of forests and consequent loss of habitat (Islam and Feeroz 1992). The total remaining population may only be in the order of a couple of hundred animals or less (Islam and Feeroz 1992), although quantitative census data are not available.

Studies in Lawachara National Park conducted during 2006 by Wildlife Trust of Bangladesh documented the presence of 55 to 60 hoolocks. Hoolocks are arboreal (tree-dwelling) and mainly frugivorous (fruit-eating), requiring tracts of closed canopy, mature forest to survive. Small family groups (2-5 animals) occupy territories based around abundant food resources. Subadults may eventually take over a parent's territory, or emigrate out of the family group to establish new territories (Ahsan 1995a). Lack of suitable habitat and/or habitat patchiness may constrain emigration and hence reduce long-term population viability.

Gibbons in general are relatively long-lived, becoming sexually mature at approximately 10 years of age and living to an age of 25-30 years (Tilson 1981). First births may not occur until 12 years of age as it takes some time for otherwise sexually mature subadults to establish territories and to pair (Aldrich-Blake and Chivers 1973; MacKinnon and MacKinnon 1977). Based on an interbirth period of 3-4 years, and assuming negligible infant mortality, each monogamous hoolock pair may produce and raise an average of only four offspring during their lifetimes (Ahsan 1995a). This low reproductive rate is, in addition to declining habitat area, potentially a major constraint on long-term population viability.

The habitat suitability model outlined below is based on measurable, physical features of habitat (availability, age, and canopy closure of trees used for feeding, sleeping and travel), and can be used to assess the suitability of any given area of habitat for use by hoolock gibbons. This provides a useful tool for managing habitat for this species, particularly within the context of protected area management. However, the model does not take population dynamics (birth rate, death rate, minimum viable population size) into consideration, and will need to be paired with population viability analyses to ensure the survival of this species within defined habitat areas. This is critically important given the small size of the Lawachara hoolock gibbon population, its spatial isolation from other subpopulations, and the inherently low reproductive rate of this species. It is instructive to note that conclusions and recommendations for the conservation of other (Javan) gibbon populations in similar circumstances have been that the removal of one female and young per year from subpopulations of 100 or less will double the risk of extinction; that where combined subpopulations are not sufficiently large to be considered genetically viable, they need to be managed as a metapopulation; that gibbon populations and habitat need to be monitored on a yearly basis; and that relict populations of 10 or less should be evaluated for intervention by translocation or captive breeding programmes (IUCN/SSC 1994).

2.0 LIFE REQUISITES

2.1 FOOD

Hoolocks are mainly frugivorous, although flowers, leaves, shoots, petioles and insects also are eaten (Prater 1971; Islam and Feeroz 1992; Feeroz *et al.* 1994). All foods are obtained from arboreal sources. Hoolocks are considered to be selective feeders, preferentially visiting food-rich trees where an abundance of food resources is readily available (Feeroz *et al.* 1994). Water is taken directly from leaves in the form of dew or other condensation while feeding.

A study conducted in Lawachara and Chunati during 1990-91 documented use of 42 plant species in 21 families (Table 1). The annual diet consisted of 51% fruit, 38% figs, 6% leaves, shoots and petioles, and 5% flowers (Islam and Feeroz 1992; Feeroz *et al.* 1994). Mature leaves were not eaten, although they were abundant throughout the year. Fruits (including figs) were obtained from 31 species; flowers from 8 species; leaves, shoots and petioles from 3 species; and seeds from 2 species. It is noteworthy that 10 *Ficus* species were utilised as food, providing an important and abundant food source, as one or more species were in flower at any given time of year. Both immature and ripe figs were used, whereas fruits of other species were used primarily when ripe.

Gibbons appear to be important seed dispersers for seed-bearing fruit trees, thus contributing to the perpetuation of their own habitat. Seed dispersal by this species may, therefore, be an important factor in habitat improvement.

Table 1
List of hoolock gibbon food trees in Bangladesh

Family	***Species***	**Part eaten**
Sapindaceae	*Allophyllus cobbe*	flowers(1,2)
Rubiaceae	*Anthocephalus chinensis*	flowers(1,2)
Miliaceae	*Aphanamixis* sp.	seeds(1,2)
Moraceae	*Artocarpus chaplasha*	fruits(1,2), flowers(1,2)
	Artocarpus lakoocha	fruits(1,2)
Burseraceae	*Bursera serrata*	fruits(1,2)
Lauraceae	*Cinnamomum* sp.	fruits(1)
Rhizophoraceae	*Carallia brachiata*	fruits(1,2)
Cordiaceae	*Cordia* sp.	fruits(1,2)
Dilleniaceae	*Dillenia pentagyna*	fruits(1,2), flowers(1,2)
Dioscoraceae	*Dioscorea* sp.	fruits(1,2)
Dipterocarpaceae	*Dipterocarpus turbinatus*	flower(2)
Leguminosae	*Entada* sp.	flowers(1,2)
Moraceae	*Ficus benjamina*	fruits(1,2)
	Ficus comosa	fruits(1,2)
	Ficus benghalensis	fruits(1,2)
	Ficus hispida	fruits(1,2)
	Ficus racemosa	fruits(1,2)
	Ficus religiosa	fruits(1,2)
	Ficus rumphii	fruits(1,2)
	Ficus spp. (3 unidentified species)	fruits(1,2)
Gutiferae	*Garcinia cowa*	fruits(1,2)
Tilliaceae	*Grewia asiatica*	fruits(1,2)
Lythraceae	*Lagerstroemia speciosa*	flowers(1,2)
Leeaceae	*Leea crispa*	fruits(1,2)
Anacardiaceae	*Mangifera sylvatica*	fruits(1,2)
Compositae	*Mikania* sp.	petioles/shoots(2)
Euphorbiaceae	*Phyllanthus embelica*	fruits(1,2)
	Pygeum sp.	fruits(1)
	Sapium baccatum	fruits(1,2)
Anacardiaceae	*Semecarpus anacardium*	fruits(1,2), flowers(2)
Myrtaceae	*Syzygium cumini*	fruits(1,2)

Family	*Species*	Part eaten
	Syzygium fruticosum	fruits(1,2)
	Syzygium spp. (3 unidentified species)	fruits(1,2)
Combretaceae	*Terminalia belerica*	fruits(1,2)
Unidentified	*Unidentified* spp. (3)	leaves, petioles, fruits and seeds(2)

Source: 1=Feeroz *et al.* 1994; 2=Islam and Feeroz 1992. Nomenclature based on original sources.

2.2 COVER

Hoolock gibbons are confined to mature, closed canopy forests by their food habits, travel patterns and nocturnal roosting requirements. In Bangladesh they are confined to evergreen and semi-evergreen hill forests, and possibly to tropical moist deciduous forests where there is an admixture of evergreen species.

As noted above, the diet for the most part consists of fruits, necessitating a year-round abundance of fruiting trees, including figs. This factor alone precludes use of young forests where fruit trees are absent or have not yet matured.

Hoolocks are completely arboreal, spending all of their time in trees and rarely if ever descending to the ground, except during accidental falls (Islam and Feeroz 1992; Ahsan 1995a). Movements between sleeping and feeding areas may follow well-established routes, although ranging patterns vary according to the availability of food (Prater 1971; Islam and Feeroz 1992). Movement through the trees is primarily via brachiation, or swinging from branch to branch (Islam and Feeroz 1992; Feeroz *et al.* 1994). Although hoolocks are good jumpers and often jump more than 3 m from one tree to another, brachiation is facilitated where tree crowns are touching or overlapping. Studies of tree phenology in hoolock gibbon habitat in Lawachara showed that nearly all sampled tree crowns were in contact with each other (Ahsan 1994). In addition, more than one third of sampled trees supported lianas or vines, providing additional travel substrate.

Hoolock gibbons spend over 60% of their time sleeping (Ahsan 1994). Certain sites are preferred for sleeping, often near a preferred food source, but as much as 1.6 km away (Islam and Feeroz 1992). Trees used for sleeping are taller than average, and tend to be located on hilltops or on adjacent slopes (Ahsan 1994). The following species have been documented as used for sleeping*: Albizia procera*, *Alstonia scholaris*, *Aporusa dioica*, *Aquillaria agallocha*, *Artocarpus chama*, *Artocarpus chaplasha*, *Artocarpus lacucha*, *Chukrassia tabularis*, *Dipterocarpus turbinatus*, *Garcinia cowa*, *Gmelina arborea*, *Litsaea sebifera*, *Miliusa roxburghiana*, *Schima wallichii*, *Tectona grandis* and *Xylia kerrii* (Islam and Feeroz 1992; Ahsan 1994).

Studies of tree phenology in hoolock habitat in Lawachara (Ahsan 1994) provided the following descriptors of habitat structure:

- Mean total height of phenological trees: 16.1 +/- 6.4 m;
- Range in total height of phenological trees: 4.5 – 40.2 m;
- Crown base height of phenological trees: mean 7.5 +/- 4.1 m; range 0.9 – 24.1 m;
- Crown width of phenological trees: mean 5.9 +/- 3.2 m; range 1 – 20 m;
- Tree density: 203 trees/ha (>10 cm dbh);
- Phenological trees supporting lianas or vines: 35.4%;
- Phenological tree crowns in contact with each other: 99.6%

2.3 SPACE

Hoolock family groups each maintain their own territories, but may on occasion move outside of these territories to feed on concentrated food sources. Territorial disputes occur primarily along territory borders and in overlapping areas of home ranges (Islam and Feeroz 1992).

