Nishorgo Support Project

MANAGEMENT PLANS FOR REMA-KALENGA WILDLIFE SANCTUARY

2006

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 PA facilities. This Management Plan provides five year development programs with framework activities and guidelines for sustainably managing the Rema-Kalenga Wildlife Sanctuary 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 Sanctuary, ii) conversion of monocultures of exotic tree species into natural and man made regeneration of indigeneous species by gradually opening the canopy, iii) development of co-management agreements (and linking biodiversity 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 Sanctuary including capacity development, infrastructure, training, and wider extension and communication.

The Plan comprises two volumes : The volume I is divided into Part I and Part II whereas the volume II provides support material and is, therefore, mainly a compilation of guidelines and lists of flora and fauna. The present situation (description of the Sanctuary, 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 Sanctuary. 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 Sanctuary, notified originally in 1981 with a total forest area of 1095 ha (of Tarap Hill RF), was expanded to 1795 ha in 1996. It 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. Tarap Hill 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 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, good natural re-growth, particularly of ground flora and middle story, has come up over the period due to favorable climatic and edaphic conditions, thereby enhancing the Sanctuary's *in-situ* conservation values. Consequently the vegetation in many areas of Rema-Kalenga has approached towards natural structure and species.

Six broad ecosystem types in and around the Sanctuary 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/water bodies, v) Tea Estates, and vi) cultivated fields: the first three being the largest in extent and also important from Sanctuary management point of view. Important biological values of the Sanctuary 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 Sanctuary provides significant scope for wildlife education and research, nature interpretation and conservation awareness. Socio-economic values of the Sanctuary 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 Sanctuary 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 PA management by focusing on an appropriate spatial 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 Sanctuary 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 Sanctuary. In total 22 villages and 3 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 Rema-Kalenga.

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 Sanctuary, while permitting sustainable use in designated zones by local people as key stakeholders.
- ➔ Conserve the biodiversity of the Sanctuary by following a 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 co-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 Sanctuary 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 Sanctuary facilities;
- ➔ Develop conservation and visitor facilities within the Sanctuary;
- ➔ 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.

Major challenges expected in achieving the management objectives include 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.

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

1. Habitat Protection Programs: Main objective of this program is to provide adequate protection to the Sanctuary 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 Sanctuary boundaries and management zones; control of illegal felling, forest fires and poaching; and stopping encroachment of the Sanctuary lands.

Reconnaissance 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 4 km-wide interface landscape zone outside of existing/proposed boundaries of the Sanctuary in order to provide a spatial context for coordination of regional landscape elements and forests. All the peripheral boundaries of the notified Sanctuary area will be identified, surveyed and marked

on the ground. The boundaries of proposed management zones and sub-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 Sanctuary, patrolling on foot by local stakeholders and FD staff will be done regularly. Forest Villagers from Debrabari will particularly be helpful in forest and wildlife 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 Sanctuary will involve local stakeholders, FD field staff and partner NGOs. A forest conflict resolution mechanism will be established as part of co-management committee because Sanctuary 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 Sanctuary 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 zones. The core zone has the highest conservation value followed by interface landscape zones which of course are important for biotic life; these two broad zones are subdivided into sub-zones as discussed below.

The total notified area of the Sanctuary is designated as broad core zone, which is sub-divided into 3 sub-zones: ecosystem sub-zone, habitat management sub-zone, and sustainable and intensive use sub-zone. All the well stocked areas are covered under the ecosystem sub-zone, where management objective is to protect and maintain remaining vegetation in good stocking and encourage natural regeneration to gradually bring back natural forests. More than one-third (37.4%) of the notified Sanctuary has been designated as ecosystem management sub-zone covering existing forests/plantations areas with good biodiversity value. The southern part of Sanctuary (south of the current Chonbari-Rema Beat boundary) is designated as an ecosystem management sub-zone with the main objective of providing long-term protection of natural forests habitat against illicit felling, forest fires, forest land encroachment and cattle grazing.

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 indigeneous 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.

All homesteads, cultivation fields and settlements within the Sanctuary will be included in sustainable and intensive use sub-zone. The traditional use by forest villagers of Debrabari is included in this sub-zone. The habitations and cultivations with respect to Debrabari are included in this sub-zone. Such areas existing at the time of Sanctuary 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 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 two specific sub-zones: support sub-zone and Tea Estate sub-zone. Consumptive use of forests by the resident villagers within the Sanctuary will be limited to the existing Forest Village (Debrabari). The consumptive use by non-residents (21 villages as identified in Chapter 6 of Part I) will be shifted to the identified 4 km-wide interface landscape zone that includes the support sub-zone comprising FD lands and khas lands, and Tea Estate sub-zone. The FD lands (bordering the Sanctuary along nearly 11.5 km) as part of the remaining Tarap Hill RF have an area 1172 ha with natural forests, short and long rotation plantations, agricultural fields, etc. Detailed recommendations for managing the FD lands and forests have been included in the Plan. Nearly 50 ha of khas lands included in the support sub-zone may be brought under co-management by raising plantations based on benefits sharing arrangements as in case of FSP. The present residents of the villages (situated within and on the periphery of the Park) will continue to use forests/plantations sustainably as per the co-management agreements to be signed with FD. Other important part of the support sub-zone comprises all the 21 identified villages where livelihoods programs will be implemented by using Landscape Development Fund (LDF).

All the three Tea Estates (Rema, Hoggly and Purkul) surrounding the Sanctuary are typically very important part of the interface landscape zone of Rema-Kalenga and are so included in Tea Estate sub-zone. 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 Rema-Kalenga forests for meeting their livelihoods consumption needs. The unemployed villagers from these 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. Rema) to fell trees inside the Sanctuary 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 Sanctuary, 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 Sanctuary. Networking with relevant NGOs acting in the landscape zone 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 Sanctuary. The development of built facilities will be undertaken to support the Sanctuary administration during the Plan implementation period. Built facilities will be developed at Sanctuary Hqs. 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 moderate in Rema-Kalenga mainly due to its accessibility and so there is good scope for developing visitors facilities. A tourism region will be identified around the Sanctuary 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. Brochures, 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 (three such trails have been identified and mapped) will be identified and developed for visitors movement through key natural and cultural features of interest (patches of high forests, 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. Kalenga Office and FRH, and Chonbari Office 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 Sanctuary 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 Office Buildings at Kalenga/Chonabri 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 focuses on providing tools/mechanisms for a better understanding of the Sanctuary 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 will 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 Rema-Kalenga
- ➔ Indicator 6b : Increased production of natural resources in targeted areas
- ➔ Indicator 6c : Increased biodiversity in targeted areas of the Sanctuary

Benchmark information base is being 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. The Sanctuary 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 the Sanctuary. 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 wildlife areas, 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 FD with technical assistance from NSP. 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 Sanctuary 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. Rema-Kalenga Sanctuary 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 of FD 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.

TABLE OF CONTENTS

VOLUME 1: *MANAGEMENT PLANS*

PART I

ASSESSING THE PRESENT SITUATION: FINDING AND ISSUES

PART II

RECOMMENDING STRATEGIC PROGRAMS FOR A SUSTAINABLE PROTECTED AREA SYSTEM

TABLE OF CONTENTS

VOLUME 2: *SUPPORT MATERIAL*

VOLUME 1

MANAGEMENT PLANS

PART I

ASSESSING THE PRESENT SITUATION-FINDING 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 forests (Figure 1) and protected areas (PAs). 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 PAs by building gainful partnerships between the Forest Department (FD) and main stakeholders based on mutual trust and shared roles and responsibilities for biodiversity conservation and sustainable use.

The country's PAs (Figure 2) have been an intimate interspersion of human habitations and cultivation through them with traditional dependency on neighbouring forests for their livelihood in a largely agrarian economy. In addition to development pressures on forest land, the traditional dependence of local communities on forests has historically been an important aspect of forests management in Bangladesh. 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 of the natural resources dependent people is 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 (PMPs) were prepared for 2 PAs covered under the conservation area management component of FSP. Although these management plans prescribed an exhaustive list of management activities to be carried out in the 2 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), aims to protect and conserve country's forests and biodiversity for future generations. This plan is an update of the PMP of Rema-Kalenga Wildlife Sanctuary (WS) prepared under FSP. The 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.

2. INTRODUCTION

At the heart of Nishorgo Program is a focus on building equitable partnerships between the FD and key local, regional and national stakeholders, who can assist in conservation efforts for Rema-Kalenga WS. 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 gainful partnerships with relevant stakeholders 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 3 PAs (Figure 3) are situated in Sylhet forest division.

The Plan provides for an overall five year framework for developing and managing Rema-Kalenga WS. 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 WS. 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 Sanctuary management. Extensive field visits were taken and stakeholders consultations on the draft Plan were held with public representatives (local MP, Poursabha chairman, UP chairman and members, etc.), BDR, potential participants, local journalists, NGOs, tribal leaders, saw mill owners, timber traders, mahaldars, FD field staff, etc.

Part I of the Plan assesses the present situation (provides a description of Rema-Kalenga WS, an assessment of its biodiversity, resources protection and management, human interactions, forest resources use patterns, surrounding landscape situation, past biodiversity 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 WS with detailed guidelines) for a sustainable Sanctuary management. 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 WS 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.

The Management Plan is based on a sustainable planning approach comprising, i) protection and conservation of all remaining natural forests and constituent biodiversity in the Sanctuary, ii) conversion of monocultures of exotic tree species into natural and man made regeneration of indigeneous species by gradually opening the canopy, iii) development of co-management agreements (and linking Sanctuary 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 WS including capacity development, facility/infrastructure development, training, and wider extension and communication.

2.1 Location and Constitution

Rema-Kalenga WS (in Chunarughat and Madhabpur Upazilas of Habiganj District) is located nearly 130 km east-northeast of Dhaka and approximately 80 km south-southwest of Sylhet city. The Sanctuary lies in between 24006' – 24014' N and between 91036' – 91039' E. The WS and its proposed interface landscape zones (a 1 km-wide strip bordering the Sanctuary on the west and north), bordering on east and south by the Indian state of Tripura, comprises forests of southern and eastern parts of Tarap Hill RF covering Kalenga, Chonbari and Rema Beats of Habiganj-2 Range. The WS was originally notified in 1981 with a total forest area of 1095 ha, and expanded to 1795 ha in 1996 (a copy annexed in Volume 2), and now includes nearly 85% of the high forest remaining in Tarap Hill RF. Parts of Tarap Hill RF are contiguous with the Sanctuary's western and northern boundaries.

The proposed 1 km-wide landscape zones includes an additional 249 ha of high forest, which in combination with Sanctuary area brings virtually all of the existing high forest within Tarap Hill RF under conservation management. In addition, the interface landscape zones include nearly 700 ha of long-rotation plantations, which are important for biodiversity conservation and provide additional wildlife habitat. The interface landscape zone will form an integral part of WS co-management and will help shift biotic pressures away from natural forest areas by involving local stakeholders. Nearly 400 ha of Tea Estate lands bordering the Sanctuary on the south-west and approximately 50 ha of khas lands bordering the Sanctuary on north-east are included in the interface landscape zones to complete a 1 km-wide buffer strip along all of the Sanctuary boundary in Bangladesh territory. Although these Tea Estate and khas lands are not under FD control, the users of these lands are important stakeholders under the co-management approach adopted under NSP.

2.2 Approach and Access

Bangladesh Railway serves well as the WS falls near to the main railway line running through Sylhet forest division (Figure 4). However, the existing road connectivity is not good, but can be improved for making the Sanctuary attractive for eco-tourism and biodiversity conservation, particularly for the people of large urban centers such as Dhaka and Sylhet. This will enable the WS, representing the accessible hill forests of Sylhet division, to be well connected by good roads, which also will provide easy access to the nearest national/international airport at Sylhet. The accessibility of Rema-Kalenga, the forests of which form international boundary with the north-eastern India, is presently limited during rains as it is connected by fair weather roads only.

A dry season road connecting the Kalenga, Chonburi and Rema Beat Offices forms nearly 5 km of the western boundary of Rema-Kalenga Sanctuary. All streams crossings on this road are bridged or culverted, but the road is unsurfaced and may not be passable by vehicle following heavy rains. A reliable road access to the Sanctuary is from the north, leaving the Madhabpur-Srimongal highway at the market town of Losna (nearly 10 km west of Srimongal) and proceeding south approximately 15 km to Kalenga Beat Office. The central and southern portions of the road are unsurfaced and vehicle access is not possible during monsoon rainy season. Kalenga Beat Office is also accessible from the west, leaving the Madhabpur-Srimongal highway at Chunarughat and proceeding directly eastward along an LGED-maintained roadway for nearly 10 km. But this route requires some unbridged stream crossings and is not always passable. An additional route from Chunarughat to Rema Beat Office proceeds southeast using public roads, and links up with the road network of the Rema Tea Garden's private ferry for crossing the Khaway River.

There is currently no road access to the interior of the Sanctuary, except an unsurfaced road forming nearly 5 km. of the western boundary. This is intersected by a number of foot trails leading into or across the Sanctuary, providing access to paddy fields and subsistence harvest areas in the interior. A major east-west foot trail (the Chouka Path) nearly bisects the Sanctuary and is used as a trade route to and from the Indian border. The BDR Camp in the far south of the Sanctuary was previously accessible by road through the Rema Tea Graden, but the portion of the roadbed within the Sanctuary has fallen into disrepair and the Camp is now accessible only by foot or motorcycle.

3. BIODIVERSITY CONSERVATION ATTRIBUTES

3.1 Statement of Biodiversity Significance

The forests of Rema-Kalenga WS (Figure 5) are very rich biologically, located as they are on the high rainfall bio-geographic zone with evergreen and semi-evergreen forests. The WS 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 the forest division, forming fertile floodplains with enhanced economic activity and high population density. Sylhet forest division is home to many tribes with their traditional lifestyle dependent on natural resources including forests for their forests-based livelihood. Forest villages were historically established within Tarpa Hill RF to ensure a regular labor supply for forestry activities including harvesting and raising plantations. For example, Tripera tribe of Debra Bari Forest Village (having 29 households) continue to help FD in forest protection and plantation activities.

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

3.2 Biodiversity Conservation Values

Socio-economic values of the WS 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 improvement of 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 WS 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 conserved, may be lost for future generations. The WS is also 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 WS 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 under the Act 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. 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 WS is part of Tarap Hill RF, which was reserved in early nineteenth century by following the reservation process per the Forest Act 1878, Assam Forest Manual 1898 and 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 many forests have been brought under encroachment for cultivation and settlements. Although the WS was notified by the Government, no efforts were made to physically demarcate the boundaries in the field. The situation got excarbated 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 PAs with limited wildlife corridors and breeding space.

3.5 Forest Geology, Rock and Soil

The rolling hills (Figure 6) of upper tertiary rocks of the WS are composed of upper tertiary rocks in which soft sandstone predominates. The highest peak among the several encompassing hills of different elevations is about 67m above mean sea level. A series of ridges run along different hills forming small micro-watersheds with a mix of streams (locally known as *cheras*). The hills of Rema-Kalenga represent the northern tips of the extensive hill system, which extends from southern Sylhet District south through Tripura and the Chittagong Hill Tract (CHT), and into Arakan State in Mynmar (Hasan, 1994).

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 the WS. They represent northern and eastern hills, interspersed with northern and eastern piedmont plains. The soils of the WS 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. Sandy loam soils are predominant in Tarap Hill RF but lack humas on hill tops; in swampy areas forest soils are clayey.

3.6 Biophysical Situation

The WS 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. The encroachment of Taral Hill RF including WS areas 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 re-growth, particularly of ground flora and middle storey, has come up due to favorable climatic and edaphic conditions, thereby enhancing the in-situ conservation values of WS. Old plantations have grown up in shape of tall multi-storied structure with re-growth of ground flora and a middle storey of naturally occurring species. Consequently the vegetation in many areas of WS has approached towards natural structure and species. However, Rema-Kalenga is still having major portion as high and comparatively better stocked forests due mainly to its inaccessibility and resulting better protection. The biophysical conditions of the WS are further described in detail in Chapter 4.

3.7 Micro-Climate

The climate of the Sanctuary is in general warm and humid but the weather is cool and pleasant during winter. The temperature varies on an average from minimum 27 degrees in February to 37 degrees in June. The humidity is high in the WS 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 WS 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.

4. BIODIVERSITY AND HABITAT

4.1 Ecosystems Analysis

A community and the environment with which it interacts is referred to as an ecosystem. The Rema-Kalenga Sanctuary and its surrounding landscape encompasses terrestrial, aquatic and forest ecosystems. A variety of plant, animal and micro-organisms and the ecological processes that make them function are present in the Sanctuary. The forests of Rema-Kalenga WS are composed of mixed tropical evergreen and semi-evergreen plant species, characterized by high rainfall and a multi-tier vegetational assemblage of rich biodiversity. Therefore, the WS is categorized under the tropical evergreen and semi-evergreen bio-geographic zone. The WS has also been shown under 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 ecosystems of Rema-Kalenga. The conservation of biodiversity in each of the representative bio-geographic zone including ecosystems is a main objective of the establishment and management of Rema-Kalenga.

Six broad ecosystem types in the WS and its interface landscape are identified as below :

i) High forests represented by the remaining natural forests,
ii) Plantations including the monoculture of exotics,
iii) Grasslands and bamboos,
iv) Wetlands/waterbodies,
v) Tea estates, and
vi) Cultivated fields

The first three ecosystems are the largest in extent and also important from the WS 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. The following main components of biodiversity are described in order to have a better understanding of the Sanctuary ecosystems. A detailed description of tea estate ecosystem and other land-uses as practiced by local stakeholders is provided in Chapter 6 of Part I.

4.2 Forests

The forests (mainly mixed tropical evergreen and semi-evergreen forests) of Sylhet forest division including the WS were reserved in early nineteenth century. Before reservation many forests were cleared for jhum (shifting cultivation), after which secondary vegetation developed over the period. The WS comprises the remaining natural forests, and the plantations (Table 4.1) 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 WS. Forest fires in summer have adversely affected the natural forest regeneration.

Many natural forests areas of Tarap Hill RF, now part of the WS, were converted by raising long rotation plantations (of teak, mahogany, garjan, karai, sal, gamari, shiso, toon, pynkado, agar, jarul, cham, jam, etc) taken up from late twenties for production forestry. Original forests have been removed in many areas and the conservation value of the WS currently stems from old plantations, which have developed a tall, multi-storied structure, and the remaining natural forests. In the oldest of plantation areas the vegetation cover has taken on the structure of natural forest. On review of the old compartment history files of Tarap Hill RF block it came out 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.

Tarap Hill forests (a part declared as Rema-Kalenga WS), which were initially divided into 8 compartments, still have comparatively better stocked forests (nearly 80% of the notified Sanctuary area still have closed forest cover), which are mainly mixed tropical evergreen forests (Figure 7). Although plantations occupy only a relatively small part of the Sanctuary, a much larger portion of the Tarap Hill RF outside of the Sanctuary has been converted to plantations by removing natural forests. A part of the interface landscape zones and a small part of the Sanctuary area have been converted to plantations, some of which have developed a tall,

closed canopy structure with an under-storey of naturally occurring trees and undergrowth vegetation. The under-storey of shrubs, herbs and bamboo (muli, mitringa and parua) is good.

Initially these forests were worked, and rightly so, under the selection-cum-improvement silvicultural system as the natural regeneration of main species was good and the terrain was generally hilly. They were subsequently opened for clearfelling followed by artificial regeneration by planting species such as garjan, champ, bonak, karai, jam, gamar, sal, teak, jam, kumbi, haritiki, bohera, dhakijam, hargoza, jarul, kadam, malakana, gamar, rata and gondrai (the first plantations were taken up in 1929 as documented in Working Plans). Teak plantations of Tarap Hill RF have been subject to illicit felling by local people but also by outsiders due to high value of teak timber. Similarly non-timber forest products (NTFPs) such as cane and creepers are illegally harvested and some wildlife damage also done by hunting.

The details of forest cover are presented in Table 4.1 as below.

Table 4.1 : Forest and land use cover in Tarap Hill Reserved Forest

Cover Type	Notified Sanctuary Area		Proposed Support Sub-Zone		Remainder of Tarap Hill RF		Total	
	Area (ha)[1]	Percent	Area (ha)[1]	Percent	Area (ha)[1]	Percent	Area (ha)[1]	Percent
High forest	1404.9	78.3	249.5	21.3	1.1	<0.1	1655.5	26.6
Low forest	0.0	0.0	10.5	0.9	41.8	1.3	52.3	0.8
Scattered trees	84.9	4.7	7.6	0.6	19.1	0.6	111.6	1.8
Bamboo	0.0	0.0	0.0	0.0	15.4	0.5	15.4	0.2
Long-rotation plantation	97.9	5.5	606.1	51.7	1729.9	53.0	2433.9	39.1
- 1920s	(0.0)	(0.0)	(1.6)	(0.1)	(0.0)	(0.0)	(1.6)	(<0.1)
- 1930s	(0.0)	(0.0)	(0.0)	(0.0)	(34.6)	(1.1)	(34.6)	(0.6)
- 1940s	(56.4)	(3.1)	(170.2)	(14.5)	(44.3)	(1.4)	(270.9)	(4.3)
- 1950s	(0.0)	(0.0)	(10.3)	(0.9)	(78.4)	(2.4)	(88.7)	(1.4)
- 1960s	(36.8)	(2.1)	(191.7)	(16.4)	(222.1)	(6.8)	(450.6)	(7.2)
- 1970s	(0.0)	(0.0)	(47.6)	(4.1)	(544.8)	(16.7)	(592.4)	(9.5)
- 1980s	(0.7)	(<0.1)	(125.9)	(10.7)	(315.4)	(9.7)	(442.0)	(7.1)
- 1990s	(4.0)	(0.2)	(58.8)	(5.0)	(490.3)	(15.0)	(553.1)	(8.9)
Short-rotation plantation	0.0	0.0	71.4	6.1	569.4	17.4	640.8	10.3
Murta plantation	0.0	0.0	0.9	0.1	24.8	0.8	25.7	0.4
Bamboo plantation	0.0	0.0	0.0	0.0	2.1	<0.1	2.1	<0.1
Cane plantation	0.0	0.0	0.0	0.0	2.1	<0.1	2.1	<0.1
Rubber plantation	0.0	0.0	0.0	0.0	284.3	8.7	284.3	4.6
Failed plantation	0.0	0.0	0.0	0.0	79.3	2.4	79.3	1.3
Agriculture	206.5	11.5	226.0	19.3	458.0	14.0	890.5	14.3
Encroached/other[4]	0.8	<0.1	0.0	0.0	37.6	1.2	38.4	0.6
Total	1795.0	100.0	1172.0	100.0	3264.9	100.0	6231.9	100.0

[1]areas are based on RIMS data.
[2]long-rotation plantations include teak (*Tectona grandis*), chikrassy (*Chikrasia tabularis*), pynkado (*Xylia dolabriformis*), mahogony (*Swietenia mahogoni*), dhakijam (*Syzigium grande*), jarul (*Lagerstroemia speciosa*), sal (*Shorea robusta*), chapalish (*Artocarpus chaplasha*), garjan (*Dipterocarpus turbinatus*), koroi (*Albizia* spp.), amora (*Spondias mangifera*), champa (*Michelia champaca*) and gamar (*Gmelina arborea*).
[3]short-rotation species include moluccana (*Albizia (Paraserianthes) falcataria*), eucalyptus (*Eucalyptus* spp.), akashmoni *(Acacia auriculiformis*) and mangium (*Acacia mangium*).
[4]includes 0.8 ha BDR Camp located in high forest in the southern part of the Sanctuary.
Source : Forest Department

4.3 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 WS. A total of 167 species including forest-dwelling and wetland-associated species documented (see List of Wildlife Species in Volume 2) in Rema-Kalenga include at least 10 species that are at high risk of extinction. The total of 35 mammal species documented in the area to date includes at least 23 species which are at a high risk of extinction in Bangladesh. The Rema-Kalenga area also supports an important herpetofauna, including 7 frogs and toads, 2 turtles, 6 lizards, and 10 snakes among the total 25 species documented to date. Two of the amphibians and 14 of the reptiles are rated as being at high risk of extinction. The Sanctuary also supports a rich diversity of other faunal groups such as invertebrates and fishes but very little information is currently available.

Large mammals such as tigers, leopards, bears, wild dogs and sambar have disappeared from the WS 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. A rich diversity of other faunal groups such as reptiles, vertebrates, fishes and amphibians is present. A good population of capped langurs and macaques is found in the WS. Of two, capped langur is used as key species for the development and implementation of forest management and conservation measures in Rema-Kalenga.

4.4 Non-Timber Forest Products (NTFPs)

The role of NTFPs in providing livelihoods, employment and income to forest dependent communities is 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. Local communities including tribals collect from the forests foods such as fruits, nuts, tubers, leaves and numerous other forest products including creepers, grass, leaves, bark, bamboo, canes, medicinal plants and wild animals.

Medicinal plants collected from natural forests of Tarap Hill RF form the main resource base for traditional medicine and health practices characterized by folk stream (village based local knowledge) and codified stream (Ayurved and Unani systems of medicine). Khan et al (2002) have identified 84 plant species that are used for medicine from Rema-Kalenga WS. A majority of rural population in the country continue to depend 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,* 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 PBSAs under Forestry Sector Project. 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 WS are necessary for managing NTFPs sustainably.

As commercial harvesting is not practiced in the WS, one of the multiple objectives of forest management will 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 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 WS in view of the 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 user groups and 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.

4.5 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. Khaway river lies on the western side of the WS. It provides good habitat, drainage and drinking water source for the wild animals and local people. The river 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.

A number of sandy-bedded streams and nallahs pass through the WS and so aquatic habitats associated with forest cover and riparian (streamside) vegetation and animal species are important part of overall habitat composition. Rema-Kalenga Sanctuary is drained (drainage is mainly westward into the Khaway River and its tributaries) by a number of small, sandy-bedded streams, which largely dry up following the end of the rainy season in October-November. It has an artificial lake created by excavating and damming a natural drainage course. Low-lying areas in the northern half of the Sanctuary and the adjacent parts of the interface landscape zones and Tarap Hill RF have been converted to rainfed paddy fields. In addition to removal of forest and natural wetland habitats, this conversion has imposed a barrier effect on the movements of some forest dwelling species.

The WS forms the catchment areas 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 old 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 was taken as mahal boundary by naming it as right or left bank.

4.6 Biodiversity Utilization

Sylhet forest division is densely 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 the PAs are surrounded by large population). However, Rema-Kalenga is comparatively less populated in view of its location near international borders and resulting poor accessibility.

4.6.1 Biodiversity Produce for Human Use

Although no commercial harvesting is done by FD in the PAs, the forests of WS and its interface landscape zone 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 are important furniture and house building material (thatch for roof construction). Although the hunting of wildlife is prohibited, local tribes depend on hunting for meeting their consumption demands for meat. The surrounding urban population use the WS for earning their livelihood through commercial sale of illicitely felled timber and fuelwood as it provides a 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 encroachment of forest land pose a big challenge both for the FD staff and other stakeholders.

The surrounding landscape of Tarap Hill RF is inhabited by more than 200 households of different villages. Officially there are 33 households in Rashidpur Beat, 95 in Kalenga Beat, 50 in Chonbari Beat and 13 in Rema Beat, but actual households numbers may be much higher due to natural population increase. Debrabari Forest Village (with a population of 29 households) inhabited by Tripura people and located in the interior of Sanctuary was established nearly 100 years ago. The inhabitants use nearby forests for meeting their subsistence demands for fuelwood, small timber for constructions, medicinal plants, grazing, timber, etc. They cultivate paddy in nearby rainfed fields, raise livestock (cattle, buffalo, pigs, goats and poultry) and grow fruits and vegetables in their homesteads.

4.6.2 Marketable Biodiversity Products

Important local markets for the biodiversity produce from the WS include Sylhet, Sunamganj, Maulvibazar, Madhabpur, Habiganj and Srimangal. The demand for biodiversaity 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. 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 a main source of supply of bamboo, cane and murta from the government forests. However, the supply of biodiversity produce from the government forests is declining due mainly to deforestation and shrinking forest lands. Other NTFPs that are harvested 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 Tarap Hill RF, a part of which is now covered under the Rema-Kalenga WS, were declared as RFs during early nineteenth century and 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. These forests had initially 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 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 Tarap Hill RF. The first Working Plan (Das, 1938-47) recommended three Working Circles (Timber A & B, Firewood A & B, and Bamboo) and the RF was included under Timber Working Circle (WC) managed under selection-cum-improvement silvicultural system in view of the hilly terrain. The RF block was divided into 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, some natural forests in this 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 present WS, was abolished in this plan. Given good rainfall and rich forest soils, the natural regeneration in the Tarap 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. Some hill forests covered under the present day Rema-Kalenga WS 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. Similarly some hill forest areas, covered under the present day Rema-Kelinga WS, were covered under short rotation WC to be planted with short rotation tree species such as malakana (*Paraserianthes falcataria*). The plantations of malakana were introduced in 1974 in Tarap RF (and now part of Rema-Kalenga WS) in order to ensure a regular supply of short rotation (10-15 years) pulpwood material for Sylhet Pulp and Paper Mill. Indeed the Rema-Kelinga WS was notified during this period (1981) and so the working inside the WS gazetted forests (of Tarap Hill RF) including clearfelling of natural vegetation and bamboo harvesting were stopped as per the provisions of Wildlife Act 1974.

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 were implemented, wildlife management in the WS 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 a separate Management Plan was prepared for Rema-Kalenga by Rosario (1997), and subsequently by Salter and Alam (2001) but the same could neither be approved nor implemented.

5.3 Habitat Protection

The forests of Tarap Hill RF were subject to indiscriminate felling prior to their reservation in early nineteenth century. The forests were brought under scientific management during British rule when in 1865 FD was established and Forest Acts of 1878 and 1927 were implemented. Tarap 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 forests and wildlife after the gazetting a part of Taral Hill RF as WS.

Participatory forestry is being implemented in Sylhet forest division under FSP. The buffer plantations (raised in the interface landscape zones of the WS) are protected by the participants (organized into user groups), who get usufructury benefits from the harvests as per the guidelines of FSP. Tarap Hill RF in general and the WS in particular is approachable by jeep, bicycle and foot, and this accessibility available to 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 not only derive forest produce from nearby forests resulting in vegetation degradation. A close proximity of forests to international borders gives rise to transnational protection problems, which require international coordination between the Forest Departments of Bangladesh and the neighbouring Indian state of Tripura.

5.4 Eco-Tourism

The accessibility of Rema-Kalenga from Sylhet and Dhaka through air, rail and road networks can be easily improved to make the WS attractive for eco-tourism, particularly to urban dwellers. A large number of tourists may visit Rema-Kalenga to have a feel of luxuriant vegetation of evergreen forests and good landscape with rolling hills and interspersed valleys. However, chartered eco-tours on the pattern of Sundarbans have not been yet popular in Sylhet forest division. 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, stem, 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 WS. 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 managment, capture of wildlife, census operations, captive breeding, etc.

5.7 Administrative Set Up

Under the overall charge of the CCF, a wildlife and nature conservation circle (WNCC, with CF as head and assisted by a staff officer of DCF rank) operates with six field level DFOs. Of the six DFOs, four are incharge 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 WMNC, Sylhet as per 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 Sanctuary management by focusing on an appropriate spatial scale to integrate relevant habitat/forest system, ecosystem and social/institutional system (Figure 8). It is an holistic approach, which takes into account relevant factors which impinge on the management of a PA in the context of a broader spatial scale. So landscape is taken as a planning and development unit for integrated Sanctuary management. It addresses the needs of households and co-management activities in the context of a broader economic, natural resource and socio-institutional environment of a WS. It provides a framework to manage a WS for multiple uses by addressing interactions between local economy, stakeholders and natural resource base. Landscape management of a WS entails biodiversity conservation by linking surrounding ecosystems and human systems. The interface landscape exercises influence in and around the boundaries of the Sanctuary. It helps restore ecological processes both within a WS and in surrounding landscapes by accounting presence and needs of local inhabitants. It promotes active involvement of main stakeholders in Sanctuary 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 management of a WS.

6.2 Interface Landscape of Rema-Kalenga Wildlife Sanctuary

A number of villages, cultivated fields, tea estates, khas lands, forests and international border fall within the zone of influence of Rema-Kalenga WS. The WS is intimately surrounded by a number of villages, cultivated fields, forests and Tea Estates. It is bordered along most of its northern and western boundaries by RFs, along part of its south-western boundary by Rema Tea Estate lands, along its southern and eastern boundaries by India, and along a small portion of its northern boundary by khas lands (Table 6.2).

Table 6.2 : Interface Landscape of Rema-Kalenga Wildlife Sanctuary

Landscape Category	Boundary Length (km)	Percent of Total
Reserved forest	11.5	37.3
-natural forest	(5.1)	(16.6)
-converted to plantations	(3.2)	(10.4)
-converted to agriculture	(3.2)	(10.4)
Tea Estate	3.5	11.4
Indian border	15.0	48.7
khas land	0.8	2.6
Total	30.8	100.0

Of the total 850 ha Tea Estate lands adjoining to the Sancuatry, 144 ha are under tea, 40 ha under rubber, and the remainder under scrub and natural forest. Most of the labourers living on Rema Tea Estates exert enormous biotic pressure on the nearby forests and wildlife of the Sanctuary. Some workers get involved in illicit felling from the WS and they transport the forest produce through the Tea Estates. Hoogli (east of the WS but near to Tarap Hill RF) and Purkul (north-west of the WS) though not adjoining to the WS are other important Tea Estates. Khas lands adjacent to the Sanctuary have been partially converted to citrus and banana plantations.