Home ranges include both abundant food source areas and preferred sleeping sites. The day range (total distance covered from one sleeping tree to the next) of a group studied over a year long period at Lawachara varied from 600 to 1600 m; total home range during the study period was 35 ha, of which 32 ha (91%) were used exclusively by this group (Islam and Feeroz 1992). Overall home range size during a longer study period (2 years) at Lawachara was somewhat larger at 50.8 ha (Ahsan 1994).

In general gibbons occur at much lower densities than sympatric primate species, probably because their specialised diet centred on figs and other fruits requires them to forage over larger areas (MacKinnon and MacKinnon 1978; Gittins 1982). The available data show that, as for other gibbon species, hoolocks need to be able to exploit relatively large areas, primarily on an exclusive (territorial) basis.

Hoolocks generally do not tolerate the presence of hornbills or Malayan giant squirrels, possibly due to food habits overlap (Islam and Feeroz 1992). However, they generally coexist with langurs and macaques, and inter-specific interactions with other primates are not known to be a major factor in use of space by this species.

3.0 IMPACTS OF DISTURBANCE

Disturbances that may affect hoolock gibbon use of habitat can take many forms. For convenience they are here divided into two main categories: 1) physical alteration of habitat, and 2) sensory disturbances.

Physical alteration of hoolock habitat in Bangladesh includes:

- ➔ Clear-felling of mature forest areas. This results in the direct removal of all forest cover used for feeding, sleeping and travel, and reduction of habitat value of the affected area to zero. Hoolock groups whose territories are affected by clear-felling may or may not be able to persist in adjacent areas, depending on the area and quality of habitat remaining within their territories, and on whether adjacent habitat areas are occupied by other hoolock groups.

- ➔ Creation and/or maintenance of linear corridors through mature forest areas. Hoolocks follow regular travel routes between sleeping and feeding areas, and depend on contiguous forest cover for travel from tree to tree. Although gaps of 3 m and possibly somewhat more can be negotiated by jumping (Section 2.2 above), wider gaps effectively create a barrier to movement. If these gaps are linear, as created by highway, railway and power line corridors, they may be uncrossable or crossable only at certain points (the locations of which may or may not be found by hoolocks), effectively fragmenting available habitat into discontinuous units. Similar to the effects of clear-felling, hoolock groups whose territories are affected by linear corridors may or may not be able to persist in adjacent areas, depending on the area and quality of habitat remaining accessible within their territories, and on whether adjacent habitat areas are already occupied by other hoolock groups.

- ➔ Selective felling in mature forest areas, resulting in removal of food and sleeping trees, and potentially resulting in fragmentation of habitat into isolated patches. As an example of this type of disturbance, in Lawachara some hoolock food trees (*Dillenia pentagyna*, *Garcinia cowa*, possibly others) are used for collecting bark for the manufacture of mosquito coils; this eventually kills the trees which are subsequently felled by fuelwood collectors (Ahsan 1995b). Also in Lawachara, some hoolock food trees (*e.g.*, *Garcinia* spp.) are illegally harvested for house poles. Selective felling of trees used for food, sleeping and travel results in incremental degradation of habitat quality, and if severe and extensive enough may ultimately result in the fragmentation of habitat into isolated patches which can no longer support a viable hoolock population. For example, in Chunati illegal felling had by the beginning of the 1990s resulted in habitat patchiness and isolation of hoolock groups (Islam and Feeroz 1992), to the extent that hoolocks may now no longer occur in the Chunati area.

- ➔ Betel cultivation in mature forest areas. In betel leaf production areas in Lawachara, the large branches of support trees are lopped off and the trees do not produce fruit; betel leaf areas are therefore avoided by primates (Ahsan 1995b), even though tree cover remains.

Sensory disturbances occurring in hoolock habitat in Bangladesh include:

- ➔ Mechanical noise. Hoolocks are disturbed by the sound of wood-cutting, public buses, trucks and trains, and move away from food sources if the sounds are nearby (Ahsan 1995b).

- ➔ Human presence. Hoolocks react to even non-threatening human presence by staring, calling and flight away from the area (personal observation). In Lawachara, local people collecting forest fruits frighten off feeding primates, presumably including hoolocks, by shouting (Ahsan 1995b), resulting both in disruption of feeding and direct competition for food sources.

In addition to these disturbance factors, some hoolocks may be directly removed from otherwise suitable habitat areas by hunting and trapping. The Khasias in Lawachara occasionally hunt primates for meat, and (at least in the past) illegal fuelwood collectors in Lawachara have also engaged in trapping primates for sale to traders (Ahsan 1995b).

4.0 MODEL DEVELOPMENT

The information review presented above indicates that high quality hoolock gibbon habitat is characterised by:

- ➔ Mature, closed canopy evergreen or semi-evergreen forest;
- ➔ An abundance of fruiting trees, with a species mix that provides a year-round food source;
- ➔ An absence of mechanical and human disturbance; and,
- ➔ Contiguous areas of habitat sufficiently large to support a genetically viable population.

As noted in the introductory section of this Annex, the HSI models are designed to be applied to individual polygons listed in the RIMS/GIS Database. Measures of habitat structure (stand maturity, canopy closure, fruiting tree abundance) are not available for individual polygons, but can be inferred from cover type, species composition and stand age descriptors in the database, and on the basis of limited field checking. A judgement of how well these inferred measures match the habitat requirements of hoolock gibbons can then be used to assign generic HSI values to each generalised land use type (Table 2). This provides a first approximation of the overall suitability of habitat in any given polygon, on a scale from 0.0 to 1.0.

Table 2
Habitat Suitability Index values for hoolock gibbons assigned to generalised land use types

Land use type	Inferred value of:			Assigned HSI value
	Stand age	Canopy closure	Fruit tree abundance	
Natural forest (high forest)	old	closed	high	1.0
Natural forest (low forest)	mid	near closed	moderate-low	0.3
Natural forest/betel garden	old	closed	low-nil	0.1
Long-rotation plantations:				
-pre-1950 plantation, mixed species	old	closed	high	0.9
-pre-1950 plantation, mostly teak	old	closed	moderate	0.7
-1950-74 plantation, mixed species	mid	closed	moderate	0.6
-1950-74 plantation, mostly teak	mid	closed	moderate-low	0.4
-1975-1989 plantation, mixed species	young-mid	near closed	low	0.3
-1975-1989 plantation, mostly teak	young-mid	near closed	low	0.1
-1990-1999 plantation	young	open	nil	0.0
Short-rotation plantations:				
-pre-1990 plantation	young	near closed	low	0.0
-1990-99 plantation	young	open	nil	0.0
Bamboo, scrub, failed plantations	young	no canopy	low	0.0
Agriculture	not applicable	not applicable	nil	0.0

The assignment of HSI values in Table 2 assumes that there is a direct relationship between habitat structure (*i.e.*, as described by stand age, canopy closure and fruit tree abundance) and utility as hoolock gibbon habitat, and that there is a continuum from the best habitats (old, closed canopy habitats with high food abundance) downward to habitats offering little or no utility to hoolocks (young, open habitats with low food abundance). On this basis natural forests and old, mixed species plantations provide the best hoolock habitat, and converted areas (bamboo and scrub, young plantations and agriculture) provide little or no habitat value.

Assigned HSI values in Table 2 for predominantly teak plantations are lower than for mixed species plantations of the same age, based on the observations that teak tends to shade out the growth of other species, resulting in a generally poorer forest structure and much lower diversity of fruiting trees, and that teak is not used as a food source by hoolocks. HSI values assigned for short-rotation plantations in Table 2 are based on the assumptions that fruiting trees are not normally planted as short-rotation crops, and that the rotation period is too short for natural ingress and development of fruiting species.

It needs to be borne in mind that the assigned HSI values in Table 2 are "averages" for the given land use type. Actual value as hoolock habitat is likely to differ among polygons of the same land use type (*e.g.*, within the natural forest land use type, one patch of natural forest will have a somewhat higher or lower value than any other patch, and within the 1950-74 mixed species plantation type, 1950 plantations will

generally have a higher value than 1974 plantations), but these differences are considered unlikely to be important within the overall accuracy level of the model.

5.0 MODEL APPLICATION

5.1 GENERAL CONSIDERATIONS

The HSI values in Table 2 provide a generic model for assessing habitat suitability for hoolock gibbons over any given area, provided that the necessary information on land use types and areas is available. However, in applying the model a number of other factors need to be taken into account, as follows:

Disturbance Effects
Human presence and mechanical noise reduces the use of otherwise suitable habitat by hoolocks, and hence reduces the actual habitat value. Lawachara has long been heavily used by subsistence and small-scale wood cutters and other NTFP harvesters, and this use is expected to continue into the Management Plan period. Ahsan (1995b) estimated that during 1988-90 an estimated 170 people collected fuelwood daily from the Lawachara Beat (current Park) area. Similarly, at present an estimated 50-75 harvesters enter the Park from each of the Srimongal (west) and Kamalganj (east) sides on a daily basis. In order to take this factor into account, a reduction effect needs to be incorporated in the model calculations as long as the disturbance factor continues to be operative. For example, in the application to the "current" scenario described in Section 5.2 below, the calculated habitat value of each polygon (standard HSI multiplied by area) is reduced by 10% to account for reduced utilisation by hoolock gibbons in response to human presence. Based on the observation that human use is widespread, and in the absence of additional information on specific use areas, this reduction is applicable throughout the area.