Land adjacent to the Sanctuary in India has been converted to rubber plantations and paddy fields. Little or no natural forest borders the Sanctuary on the east or south, although some scrub vegetation remains. A contingent of the Bangladesh Rifles (BDR) is responsible for maintaining security along the Bangladesh-Indian Border (bordering Indian state of Tripura), which forms the eastern and southern boundaries of the Rema-Kalenga Sanctuary. BDR has established two camps in the area, one adjacent to the Kalenga Beat Office and one in the interior of the Sanctuary along the southern boundary. The presence of substantial staff of BDR brings additional biotic pressure on one hand but on the other hand helps check illicit felling from the forests. Visitors are not attracted to Rema-Kelega due to its poor accessibility and visitors facilities. Only two Forest Rest Houses (at Kalenga and Chonbari Beat Offices) are available for visitors.

6.3 Stakeholders Assessment

Three main categories of stakeholders (primary, secondary and institutional) have been identified by NACOM (2004) through RRA/PRA carried out in Rema-Kalenga WS. The primary stakeholders from the

surrounding villages have been identified in Section 6.4. Main institutional stakeholders, involved with the developmental and administration activities in the interface landscape zones include FD, NGOs and credit Banks, community-based organizations, Police, BDR and local government bodies such as Union Parishads and Gram Sarkar. A number of NGOs (ASA, BRAC, BRDB, PASA, Krishi Bank, Grameen Bank, etc.) are active in income generating activities and micro-credit programs in the surrounding landscape. There is only one community-based organization (Village Development Programme based at Basulla in Gazipur) with 64 members, which deals with local cultural and welfare activities in the locality.

Four categories of secondary stakeholders (not directly involved with forest extraction but are linked with forest-based activities including timber processing, trading and utilization)) include fuelwood traders, furniture shop owners, sawmill owners and timber traders. The fuelwood traders of Gazipur Bazar, Sindurkhan Bazar and Chunarughat Bazar buy fuelwood from the primary collectors for trading. They procure fuelwood from individual collectors and stack them for sale for local consumption and but for subsequent transport by truck and train to Habiganj, Brahamanbaria, Srimongal, Moulvibazar and Comilla. There are several furniture shops at Chunarughat for the sale furnitures, manytimes made of illicit timber collected mainly from Taral Hill RF. A total 12 saw mills process both legal and illicitly felled timber for making furnitures in these furniture shops. Nearly 15-20 timber traders of Gazipur, Nalmuk Bazar, Sindurkhan Bazar and Chunarughat Bazar are associated with timber trading.

6.4 Interface Villages

Based on a RRA/PRA study conducted by NACOM during May-July 2004, a total of 22 villages (8 of them are tribal villages) have been identified having stakes of different levels in the WS. Of these, Debrabari Forest Village is located inside the WS, 9 villages (Kalengabari, Kalibari, Mongoliabari, Puranbari, Chakidarbari, Chanbari, Rema-Balumara, Hatimara and Krishnachara) are on the periphery of WS, and 12 villages (Harinmara, Himalia, Chamaltoli, Nichintapur, Lalkear, Barabda, Sayadabaj, Alinagar, Krishnanagar, Basulla, Kabilashpur and Jamburachara) are located outside of the WS.

Ten villages inside and on the periphery of WS have major stakes in the WS as local villagers depend on the WS for meeting their basic consumption needs. In addition to fuelwood, timber, bamboo and other NTFPs, they collect vegetables, fruits, fodder and sungrass from the WS. The collected vegetables include bamboo shoots (manthana), dhekishak, kachshak, bandhugi, banaita, banana thor, banana muchi, ramkala, thankuni, aorai kalai, karam, gantha, muia, palon shak, kachu, kachur lati, etc. The forest fruits collected by them include kow, jam, hill mango, lata mango, chamkatahal, latkon, dumur, hill banana, amra, hortuki, boira, tera, jambura, kanthal, cane fruits, etc. For consumption they also hunt jungle fowl, wild boar, hill moyna, parrots, shalik, etc. Tipra tribals from Debrabari Forest Village get involved in forest protection efforts by joining patrol parties of FD. The remaining 12 villages lying outside the WS have minor stakes mainly in terms of associated with fuelwood collection. A number of Tripura villages/housing clusters (for example, Chonbari, Mongoliabari, Kaliabari, Krishnachara, together comprising 60 or more households) are scattered (from Chonbari Beat Office to near the Indian Border) along the north-western and northern boundaries of the Sanctuary.

Local people practice cultivation of paddy on rainfed fields and horticulture on their home gardens. They depend heavily on nearby forests for meeting their subsistence consumption needs. The settlements in the vicinity of the Sanctuary include Kalenga Office Tila (comprising 57 Bengalee households) near to the Kalenga Beat Office and Hizmalia (comprising nearly 200 households) at the western edge of the RF near Kalenga Beat Office. Local people are involved in paddy farming, small scale trading and as daily laborers. They also use nearby forests for fuelwood, timber and cultivation on encroached forest lands (nearly 400 families were evicted from the RF areas in 1982).

6.5 Tea Estates

There is one Tea Estate (Rema) bordering the WS and two neighbouring Tea Estates (Hoogli and Purkul). Huge amount of labor required for tea collection exert heavy impacts on the forests of WS and Tarap Hill RF (Figure 9). Some parts of these Tea Estates have not so far been brought under tea cultivation and have over the period developed unmanaged secondary vegetation, which provide additional wildlife habitat. For example, of the total 850 ha lands of Rema Tea Estate adjoining to the Sancuatry, 144 ha are under tea, 40 ha under rubber, and the remainder under scrub and natural forest. A large number of workers employed by the Tea Estates and their family members depend on the nearby forests for meeting their forests-based consumption needs. The unemployed villagers from Rema and Hoogly Tea Estates are particularly involved in fuelwood collection and timber felling. For instance, nearly 1200 workers and their dependents living on Rema Tea Estates put heavy biotic pressure on the Sanctuary. Some workers get involved in illicit felling from the WS, and they transport the forest produce through the Tea Estates. On an average 200 local people enter Rema-Kalenga forests mainly for fuelwood (150-200 monds on an average each day), bamboo

and timber collection. In addition to local consumption of fuelwood, a substantial amount is transported to nearby centres such as Gazipur, Lalmukh Bazar, Sindhurkhan Bazar and Chunarughat.

Hoogli (east of the WS but near to Tarap Hill RF) and Purkul (north-west of the WS) Tea Estates are not adjoining to the WS and so have only minor stakes in the WS. But these two Tea Estates are important for the Tarap Hill RF as they are very close to its boundaries and so indirectly affect the WS. Shade tree species such as *Albizzia lebbec* and *Deris robusta* are planted inside tea gardens for providing adequate shade to tea bushes. Timber smugglers many times pass through Tea Estates to enter in Tarap Hill RF and the WS and along the transport routes sometimes get involved in felling of trees inside the Tea Estates. So joint protection efforts are required from FD field staff and Tea Estate managers for control of illicit removals. Some of the poor labourers may be involved in the protection of forests of theWS by forming groups for taking income generation activities through LDF. However, this policy decision will require vetting from the Tea Estates Employers Association (Chittagong). The FD will approach the Chairman of Tea Employers Association to issue suitable instructions to the authorities of three identified Tea Estates.

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 Rema-Kalenga WS 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 approach that will ensure long-term protection and conservation of biodiversity within the WS, while permitting sustainable use in designated zones by local people as key stakeholders.
- To conserve the biodiversity of the WS by following a co-management 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 implement income generation activities for sustainable livelihood development and up-scaling of skill development among the local stakeholders
- 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 eco-tourism in suitable zones and develop visitor amenities

1.2 Framework Activities

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

- Survey, demarcate and mark the WS 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;
- Srengthen FD institutional capacity for PA management;
- Build conservation awareness, constituencies and extension activities on conservation issues;
- Train local stakeholders including participants, FD staff and NGOs in conservation management and income generation activities, and raise their awareness level;
- Develop conservation and visitor facilities within the WS;
- 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 WS. 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 boundaries, lack of funds, lack of trained professionals, inadequate staffing and infrastructure, monoculture, man-animal conflicts, etc.

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 Wildlife Sanctuary under the Wildlife (Preservation) (Amendment) Act, 1974 and the need to establish gainful partnerships with key stakeholders based on sustainable use, the following management strategies have guided the development of this Management Plan, and of the management and development programs outlined in Part-II. The overall focus of management planning in the WS is to manage the Sanctuary in as natural and undisturbed condition as possible, and to provide protection to their constituent biodiversity including wildlife population. However, such a management of the WS 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 the 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 WS. The management of Sanctuary 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 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 interface landscape based on co-management agreements, specifying roles and responsibilities for stakeholders' partnerships. As far as possible subsistence use will be gradually shifted to the proposed landscape zones and no new settlement or in-migration will be permitted within the core area. Visitor use for outdoor recreation, research and educational purposes will be encouraged in designated areas.

Boundaries of the WS will be surveyed, demarcated and maintained regularly. Specific zones will be designated for achieving different management objectives. Within the Sanctuary 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 the 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.

Co-management councils and committees will be formed in Rema-Kalenga and their constitution approved by the Government. The committee will have an oversight role in the implementation of this Plan.

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.

2.3.3. Project Objectives

Nishorgo Support Project 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.

2.3.4. 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 exacerbated 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.

2.3.5. 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.

2.3.6. Landscape Development Fund (LDF)

Main focus of co-management is on equitably sharing roles and responsibilities by main stakeholders for biodiversity conservation in the WS. 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 a landscape development fund is being designed for funding alternative income generating activities. An initial amount of USD 300,000/- is earmarked to be used as seed money.

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 Sanctuary. Main objective of this program is to provide adequate protection to the WS 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 Sanctuary boundary, iii) controlling illegal removals from the WS, and iv) checking encroachment of the Sanctuary lands.

3.2 Updating of Existing Forest Cover and Landscape Maps

Detailed forest cover/landscape mapping for Rema-Kalenga WS (and all of Tarap Hill 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 specific zones within the two 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 and a 1 km wide interface landscape zones outside of existing/proposed Park boundaries in order to provide a spatial context for coordination of regional landscape elements including dependent human population 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. Land-use and base maps will be prepared by acquiring latest satellite imageries (e.g. high resolution IKONOS or aerial images) for the WS. 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 WS 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 implementation of this Plan. 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) or other markers (wooden or iron pillers, trenches, mounds, etc.) will be put in place (see Tecsult 2001 for detailed guidelines) 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 maintenance program will be necessary annually for boundary and pillar renovation and maintenance.

All the locations where primary access routes cross the Sanctuary's outer boundaries will be clearly marked with signs indicating the Park's name and summarizing key regulations in written text and symbols. All outer boundaries of Rema-Kalenga WS will be defined and marked on the ground. Location of boundaries will be based on remaining boundary posts along the Bangladesh-India border (resurveyed as necessary) and elsewhere on descriptions in the Gazette Notifications for the WS. All the boundary will be surveyed and marked at all turning points, and at maximum 200 m intervals along straight stretches, using concrete posts. All the crossings where main access routes cross WS's outer boundaries will be marked and mapped with signs and relevant details. Two types of signboards will be used, i) a well designed, large wooden signboard at WS Headquarter, and ii) concrete slab boards at other relevant locations. Possible candidate locations for signboards are Sanctuary HQ, Kalenga-Rema road crossing point (northern Sanctuary boundary), Kalenga-Rema road crossing point (western Sanctuary boundary), boundary at Rema Tea Estate Patrol Camp, Boundary at Kalenga Chara Patrol Camp, India-Bangladesh border at Debrabari Forest Village, India-Banladesh border at Chouka Path crossing point, and India-Bangladesh border at southwestern corner of WS.

3.3.1 Inconsistency in Sanctuary 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 Sanctuary 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 WS. 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 Rema-Kalenga WS is 1795 ha as against the area 1785 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 Sanctuary.

3.4.1 Control of Illicit Felling

Illicit felling inside the Sanctuary will be checked through extensive joint patrolling (FD staff and local stakeholders) inside the forests, particularly the core areas. The villagers from Forest Villages (e.g. Debrabari) will be very helpful in forest protection efforts. The current practice of appointing forest protection helpers from the nearby villages has not proved useful and so will be discontinued. Instead co-management groups and committees will be involved in forest protection. 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 PA, 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 and encroachment within the WS. It will be essential to regulate illegal running of sawmills and furniture shops located nearby the WS. Guidelines may include that no sawmill should function, say 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 WS.

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 FD 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 WS. 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.

3.4.2 Control of Poaching

Poaching of wildlife inside the WS 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 Debrabari Forest Village) and FD field staff will regularly be done. Special care should be taken during moon nights when incidences of poaching may increase due to better visibility. However. effectively checking 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)

NTFPs are presently collected from the WS 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 staus of NTFPs, time and methods of collection and limits of sustainable collection. 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.

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 will guard against the forest fire as well. 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

The villagers (e.g. Forest Villagers, Tea Estate labourers) in and around the Sanctuary maintain cattle who invariably graze in forests. No grazing will be allowed in the WS 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, suitable 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 should 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 boundaries of the WS 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 the Forest Village and surrounding Tea Estates. Local stakeholders will be responsible for checking wildlife damage. They will be trained by FD staff and NGOs and the equipments (e.g. batteries, crackers) 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 WS needs to be formalized through co-management agreements to be signed with groups of users. For example, there is one forest villages established inside the WS (Debrabari) by allotting forest lands and have villagers' established rights for forest use 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 4 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 for Rema-Kalenga under NSP as well. The participants will have responsibility for the protection of neighboring 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 be 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 Rema-Kalenga. These forests 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. Watershed conservation as a result of habitat conservation can be an additional incentive to local people in terms of water yield for agricultural purposes. A draft co-management agreement format applicable for the benefits sharing from natural forests (particularly from core areas) is prepared.

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 will be helpful in generating value additions through capacity building of local people. Landscape Development Fund (LDF) will help provide finance for organized groups 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 the Sanctuary. The FD may countersign the benefit sharing agreement. A new co-management agreement format to be signed between user groups and the implementing NGO is developed for the AIG activities to be carried out through LDF. Existing traditional users from established Forest Village (e.g. Debrabari) 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

Important sources of forest related conflicts among local stakeholders in and around the Sanctuary may relate to forest extraction, forest land encroachment, land disputes, forest offence cases, forest grazing, money lending, children and family affairs, local politics, etc. Present practice of local conflicts resolution involves help from local elites and public representatives (e.g. chairman and members of local Union Parishad, local MP, Gram Sarkar members, village leaders, Imams, etc.). A large number of forest offence cases, mainly related to illicit felling, have been registered by FD and are awaiting court decisions. Local community organizations including user groups can help resolve forest conflicts.

Co-management activities in the WS will involve local stakeholders, NGO staff and FD field staff. A conflict may arise due to misunderstanding or a disagreement between two or more parties engaged in co-management activities in the Sanctuary. This disagreement under NSP could be among the local stakeholders, NGO partners and FD field staff. Some 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 PAs is indeed high, thereby giving rise to possibilities of forest 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. Conflict prevention is more important than PA conflict resolution. Developing coalitions, alliances, peace making, networking, and local experiences are essential in conflict prevention. Productive, peaceful and rewarding relationships and good understanding among the local stakeholders of NSP will help prevent 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, flagging 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 inclusively 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 WS.

3.6.2 PA Conflict Resolution

In case a conflict cannot be prevented in the WS, its resolution is better than a conflict runs its course. Identification of local 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 gaols
- 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 maps and updating them by using latest imageries/aerial photos and ground truthing	Updated maps prepared by RIMS	RIMS (FD)/NSP
	-Establishing co-management committees –	Co-management committees established	NSP/FD
	-Forming and training user groups	User groups formed and trained	FD/NSP/ Stakholders
	-Signing co-management/benefit sharing agreements	Co-management/benefit sharing agreements signed	Stakeholders/ FD/NSP
	- Controlling poaching, forest land encroachment and illicit removals from the WS, and checking forest grazing and fires by associating local stakeholders	Reduced level of biotic interference	FD/NSP/ Stakeholders
	-Providing incentives for good protection efforts and disincentives for poor protection	Capable 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 Sanctuary through pillars and markers	Boundaries of Sanctuary delineated in field	FD/NSP
	-Maintaining a register of the Sanctuary boundaries and pillars, and conducting annual inspections by supervisory FD field staff	Inspections done and register updated	FD
	-Conducting regular meetings of co-management committees and user groups	Community action and reduced biotic interference	Stakeholders/ FD/NSP
	-Controlling poaching, forest land encroachment and illicit removals from the Sanctuary	Reduced level of biotic interference	Stakeholders/ FD/NSP
	-Checking forest grazing and fires by associating local stakeholders	Less forest fires and grazing	Stakeholders/ FD/NSP
	-Providing incentives for good protection efforts	Good FD field staff and stakeholders rewarded	FD/NSP
	-Resolving forest conflicts	Forest conflicts resolved	Stakeholders/ FD/NSP
3	-Maintaining a register of the Sanctuary 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	Reduced level of biotic	Stakeholders/

	encroachment and illicit removals from the Park and checking forest grazing and fires by associating local stakeholders	interference	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 Sanctuary 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	Reduced level of biotic interference	Stakeholders/ FD/NSP
	- Controlling poaching, forest land encroachment and illicit removals from the Sanctuary, 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	Forest conflicts resolved	Stakeholders/ FD/NSP
5	-Maintaining a register of the Sanctuary 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	Reduced level of biotic interference	Stakeholders/ FD/NSP
	- Controlling poaching, forest land encroachment and illicit removals from the Sanctuary, 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 Main 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 a 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 WS based on management objectives to be achieved spatially. The Sanctuary area is, therefore, divided into two broad zones (core zones and interface landscape zones, each subdivided further into specific zones) based on existing forests, landscape elements and management objectives. The proposed management follows internationally accepted management zoning principles (MacKinnon and MacKinnon, 1986) applied to a PA. It provides the 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, services and transportation facilities), for designating areas used to provide benefits to local people, and for identifying interface landscape zones influencing the core zones. Illegal removals and commercial harvests will be checked and stopped in order to achieve the objectives of Sanctuary 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 WS area and surrounding landscape such that i) the areas of highest conservation value (natural forests and/or old plantations) are protected, regenerated and managed towards natural forest composition and structure, particularly in core zone, ii) the areas used to provide benefits to local people through sustainable use of forests are defined, and iii) 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

All the notified area of Rema-Kalenga WS is designated as broad core zone, which has high conservation value. This broad core zone is sub-divided into three specific sub-zones: i) Ecosystem Sub-Zone, ii) Habitat Management Sub-Zone, and iii) Sustainable Use Sub-Zone (Figure 9) as described below. All the well stocked areas with wildlife of the WS 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

Within the core zone, this 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 one-third (37.4%) of the notified Sanctuary area has been designated as Ecosystem Management Sub-Zone covering natural forests/plantations areas with good biodiversity value. The southern part of Rema-Kalenga WS (south of the current Chonbari-Rema Beat boundary) is designated as an Ecosystem Management Sub-Zone with the main objective of providing long-term protection of natural forests habitat against illicit felling, forest fires, forest land encroachment and cattle grazing.

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. The 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 wherever necessary to encourage natural vegetation. Effective protection against biotic pressure (illicit felling, forest land encroachment, forest fire and grazing) will allow natural processes of regeneration in degraded forest areas.

Co-management practices will be implemented (through associated co-management committees to be formed at different levels) in strengthening protection efforts against illicit felling, forest land encroachment, forest fires and cattle grazing. In lieu of reduced removals by the local communities from the Ecosystem Sub-Zone, they will be provided alternative means from interface landscape zones and other alternative income generation activities for sustainable livelihoods through LDF. 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 picknicks will not be allowed.

The protection efforts will be facilitated through communication outreach activities, public awareness, stakeholders' access to interface landscape zone 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 10 identified villages including Debrabari Forest Village 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 identified NTFPs (including grasses, bamboo, canes and medicinal herbs and shrubs) for bonafide consumption will be allowed in lieu of their increased protection efforts for core zones. 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. 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 canes will gradually be reduced through harvesting followed by planting by local herbs and shrubs. Enrichment plantations of fruit bearing species for wildlife 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. The present practice of under-planting cane after clearfelling understorey in forested areas will be done away with.

4.3.2 Habitat Management Sub-Zone

This sub-zone is constituted to manage the habitat for wildlife management and conserve forests and other critical habitats. Habitat management sub-zone, as a part of core zone, will comprise more than half (51%) of the total notified area of the WS. Natural forests and some old plantations in the northern half of the WS (north of the current Chonbari-Rema Beat boundary) has been designated as Habitat Management Sub-Zone, where habitat will continue to remain suitable for wildlife by checking consumptive use. This will be achieved by maintaining and if possible augmenting forest cover by using assisted natural regeneration techniques such as enrichment plantations, and subsidiary silvicultural operations. The requirements of capped langur, as a representative species, will guide management decisions and monitoring of habitat condition (see Volume 2 for Habitat Suitability Model for capped langur in Rema-Kalenga).

Main management objective in this 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 sub-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 plantation 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 selective harvesting by adopting low impact felling techniques. 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 Models developed for capped langurs (see 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.

4.3.3 Sustainable and Intensive Use Sub-Zone

All homesteads, cultivation fields and settlements within the WS will be included in this Sub-Zone after demarcating their physical area applicable at the time of gazette notification. No further in-migration will be allowed and all the residents will be registered.

Forest village (Debrabari) and agricultural land within the Rema-Kalenga WS included under this sub-zone will be marked and no further in-migration will be allowed. 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 three villages will be engaged in co-management activities with formal co-management agreements signed with FD.

Intensive use areas incorporate the relatively small areas required for administrative buildings and staff quarters, visitor accommodations and other facilities. The following four intensive use areas are also included in this sub-zone:

- Sanctuary HQs located at the existing Chonbari Beat Office;
- Existing BDR Camp on an estimated area of 0.8 ha in the far south of the Sanctuary near to the Indian border;
- A Guard Camp to be established at Kalenga Chara, at the northeastern corner of Sanctuary (possibly on khas lands immediately adjacent to, but outside the Sanctuary) ; and
- A Guard Camp to be established at the Rema Tea Estate/Sanctuary boundary, in the southern part of the Sanctuary (possibly on khas land or Tea Estate Land on the Sanctuary boundary).

Future facility development will be based on environmentally friendly guidelines and green management principles. Adverse environmental impacts of infrastructure development will be minimized by carrying out Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA, the relevant guidelines are presented in Volume 2) before taking up design, construction and operation building works. 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. Detailed guidelines for facilities development are discussed in the next Chapter.

4.3.4 Habitat Improvement Works in Core Zone

Different habitat improvement activities to be carried out in the core zone are further explained as below.

4.3.4.1 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 malakana plantations along with mixed plantations of other species. 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 10 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)** The stumps of coppice tree species (teak and eucalyptus being strong coppicer) 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 indigeneous fruit bearing shrubs and trees, and palatable grasses during the second year.

4.3.4.2 Enrichment Plantations in Core Zone

Enrichment plantations will be taken up in degraded areas of the core zone (especially ecosystem management sub-zone and habitat management sub-zone). Additionally, the enrichment plantations also will be done after canopy is opened in monoculture of exotics. Planting (spacing 2.5m x 2.5m) of indigeneous shrub and tree species may be taken up in alternate rows whereas fruit tree species for wildlife (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*. A plantation journal will be maintained for each of the enrichment plantations. 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 up only during the first year. Plantations of species attractive to butterflies, bees and other pollinator insects will be included in the planting species mix.

4.3.4.3 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.

4.3.4.4 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 in identified gaps. 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*.

4.3.4.5 Maintenance of Waterbodies

This operation is applicable to the entire core zone. A number of natural waterbodies are present in Sylhet Division and they will be maintained for use of wildlife and also local people. An inventory of existing water bodies and a list of wildlife using different water bodies 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 benefits sharing basis. Plantation of shrubs and herbs may be taken up around water bodies 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.

4.3.4.6 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.

4.3.5 Habitat Restoration Works in Core Zone

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

4.3.5.1 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.

4.3.5.2 Eco-restoration

Good rainfall, incident radiation and soil are some of the favourable factors that are present in Sylhet 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 husbandary 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 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 the core 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 husbandary practices. Over the period the woody vegetation cover will extent 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 indigeneous shrub and tree species (e.g. chapalish, chikrassi, toon, karoi, garjan, dhakijam, pynkado, gamar, albizzia, kadam, etc.) can be taken up in degraded and barren areas that do not have rootstock.

4.4 Interface Landscape Zone

This 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-forest livelihood opportunities 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 before carrying out co-management activities. Though interface landscape zone will have comparatively less conservation value, they will play an important role in supporting the biodiversity conservation in core zones. Interface landscape zone is further categorized into 2 suv-zones (Support Sub-Zone and Tea Estate Land Sub-Zone) depending upon the uses to which different areas are managed. An Interface landscape zone supports the protection of biodiversity in core zones 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 Support Sub-Zone

Consumptive use of forests by the resident villagers within the WS will be limited to the existing Forest Village (Debrabari) situated within the WS. Consumptive use by non-residents will be shifted gradually to a 1 km-wide external support sub-zone bordering the Bangladesh portion of the Sanctuary boundary and comprise FD lands and Khas lands as described below:

1. Forest Department Land: The FD lands (bordering the WS along nearly 11.5 km) as part of the remaining Tarap Hill RF have an area of 1172 ha with natural forests, short and long plantations, agricultural fields and village settlements. Management of FD lands will focus on sustainable use of the remaining natural patches, bringing selected plantations under co-management agreements, checking conversion of forest land into agriculture and maintaining biodiversity conservation values. Local stakeholders will be identified and co-management agreements signed for providing livelihood opportunities and protecting habitat. Production forestry consistent with biodiversity conservation may be implemented after preparing a site-specific plan. But clearfelling of natural forests will not be taken up in view of hilly terrain and important biodiversity values. If required, selection-cum-improvement silvicultural system may be adopted in places where natural regeneration need to be encouraged by gradually opening top canopy. Enrichment planting and subsidiary silvicultural operations will be defined in this site specific plan. Reduced impact logging techniques will be followed in case selective harvesting is prescribed in the site specific plan. Habitat improvement and rehabilitation works as described in sections 4.3.4 and 4.3.5 will be carried out.
2. Nearly 50 ha of khas lands to the north-eastern end of the WS are included in the 1 km-wide support sub-zone. These khas lands may be brought under participatory forestry by raising plantations based on PBSAs, similar to the FSP.
3. All the 21 villages (as identified in Chapter 6 of Part I) having stakes in the WS will be included in this sub-zone. The livelihood programs as discussed in the next Chapter will be implemented by organizing groups by partner NGOs.

4.4.2 Tea Estate Land Sub-Zone

These lands, bordering the WS along 0.8 km of its southestern boundary, are a good source of bamboo, sungrass and fodder to Tea Estate labourers. However, the area under the vegetation is reducing, as a result of which the Tea Estate labourers and their families put pressure on nearby forests including core zone for meeting their for fuelwood, timber and other NTFPs. Tea Estates Managers will, therefore, need to be encouraged to retain secondary vegetation in order to meet the demands of the labourers and their families, and also to provide additional wildlife habitat. In addition, they will also try for enrichment plantations of indigeneous tree species particularly on 400 ha of Tea Estate lands included in the 1-km wide support zone of the WS.

The labourers and their families residing the Tea Estate lands in proximity to the WS use sungrass, bamboo, fuelwood, small timber and fodder from the unused Tea Estate lands. 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 Sanctuary/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

The boundaries of core zone (ecosystem management sub-zone, habitat management sub-zone, sustainable and intensive use sub-zone) will be marked with posts having legible inscriptions in Bangla for easy differentiation (Table 4.1). 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.

Main management objectives under each zone are summarized in Table 4.1 as below:

Table 4. 1 : Management zoning for Rema-Kalenga Wildlife Sanctuary

Zone	Main Management Objective	Indicative Area
CORE ZONE		
I) Ecosystem Management Sub-Zone	-long-term protection of contiguous natural forest cover	671.7 ha
II) Habitat Management Sub-Zone	-maintenance of wildlife habitat suitability and limited sustainable use in natural forest and old long-rotation plantations where these are interspersed with established paddy fields and habitation	916.0 ha
III) Sustainable and Intensive Use Sub-Zone	-management of agricultural use and habitation, including restriction of agricultural use to legitimate Forest Villagers, and reclamation of excess agricultural areas to participatory plantations and natural forest cover. The Village Use/Sustainable Use Zones will include all established paddy fields, habitations, and homestead woodlots -delimitation of the BDR Camp in the southern portion of the Sanctuary	207.3 ha
Total Sanctuary gazetted area		**1795.0 ha**
INTERFACE LANDSCAPE ZONE		
I) Support Sub-Zone	**-**sustainable management and use of forests/plantations on FD lands within a 1 km-wide strip where the Sanctuary is bordered by FD lands **-**maintenance of wildlife habitat in natural forests and old plantations on FD lands **-**maintenance and sustainable use of forest and secondary vegetation on khas lands bordering the Sanctuary **-**identified 21 villages where livelihood programs will be implemented	1172 ha (+50 ha of khas land)
II) Tea Estate Land Sub-Zone	**-**sustainable use of trees and secondary vegetation on Tea Estate lands bordering the WS	400 ha of Tea Estate land

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 Zone

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

Yr	Sub-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 Natural regeneration established	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)	Improved habitat	FD
		-Implementing habitat improvement works (canopy manipulation, grassland development, special habitats maintainance, waterbodies maintainance, etc.)	Rehabilitated habitat	FD
		-Implementing habitat restoration works (identification of micro-watersheds, watershed management, eco-restoration activities including soil/water conservation and other low input land husbandry practices)	Forest use areas delineated on ground and maps	FD/Forest Villagers
	Sustainable and Intensive Use sub-Zone	-Delineating the habitation and forest land assigned to Debrabari Forest Village	Forests regenerated & Villagers' income enhanced	FD/Forest Villagers/ NSP
		- Involving Forest Villagers in forest protection, and in income generation activities by using LDF	Cleaning of forest floor stopped	FD/Forest Villagers/NSP
		-Motivating Forest Villagers to adopt biodiversity friendly betel leaves growing practices	Income of villagers enhanced and forests protected	FD/Forest Villagers/NSP
		-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	FD buildings maintained	FD/NSP
		-Existing FD buildings maintained by following environmental friendly guidelines		
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
		-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 Natural regeneration established	FD
		-Carrying out subsidiary silvicultural operations required for encouraging natural regeneration (including gradual canopy opening in exotic		FD

		monoculture and enrichment planting in identified gaps without existing rootstock)	Improved habitat	
		-Implementing habitat improvement works (canopy manipulation, grassland development, special habitats maintainance, waterbodies maintainance, etc.)	Rehabilitated 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)	Forest Villagers' income enhanced	FD
	Sustainable and Intensive Use sub-Zone	- Forest Villagers continue to involved in forest protection, and in income generation activities by using LDF	Cleaning of forest floor stopped	FD/Forest Villagers
		-Encourage Forest Villagers to adopt biodiversity friendly betel leaves growing practices	Income of villagers enhanced and plantations and core protected	FD/Forest Villagers
		-With the villagers of peripheral villages continue protecting nearby plantations and core areas by associating them in LDF funded activities	New habitations stopped	FD/Villagers/NSP
		- No new habitations by Forest Villagers of Debrabari are allowed	Buildings are constructed	FD/Forest Villagers/NSP
		-Proposed FD buildings are developed by following environmental friendly guidelines		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
		-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 and Intensive Use sub-Zone	-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
		-Villagers of peripheral villages such as Dolubari	Plantations protected	FD/Villagers/N

		and Bhagmara continue protecting nearby plantations -Keeping a vigil that the Forest Villagers of Debrabari do not add more habitations -FD buildings are maintained by following environmental friendly guidelines	Convinced Forest Villagers Better maintained FD buildings	SP FD/NSP/ Forest Villagers FD
4	Ecosystem Management sub-Zone Habitat Management sub-Zone Sustainable and Intensive Use sub-Zone	-Protecting forests and other biodiversity against biotic interference (illicit removals, poaching, land encroachment, forest grazing, fires, etc.) -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) -Carrying out silvicultural operations for 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) -Implementing habitat improvement works (canopy manipulation, grassland development, special habitats maintainance, waterbodies maintainance, etc.) -Implementing habitat restoration works (identification f micro-watersheds, watershed management, eco-restoration activities including soil/water conservation and other low input land husbandry practices) -Continue involving Forest Villagers in forest protection, and in income generation activities by using LDF -Continue motivating Forest Villagers to adopt biodiversity friendly betel leaves growing practices -Villagers of peripheral villages such as Dolubari and Bhagmara continue protecting nearby plantations -Keeping a vigil that the Forest Villagers of Debrabari do not add more habitations -FD buildings are maintained by following environmental friendly guidelines	Reduced level of biotic interference including illicit felling Natural regeneration established Enhanced wildlife Natural regeneration established Improved habitat Rehabilitated habitat Forest Villagers' income enhanced Cleaning of forest floor stopped Plantations protected Convinced Forest Villagers Better maintained FD buildings	Stakeholders/ FD/NSP FD FD FD FD FD FD/Forest Villagers FD/Forest Villagers/NSP FD/Villagers/NSP FD/NSP/ Forest Villagers FD
5	Ecosystem Management sub-Zone Habitat	-Protecting forests and other biodiversity against biotic interference (illicit removals, poaching, land encroachment, forest grazing, fires, etc.) -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) -Carrying out silvicultural operations for improving habitat for wildlife -Carrying out subsidiary silvicultural operations	Reduced level of biotic interference including illicit felling Natural regeneration established Enhanced wildlife Natural regeneration established	Stakeholders/ FD/NSP FD FD

	Management sub-Zone	required for encouraging natural regeneration (including gradual canopy opening in exotic monoculture and enrichment planting in identified gaps without existing rootstock)	Improved habitat	FD
		-Implementing habitat improvement works (canopy manipulation, grassland development, special habitats maintainance, waterbodies maintainance, etc.)	Rehabilitated 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)	Forest Villagers' income enhanced	FD
	Sustainable and Intensive Use Zonesub	-Continue involving Forest Villagers in forest protection, and in income generation activities by using LDF	Cleaning of forest floor stopped	FD/Forest Villagers
		-Continue motivating Forest Villagers to adopt biodiversity friendly betel leaves growing practices	Plantations protected	FD/Forest Villagers/NSP
		-Villagers of peripheral villages such as Dolubari and Bhagmara continue protecting nearby plantations	Convinced Forest Villagers	FD/Villagers/NSP
		-Keeping a vigil that the Forest Villagers of Debrabari do not add more habitations	Better maintained FD buildings	FD/NSP/ Forest Villagers
		-FD buildings are maintained by following environmental friendly guidelines		FD