The hoolock gibbon population in Lawachara also is subjected to significant levels of mechanical noise, both from the railway line (24 train movements per day) and highway (traffic levels probably averaging less than 25 vehicle movements per hour) that cross the Park in an east-west direction. These roughly parallel transportation corridors pass through some prime hoolock habitat, but the effects of the associated disturbance on habitat use by hoolocks are impossible to assess on the basis of available information. Although Ahsan (1995b) noted that hoolocks are disturbed by traffic noise, they may also accommodate to some extent to predictable, non-threatening disturbances, thus reducing or neutralising any disturbance effect. In the absence of more detailed information on how and at what distance hoolocks react to regular mechanical disturbances, effects of avoidance of mechanical disturbance are not built into the model application. However, it should be noted that more general disturbance effects associated with human presence are already accounted for by the HSI reduction described above, and this could be argued to sufficiently cover any additional effects of mechanical disturbance. Also, polygons bisected by the railway line and/or highway will be assigned reduced value if the area of the subpolygons and adjacent habitat fall below a specified critical level (see Barrier Effects below), thus potentially additionally reducing the calculated habitat value of polygons adjacent to these corridors.

Barrier Effects
As noted in Section 2.2, hoolock gibbons are entirely arboreal, and do not normally descend to the ground except by accident. Although they can jump across gaps of 3 m or more, larger breaks in tree cover may impede travel. Long, linear gaps, such as along transportation corridors and powerline corridors, may act as partial or complete barriers to hoolock movements, depending on width, length, and location in relation to sleeping and feeding areas. Construction and maintenance of such corridors may thus make some segments of otherwise suitable hoolock habitat inaccessible and hence unusable. In order to account for this effect, application of the model requires an assessment of habitat block size within and adjacent to all polygons that are segmented by corridors.

Home range sizes of hoolock family groups have been reported as approximately 35-50 ha (Section 2.3 above). Taking 50 ha as a conservative estimate of the habitat area required by one hoolock group, application of the model includes the following steps:

- ➔ Examination of all polygons crossed by linear corridors, to determine if any of the resultant segments are less than 50 ha in area;

- ➔ For all segments <50 ha in area, determination of the HSI value of all directly adjoining polygons; and,

➔ Assignment of an HSI value of 0.0 for all segments that are <50 ha in size, and that are completely bordered by non-gibbon habitat.

Habitat Fragmentation
Manipulation of vegetation cover at Lawachara has resulted in a mosaic of short-rotation and long-rotation plantations of various ages, and various other land use types. Many of these types have no value as hoolock gibbon habitat (Table 2), effectively precluding gibbon movements through or across them. Depending on size and other factors (*e.g.*, history of land use) otherwise suitable habitat may not be used or usable when surrounded by such non-habitat areas.

In order to account for this habitat fragmentation effect, application of the model includes the following steps:

➔ Examination of all polygons, to identify those that are less than 50 ha in area (assuming, as for Barrier Effects, that 50 ha is a conservative estimate of the habitat area required by one hoolock group);

➔ For all polygons <50 ha in area, determination of the HSI value of all directly adjoining polygons; and,

➔ Assignment of an HSI value of 0.0 for all polygons that are <50 ha in size, and that are completely bordered by non-gibbon habitat.

5.2 EXAMPLE APPLICATIONS

In order to illustrate the application of the Hoolock Gibbon Habitat Suitability Model and its outputs, the model has been applied to three different scenarios in and adjacent to Lawachara National Park:

1. A "pre-development" scenario representing a recreation of conditions that would prevail had no plantation development or other human uses of forest occurred in the area (*i.e.*, if all of the area had remained covered by mature evergreen and semi-evergreen forest). For purposes of this scenario, it was assumed that all of the area had an HSI value of 1.0 prior to development.

2. A "current" scenario representing current area and type of forest cover, including plantations and other land uses, as determined from the RIMS database and limited field checking. This scenario utilised the HSI values in Table 2 and the disturbance, barrier effect and fragmentation effect penalties outlined above. Details of polygon descriptors, HSI and HU values are in Appendix 1 attached.

3. A "Management Plan implementation" scenario representing area and type of forest cover that will be retained and/or developed under the management zoning and forest management schemes outlined in the current Management Plan. For purposes of this scenario, current vegetation cover in all Ecosystem Management Zone and Habitat Management Zone polygons was "aged" by 10, 25 and 50 years, HSI values equivalent to these forest/plantation ages (see Table 2) were reassigned, and HU values were recalculated. The following assumptions also were applied:

➔ That all short-rotation plantation areas in Habitat Management Zones will be converted to permanent tree cover using framework species (HSI value therefore equivalent to long-rotation, mixed species plantations);

➔ That plantations currently comprised mostly of teak will be converted to mixed species plantations, using framework species and / or hoolock food trees (HSI equivalent to long-rotation, mixed species plantations);

➔ That the disturbance effects of human presence and mechanical noise will be removed within 10 years, that the barrier effect of the railroad will be removed within 10 years, and that the barrier effect of the highway will be removed within 25 years;

➔ That all Transportation Corridors, Intensive Use Zones, Village Use Zones and Sustainable Use Zones will continue to be utilised for their stated purpose, and will retain the same HSI values throughout; and

➔ That External Buffer Zones and the remainder of West Bhanugach Reserved Forest will be maintained under periodically harvested short-rotation plantations (HSI value therefore equivalent to short-rotation plantations).

5.3 OBSERVATIONS AND CONCLUSIONS FROM MODEL APPLICATION

Results of application of the hoolock gibbon HSI model to the pre-development, current and Management Plan implementation scenarios are summarised in Table 3.

Table 3
Availability of hoolock gibbon habitat under different development scenarios

Scenario	Number of Habitat Units				
	Notified NP area	**Proposed NP Extension**	**Proposed External Buffers**	**Remainder of West Bhanugach RF**	**Total**
Pre-development	1221	281	87	1011	2600
Current	404	92	0	36	532
Management Plan implementation (10 years)	666	132	0	0	798
Management Plan implementation (25 years)	751	210	0	0	961
Management Plan implementation (50 years)	792	234	0	0	1026

When interpreting these results it needs to be borne in mind that the model utilises only a crude measure of habitat conditions, and that changes in habitat availability indicated by the model results are best viewed as overall trends. The model results do, however, provide useful insights into changes in temporal and spatial availability of hoolock gibbon habitat in relation to land use and management actions. The results of the model application suggest that:

1. Only approximately 20% of the original (pre-development) hoolock gibbon habitat that occurred in West Bhanugach Reserved Forest remains (*i.e.*, 532 of 2600 HUs).

2. Of the currently available habitat (532 HUs), most is located within the notified Park boundaries (404 HUs, or 76%) and the proposed extension (92 HUs, or 17%). However, even within these areas hoolock gibbon habitat has been reduced to a fraction of its pre-development level; only 33% of original habitat within the Park and proposed extension remains. By contrast, no hoolock gibbon habitat remains within the External Buffer Zones and only approximately 4% of original habitat within the rest of West Bhanugach RF remains.

3. Clear-felling of 62 ha of mature plantation in the proposed extension during late 1999-early 2000 removed 22 HUs, comprising approximately 19% of the then available hoolock gibbon habitat in the proposed extension, and 4% of the then available habitat within the whole of West Bhanugach RF.

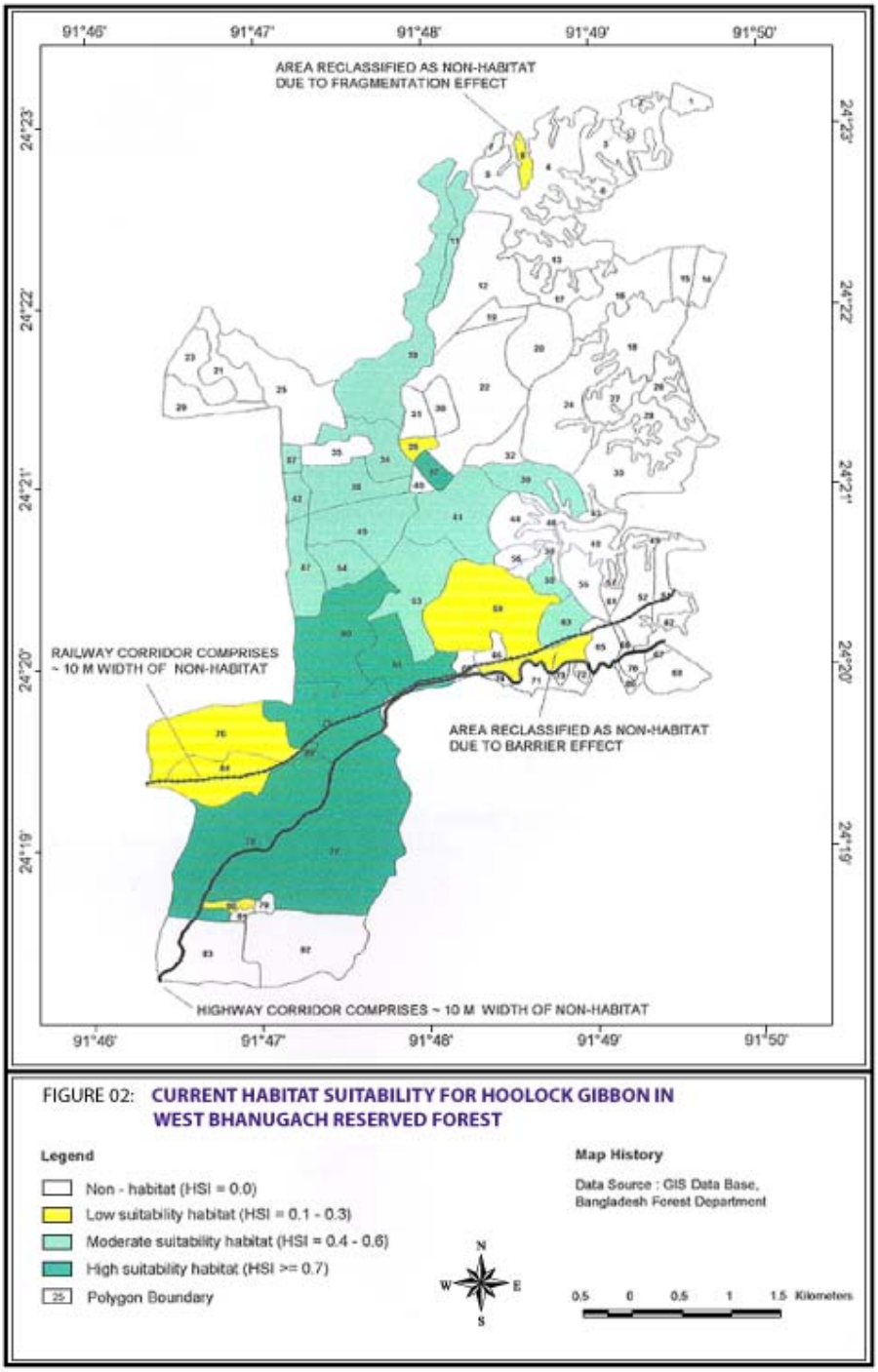
4. Remaining hoolock gibbon habitat occurs in a contiguous block (Figure 2). Two small areas that are structurally suitable for hoolock use are cut off from this block: 1) polygon 8, comprising 6.3 ha of low suitability habitat separated from the main block by intervening non-habitat areas; and 2) part of polygon 59, comprising 20 ha of low suitability habitat separated from the main block by the railway line and adjacent non-habitat areas. Both of these areas have been reclassified as non-habitat for purposes of current habitat suitability assessment.

5. Within the Park and proposed extension, 462 ha (31% of area) are currently classified as non-habitat (HSI=0.0), 114 ha (8%) as low suitability habitat (HSI=0.1-0.3), 433 ha (29%) as moderate suitability habitat (HSI=0.4-0.6) and 493 ha (33%) as high suitability habitat (HSI=0.7 or more).

6. Implementation of the Management Plan could potentially increase hoolock gibbon habitat availability

within the Park and proposed extension by a predicted 302 HUs after 10 years, 465 HUs after 25 years, and 530 HUs after 50 years, representing increases of 61%, 94% and 107% over current levels. This increase will be achieved by expanding the spatial extent of hoolock gibbon habitat (*i.e.*, by converting current non-habitat areas to useable gibbon habitat) and by improving the suitability of current habitat areas.

7. Achievement of gains in hoolock gibbon habitat will require close adherence to the forest management prescriptions outlined in the Management Plan. Chief among these are:



- ➔ Retaining all existing mature/maturing forest cover;
- ➔ Adding the proposed extension to the national park;
- ➔ Converting selected areas to mature forest cover by planting framework species;
- ➔ Using selected hoolock food plants as framework species;

- ➔ Avoiding creating gaps in forest cover, especially linear gaps; and,
- ➔ Narrowing existing linear gaps by planting framework species along margins.

8. Predicted hoolock gibbon habitat availability within the Park and proposed extension after 50 years of management represents approximately two-thirds (68%) of pristine or pre-development habitat. A complete return to pristine conditions is not possible because:

- ➔ It is probably not possible to completely recreate ideal habitat conditions. The model assumes that even the very best recreated habitats (*i.e.*, mature, mixed species plantations) represent only 90% of the habitat value of undisturbed natural forest.

- ➔ Selected areas are zoned such that they are permanently removed from the hoolock gibbon habitat base (5.0 ha of Intensive Use Zone, 14.8 ha of Transportation Corridor, 18.5 ha of Village Use Zone).

9. A large area (318.6 ha) currently designated as Sustainable Use Zone provides very limited hoolock gibbon habitat, and for purposes of the Management Plan scenario it has been assumed that this will continue to be the case. Reduction in the area designated for betel leaf production (129.8 ha) and short-rotation plantations (188.8 ha), and conversion of the recaptured areas to a natural forest management regime, could potentially result in additional gains in hoolock gibbon habitat area. However, the potential for conversion is limited given current and expected future land use demands in the Park area.

10. Application of the hoolock gibbon HSI model suggests that in the best case gibbon habitat availability could be approximately doubled over 25-50 years of appropriate management, with moderate to high suitability habitat distributed over more than 1000 contiguous hectares. Assuming a current maximum population size of 20 animals, and that population size is directly related to habitat availability, an increase in the hoolock population to approximately 40 animals could reasonably be expected. Although an improvement over the current situation, this small, isolated population would still be vulnerable to extirpation and would need to continue to be carefully monitored.

11. As noted in Part 1, Section 2.1.2 of this Annex, the hoolock gibbon was selected as a key species representing the biodiversity of mature evergreen and semi-evergreen forest. As such, retention and expansion of these habitat types is expected to benefit all other included species.

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PART THREE

CAPPED LANGUR HABITAT SUITABILITY INDEX MODEL

1.0 GENERAL BACKGROUND

The capped langur (*Presbytis (Trachypithecus) pileatus*) occupies a very limited world range restricted to eastern Bangladesh, northeastern India, northern Myanmar and a small part of southern China (Prater 1971; Roonwal and Mohnot 1977; WCMC 1998). Its status within this range is rated as Vulnerable (*i.e.*, not Critically Endangered or Endangered, but facing a high risk of extinction in the wild in the medium-term future) (WCMC 1998).

In Bangladesh capped langurs are found in the moist deciduous (sal) forests of Tangail and Mymensingh Forest Divisions, and in the semi-evergreen and evergreen hill forests of Sylhet and Chittagong FDs, the Chittagong Hill Tracts, and south to the Teknaf Peninsula in Cox's Bazar FD (Green 1978; Gittins 1980; Siddiqui and Faizuddin 1981; Gittins and Akonda 1982; Khan 1982; Wahab and Faizuddin 1984; Akonda *et al.* 1986; Khan 1986). It does not occur in coastal forests or the Sundarbans (Siddiqui and Faizuddin 1981; Khan 1982). Populations in the north and east are contiguous with populations in adjacent India and Myanmar, but the western extent in Bangladesh is delimited by the Padma-Jamuna River (Khan 1982; Akonda *et al.* 1986).

Given the restricted world distribution of capped langurs, Bangladesh has been considered to represent the best opportunity for long-term preservation of a genetically viable population of the species (Stanford 1986). The Madhupur Tract was at least until recently the main centre of abundance, with higher population densities than elsewhere in the country, but there is evidence of recent population declines related to habitat loss (Akonda *et al.* 1986; GoB 1992). The species remains widely distributed (FSP observations) but there are no recent comparative data on population densities.

Although capped langurs can make at least some use of plantation forests, degraded forest cover and open areas, they are essentially a forest dwelling species and require relatively contiguous tree cover to survive. Reduction in forest habitat area and/or quality is therefore a constraint on long-term population viability.

The habitat suitability model outlined below is based on measurable, physical features of habitat (availability, age, and canopy closure of trees used for feeding, sleeping and travel), and can be used to assess the suitability of any given area of habitat for use by capped langurs. This provides a useful tool for managing habitat for this species, particularly within the context of protected areas management. However, the model does not take population dynamics (birth rate, death rate, minimum viable population size) into consideration, and will need to be paired with population viability analyses to ensure the survival of this species within defined habitat areas.

2.0 LIFE REQUISITES

2.1 FOOD

Capped langurs feed on fruits, flowers and leaves (Prater 1971; Islam and Hussain 1982; Stanford 1986; Feeroz *et al.* 1994; Das 1998). Although most feeding occurs in trees, they may also feed on herbaceous undergrowth (Stanford 1986), and in vegetable gardens and croplands where forest habitat is degraded or fragmented (Akonda *et al.* 1986; Das 1998). Water is obtained primarily from dew or rain-drenched leaves, at least during the rainy season (Prater 1971, Israel and Sinclair 1994). They have also been observed drinking at streams and small pools (Islam and Hussain 1982).

Like other leaf monkeys, the capped langur presumably has digestive tract adaptations that enables it to break down fibre and secondary compounds, and hence efficiently derive nutrients from leaves (Bauchop and Martucci 1968). Depending on food availability, capped langurs may consume large amounts of leaves compared with sympatric species, enabling them to occupy a wider habitat niche (Feeroz *et al.* 1994). Studies in the deciduous forests of Madhupur have shown that in this area leaves make up approximately two-thirds of the diet (Islam and Hussain 1982; Craig 1991), and are obtained from a variety of tree species (Table 1). Fruits and seeds (26% of diet composition, obtained from 12 species) also are important (Islam and Hussain 1982). Fruits appear to be preferred over leaves when available, and in semi-evergreen forests greater quantities of fruits and seeds are eaten (Stanford 1986). A year-long study at Lawachara,

where fruits are more abundant than in the deciduous forests of Madhupur, documented a diet composition of 20% leaves, 67% fruits and figs, 4% seeds, 2% climbers, 1% buds, 1% flowers and 1% insects (Feeroz *et al*. 1994). Fruits and figs were obtained from 31 species; leaves, shoots and/or petioles from 11 species; flowers from 2 species and seeds from 3 species (Table 1).