4.6.2 Summary of Main Prescriptions in Landscape Zone

Main prescriptions outlined under the above-developed management programs in Landscape Zone 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

Yr	Sub-Zone	Main Activities	Main Outputs/ Success Criteria	Responsibility
1	Support Sub-Zone	-Short rotation plantations 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	FD/FSP
		-Establishing communication channels with the land owning agencies (LGED)	Land Owning Agencies contacted	FD/Land Owning Agencies
		-Planting strip plantations along roads	-do-	FD/FSP
	Tea Estate Sub-Zone	-Establishing contacts with Tea Employers Association, Chittagong and the Management Authorities of 6 identified Tea Estates	Instructions issued by the Association to	FD/NSP
		-Encouraging the Management Authorities of Tea Estates to bring vacant land under plantations for the benefits of local people and also wildlife	Tea Estate management	Tea Estates/ FD/NSP
		-Motivate Tea Estate workers and if possible involve them in income generation activities	Groups of workers formed	Tea Estates/ FD/NSP
2	Support Sub-Zone	-Short rotation plantations protected under co-management	Plantations protected	FD/ Stakeholders

		-Remaining vacant FD lands brought under woodlots under FSP	Woodlots established	FD/FSP
		-Villagers from the 16 identified villages start LDF funded activities in lieu of their forest protection efforts	Income of the villagers enhanced	NSP/FD/ Stakeholders
		-Maintaining communication channels with the land owning agencies (LGED)	Regular contacts established	FD/Land Owning Agencies
		-Planting and managing strip plantations along roads	Strip plantations protected	FD/FSP
	Tea Estate Sub-Zone	Maintaining regular contacts with Tea Employers Association, Chittagong and the Management Authorities of 6 identified Tea Estates	Better coordination established between FD and Tea Estate Management	FD/Tea Estate Management
		-Pursue the Management Authorities of Tea Estates to bring vacant land under plantations for the benefits of local people and also wildlife	Vacant land brought under plantations	FD/NSP/ Tea Estate Management
		-Involve Tea Estate workers in income generation activities	Groups of workers formed and motivated	NSP/FD/Workers/Tea Estate Management
3, 4 and 5	Support Sub-Zone	-Continue protecting short rotation plantations	Plantations protected	FD/ Stakeholders
		-16 identified villages continue to be covered under LDF in lieu of their forest protection efforts	Villagers' income enhanced and forests protected	NSP/FD/ Stakeholders
		-Woodlots raised on vacant FD lands continue to be protected	Protected woodlots	FD/FSP
		-Continuing good communication with the land owning agencies (LGED, Railways)	Land Owning Agencies convinced	FD/NSP/Land Owning Agencies
		-Protecting strip plantations along roads and railway lines	Strip plantations protected	FD/FSP
		-Continuing regular contacts with Tea Employers Association, Chittagong and the Management Authorities of 6 identified Tea Estates	Better coordination established	FD/NSP/ Tea Estate Management
	Tea Estate Sub-Zone	-Management Authorities of Tea Estates continue to bring vacant land under plantations for the benefits of local people and also wildlife	Vacant land planted	Tea Estate Management
		-Tea Estate workers continue to be involved in income generation and protection activities	Groups of workers with enhanced income	NSP/FD/ Workers/Tea Estate Management

5. LIVELIHOOD PROGRAMS

5.1 Objectives

As per the Wildlife (Preservation) (Amendment) Act, 1974 no commercial harvesting is allowed inside the WS. So other relevant mechanisms of benefits flows to local communities need to be explored as 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. Additional benefits need to be mobilized through off-PA activities including alternative income generation activities and self-employment.

Main objective of livelihood programs is to develop appropriate linkages with relevant livelihood programs and projects/initiatives that will reduce biotic pressure on forests by providing alternative livelihood opportunities to poor stakeholders living both within and outside of the WS. The up-scaling of skills will be taken up for generating value additions through capacity building of local people. Landscape Development Fund will be used to provide finance for the members of organized groups and co-management committees. 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 WS. This program will be implemented both in the core and interface landscape zones.

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. Wherever possible networking with other NGOs providing rural development services in the locality will be done and maintained. The following production technologies are proposed by RDRS to be implemented mainly in the interface landscape zone of the WS:

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 WS (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 Sanctuary's landscape 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 towns 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.

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.

The climate of Rema-Kalenga is suitable for orchid and the moist forests are particularly good for orchids. Some participants may be encouraged to get involved in orchid related activities.

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 WS. The following livestock rearing technologies are found suitable for their implementation in and around the WS :

- 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 WS 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 WS and off-PA based income generation activities. In the forests being managed for biodiversity conservation in the PA, 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 WS. 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 WS 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 WS 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 (NTFPs)

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), waeving 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 paer industry. Nevertheless the supply of bamboo and canes from natural forests has declined due mainly to clearfelling 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 Formation of User Groups

Biodiversity user groups will be formed and motivated by selecting participants from neighbouring paras and villages. The composition of a user group will not be too large, though the number of members in a group would depend on the availability of forests and residing population. Usually a group may comprise 15 to 25 members selected amongst the deprived sections of society including ultra poor, poor, landless, widow, ethnic minorities.

5.6 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
	-Finalizing operational guidelines for LDF	LDF operational guidelines finalized	NSP/FD/ Stakeholders
			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
	-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	Stakeholders encouraged	NSP/
		Enterprise development studied	

	cottage industries -Conducting enterprise development assessment		Stakeholders NSP
3	-Continue holding discussions with local stakeholders on selected production technologies -Training material on the finalized production technologies reviewed based on the project experiences -Demonstration centres for proven technologies improved based on the project experiences -Upgrading farmers training schools based on the project experiences -Continue imparting training to local stakeholders -Helping in developing market linkages -Training on small enterprise development	-Stakeholders' consultations continued Training materials reviewed Demonstration centres improved Farmers training schools upgraded Training to groups continued -Market linkages established Stakeholders trained	NSP/FD/ Stakeholders NSP NSP NSP NSP/FD/ Stakeholders NSP/Federations NSP/Federations
4	-Continue holding discussions with local stakeholders on selected production technologies -Continue arranging visits to demonstration centres -Continue arranging training in farmers training schools -Continue imparting training to local stakeholders -Helping in enterprise development	-Stakeholders' consultations continued Demonstration centres visited Training in Farmers training schools continued Training to groups continued Small enterprises establihsed	NSP/FD/ Stakeholders NSP NSP NSP/FD/ Stakeholders NSP/Federations
5	-Continue holding discussions with local stakeholders on selected production technologies -Continue arranging visits to demonstration centres -Continue arranging training in farmers training schools -Continuing with enterprise development and market assistance activities	-Stakeholders' consultations continued Demonstration centres visited Training in Farmers training schools continued Enterprise development continued	NSP/FD/ Stakeholders NSP NSP NSP/Federations

6. FACILITIES DEVELOPMENT PROGRAMS

During the implementation of the Management Plan the development of Sanctuary facilities will be undertaken to support the long-term administration. In addition to built facilities, the Facilities Development Program 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 arrange for field equipments for FD field staff responsible for the management of Sanctuary.

6.2 Built Facilities

The development of built facilities will proceed in a well-planned and phased manner, that is appropriate to a Sanctuary setting, in order to ensure that they do not negatively impact the area's natural resources or ecotourism potential. Existing FD facilities will be fully utilised and incorporated in Sanctuary management where these can be renovated on a cost-effective basis. In order to ensure efficient utilisation of available financial resources, development of built facilities will proceed in a well-planned, phased manner. All facilities will be appropriate to a Wildlife Sanctuary setting, in order to ensure that they do not negatively impact the area's natural resources or visitor use potential. Built facilities will be concentrated in three areas, comprising:

- Sanctuary Headquarters (incorporating the existing Chonbari Beat Office facilities);
- Guard Camp at Kalenga Chara; and,
- Guard Camp at the Rema Tea Estate/Sanctuary boundary.

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

Table 6.1 : Built facilities development in Rema-Kalenga Wildlife Sanctuary : use of existing facilities

Location	Current Facility and Use	Use during Plan Period	Action Required
Sanctuary Headquarters (Chonbari Beat Office Complex)	Beat Office/Beat Officer's Residence (1 office, 2 bedrooms, 1 sitting room, 2 storerooms, 2 toilets). Building footprint ~100 m^2.	Sanctuary Office (office space for ACF and Forest Range Officer)	-general renovation/repairs -installation of water supply and electricity hookup -repainting and regular maintenance
	Double Guard Quarters (each with 2 bedrooms, 1 bathroom, 1 storeroom, 1 kitchen). Building footprint ~90 m^2.	Staff Quarters	-as above
	Double Guard Quarters (each with 2 bedrooms, 1 bathroom, 1 storeroom, 1 kitchen). Building footprint ~90 m^2.	Guard Quarters (2)	-as above
	Rest House (2 bedrooms, 1 storeroom, 1 toilet). Building footprint ~110 m^2.	Rest House	-as above

Table 6.2 : Built facilities development in Rema-Kalenga Wildlife Sanctuary: new facilities

Location	Facility and Use During Plan Period	Action Required
Sanctuary Headquarters (Chonbari Beat Office Complex)	ACF's Quarters (1, area ~120 m^2)	-site selection -design and construction -installation of water supply and electricity hookup -regular maintenance
	Forest Ranger's Quarters (1, area ~100 m^2)	-as above
	Forester's Quarters (1, area ~80 m^2)	-as above
	Plantation Mali's Quarters (1, area ~40 m^2)	-as above
Kalenga Chara Camp	Forester's Quarters (1, area ~80 m^2)	-as above
	Guard's Quarters (2, each ~60 m^2)	-as above
	Plantation Mali's Quarters (1, area ~40 m^2)	-as above

Location	Facility and Use During Plan Period	Action Required
Rema Tea Estate Camp	Forester's Quarters (1, area ~80 m^2)	-as above
	Guard's Quarters (2, each ~60 m^2)	-as above
	Plantation Mali's Quarters (1, area ~40 m^2)	-as above

Approximately half of the built facility requirements at Sanctuary Headquarters can be satisfied through the use of existing buildings. Renovations, and subsequently a regular schedule of maintenance, will be required. The necessary renovations will be completed and new construction will be initiated during the first year of the Management Plan. All new staff quarters will need to be constructed at the Kalenga Chara and Rema Tea Estate Guard Camps (for four personnel in each location). Construction of these quarters will be scheduled during the first and second years of this Plan. At each location, design standards for both renovations and new construction will be based on FSP's "Guidelines for Conservation Area Facilities Development" (Tecsult 2001), and a regular schedule of maintenance and upkeep will be maintained. Renovation and construction work will be completed at Sanctuary Headquarters as a matter of priority, with other facilities developments to be completed as soon as possible thereafter (see Chapter 10 for work schedule and budget).

6.3 Roads and Trails

Road access to the Sanctuary Headquarters is currently provided by a fair weather, unsurfaced road linking the Kalenga and Rema Beat Offices. The Beat Offices are themselves linked to the national road system only by fair weather roads maintained wholly or in part by agencies other than Forest Department. Given the expense of constructing and maintaining all-weather roads, easy access to the Sanctuary from outside is likely to remain problematic for the foreseeable future. This is not, however, expected to be a major constraint on effective management of the Sanctuary, as the main requirements for such management are for ready access to the Sanctuary interior, which will be primarily by foot or motorcycle. Difficulty of access from outside is actually a positive factor at present, as it constrains road transport of illegally felled timber.

The primary focus during the Plan period will be on ensuring that the road linking the Kalenga and Rema Beat Offices is maintained to a sufficient standard to permit year-round access by Sanctuary and other FD staff using light four-wheel drive vehicles and motorcycles. This road is a key element in Sanctuary management as it provides the primary vehicle access to the Sanctuary Headquarters and to trail heads (foot trails) into the interior of the Sanctuary, and forms an important part of the boundary between the Sanctuary and the interface landscape zone. It is anticipated that this road can be maintained by hand and will not require widening, surfacing or the use of heavy machinery. No road access into the interior of the Sanctuary will be developed or permitted.

Numerous foot trails have been developed throughout the Sanctuary in conjunction with plantation development, BDR and FD patrols, and linking village areas with paddy fields and subsistence use areas. These will be retained as is for foot patrols by Sanctuary staff. It is anticipated that little or no maintenance of these trails will be required. The need for access road upgrading, and further development of the internal trail system, will be re-evaluated at the end of the Plan period.

6.4 Equipments

Vehicles, field equipment and office equipment will be provided as required to support the management and administration programmes.

6.4.1 Vehicles

Double-cab pickups will be provided for the ACF/OIC. In addition three 100 cc motorcycles will be provided for use at Sanctuary Headquarters, one for use at Rema Tea Estate Camp, and one each at Rema and Kalenga Beat Offices for use by regular FD staff in interface landscape.

6.4.2 Field Equipment

Two walkie-talkies will be provided for use at Sanctuary Headquarters, and one each at the Kalenga Chara and Rema Tea Estate Guard Camps. These will be suitable for communication among these sites and between all sites and the Habigonj-2 Range Office. Compasses, binoculars, GPS-units and other field equipment will be provided as required for support of the Sanctuary management programmes.

6.4.3 Office Equipment

Office furniture (desks, filing cabinets *etc.*) and supplies will be provided as required for use at Sanctuary Headquarters.

6.5 Summary of Main Prescriptions

Main prescriptions outlines under the above-developed facilities development 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 main objectives 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 currently limited in Rema-Kalenga due to relatively difficult access to the Sanctuary area and its primary focus on biodiversity conservation. However, the conservation tourism will get a great boost after the approach road to the WS is maintained. Subsequently a number of tourism facilities may be developed. The basic information about the WS will be made available to visitors in the form of information handouts and brochures.

7.2.1 Identification of Tourism Areas

A tourism region will be identified around the WS 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 FRHs at Kalenga and Chonbari will provide accommodation to tourists. But when the number of tourists increase local enterprenuers on the fringes (in interface landscape zone) of the Sanctuary 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 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 1-2 days duration) may be organized at places of interest within the WS 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

7.2.2.1 Use Types and Facilities

Only 2 FRHs (under the control of DFO, Sylhet) are available for night halts inside the Sanctuary. The Chonbari and Kalenga Forest Rest House will be renovated to habitable condition for use of visitors, FD staff, researchers, etc. The use of these FRHs 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 Sanctuary area in the hotel accommodation 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. An Environmental Education Centre to be established at Kalenga Range Office will serve as nature interpretation centre (NIC) with up-to-date information. Suitably trained staff will be posted at all of these locations with adequate information and publicity material about the Sanctuary's importance and facilities. Additional training on public relations and visitors management will be provided to the Sanctuary 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 existing FRHs will be connected with nature trails. 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 guidelines/standards will be followed while designing, developing and maintaining the trails.

- 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.

The following three hiking trails were identified and mapped (Figure) as a part of management planning process :

1. Short Trail : An half an hour undulating walk trail, nearly 1 km long and mostly 1 m wide, has been identified along the lake. The trail starts from the Watch Tower (located at the top of a *tila* with GPS locations 24.17786 N and 91.62805 E) situated at the Sanctuary's boundary and ends at the same point after traversing around the lake. Main flora to be encountered around the lake include jam, haritaki, bahera, belpui, amra, jambura, guava, kathal, bel, chapalish, dewa, boroi, gamari, etc. Important fauna to be sighted along the trail include squirrels, honuman, monkey, hollok, deer, mecho bag, jungle fowl, wildboar, wild dog, fox, civet, and birds such as moyna, tia, bubuli, finge, etc.

A detailed description of the trail is presented in Annexure 7.2.1.

2. Medium Trail : A 3 km long trail with an expected walk of one hour is identified near Nishorgo Office; it starts from Chonbari Beat Office and returns back after completing loop through the Watch Tower. Naturally occurring tree species are dewa, tundul (civit), bat (banyan tree), pahari am, jarul, moskon, urijam, jail bhadi, sheora, koroi, jarul, aam, tentul, kathal, kakra, boil, jam, chapalish, haritaki, kao, etc. Among the planted tree species are teak, arjun, mehogony, kadam, haritaki, behera, etc. Most common mammals to be seen along the trail are honuman, small deer, mecho bag, civit, fox, bonbiral, squirrel, wild boar and mangoose. Several types of snakes are found; the most common being python, darash, gokhra, dora, laodoga and guishap. Commonly found birds are jungle fowl, moyna, tia, bulbuli and finge. A detailed description of the trail is presented in Annexure 7.2.2.