Table 1
List of capped langur food trees in Bangladesh

Family	Species	Location and part eaten		
		Lawachara NP	Madhupur NP	Other areas
Leguminosae	***Acacia chinensis***	Fr[1]		
	Acacia falcataria	L/P/Sh[1]		
	Acacia pinnata (?)		U[4]	
	Acacia sp.		L[2]	
Rubiaceae	***Adina cordifolia***		L[2]P[2]NR[3]	
Leguminosae	*Albizia mollis*		NR[3]	
	Albizia procera		Se[5]NR[3]	
	Albizia sp.	Fr[1]L/P/Sh[1]	L[2]	
Apocynaceae	***Alstonia scholaris***	Fl[1]L/P/Sh[1]		
Miliaceae	***Amoora wallichii***	Fr[1]		
Rubiaceae	*Anthocephalus chinensis*	Fr[1]L/P/Sh[1]		
Miliaceae	*Aphanamixis* sp.	Fl[1]		
Thynelaceae	***Aquilaria agallocha***	Fr[1]		
Moraceae	*Artocarpus chama*			Chunati WS: NR[4]
	Artocarpus chaplasha	Fr[1]		
	Artocarpus lakoocha	Fr[1]	Fr[2] P[2]	
	Artocarpus sp.	U[4]		
Euphorbiaceae	*Baccaurea sapida*	Fr[1]		
Burseraceae	*Bursera serrata*	Fr[1]		
Leguminosae	*Butea frondosa*		NR[3]	
Capparidaceae	*Capparis* sp.		L[2]	
Leguminoseae	***Cassia fistula***	Fr[1]	Fr[2]L[2]	
Fagaceae	*Castanopsis indica*	Fr[1]		
	Castanopsis tribuloides	Fr[1]		
Lauraceae	*Cinnamomum* sp.	Se[1]		
Connaraceae	***Connarus paniculatus***	Se[1]		
Cordiaceae	*Cordia* sp.	Fr[1]		
Papilionaceae	*Dalbergia* sp.		L[2]	
	Derris sp.		L[2]	
Dilleniaceae	***Dillenia pentagyna***	Fr[1]	Fl[2]Fr[2]L[2]Sh[2]NR[3]	
Dioscoreaceae	*Dioscorea* sp.	Fr[1]		
Leguminoseae	***Entada scandens***		NR[3]	
Mimosoidae	***Enterolobium (Samanea) saman***		L[2]	
Moraceae	*Ficus comosa*	Fr[1]		
	Ficus hispida	Fr[1]		
	Ficus racemosa	Fr[1]		
	Ficus sp.	Fr[1] (1 species)	NR[3]	
Burseraceae	***Garuga pinnata***		NR[3]	
	Garuga sp.		U[4]	
Tilliaceae	***Grewia asiatica***	L/P/Sh[1]		
Verbenaceae	*Gmelina arborea*	Fr[1]		
Malvaceae	*Hibiscus rosa sinensis*		L[2] Sh[2]	
Rubiaceae	*Hymenodictyon exelsum*		NR[3]	
Malvaceae	*Kydia calycina*		NR[3]	
Lythraceae	*Lagerstroemia parviflora*		Fl[2]L[2] NR[3]	
	Lagerstroemia speciosa	L/P/Sh[1]		
Anacardiaceae	*Lannea grandis*		NR[3]	
Leeaceae	*Leea crispa*	Fr[1]		
Euphorbiaceae	*Mallotus* sp.	Fr[1]		
Anacardiaceae	*Mangifera indica*		Fr[2]	

Family	Species	Location and part eaten		
		Lawachara NP	Madhupur NP	Other areas
Leguminosae	*Mezoneuron enneaphyllum*	Se[1]		
Rutaceae	*Micromelum pubescens*		L[2]	
Compositae	*Mikania* sp.	L/P/Sh[1]		
Annonaceae	***Miliusa velutina***		L[2] NR[3]	
Papilionoidae	*Mucuna prurita*		Se[2]	
Bignonaceae	*Oroxylum indicum*	L/P/Sh[1]		
Euphorbiaceae	*Phyllanthus embelica*		Fr[2] L[2] Sh[2]	
Rubiaceae	*Randia* sp.	Fr[1]	Fr[2]L[2]	
Euphorbiaceae	*Sapium baccatum*	Fr[1]		
Sapindaceae	*Schleichera trijuga*		NR[3]	
Dipterocarpaceae	*Shorea robusta*		Fl[2] L[2] Sh[2] NR[3]	
Smilaceae	*Smilax macrophylla*	Fr[1]		
	Smilax sp.	Fr[1]		
Leguminosae	*Spatholobus* sp.	L/P/Sh[1]		
Anacardiaceae	*Spondias mangifera*		Fr[2] P[2] NR[3]	
Urticaceae	*Steblus asper*		L[2]	
Anacardiaceae	*Swintonia floribunda*			Teknaf GR: NR[4]
Myrtaceae	*Syzygium cumini*	Fr[1]	Fr[2]	
	Syzygium fruticosum	Fr[1]		
Verbenaceae	*Tectona grandis*	L/P/Sh[1]		
Papilionaceae	*Tephrosia candida*		Fr[2] L[2]	
Combretaceae	***Terminalia arjuna***		L[2] P[2]	
	Terminalia belerica	Fr[1]	NR[3]	
	Terminalia catappa	L/P/Sh[1]		
Acanthaceae	*Thunbergia grandiflora*	Fr[1]		
Verbenaceae	*Vitex* sp.	Fr[1]		
Vitaceae	*Vitis* sp.		Fr[2]	
Connaraceae	unidentified tree species		Fl[2] Fr[2] L[2]P[2]	

Notes:
Plant parts: Fl=flowers, Fr=fruits, L=leaves, P=petioles, Se=seeds, Sh=shoots; U=unidentified. NR=capped langurs were observed in the species indicated, but activities were not recorded (*i.e.*, feeding likely but not confirmed).
Sources: 1=Feeroz *et al.* 1994; 2=Islam and Hussain 1982; 3=Akonda *et al.* 1986; 4=FSP observations (1999).
Nomenclature: based on original sources.

2.2 COVER

Capped langurs are associated primarily with dense forests where arboreal feeding and travel are facilitated by contiguous tree cover (Prater 1971; Green 1978; Islam and Hussain 1982; Akonda *et al.* 1986; Stanford 1986). This includes both natural forest cover (deciduous and semi-evergreen) and old, mixed species plantations (FSP observations). Limited observations suggest that even though some use is made of degraded, low forest cover and mature, short-rotation plantations, this use may depend on the continuing availability of emergent food trees and adjacent pockets of dense, mixed species cover. Use of gardens and croplands as reported in some areas (Akonda *et al.* 1986; Das 1998) is considered to be a response to loss of forest habitat.

Surveys in the Madhupur Tract (Gittins and Akonda 1982) documented highest densities of capped langurs in natural forest areas (7 groups [58.8 individuals]/km^2), and much lower densities in scrub forests (1.4 groups [11.8 individuals]/km^2). Studies in Madhupur National Park have indicated that the most suitable habitat is characterised by tall sal (*Shorea robusta*) trees and the associated climber *Entada scandens* (Akonda *et al.* 1986). In this area capped langurs also are found in mixed forest cover comprised of *Shorea robusta*, *Albizia procera*, *Dillenia pentagyna*, *Adina cordifolia*, *Terminalia belerica* and other species, but are absent from the western part of the park which has been converted to rubber plantations and poor vegetation cover with low trees (Akonda *et al.* 1986). Recent reconnaissance surveys in Madhupur found capped langurs in sal forest habitats ranging from mature stands (canopy height 12-15 m) to scrub (mean height 4 m), and included one observation of a troop in a 10 year old *Acacia mangium* plantation, feeding on *Acacia pinnata*, a climber which is a natural associate of sal (FSP observations).

In semi-evergreen forest areas, recently observed or reported habitat use includes extensive natural forests (at Rema-Kalenga); emergent trees in natural forest heavily degraded by fuelwood cutting (Teknaf); natural forest recovering from use as betel leaf plantation (Lawachara); riparian forest (Hazarikhil, Lawachara); mature mixed species plantations (Chunati, Hazarikhil, Lawachara); mature teak plantations with natural associates (Hazarikhil, Rema-Kalenga, Teknaf); maturing (late 1980s to mid-1990s) short rotation plantations of *Acacia auriculiformis*, *Acacia mangium*, *Anthocephalus*, and *Eucalyptus* (Chunati and Lawachara); and late 1980s *Albizia falcateria* plantations (Lawachara). Use of short-rotation plantations appears to be limited but has not been quantified.

There is some evidence of preferential use of forest edge or forest gap vegetation for feeding. In Madhupur National Park, Stanford (1986) reported that capped langurs feed during early morning and dusk within 5 m of the forest edge (*i.e.*, near forest/meadow interfaces), moving to the forest interior to feed and rest during mid-day. Observations during reconnaissance surveys also documented use of edge areas (forest/paddy field edge, forest/road and trail edge), but the number of observations was insufficient to determine if such use was preferential.

Stanford (1986) reported that gaps in forest cover were crossed on the ground, but his observation that 90% of sightings of capped langurs on the ground were adult males, and that females and immatures observed on the ground were always behind adult males, suggests a degree of caution in leaving the security of tree cover. Travel on the ground exposes langurs to attack by dogs and other predators (Islam and Hussain 1982). Travel on the ground is necessary for access to food resources such as gardens and other croplands, and may be the most efficient escape mechanism in open and/or degraded forest habitats (FSP observations in Madhupur National Park), but the need for such travel limits the suitability of these habitats for use by capped langurs.

2.3 SPACE

Capped langurs are organised into one-male, multi-female/dependent young social groups, with excess males occurring either singly or in multi-male troops (Prater 1971; Akonda *et al.* 1986). Reported group size in Bangladesh varies from 1 to 21, with an average of 5-6 (Islam and Hussain 1982; Akonda *et al.* 1986). A decrease in mean group size, a high number of all male and all adult groups, and a high adult:young proportion, are all considered to be indicators of downward population trend (Akonda *et al.* 1986; GoB 1992).

Daily travel ranges may be quite small (*e.g.*, 50-500 m/day, mean 224.5 m/day at Madhupur) within a home range of approximately 20 ha (Stanford 1986). A large part of the day is spent feeding within a relatively small area (Islam and Hussain 1982). Capped langur groups may feed in the same or adjacent trees with little intergroup aggression (Stanford 1986), the limited encounters between leader males (display jumps, vocalisation) possibly functioning to maintain group integrity, rather than to gain possession of food areas or territory (Islam and Hussain 1982).

3.0 IMPACTS OF DISTURBANCE

Disturbances that may affect capped langur use of habitat can take a number of forms. For convenience they are here divided into two main categories: 1) physical alteration of habitat, and 2) sensory disturbances.

Physical alteration of capped langur habitat in Bangladesh includes:

- ➔ Clear-felling of forest areas. This results in the direct removal of all forest cover used for feeding, sleeping and travel, and reduction of habitat value of the affected area to zero. Capped langur groups whose home ranges are affected by clear-felling may or may not be able to persist in adjacent areas, depending on the area and quality of habitat remaining, and on whether adjacent habitat areas are occupied by other capped langur groups.
- ➔ Creation and/or maintenance of linear corridors through forest areas. Although capped langurs can cross gaps in forest cover on the ground, this increases exposure to predators and, in areas bisected by roads, exposure to traffic mortality.
- ➔ Selective felling in forest areas. As an example of this type of disturbance, in Lawachara some capped langur food trees (*Dillenia pentagyna*, possibly others) are used for collecting bark for the

manufacture of mosquito coils; this eventually kills the trees which are subsequently felled by fuelwood collectors (Ahsan 1995). Also in Lawachara, some potential capped langur food trees (*e.g.*, *Garuga* spp., *Vitex* spp.) are illegally harvested for house poles (Ahsan op. cit.); others very likely are included in illegal fuelwood harvest (FSP observations). Selective felling of trees used for food, sleeping and travel results in degradation of habitat quality, and if severe and extensive enough may ultimately result in the fragmentation of habitat into isolated patches which can no longer support a viable capped langur population. For example, as noted above large areas in Madhupur National Park are no longer usable by capped langurs due to incremental and ultimately extensive removal of tree cover.

- ➔ Betel cultivation in forest areas. In betel leaf production areas in Lawachara, the large branches of support trees are lopped off and the trees do not produce fruit; betel leaf areas are therefore avoided by primates (Ahsan 1995), even though tree cover remains.

Sensory disturbances occurring in capped langur habitat in Bangladesh include:

- ➔ Mechanical noise (*e.g.*, wood-cutting, traffic). Limited observations of capped langurs using habitat adjacent to the main highway in Madhupur, and adjacent to the railway tracks in Lawachara (FSP observations), suggest a degree of accommodation to mechanical noise, but the limits and degree of tolerance have not been determined.

- ➔ Human presence. In areas where they are not harassed capped langurs may become relatively well habituated to people (Green 1978; Islam and Hussain 1982; GoB 1992). However, they are generally considered to be shy and wary, and quick to take flight (Prater 1971; Israel and Sinclair 1994; Das 1998). They may also sit absolutely still when approached (Israel and Sinclair 1994). Both reactions interrupt normal behaviour patterns and can affect habitat suitability in areas where disturbances are frequent or prolonged. As feeding, drinking and other activities of capped langurs are highly synchronised (Islam and Hussain 1982), any disruptive disturbance may affect the whole group. Disturbance to langurs by visitors to well-used protected areas, such as Madhupur National Park, is a potentially serious problem. In Lawachara, local people collecting forest fruits frighten off feeding primates, presumably including capped langurs, by shouting (Ahsan 1995), resulting both in disruption of feeding and direct competition for food sources.

In addition to these disturbance factors, some capped langurs may be directly removed from otherwise suitable habitat areas by hunting and trapping. The Khasias in Lawachara occasionally hunt primates for meat, and (at least in the past) illegal fuelwood collectors in Lawachara have also engaged in trapping primates for sale to traders (Ahsan 1995).

4.0 MODEL DEVELOPMENT

The information review presented above indicates that high quality capped langur habitat is characterised by:

- ➔ Mature, closed canopy moist deciduous or semi-evergreen forest, with gaps and openings providing forest edge habitat;
- ➔ A species mix of fruiting and leaf-bearing trees that provides a year-round food source;
- ➔ Low levels of mechanical and human disturbance; and,
- ➔ Contiguous areas of habitat sufficiently large to support a genetically viable population.

As noted in the introductory section of this Annex, the HSI models are designed to be applied to individual polygons listed in the RIMS/GIS Database. Measures of habitat structure (stand maturity, canopy closure, fruiting tree abundance) are not available for individual polygons, but can be inferred from cover type, species composition and stand age descriptors in the database, and on the basis of limited field checking. A judgement of how well these inferred measures match the habitat requirements of capped langurs can then be used to assign generic HSI values to each generalised land use type (Table 2). This provides a first approximation of the overall suitability of habitat in any given polygon, on a scale from 0.0 to 1.0.

Table 2
Habitat Suitability Index values for capped langurs assigned to generalised land use types

Land use type	Inferred value of:			Assigned HSI value
	Stand age	Canopy closure	Fruit tree abundance	
Natural forest (high forest)	old	closed	high	1.0
Natural forest (low forest)	mid	near closed	moderate-low	0.6
Natural forest/betel garden	old	closed	low-nil	0.4
Long-rotation plantations:				
-pre-1950 plantation, mixed species	old	closed	high	1.0
-pre-1950 plantation, mostly teak	old	closed	moderate	0.8
-1950-74 plantation, mixed species	mid	closed	moderate	0.8
-1950-74 plantation, mostly teak	mid	closed	moderate-low	0.6
-1975-1989 plantation, mixed species	young-mid	near closed	low	0.6
-1975-1989 plantation, mostly teak	young-mid	near closed	low	0.4
-1990-1999 plantation	young	open	nil	0.2
Short-rotation plantations:				
-pre-1990 plantation	young	near closed	low	0.2
-1990-99 plantation	young	open	nil	0.1
Bamboo, scrub, failed plantations	young	no canopy	low	0.2
Agriculture	not applicable	not applicable	nil	0.1

The assignment of HSI values in Table 2 assumes that there is a direct relationship between habitat structure (*i.e.*, as described by stand age, canopy closure and fruit tree abundance) and utility as capped langur habitat, and that there is a continuum from the best habitats (old, closed canopy habitats with high food abundance) downward to habitats offering little or no utility to capped langurs (young, open habitats with low food abundance). On this basis natural forests and old, mixed species plantations provide the best capped langur habitat, and converted areas (bamboo and scrub, young plantations and agriculture) provide the least habitat value.

Assigned HSI values for predominantly teak plantations are lower than for mixed species plantations of the same age, based on the observation that teak tends to shade out the growth of other species, resulting in a generally poorer forest structure and much lower diversity of fruiting trees. Also, although teak is used for feeding by capped langurs, it sheds its leaves and hence does not provide a year-round food source.

Short-rotation plantations are assigned low HSI values based on the assumptions that fruiting trees are not normally planted as short-rotation crops, and that the rotation period is too short for natural ingress and development of fruiting species. Short-rotation plantations do, however, provide a source of leaves that can be used as food, presumably mostly in near-mature plantations that have the tallest and best developed trees, and which provide at least minimal escape cover in addition to a food source.

Agricultural lands are assigned a very low HSI value on the assumption that use occurs only when adjacent forest habitats are degraded, and that agricultural lands themselves are not valuable capped langur habitats.

It needs to be borne in mind that the assigned HSI values in Table 2 are "averages" for the given land use type. Actual value as capped langur habitat is likely to differ among polygons of the same land use type (*e.g.*, within the natural forest land use type, one patch of natural forest will have a somewhat higher or lower value than any other patch, and within the 1950-74 mixed species plantation type, 1950 plantations will generally have a higher value than 1974 plantations), but these differences are considered unlikely to be important within the overall accuracy level of the model.