3. Long Trail : This 6 km long undulating trail (with 1-4 km width) takes 3 hours walk after starting from Chobari Beat Office. It traverses through dense forests from north-eastern to south-eastern side to reach Debrabari Forest Village, and finally returns back to starting point through south-western side. Few steep slopes are to be crossed while walking through the trail with ups and downs. The vegetation around this trail is mainly natural with sporadic plantations. The dominant plant species of natural forest are chapalish, dewa, hargoja, jam, garjan, civit, bat, pisti, urium, jail bhadi, koroi, jarul, aam, tentul, kekra, boiljam, haritaki, kao, awal, tila jarul, jir, banak, chikrassi, buitta, kawal tuli, shimul, gila lat, bamboo, etc. Main planted tree species are garjan, sal, teak, jarul, etc. This rich natural vegetation supports a diverse wildlife including honuman, hollok, small deer, mecho bag, civit, wild dog, bonbiral, squirrel, mangoose, snakes, jungle fowl, wildboar, monkey and wild fowl. Main birds to be watched are dhanesh, moyna, tia, bulbuli, finge, etc. Further description of this trail can be seen in Annexure 7.2.3.

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 main access road through the Sanctuary. 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.

7.2.3 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 and co-management committees will be sought in developing community-based tourism.

7.2.4 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 Sanctuary 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 the Sanctuary 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 Sanctuary 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 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 each PA at accessible place (say at PA HQ). Landscape features of the Sanctuary may 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 vacant building at Chonbari Beat will be converted as an Environmental Education Centre by renovating with minor modifications. This addition 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, explaintory 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 Sanctuary, 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

Other land-based sectors, have profound effects (both negative and positive) on the Sanctuary management. 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 the Sanctuary. 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 Sanctuary 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 Sanctuary 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 Sanctuary 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
	-Identifying an existing building for establishing Nature Interpretation Centre	Building for NIC selected	FD
	-Identifying and mapping existing nature and hiking trails	Existing trails mapped	FD/NSP
	-Establishing regular contacts with relevant ministries and departments for inter-sectoral conservation planning	Relevant ministries and departments contacted	FD
	-Developing a policy on public-private conservation partnership	Public-Private partnership policy drafted	NSP
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	-Regulating tourism within the Park	Tourism regulated	FD

5	-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 materials including pamphlets, brochures and maps	Publicity material development distributed	FD/NSP
	- 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

A research, monitoring and capacity building program will be developed with main objectives i) to better understand the Sanctuary'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 (capped langurs), 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 Sanctuary's management program, and vi) to gradually reduce the extent and degree of uncertainty while taking the Sanctuary 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 WS 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 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, 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

Some relevant topics of biological research may include wildlife-population viability analyses, population dynamics and feeding behaviour, wildlife habitat/niche use behaviour, 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, 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. In Rema-Kalenga WS macro-level habitat management will be based on the needs of the capped langur, representing leaf-eating species that are able to utilize 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 this and associated species. Habitat Suitability Index (HSI) models have been developed (see Volume 2) for this species (Tecsult, 2001) and will form the basis for decisions on how to manage the Sanctuary'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 the Sanctuary 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 of WS. A survey of natural regeneration (density of seedlings and saplings per ha) in the forests of WS 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 PA based mainly on traditional forest management practices. There is great necessity of imparting conservation training to the FD field staff responsible for managing the Sanctuary. 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 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	

	-Approving the draft Wildlife Act	Draft Wildlife Act gazetted after Parliament approval	FD 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 Sanctuary effectively are approved, developed and posted. Improvements in financial organizational systems will aim for the financial sustainability for the Sanctuary.

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 Rema-Kalenga WS is spread over three (Rema, Kalenga and Chonbari) of the four Beats in Habiganj-2 Range. Rema-Kalenga WS will be managed as one management and administrative unit under newly established wildlife management & nature conservation division. This means that the WS designated parts of Rema, Kalenga and Chonbari Beats will be split off to form a single Sanctuary management unit under the overall charge of an ACF with Headquarters at the site of the current Chonbari Beat Office.

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 National Park of Sylhet Forest Division. A staff strength of 34 is approved for the division, including technical staff (one ACF, one DR/Fr and three FG/Boatman for each PA).

Rema-Kalenga Sanctuary 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.

The ACF will reside at Rema-Kalenga WS HQ and as Officer in Charge be exclusively responsible for the management of WS as per the Plan. He will be assisted in his office by a Deputy Forest Range Officer in developing and coordinating all WS management activities with specific responsibility for management of field staff and budget. He along with ACF will maintain a close working relationship with the territorial staff of FD, particularly the Range Officer of Habiganj-2 Range in order to coordinate management activities in interface landscape zone and control illicit removals from WS areas.

Three trained Forest Guards, as sanctioned per the organogram, will be in Charge of specific areas with Headquarters at Kalenga, Chonbari and Rema. They, reporting directly to ACF, will be responsible for the coordination and implementation of day-to-day management activities in their respective WS areas. Over a time these posts will be upgraded and manned by trained Foresters. Additional staff (say, FGs) will be deployed by establishing petrol camps on the northeastern boundary of the WS at Kalenga Chara, and at the Rema Tea Estate/Sanctuary boundary on the trail to BDR camp in the extreme southern portion of the Sanctuary. Active help from local stakeholders will be sought during patrolling of the WS, and also will particularly be responsible for activities in sustainable use areas.

9.4 Duties and Responsibilities

The Sanctuary 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 the Sanctuary 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 the Sanctuary. 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; 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 Chonbari Beat Office will be the HQ of ACF to be posted exclusively for managing the Sanctuary. He will be provided official residence at Chonbari along with other technical staff.

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 Sanctuary. Eco-tourism activities and entry fees for the Sanctuary will be a good source of revenue in future.

10. THE BUDGET

The budget requirements for the implementation of Rema-Kalenga 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	5000					5000		300	note 1
1.2 Boundary Demarcation										
1.2.1 signboards	nos	15	15				30	3	90	note 2
1.2.2 outer and zonal boundary posts	km	25	25	25			75	5	375	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)	25	25	20			70	2	140	
1.4 Formalization of co-management committees / councils	lump sum								30	
1.5 Control of illicit felling, poaching, encroachment, forest fires and grazing by user groups and patrolling groups	lump sum								200	note 4
1.6 Communication networks : maintenance of walki talkies, mobile telephones, etc.	lump sum								200	
1.7 Provision of arms and ammunition for control of organized smugglers	lump sum								300	
1.8 Rewards/Incentives for biodiversity protection efforts by local Stakeholders and FD Staff	lump sum								90	
1.9 Resolution of forest conflicts	no. of meet-ings	30	30	25	25	20	100	1	100	note 5
2. Management Programs										
2.1 Landscape Management Zoning										note 6
2.2 Core Zones Management										
2.2.1 Protecting forests and other biodiversity	ha	5000	5000	5000	5000	5000	5000			note 7
2.2.2 Canopy opening and enrichment planting	ha	60	70	100	70	50	50	8.8	3080	note 8
2.2.3 Replanting framework species	ha	70					70	24	1680	note 9
2.2.4 Short-rotation plantation management	ha		20	20	10		50	10	500	note 10
2.2.5 Habitat improvement works	ha	50	60	100	60	20	290	15	4350	note 11
2.2.6 Habitat restoration works	ha	50	50	100	60	20	280	10	2800	note 11
2.2.7 Renovations of existing Water bodies	No.	10					5	100	1000	note 11

Strategic Programs	Unit	Quantity/ Year						Unit Cost '000 Taka	Total Cost '000 Taka	Notes
		Y1	Y2	Y3	Y4	Y5	Total			
2.3 Interface Landscape Zones Management										
2.3.1 Sustainable Use Sub Zones										
2.3.2 Delineating the forest land assigned to Debra Bari Forest Village	lump sum								15	
2.3.3 Delineating short rotation plantations and assigning to local groups	lump sum								10	
2.3.4 Motivating Forest Villagers for biodiversity conservation	lump sum								10	
2.3.5 Signing PCBSAs with Forest Villagers	lump sum								15	
2.3.6 Village Use Sub Zone										
2.3.7 Delineating the habitation of Forest Villagers (Debra Bari)	lump sum								20	
2.3.8 Intensive Use Sub Zone										
2.3.9.1 Maintaining existing FD buildings	2m	60	80	40	10	10	200	7	1400	
2.3.10 Support Sub Zone										
2.3.4.1 Managing existing plantations and natural vegetation	Ha	100	150	100	100	50	500	1.5	750	
2.3.11 Forming groups and implementing livelihood programs for identified villages	lump sum								40	note 12
2.3.12 Transport Corridors Sub-Zones										note 13
2.3.13 Liaisoning with Land Owning Agencies	lump sum								15	
2.3.14 Raising strip plantations along roads and railway lines	Km		1	1	1		3	32	96	
2.3.15 Tea Estate Sub Zones										note 14
2.3.16 Liaisoning with Tea Employers Association	lump sum								20	
2.3.17 Forming user groups of Tea Estate workers	lump sum								100	
3. Livelihoods Programs										
3.1 Selecting priority production technologies	lump sum								20	
3.1.1 Conducting reconnaissance surveys and demand-supply assessment	lump sum								40	
3.1.2 Identifying a list of feasible production technologies based on supply – demand assessment	lump sum								5	
3.1.3 Stakeholders' Consultations on the proposed production technologies	lump sum								40	
3.2 Developing demonstration centers										
3.2.1 Developing identified fields as demonstration centers	HH	50	75	100	75	50	350	3	1050	
4. Facility Development Programs										
4.1 Facilities and Infrastructure										
4.1.1 Headquarters (Rema Kalenga Range Office)										
4.1.2 Conversion of Beat Officer's Quarters to Forester's Quarters (2)	m^2	160					160	7	1120	
4.1.3 Conversion of Wildlife semi-permanent Park Office	m^2	100					100	7	700	

Strategic Programs	Unit	Quantity/ Year						Unit Cost '000 Taka	Total Cost '000 Taka	Notes
		Y1	Y2	Y3	Y4	Y5	Total			
4.1.4 Demolition and removal of derelict buildings	lump sum								40	
4.1.5 Construction of ACF's Quarters	m^2	120					120	12.5	1500	
4.1.6 Renovation of Forest Banglo (1)	m^2	60					60	7	420	
4.1.7 Student hut / dormitory	m^2	150					150	12.5	1875	
4.1.8 Dormitory / Barrack for staff	m^2	300					300	7	2100	
4.1.9 Construction of Ranger's Quarters	m^2	100					100	12.5	1250	
4.1.10 Construction of Guard's Quarters (4, each ~60 m^2)	m^2	240					240	12.5	3000	
4.2 Construction of Public Toilet	m^2		10				10	12.5	125	
4.3 Vehicles										
4.3.1 Double-cab pickups	nos	1					1	2500	3600	
4.3.2 100 cc motorcycles	nos	10					10	130	1300	
4.4 Equipment										
4.4.1 Office equipment	misc	40%	60%				100%	100	100	
4.4.2 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	Note 17
5.2 Nature trails	km	0	7	7	6	0	20	8	160	
5.3 Identifying suitable sites for Nature Camps		2					2	2	4	
5.4 Toilets/Restrooms	no.	1	2	2			5	75	375	
5.5 Resting Facility	no.		1	1	1		3	100	300	
5.6 Trash cans	no.	5	3	2	2		12	1.5	18	
5.7 Identifying & training eco-guides	no.	5	5				10	5	50	
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	
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	**2**			6	30	180	
6.1.2 Research studies	m-m	4	4	2	1		12	75	900	
6.2 Conservation Monitoring										
6.2.1 Biodiversity health monitoring	m-m	15	4	3	2	1	25	30	750	
6.2.2 Socio-economic monitoring	m-m	5	2	2	1		10	30	300	
6.3 Conservation Capacity Building										
6.3.1 Overseas study tours (1 DFO, 1 ACF, 1 Forest Ranger)	m-m						2.5	200	450	
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.									
6.3.5 Overseas tour of user groups	No.	25	25				50	20	1000	note 17

Strategic Programs	Unit	Quantity/ Year						Unit Cost '000 Taka	Total Cost '000 Taka	Notes
		Y1	Y2	Y3	Y4	Y5	Total			
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 (6)	m-m	72	72	72	72	72	360	2.5	933	
- Forest Guards (6)	m-m	72	72	72	72	72	360	2	720	
- Plantation Malis (6)	m-m	72	72	72	72	72	360	2	720	
7.2 Operating Costs										
- support staff, utilities, vehicle fuel and upkeep, *etc.*	months	12	12	12	12	12	60			

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 IRS imagery , if available), updated Forest Department plantation records, ground-truthing by Sanctuary 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 15) and to designate participatory use areas (estimated 15).
3 calculated based on approximate boundary length.
4 estimated mainly for conducting group meetings before proceeding for patrol duties. 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 is covered under item 1.1
7 cost of protection is covered under item 1
8 based on 218 ha of Ecosystem Management Zone in the proposed Park extension that may be subject to selective felling or other silvicultural treatment, and 165 ha of Habitat Management Zone in the Park area. Total of 383 ha is rounded up to 425 ha to account for potential additions to Habitat Management Zone (plantations that are currently zoned as Sustainable Use Zone, but that are in excess of area requirements specified under Land Use Agreements).
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 native framework species and managed for a rapid return to forest cover and eventual incorporation in the Ecosystem Management Zone.
10 based on current area of plantations in the Sustainable Use Zone (189 ha) plus part area of Support Zones (87 ha), rounded down to 150 ha to account for potential additions to Habitat Management Zone (plantations that are currently zoned as Sustainable Use Zone, but that are in excess of area requirements specified under Participatory Conservation and Benefit Sharing Agreements).
11 rough estimates for a number of site specific activities as listed in the text (Section 4.3.2.1); the funds requirements will be precisely estimated after inspecting the sites.
12 rough estimates for a number of site specific activities as listed in the text (Section 4.3.2.2); the funds requirements will be precisely estimated after inspecting the sites.
13 rough estimates for a number of site specific activities as listed in the text (Section 4.3.2.1.5); the funds requirements will be precisely estimated after inspecting the sites.
14 costs are covered under livelihoods programs (Chapter 5 of Part II).
15 strip plantations being raised under buffer zone planting of FSP will be used for raising linear plantations in Transport Corridor Zones
16 Tea Estate workers will be covered under livelihoods programs as covered under Chapter 5 of Part II.
17 this item is already covered under 4.1.1.2
18 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).
19 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
20 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.

REFERENCES

Alam, MK (1988). *Annotated check list of the woody flora of Sylhet forests*. Bulletin 5, Plant Taxonomy Series, BFRI, Bangladesh.

Art, HM; Alam, MK and Bari, A (2004). *Assessment of Forest Department's Institutional* Organization and Capacity to Manage the Protected Area System of Bangladesh. Nishorgo Support Project, Bangladesh.

GOB (1992) *Forestry Master Plan. Conservation*. Government of Bangladesh. ADB TA No. 1355-BAN.

Khan, MS; Hasan, MA and Uddin, MZ (2002) Ethnobotanical Survey in Rema-Kalenga Wildlife Sanctuary (Habiganj) in Bangladesh. *Bangladesh Journal of Plant Taxonomy*, 9(1) : 51-60.

MacKinnon, J; MacKinnon, K; Child, G and Thorsell, J (1986) *Managing protected areas in the tropics,* IUCN, Gland, Switzerland.

NACOM (2004) *Site-Level Field Appraisal for Protected Area Co-Management : Lawachara National Park*. Nishorgo Support Project, Bangladesh.

Nasim, A (2004) *Core Indicators for Protected Areas.* Nishorgo Support Project, Bangladesh.

Rosario, EA (1997) *The Conservation Management Plan of the Protected Areas other than those in the Sundarban in Bangladesh.* Forest Resource Management Project, Forest Department, Bangladesh.

Tecsult (2000) *Training Requirements for Participatory Protected Area Management*. Forestry Sector Project, Bangladesh.

Tecsult (2001) *First Five Year Management Plan for Rema-Kalenga Wildlife Sanctuary*. Forestry Sector Project, Bangladesh.

Tecsult (2001) *Guidelines for the development of Conservation Area Facilities*. Forestry Sector Project, Bangladesh.

VOLUME 2

SUPPORT MATERIAL

TABLE OF CONTENTS

VOLUME 2: *SUPPORT MATERIAL*

Annexure 1

NOTIFICATION

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

(to be substituted for the notification bearing the same number and date)
Government of the People's Republic of Bangladesh
Ministry of Environment and Forest
Section - 3

No. - Po Bo Mo (Sec-3) 7/96/371 Date: 07-07-96 AD
23-03-1403 Bangla

Notification

Whereas the Government, in exercise of the powers conferred by Article 23(1) and (2) of the Bangladesh Wild Life (Preservation) Order, 1973 (President's Order No. 23 of 1973) as amended by the Bangladesh Wild Life (Preservation) (Amendment) Act, 1974 (Act No. XVII of 1974), declared, by Notification No. 11/FOR-68/81/882 dated 22/12/81 published in the Bangladesh Gazette dated 7/1/82, an area of 2705 acres of land of the Torofhil Reserved Forest under the Sylhet Forest Division as a wildlife sanctuary;

And whereas it is necessary to extend the limits of the said wildlife sanctuary by inclusion of an area of a further 1730 acres of land of the said Torofhil Reserved Forest;

Now, therefore, the Government, in exercise of the powers conferred by the said Order, is pleased to declare an additional 1730 acres of land as wildlife sanctuary.