5.0 MODEL APPLICATION

5.1 GENERAL CONSIDERATIONS

The HSI values in Table 2 provide a generic model for assessing habitat suitability for capped langurs over any given area, provided that the necessary information on land use types and areas is available. However,

in applying the model a number of other factors need to be taken into account, as follows:

Disturbance Effects
Human presence and mechanical noise reduces the use of otherwise suitable habitat by capped langurs, and hence reduces the actual habitat value. Lawachara has long been heavily used by subsistence and small-scale wood cutters and other NTFP harvesters, and this use is expected to continue into the Management Plan period. Ahsan (1995) estimated that during 1988-90 an estimated 170 people collected fuelwood daily from the Lawachara Beat (current Park) area. Similarly, at present an estimated 50-75 harvesters enter the Park from each of the Srimongal (west) and Kamalganj (east) sides on a daily basis. In order to take this factor into account, a reduction effect needs to be incorporated in the model calculations as long as the disturbance factor continues to be operative. For example, in the application to the "current" scenario described in Section 5.2 below, the calculated habitat value of each polygon (standard HSI multiplied by area) is reduced by 10% to account for reduced utilisation by capped langurs in response to human presence. Based on the observation that human use is widespread, and in the absence of additional information on specific use areas, this reduction is applicable throughout the area.

The capped langur population in Lawachara also is subjected to significant levels of mechanical noise, both from the railway line (24 train movements per day) and highway (traffic levels probably averaging less than 25 vehicle movements per hour) that cross the Park in an east-west direction. These roughly parallel transportation corridors pass through some prime capped langur habitat, but the effects of the associated disturbance on habitat use by this species are impossible to assess. Observations of capped langurs near the rail line in Lawachara and near the highway in Madhupur (Section 3.0 above) suggest that capped langurs may also accommodate to some extent to predictable, non-threatening disturbances, thus reducing or neutralising any disturbance effect. In the absence of more detailed information on how and at what distance this species reacts to regular mechanical disturbances, effects of avoidance of mechanical disturbance are not built into the model application. However, it should be noted that more general disturbance effects associated with human presence are already accounted for by the HSI reduction described above, and this could be argued to sufficiently cover any additional effects of mechanical disturbance.

Barrier Effects
As noted in Section 2.2, capped langurs are largely arboreal, and most feeding and travel is associated with dense tree cover. Although langurs can move efficiently when on the ground, long, linear gaps, such as along transportation corridors and powerline corridors, may act as partial barriers to movements, depending on width, length, and location in relation to sleeping and feeding areas. Construction and maintenance of such corridors may thus make some segments of otherwise suitable habitat less accessible, and expose capped langurs that do cross them along the ground to increased risk of predation and traffic mortality.

Although this barrier effect may generally lower habitat suitability where forest cover is segmented by corridors, the effect is not sufficiently predictable to be incorporated in the model. It may be at least partially counteracted by a proclivity for feeding in the proximity of forest edges and gaps, although the overall impact of corridors on habitat suitability for langurs is still likely to be negative.

Habitat Fragmentation
Manipulation of vegetation cover at Lawachara has resulted in a mosaic of short-rotation and long-rotation plantations of various ages, and various other land use types. Many of these types have low value as capped langur habitat (Table 2), which may effectively inhibit capped langur movements through or across them. Depending on size and other factors (*e.g.*, history of land use), otherwise suitable habitat may not be used or may be used only minimally when surrounded by such low value habitat areas.

This habitat fragmentation effect is not sufficiently predictable to be included in the model, but is at least partially reflected in the general lowering of calculated habitat availability (HSI value multiplied by area) where low value habitats are extensive.

5.2 EXAMPLE APPLICATIONS

In order to illustrate the application of the Capped Langur Habitat Suitability Model and its outputs, the

model has been applied to three different scenarios in and adjacent to Lawachara National Park:

1. A "pre-development" scenario representing a recreation of conditions that would prevail had no plantation development or other human uses of forest occurred in the area (*i.e.*, if all of the area had remained covered by mature evergreen and semi-evergreen forest). For purposes of this scenario, it was assumed that all of the area had an HSI value of 1.0 prior to development.

2. A "current" scenario representing current area and type of forest cover, including plantations and other land uses, as determined from the RIMS database and limited field checking. This scenario utilised the HSI values in Table 2 and the disturbance penalty outlined above. Details of polygon descriptors, HSI and HU values are in Appendix 1 attached.

3. A "Management Plan implementation" scenario representing area and type of forest cover that will be retained and/or developed under the management zoning and forest management schemes outlined in the current Management Plan. For purposes of this scenario, current vegetation cover in all Ecosystem Management Zone and Habitat Management Zone polygons was "aged" by 10, 25 and 50 years, HSI values equivalent to these forest/plantation ages (see Table 2) were reassigned, and HU values were recalculated. The following assumptions also were applied:

- ➔ That all short-rotation plantation areas in Habitat Management Zones will be converted to permanent tree cover using framework species (HSI value therefore equivalent to long-rotation, mixed species plantations);
- ➔ That plantations currently comprised mostly of teak will be converted to mixed species plantations, using framework species and/or capped langur food trees (HSI equivalent to long-rotation, mixed species plantations);
- ➔ That the disturbance effects of human presence and mechanical noise will be removed within 10 years;
- ➔ That all Transportation Corridors, Intensive Use Zones, Village Use Zones and Sustainable Use Zones will continue to be utilised for their stated purpose, and will retain the same HSI values throughout; and,
- ➔ That External Buffer Zones and the remainder of West Bhanugach Reserved Forest will be maintained under periodically harvested short-rotation plantations (HSI value therefore equivalent to short-rotation plantations).

5.3 OBSERVATIONS AND CONCLUSIONS FROM MODEL APPLICATION

Results of application of the capped langur HSI model to the pre-development, current and Management Plan implementation scenarios are summarised in Table 3.

Table 3
Availability of capped langur habitat under different development scenarios

Scenario	Number of Habitat Units				
	Notified NP area	Proposed NP Extension	Proposed External Buffers	Remainder of West Bhanugach RF	Total
Pre-development	1221	281	87	1011	2600
Current	585	130	14	193	922
Management Plan implementation (10 years)	873	188	14	193	1268
Management Plan implementation (25 years)	925	251	14	193	1383
Management Plan					

implementation (50 years)	952	268	14	193	1427

When interpreting these results it needs to be borne in mind that the model utilises only a crude measure of habitat conditions, and that changes in habitat availability indicated by the model results are best viewed as overall trends. The model results do, however, provide useful insights into changes in temporal and spatial availability of capped langur habitat in relation to land use and management actions. The results of the model application suggest that:

1. Only approximately 35% of the original (pre-development) capped langur habitat that occurred in West Bhanugach Reserved Forest remains (*i.e.*, 921 of 2600 HUs).

2. Of the currently available habitat (921 HUs), most is located within the notified Park boundaries (584 HUs, or 63%) and the proposed extension (130 HUs, or 14%). However, even within these areas capped langur habitat has been reduced to a fraction of its pre-development level; only 48% of original habitat within the Park and 46% of original habitat within the proposed extension remains. The External Buffer Zones and remainder of West Bhanugach Reserved Forest also retain some habitat value (207 HUs, or 22% of total currently available habitat), but these areas have been greatly modified and currently available habitat is less than 10% of the pre-development level.

3. Clear-felling of 62 ha of mature plantation in the proposed extension during late 1999-early 2000 removed 33 HUs, comprising approximately 20% of the then available capped langur habitat in the proposed extension, and 4% of the then available habitat within the whole of West Bhanugach RF.

4. Remaining capped langur habitat occurs in a contiguous block, with the exception of the western External Buffer Zone which is cut off from the remainder of the area by a clear-felled (late 1999-early 2000) mixed plantation (Figure 3). Currently available habitat is a mosaic of low, moderate and high suitability areas, with most of the moderate and high suitability habitat included within the Park and proposed extension. Low suitability areas generally are confined to the remainder of West Bhanugach RF, the External Buffer Zones, and peripheral areas of the Park.

5. Within the Park and proposed extension, 82 ha (5% of area) are currently classified as non-habitat (HSI=0.0), 360 ha (24%) as low suitability habitat (HSI=0.1-0.3), 477 ha (32%) as moderate suitability habitat (HSI=0.4-0.6) and 584 ha (39%) as high suitability habitat (HSI=0.7 or more).

6. Implementation of the Management Plan could potentially increase capped langur habitat availability within the Park and proposed extension by a predicted 346 HUs after 10 years, 461 HUs after 25 years, and 505 HUs after 50 years, representing increases of 48%, 64% and 71% over current levels. This increase will be achieved by expanding the spatial extent of capped langur habitat (*i.e.*, by converting current non-habitat areas to useable habitat) and by improving the suitability of current habitat areas.