Due to administrative decentralisation, as the whole area of the said 4435 (2705 + 1730) acres of land falls within the Hobigonj District and it is necessary to describe the boundaries of the said area of land more specifically and accurately, the Government is, therefore, pleased to amend the description of the said area of 4435 acres of land as mentioned in the Schedule below.

Schedule

Amended description of the land declared as wildlife sanctuary:

District - Hobigonj, P.S.- Chunarughat
4435 acres (1795.54 hectares) of land within the following boundaries out of the total 11,700.21 acres of land of the Torofhil Reserved Forest.

Boundaries:
To the north: the pillar marked as "FD" at a distance of 11.20 chains at 159 ^{o}0' bearing from pillar No. 1951 at the Bangladesh - India international border is marked as No. 1 Station. From the said No. 1 Station the boundary line reaches the No. 16 Station at Rema - Kalenga road at the following bearings and distances:

Bearing	Distance
298^{o}	8.40 chains
292^{o}	10.20 chains
182^{o}	2.80 chains
255^{o}	8.50 chains
284^{o}	6.60 chains
248^{o}	14.25 chains
257^{o}30'	35.40 chains
267^{o}15'	11.65 chains
241^{o}	27.10 chains
213^{o}	58.50 chains
281^{o}	5.80 chains
260^{o}	7.50 chains
305^{o}45'	2.60 chains
292^{o}	5.53 chains

Bearing	Distance
328°	2.72 chains

To the west: from the above-mentioned No. 16 Station, the boundary line runs towards the south along Rema and reaches the No. 80 Station at the following bearings and distances:

Bearing	Distance
201°30'	3.53 chains
221°	1.40 chains
207°30'	3.51 chains
194°30'	8.28 chains
177°30'	25.38 chains
214°45'	2.56 chains
171°15'	2.15 chains
129°	1.92 chains
164°	1.30 chains
169°30'	8.74 chains
166°30'	7.96 chains
169°	5.00 chains
167°30'	4.01 chains
170°	5.53 chains
165°	7.09 chains
163°	2.65 chains
154°	2.68 chains
170°	4.56 chains
171°30'	2.12 chains
201°	2.83 chains
203°15'	3.24 chains
171°45'	3.35 chains
215°	2.46 chains
195°	3.62 chains
183°15'	2.85 chains
185°15'	2.12 chains
156°30'	8.20 chains
174°45'	1.03 chains
201°	7.32 chains
170°	2.41 chains
162°	3.95 chains
191°	6.90 chains
181°	3.94 chains
187°15'	4.24 chains
167°	1.82 chains
124°30'	1.88 chains
107°	6.04 chains
119°15'	3.15 chains
156°	0.74 chains
190°	4.98 chains
155°45'	5.90 chains
143°15'	2.22 chains
153°	2.56 chains
170°	4.16 chains
155°	3.44 chains
163°30'	4.13 chains
165°45'	4.54 chains
158°45'	2.04 chains
149°30'	4.15 chains
169°30'	4.18 chains
201°	2.82 chains
205°15'	5.67 chains
196°15'	5.38 chains
193°15'	2.88 chains
178°15'	2.30 chains

Bearing	Distance
172°	3.53 chains
186°45'	3.80 chains
212°	4.57 chains
229°	5.27 chains
240°	3.18 chains
246°15'	4.36 chains
219°30'	4.50 chains
204°	3.56 chains
193°15'	8.48 chains, near gorzan tree

Thereafter, from No. 80 Station the boundary line turns to the southeast and reaches No. 81 Station at a bearing of 135° and distance of 28.48 chains. From there the boundary line reaches No. 89 Station at the following bearings and distances:

Bearing	Distance
180°	98.20 chains
270°	15.60 chains
274°	19.50 chains
273°	21.30 chains
274°30'	19.20 chains
210°	2.75 chains
163°	6.00 chains
172°	42.80 chains

Thereafter, the boundary line reaches Remachhara at the Bangladesh - India International border, at 178° bearing and 54.50 chains distance.

To the south: from the above-mentioned point the boundary line runs towards the east along Rekhachhara and reaches up to the international boundary pillar No. 1960, and from there in the same way up to pillar No. 1959, and from there in the same way up to the international pillar No. 1958.

To the east: thereafter the boundary line runs along the same boundary, first towards the northwest and then towards the northeast and then towards the north and reaches the international boundary pillar No. 1957. Thereafter the boundary line runs along the same international boundary, towards the north and northwest and reaches pillar No. 1956, then towards the northeast, along the same international boundary, and reaches pillar No. 1955, and from there the boundary line, along the same international boundary, reaches pillar No. 1954. Thereafter from the said pillar No. 1954, the boundary line runs along the international boundary, first towards the north and then towards the east and reaches pillar No. 1953. From there it runs towards the north, via Kalengachhara, and reaches the international boundary pillar No. 1952. Thereafter from the said pillar No. 1952, the boundary line runs along Kalengachhara and reaches the first starting station, i.e., No. 1 Station.

By the order of the President,
Signed,
7-7-96 AD
(AHBAB AHMED)
Secretary

No. Po Bo Mo (Sec-3) 7/96/371 (6) dated 07-7-96 AD
23-3-1403 Bangla

Copy forwarded for information and further necessary action to:

1. Chief Conservator of Forests, Directorate of Forests, Dhaka.
   This is in reference to his Letter No. - Pro Bo Sa (Pro.) /4D-230/96/916, dated 9/12/96

2. Conservator of Forests, Central Region, Dhaka.

3. Conservator of Forests, Wildlife Circle, Dhaka.

4. Deputy Commissioner, Hobigonj.

5. Divisional Forest Officer, Sylhet.

6. Deputy Controller, Bangladesh Government Press, Dhaka. He is requested to publish it in the next issue of the Gazette and to send 50 copies to this Ministry.

Annexure 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.

Annexure 3

LIST OF WILDLIFE SPECIES

PART ONE

BIRD SPECIES REPORTED FROM REMA-KALENGA WILDLIFE SANCTUARY AREA

Sources

The following list is based on:

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

2. BCAS. 1997. Biological survey. Final Report. Prep. for Forest Resources Management Project by Bangladesh Centre for Advanced Studies, Dhaka.

3. Roy, P.C. and M. A. Azam. 1995. Wildlife survey in Rema-Kalenga Wildlife Sanctuary. Pages 1-10, *in:* Wildlife research activities of Sylhet Forest Division, 1994-95. Forest Department, Government of the People's Republic of Bangladesh.

Nomenclature

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.

Alternative nomenclature is given in parentheses.

Status

Frequency/abundance ratings listed under "Status" below are based on Thompson and Johnson (1999) and are defined as:

- rare (1-5): number of sightings of rare species in Rema-Kalenga 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.

Extinction risk ratings also listed under "Status" below are based on:

> IUCN Bangladesh. 2000. Red book of threatened birds of Bangladesh. IUCN – The World Conservation Union. xi + 116 pp.

The risk ratings are limited to species that are resident in Bangladesh and are defined as:

- Critically Endangered (CR): facing an extremely high risk of extinction in the wild in Bangladesh in the immediate future;
- Endangered (EN): not Critically Endangered but facing a very high risk of extinction in the wild in Bangladesh in the near future;
- Vulnerable (VU): not Critically Endangered or Endangered but facing a high risk of extinction in the wild in Bangladesh in the medium-term future;
- Data Deficient (DD): inadequate information to make a direct, or indirect, assessment of risk of extinction in Bangladesh;
- Not Threatened (NT): no apparent threat of extinction in Bangladesh.

Species that are known only as migrants in Bangladesh are designated with an M under "Status".

A few species listed for Rema-Kalenga in the sources cited above are not included in either of IUCN's lists of resident or migratory birds of Bangladesh; these are designated NR (not rated for extinction risk) under "Status".

List of Species

Common name	Scientific name	Source	Status
Small Buttonquail (Little Bustard Quail)	Turnix sylvatica	3	DD
Red Junglefowl	*Gallus gallus*	1,2,3	common/NT
Kalij Pheasant	*Lophura leucomelanos*	1,2	uncommon/EN
Fulvous Whistling-duck (Large Whistling Teal)	*Dendrocygna bicolor*	3	NT
Lesser Whistling-duck (Whistling Teal)	*Dendrocygna javanica*	3	NT
Cotton Pygmy-goose (Teal)	*Nettapus coromandelianus*	3	NT
Eurasian Wryneck	*Jynx torquilla*	3	M
Yellow-crowned (Yellowfronted Pied) Woodpecker	*Dendrocopos (Picoides) mahrattensis*	3	DD
Rufous Woodpecker	*Celeus (Micropterus) brachyurus*	3	NT
Greater Yellownape (Large Yellownaped Woodpecker)	*Picus flavinucha*	1,3	uncommon/NT
Grey-headed Woodpecker	*Picus canus*	1	common/NT
Black-rumped Flameback (Red-backed/Lesser Golden-backed Woodpecker)	*Dinopium benghalense*	1,2,3	rare (1)/NT
Bay Woodpecker	*Blythipicus pyrrhotis*	2	DD
Lineated Barbet	*Megalaima lineata*	1,2,3	common/NT
Blue-throated Barbet	*Megalaima asiatica*	1	common/NT
Blue-eared Barbet	*Megalaima australis*	1	uncommon/NT
Coppersmith (Crimson-breasted) Barbet	*Megalaima haemacephala*	2,3	NT
Oriental Pied Hornbill	*Anthracoceros albirostris*	2	EN
Common Hoopoe	*Upupa epops*	3	NT
Red-headed Trogon	*Harpactes erythrocephalus*	1	uncommon/EN
Indian Roller	*Coracias benghalensis*	1,3	uncommon/NT
Dollarbird (Broad-billed Roller)	*Eurystomus orientalis*	3	CR
Common (Small) Kingfisher	*Alcedo atthis*	2,3	NT
(Brown-headed) Stork-billed Kingfisher	*Halcyon (Pelargopsis) capensis*	3	NT
White-throated (White-breasted) Kingfisher	*Halcyon smyrnensis*	1,2,3	uncommon/NT
Pied Kingfisher	*Ceryle rudis*	3	NT
(Little) Green Bee-eater	*Merops orientalis*	2,3	NT
Chestnut-headed Bee-eater	*Merops leschenaulti*	2,3	NT
Common Hawk Cuckoo	Hierococcyx varius	2	NT
Indian Cuckoo	*Cuculus micropterus*	3	NT
Drongo Cuckoo	*Surniculus lugubris*	1	uncommon/NT
Asian Koel (Kalokokil)	*Eudynamys scolopacea*	3	NT
Green-billed Malkoha	*Phaenicophaeus (Rhopodytes) tristis*	1,3	uncommon/NT
Greater Coucal (Crow Pheasant)	*Centropus sinensis*	1,3	uncommon/NT
Lesser Coucal	*Centropus bengalensis (toulou)*	1,3	uncommon/NT
Vernal Hanging Parrot (Lorikeet)	*Loriculus vernalis*	1,2,3	uncommon/NT
Alexandrine (Large Indian) Parakeet	Psittacula eupatria	3	CR
Blossom-headed Parakeet	*Psittacula roseata*	2	NT
Red-breasted Parakeet	*Psittacula alexandri*	1,2,3	abundant/NT
Asian Palm Swift	*Cypsiurus balasiensis (parvus)*	1,2	common/NT
Barn Owl	*Tyto alba*	2	NT

Common name	Scientific name	Source	Status
Oriental Scops Owl	*Otus sunia*	1	common/NR
Collared Scops Owl	*Otus bakkamoena*	1	common/NT
Eurasian Eagle Owl	*Bubo bubo*	2	NR
Spot-bellied Eagle Owl	*Bubo nipalensis*	1	rare (1)/EN
Brown Fish Owl	*Ketupa (Bubo) zeylonensis*	3	VU
Asian Barred Owlet	*Glaucidium cuculoides*	1	uncommon/DD
Jungle Owlet	Glaucidium radiatum	1	common/NT
Spotted Owlet	*Athene brama*	3	NT
Brown Hawk Owl	*Ninox scutulata*	1	common/NT
Grey (Jungle) Nightjar	*Caprimulgus indicus*	3	EN
Large-tailed Nightjar	*Caprimulgus macrurus*	1	common/NT
(Blue) Rock Pigeon	*Columba livia*	2,3	NT
Oriental Turtle Dove	*Streptopelia orientalis*	1	uncommon/M
Spotted Dove	*Streptopelia chinensis*	1,2,3	common/NT
Red Collared Dove	*Streptopelia tranquebarica*	2	NT
Eurasian Collared (Ring) Dove	*Streptopelia decaocto*	3	NT
Emerald Dove	*Chalcophaps indica*	1,3	uncommon/NT
Pompadour (Grey-fronted) Green Pigeon	*Treron pompadora*	1,3	uncommon/NT
Yellow-footed Green Pigeon	*Treron phoenicoptera*	3	NT
Wedge-tailed Green Pigeon	*Treron sphenura*	2	M
White-breasted Waterhen	*Amaurornis phoenicurus*	2,3	NT
Ruddy-breasted (Ruddy) Crake	*Porzana fusca (Amaurornis fuscus)*	3	DD
Watercock	*Gallicrex cinerea*	3	NT
Pintail Snipe	*Gallinago stenura*	3	M
Wood Sandpiper	*Tringa glareola*	3	M
Pacific (Eastern) Golden Plover	*Pluvialis fulva (dominica)*	3	M
Black (Pariah) Kite	*Milvus migrans*	3	NT
Brahminy Kite	*Haliastur indus*	2,3	NT
Pallas's Fish (Fishing) Eagle	*Haliaeetus albicilla (leucoryphus)*	3	CR
(Himalayan) Grey-headed Fish (Fishing) Eagle	*Ichthyophaga ichthyaetus (nana)*	3	NT
White-rumped (White-backed) Vulture	*Gyps bengalensis*	3	NT
Crested Serpent Eagle	*Spilornis cheela*	2,3	NT
Eurasian Marsh Harrier	*Circus aeruginosus*	1,3	rare (1)/M
Pied Harrier	*Circus melanoleucos*	1,3	rare (1)/M
Eurasian Sparrowhawk	*Accipiter nisus*	1	rare (1)/M
Common (Eastern) Kestrel	*Falco tinnunculus*	3	M
Little Egret	*Egretta garzetta*	2,3	NT
Grey Heron	*Ardea cinerea*	3	NT
Great (Large) Egret	*Casmerodeus albus (Egretta alba)*	3	NT
Cattle Egret	Bubulcus ibis	1,2,3	uncommon/NT
Indian Pond Heron	Ardeola grayii	1,2,3	uncommon/NT
Black-crowned Night Heron	*Nycticorax nycticorax*	3	NT
Malayan Night Heron (Tiger Bittern)	*Gorsachius melanolophus*	3	CR
Cinnamon (Chestnut) Bittern	*Ixobrychus cinnamomeus*	3	NT
Asian Openbill (Openbill Stork)	*Anastomus oscitans*	3	NT
Asian Fairy Bluebird	*Irena puella*	3	NT
Blue-winged Leafbird	*Chloropsis cochinchinensis*	1	uncommon/NT
Golden-fronted Leafbird	*Chloropsis aurifrons*	1,2,3	common/NT
Brown Shrike	*Lanius cristatus*	3	M