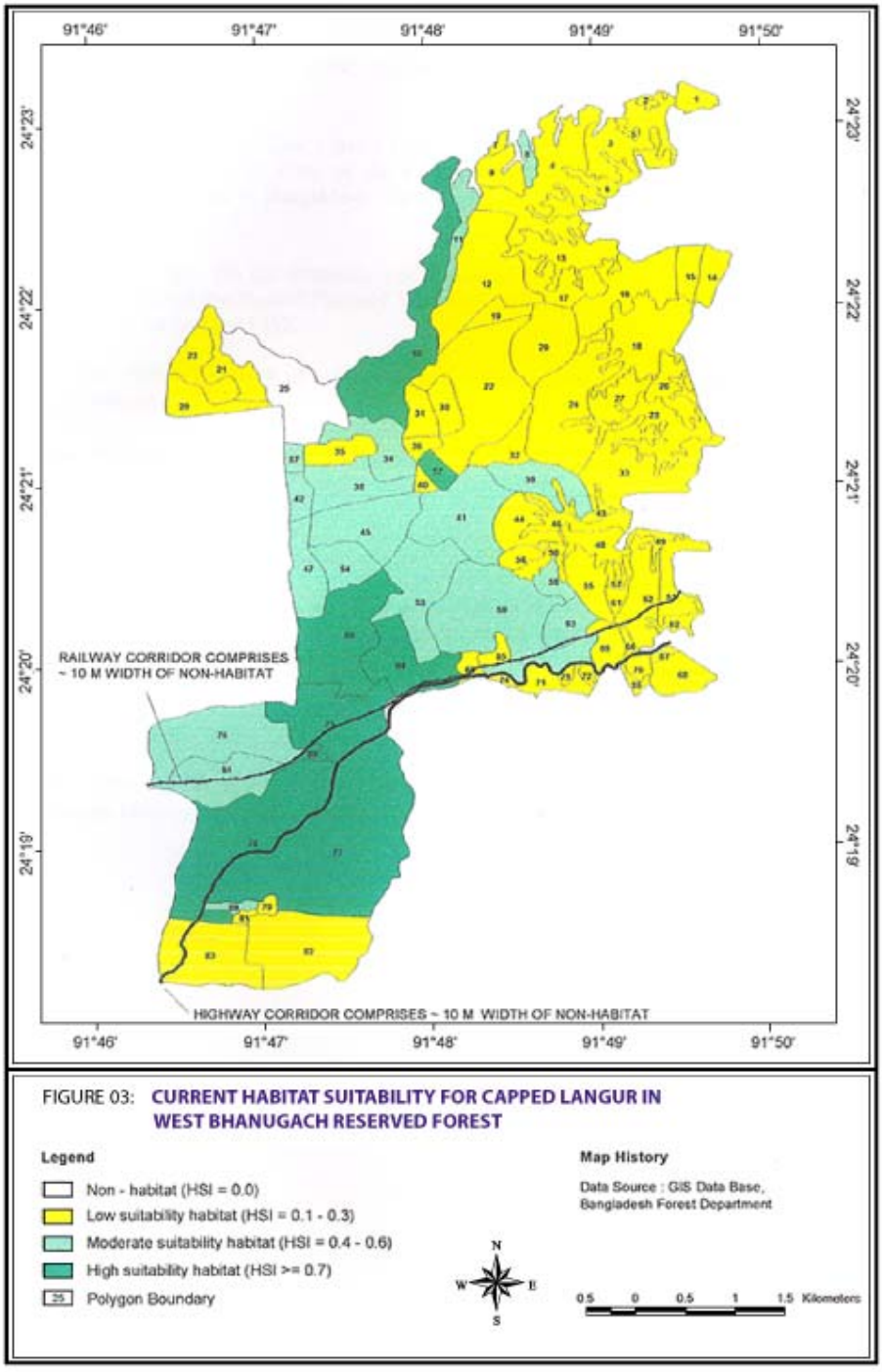
7. Achievement of gains in capped langur habitat will require close adherence to the forest management prescriptions outlined in the Management Plan. Chief among these are:

- ➔ Retaining all existing mature/maturing forest cover;
- ➔ Adding the proposed extension to the national park;
- ➔ Converting selected areas to mature forest cover by planting framework species;
- ➔ Using selected capped langur food plants as framework species;
- ➔ Avoiding creating gaps in forest cover, especially linear gaps; and,
- ➔ Narrowing existing linear gaps by planting framework species along margins.

8. Predicted capped langur habitat availability within the Park and proposed extension after 50 years of management represents approximately 80% of pristine or pre-development habitat. A complete return to pristine conditions is not possible because selected areas are zoned such that they are permanently removed from the capped langur habitat base (5.0 ha of Intensive Use Zone, 14.8 ha of Transportation Corridor, 18.5 ha of Village Use Zone). Also, a large area (318.6 ha) currently designated as Sustainable Use Zone provides very limited capped langur habitat, and for purposes of the Management Plan scenario it has been assumed that this will continue to be the case. Reduction in the area designated for betel leaf production (129.8 ha) and short-rotation plantations (188.8 ha), and conversion of the recaptured areas to a natural forest management regime, could potentially result in additional gains in capped langur habitat area.

However, the potential for conversion is limited given current and expected future land use demands within the Park.

9. The capped langur was selected as a key species representing the biodiversity of mature semi-evergreen forest and earlier seral stages. As such, retention and expansion of these habitat types is expected to benefit all other included species.



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9 Guidelines for establishing enrichment and buffer plantations

The following simple guidelines are prepared for the use of field staff while raising enrichment and buffer plantations:

Enrichment Plantations Guidelines:
The enrichment plantations can be taken up in identified areas of the core zone as discussed below:

- Identification of suitable areas for enrichment planting
- Advance closure (suitable protection measures against hacking, grazing and forest fires) of identified areas
- Collection and treatment of seeds, development and maintenance of nursery
- Cutting of unwanted bushes (say around 1 m radius of the pits in which seedlings are to be planted in identified gaps), climbers and tall weeds (bushes not hindering natural regeneration will be retained as biodiversity but also for creating moist conditions locally)
- Cutting back of old, high and malformed stumps, and faulty coppice shoots
- On an average 360 seedlings per ha mainly of indigenous species (multi-species plantations to optimize species and habitat heterogeneity) will be planted in the identified gaps (of more than 0.5 ha).
- In the pits of size 45m x 45m x 45m (dug in the month of Feb. – March) 1 kg of cowdung and/or fertilizer (application of fertilizer as 50 gms per seedling – 20 gms TSP, 20 gms MP and 10 gms Urea) will be applied.
- No burning and clear cutting of existing vegetation will be taken up. In case of weeds a circular area of 1 m radius around the pit can be cleared before taking up planting on the onset of monsoon rains (in the month of June-July).
- The dead and hollow trees suitable for wildlife will not be removed.
- Half-moon trenches around the planted seedlings are suggested in the slopes as an integral part to conserve and trap soil, and retain soil moisture.
- Weeding, beating up and cleaning will be taken up as and when required. Normally 3 weeding are taken up in the 2nd financial year and 2 weeding in the 3rd financial year. Vacancy filling, if required, will be done along with weeding. Singling of coppice shoots leaving 2-3 shoots per stool will be taken during 2nd year for the regenerating coppice stumps dressed during the first year.
- Suitable species for enrichment plantations are mainly indigenous species that (in mixture) may include siris, sisoo, simul, chikrasi, jarul, gamar, garjan, telsur, koroi, champa, mahogany, kadam, arjun, haritoki, pitali, chapalish, boilam, agar, hargoja, padauk, jam, dhakijam, toon, bazna, jalpai, chalta, amla, bahera, ficus species, bamboo, etc. Monoculture will not be allowed and canes will be not be planted.
- Exotic species such as acacia, eucalyptus and mangium will not be planted inside the core zone.
- Palatable grasses for fodder plantations may include *Typha angustifolia, Alpimia nigra, Themeda arundinacea, Saccharum arundinaceum, Sacharum longisetosum, Sacharum narenga, Sacharum hookeri, Phragmites karka, Arundo donax, Impreta cylinder, Sacharum spontaneum, Cymbopogan flexuosus* and *Setaria palmafolia*. These grasses may also be used for gully plugging in case soil erosion takes place due to gradient and run off.
- Planting of fruit bearing and wide crown tree species such as chapalish and artocarpus will particularly be suitable for arboreal fauna such as hoolock.
- Plantation of shrubs and vegetables may be taken up around waterbodies (e.g. *charas*, ponds) by involving local stakeholders.
- Subsidiary silvicultural operations such as cleaning of weeds, climber cutting and freeing of natural regeneration from suppression will be taken up for encouraging natural regeneration. In coppicing species stump dressing and stool thinning (retaining 2-3 shoots per stool) will be carried out. Bamboo clumps will be decongested.

Buffer Plantation Guidelines:
The following guidelines will be adopted while raising buffer plantations in support (or buffer reserve) sub-zone of interface landscape zone based on participatory conservation benefits sharing agreements:

- Block plantations of both indigenous (list as in case of enrichment plantations) and fast growing species such as acacia will be taken in mixture at 2m x 2m (2500 seedlings/ha) by associating local stakeholders (e.g. members of community patrolling groups and user groups).
- The rotation age for the fast growing species would be 10 years (two thinning at 4^{th} and 7^{th} year) and 30 years (two thinning at 10^{th} and 20^{th} year) for long rotation species. The fruit bearing trees suitable for wildlife will be planted and retained at the time of felling.
- The usufructury benefits from 2^{nd} thinning and final felling will be shared by following the FSP guidelines (45% of the total proceeds to FD, 45% to participants and 10% to co-management committee by establishing Tree Farming Fund as under FSP).
- Other guidelines will be applicable as described above for enrichment plantations based on site specific characteristics.

By adopting FSP guidelines, strip plantations will be raised along the linear corridors including roads maintained by Union Parishads.