Common name	Scientific name	Source	Status
Long-tailed (Blackheaded) Shrike	*Lanius schach*	3	NT
Common Green Magpie	*Cissa chinensis*	3	DD
Rufous Treepie	*Dendrocitta vagabunda*	2,3	NT
House Crow	*Corvus splendens*	3	NT
Large-billed (Jungle) Crow	*Corvus macrorhynchos*	1,2,3	common/NT
Ashy Woodswallow (Swallow Shrike)	*Artamus fuscus*	3	NT
Black-hooded Oriole	*Oriolus xanthornus*	1,2,3	common/NT
Large Cuckooshrike	*Coracina macei*	1	common/NT
Black-winged Cuckooshrike	*Coracina melaschistos*	1	uncommon/M
Rosy Minivet	*Pericrocotus roseus*	1	uncommon/NR
Scarlet Minivet	*Pericrocotus flammeus*	1,3	common/NT
Bar-winged Flycatcher-shrike	*Hemipus picatus*	1	uncommon/NT
Black Drongo	*Dicrurus macrocercus (adsimilis)*	1,2,3	common/NT
Ashy Drongo	*Dicrurus leucocephalus*	1	uncommon/M
Crow-billed Drongo	*Dicrurus annectans*	3	DD
Bronzed Drongo	*Dicrurus aeneus*	1,2,3	common/NT
Lesser Racket-tailed Drongo	*Dicrurus remifer*	1,2,3	uncommon/DD
Spangled (Hair-crested) Drongo	*Dicrurus hottentottus*	1	common/NT
Greater Racket-tailed Drongo	*Dicrurus paradiseus*	1,2,3	common/NT
Black-naped Monarch (Blue Flycatcher)	*Hypothymis azurea*	1,2,3	common/NT
Common Iora	*Aegithina tiphia*	1,2,3	common/NT
Large Woodshrike	*Tephrodornis gularis*	1	common/NT
Black-breasted Thrush	*Turdus dissimilis*	1	rare/M
Red-throated Flycatcher	*Ficedula parva*	1	common/M
Verditer Flycatcher	*Eumyias thalassina*	1	uncommon/M
Pale-chinned (Brook's) Flycatcher	Cyornis poliogenys	1	uncommon/NT
Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	1	common/NT
Oriental Magpie Robin	*Copsychus saularis*	1,2,3	common/NT
White-rumped Shama	*Copsychus malabaricus*	3	NT
Common Stonechat	*Saxicola torquata*	1	uncommon/M
Chestnut-tailed Starling (Greyheaded Myna)	*Sturnus malabaricus*	3	NT
Asian Pied Starling (Pied Myna)	*Sturnus contra*	1,2,3	common/NT
Common Myna	*Acridotheres tristis*	1,2,3	common/NT
Jungle Myna	Acridotheres fuscus	2,3	NT
Hill Myna	*Gracula religiosa*	1,2,3	uncommon/NT
Great (Grey) Tit	*Parus major*	3	NT
Barn (Common) Swallow	*Hirundo rustica*	2,3	M
Wire-tailed Swallow	*Hirundo smithii*	3	DD
Nepal House Martin	*Delichon nipalensis*	3	DD
Black-crested Bulbul	*Pycnonotus melanicterus*	1	uncommon/NT
Red-whiskered Bulbul	*Pycnonotus jocosus*	1,2,3	abundant/NT
Himalayan (White-cheeked) Bulbul	Pycnonotus leucogenys	3	NR
Red-vented Bulbul	Pycnonotus cafer	1,2,3	abundant/NT
Olive Bulbul	Iole viridescens	1	uncommon/DD
Ashy (Bronze-eared) Bulbul	*Hemixos flavula (Hypsipetes flavalus)*	3	NT
Oriental White-eye	*Zosterops palpebrosus*	1,2	common/NT
Reed Warbler	*Acrocephalus* sp.	3	
Mountain (Golden-headed) Tailorbird	*Orthotomus cuculatus*	3	DD
Common Tailorbird	*Orthotomus sutorius*	1,2,3	common/NT
Dark-necked Tailorbird	*Orthotomus atrogularis*	1	common/DD

Common name	Scientific name	Source	Status
Greenish Warbler	*Phylloscopus trochiloides*	1	common/M
Yellow-vented Warbler	*Phylloscopus cantator*	1	uncommon/M
Golden-spectacled Warbler	*Seicercus burkii*	1	common/M
Lesser Necklaced Laughingthrush	*Garrulax monileger (monilegerus)*	3	NT
Greater Necklaced Laughingthrush	*Garrulax pectoralis*	1	common/NT
Abbott's Babbler	*Malacocincla (Trichastoma) abbotti*	1,3	common/NT
Puff-throated (Spotted) Babbler	*Pellorneum ruficeps*	1	common/NT
Striped Tit Babbler	*Macronous gularis*	1	common/NT
Jungle Babbler	*Turdoides striatus*	3	NT
Brown-cheeked Fulvetta (Quaker Babbler)	*Alcippe poioicephala*	1	uncommon/NT
Rufous-winged (Assam) Bushlark	*Mirafra assamica*	3	NT
Pale-billed (Tickell's) Flowerpecker	**Dicaeum erythrorhynchos**	2,3	NT
Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	1,2	common/NT
Ruby-cheeked Sunbird	*Anthreptes singalensis*	1	common/NT
Purple-rumped Sunbird	*Nectarinia zeylonica*	2	NT
Purple Sunbird	*Nectarinia asiatica*	3	NT
Crimson Sunbird	*Aethopyga siparaja*	1	common/NT
Little Spiderhunter	*Arachnothera longirostra*	2	NT
House Sparrow	*Passer domesticus*	3	NT
White Wagtail	*Motacilla alba*	3	M
Yellow Wagtail	*Motacilla flava*	3	M
Grey Wagtail	*Motacilla cinerea*	3	M
Paddyfield (Australasian) Pipit	*Anthus rufulus (novaeseelandiae)*	2,3	M
Olive-backed Pipit	*Anthus hodgsoni*	1	uncommon/M
Baya Weaver	*Ploceus philippinus*	3	NT
Scaly-breasted (Spotted) Munia	*Lonchura punctulata*	3	NT
Black-headed Munia	*Lonchura malacca*	3	NT

This list is still incomplete, and additional survey work is required.

PART TWO

MAMMAL SPECIES REPORTED FROM REMA-KALENGA WILDLIFE SANCTUARY AREA

Sources

The following list is based on:

1. BCAS. 1997. Biological survey. Final Report. Prep. for Forest Resources Management Project by Bangladesh Centre for Advanced Studies, Dhaka.

2. Roy, P.C. and M. A. Azam. 1995. Wildlife survey in Rema-Kalenga Wildlife Sanctuary. Pages 1-10, *in:* Wildlife research activities of Sylhet Forest Division, 1994-95. Forest Department, Government of the People's Republic of Bangladesh.

3. Gittins, S.P. and A.W. Akonda. 1982. What survives in Bangladesh? Oryx XVI(3):275-281.

4. 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.

5. information from local Forest Department staff, May-December 1999

6. information from BDR, May-December 1999

7. information from local villagers, May-December 1999

8. observations by the FSP Biodiversity Conservation and Management Specialists, May-December 1999

9. M.M. Kabir *pers. comm.* 1999

Nomenclature

Nomenclature follows:

Baillie, J. and B. Groombridge (eds.). 1996. 1996 IUCN red list of threatened animals. IUCN, Gland, Switzerland.

IUCN Bangladesh. 2000. Red book of threatened mammals of Bangladesh. IUCN – The World Conservation Union. xii + 71 pp.

Alternative nomenclature is given in parentheses.

Status

Comments on status (nearly extirpated, probably extirpated, extirpated) are based on the sources listed above and refer to current known status in Rema-Kalenga Wildlife Sanctuary. Additional extinction risk ratings listed under "Status" are based on IUCN Bangladesh (2000) and refer to extinction risk within Bangladesh as a whole. The risk ratings are defined as:

- Critically Endangered (CR): facing an extremely high risk of extinction in the wild in Bangladesh in the immediate future;
- Endangered (EN): not Critically Endangered but facing a very high risk of extinction in the wild in Bangladesh in the near future;
- Vulnerable (VU): not Critically Endangered or Endangered but facing a high risk of extinction in the wild in Bangladesh in the medium-term future;
- Data Deficient (DD): inadequate information to make a direct, or indirect, assessment of risk of extinction in Bangladesh;
- Not Threatened (NT): no apparent threat of extinction in Bangladesh.

List of Species

Common name	***Scientific name***	**Source**	**Status**
Grey Musk/House (White-tailed) Shrew	Suncus murinus	2	NT
(Common) Indian Flying Fox	*Pteropus giganteus*	1,2	NT
Indian False Vampire	*Megaderma lyra*	1	NT
Indian Pipistrelle	*Pipistrellus coromandra*	1	NT
Slow Loris	*Nycticebus coucang*	3	CR
Assamese Macaque	*Macaca assamensis*	2	DD
Rhesus Macaque	*Macaca mulatta*	1,2,3,9	VU
Pig-tailed Macaque	Macaca nemestrina	1,3,8	CR
Phayre's Langur (Leaf Monkey)	*Trachypithecus (Presbytis) phayrei*	1,2,3,8,9	CR
Capped Langur	*Trachypithecus (Presbytis) pileatus*	1,2,3,8,9	EN
Hoolock Gibbon	Hylobates hoolock	1,4,5,8	nearly extirpated/CR
Jackal	*Canis aureus*	1,2,3,5	VU
Asiatic Wild Dog	*Cuon alpinus*	5,7	probably extirpated/CR
Jungle Cat	*Felis chaus*	2	EN
Leopard	*Panthera pardus*	5,6	probably extirpated/CR
Tiger	*Panthera tigris*	7	extirpated/CR
Fishing Cat	*Prionailurus viverrinus (Felix viverrina)*	1,2	EN
Small Indian Mongoose	*Herpestes auropunctatus*	1,2	NT
Common (Grey) Mongoose	*Herpestes edwardsi*	2	VU
Crab-eating Mongoose	*Herpestes urva*	1	EN
Common Otter	*Lutra lutra*	1,2,3	CR
Sun Bear and/or Sloth Bear and/or Asiatic Black Bear	*Ursus malayanus* *Melursus ursinus* *Ursus thibetanus*	5,7	extirpated/CR/CR/EN
Small Indian Civet	*Vivericulla indica*	2	VU
Asian Elephant	*Elephas maximus*	5	extirpated/CR
Wild Boar	*Sus scrofa*	1,2,3,5,6,7,8	NT
Sambar	*Cervus unicolor*	1,2,5,7	nearly extirpated/CR
Barking Deer	*Muntiacus muntjac*	1,3,5,6,7	EN
Indian Pangolin	*Manis crassicaudata*	1	CR
Hoary-bellied Himalayan (Irrawaddy) Squirrel	*Callosciurus pygerythrus*	1	NT
Orange-bellied Himalayan Squirrel	*Dremomys lokriah*	1	DD
Black (Highland) Giant Squirrel	*Ratufa bicolor*	1,2	DD
Bandicoot Rat	*Bandicota bengalensis*	2	NT
House Mouse	*Mus musculus*	2	NT
Indian Porcupine	*Hystrix indica*	3	EN
Rufous-tailed Hare	*Lepus nigricollis*	3	EN

This list is incomplete and additional survey work is required.

PART THREE

REPTILE AND AMPHIBIAN SPECIES REPORTED FROM REMA-KALENGA WILDLIFE SANCTUARY AREA

Sources

The following list is based on:

1. BCAS. 1997. Biological survey. Final Report. Prep. for Forest Resources Management Project by Bangladesh Centre for Advanced Studies, Dhaka.

2. Roy, P.C. and M. A. Azam. 1995. Wildlife survey in Rema-Kalenga Wildlife Sanctuary. Pages 1-10, *in:* Wildlife research activities of Sylhet Forest Division, 1994-95. Forest Department, Government of the People's Republic of Bangladesh.

3. Gittins, S.P. and A.W. Akonda. 1982. What survives in Bangladesh? Oryx XVI(3):275-281.

Nomenclature

Nomenclature follows:

Baillie, J. and B. Groombridge (eds.). 1996. 1996 IUCN red list of threatened animals. IUCN, Gland, Switzerland.

IUCN Bangladesh. 2000. Red book of threatened amphibians and reptiles of Bangladesh. IUCN – The World Conservation Union. xi + 95 pp.

Alternative nomenclature is given in parentheses.

Status

Extinction risk ratings listed under "Status" are based on IUCN Bangladesh (2000) and refer to extinction risk within Bangladesh as a whole. The risk ratings are defined as:

- Critically Endangered (CR): facing an extremely high risk of extinction in the wild in Bangladesh in the immediate future;
- Endangered (EN): not Critically Endangered but facing a very high risk of extinction in the wild in Bangladesh in the near future;
- Vulnerable (VU): not Critically Endangered or Endangered but facing a high risk of extinction in the wild in Bangladesh in the medium-term future;
- Data Deficient (DD): inadequate information to make a direct, or indirect, assessment of risk of extinction in Bangladesh;
- Not Threatened (NT): no apparent threat of extinction in Bangladesh.

List of Species

Common name	***Scientific name***	Source	**Status**
Amphibians			
Common Toad	*Bufo melanostictus*	1,2	NT
Skipper Frog	*Euphlyctis (Rana) cyanophlyctis*	1,2	NT
Bull Frog	*Hoplobatrachus tigerinus (Rana tigerina)*	1,2	NT
Cricket Frog	*Limnoechtes (Rana) limnocharis*	2	NT
Boulenger's Frog (Pana Bang)	*Rana alticola (tytleri)*	2	VU
Taipeh Frog (Gach Bang)	*Rana taipehensis (temporalis)*	2	EN
Tree Frog	*Rhacophorus* sp.	2	-
Reptiles			
Malayan Box Turtle	*Cuora amboinensis*	1,2	EN
Spotted Flapshell Turtle (Soft-shelled Terrapin)	*Lissemys punctata*	1,2	VU
Wall Lizard	*Gekko gecko*	2	VU
House Lizard	*Hemidactylus brookii*	2	NT
Garden Lizard (Rakta chusha)	*Calotes* spp.	2	-
Striped Skink	*Mabuya dissimilis*	2	VU
Bengal Monitor	*Varanus bengalensis*	1	VU
Ring Lizard (Kalo Gui)	*Varanus salvator*	2	EN
Rock Python	*Python molurus*	2,3	EN
Striped Keelback	*Amphiesma stolata*	2	NT
Ornate Flying/Golden Flying (Tree) Snake	*Chrysopelea ornata*	1,2	EN
Rat Snake	*Coluber (Ptyas) mucosus*	2	VU
Green Rat Snake	*Coluber (Zaocys) nigromarginatus*	2	VU
Wolf Snake	*Lycodon* sp.	2	VU
Red-necked Keelback	*Rhabdophis subminiatus (subminiata)*	1	VU
Checkered Keelback	*Xenochrophis piscator*	2	NT
King Cobra	*Ophiophagus hannah*	2	EN
Green (Bamboo) Pit Viper	*Trimeresurus gramineus*	2	EN

This list is incomplete and additional survey work is required.

Annexure 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 Rema-Kalenga Wildlife Sanctuary. The list comprises species that are known to occur in Rema-Kalenga (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.

Family	***Species***
Leguminosae	Albizia chinensis
Leguminosae	Albizia procera
Moraceae	Artocarpus lacucha
Euphorbiaceae	*Bischofia javanica*
Rhizophoraceae	*Carallia brachiata*
Leguminosae	*Cassia fistula*
Leguminosae	*Cassia siamea*
Fagaceae	*Castanopsis hystrix*
Fagaceae	*Castanopsis indica*
	Castanopsis tribuloides
Dilleniaceae	*Dillenia pentagyna*
Elaeocarpaceae	*Elaeocarpus* spp.
Juglandaceae	*Engelhardtia spicata*
Ternstroemiaceae	*Eurya acuminata*
Moraceae	*Ficus benghalensis*
Moraceae	*Ficus benjamina*
Moraceae	*Ficus comosa*
Moraceae	*Ficus hispida*
Moraceae	*Ficus infectoria*
Moraceae	*Ficus racemosa*
Moraceae	*Ficus religiosa*
Moraceae	*Ficus rumphii*
Moraceae	Ficus semicordata
Euphorbiaceae	Glochidion arborescens
Verbenaceae	Gmelina arborea
Euphorbiaceae	*Macaranga* spp.
Euphorbiaceae	*Mallotus* spp.
Magnoliaceae	Michelia champaca
Fagaceae	*Quercus spicata*

Family	***Species***
Theaceae	*Schima wallichii*
Moraceae	*Streblus asper*
Myrtaceae	*Syzygium fruticosum*
Myrtaceae	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.

Annexure 5

LIST OF PLANT SPECIES

The following list of plant species reported from the Rema-Kalenga area is based on the following sources:

1. Roy, P.C. and M. A. Azam. 1995. Vegetation survey in Rema-Kalenga Wildlife Sanctuary. Pages 11-20, *in:* Wildlife research activities of Sylhet Forest Division, 1994-95. Forest Department, Government of the People's Republic of Bangladesh.

2. BCAS. 1997. Biological survey. Final Report. Prep. for Forest Resources Management Project by Bangladesh Centre for Advanced Studies, Dhaka.

3. RIMS Database (plantation species composition).

The list is sorted in alphabetical order by species name.

Family	Scientific Name	Growth form	Source
Leguminosae	*Acacia auriculiformis*	tree	3
Leguminosae	*Acacia mangium*	tree	3
Gleicheniaceae	*Achyranthes aspera*	herb	2
Acanthaceae	*Adhatoda zeylanica*	shrub	2
Leguminosae	*Albizia falcataria*	tree	3
Leguminosae	*Albizia odoratissimus*	tree	2
Leguminosae	*Albizia procera*	tree	2
Leguminosae	*Albizia* spp.	tree	3
Zingiberaceae	*Alpinia nigra*	herb	1,2
Araceae	*Amerphophalus bulbifer*	herb	1
Moraceae	*Artocarpus chaplasha*	tree	1,2,3
Poaceae	*Bambusa longispiculata*	bamboo	2
Poaceae	*Bambusa polymorpha*	bamboo	2
Poaceae	*Bambusa tulda*	bamboo	1,2
Leguminosae	*Bauhinia acuminata*	tree	2
Bombacaceae	*Bombax ceiba*	tree	2
Burseraceae	*Bursera serrata*	tree	1,2
Palmae	*Calamus* sp.	climber	3
Verbenaceae	*Callicarpa arborea*	tree	2
Cannaceae	*Canna indica*	herb	1
Lecythidaceae	*Careya arborea*	shrub	2
Fagaceae	*Castanopsis hystrix*	tree	2
Fagaceae	*Castanopsis tribuloides*	tree	2
Meliaceae	*Chikrasia tabularis*	tree	3
Marantaceae	*Clynogene dichotoma*	shrub	3
Verbenaceae	*Clerodendrum inerme*	shrub	2
Verbenaceae	*Clerodendrum infortunatum*	shrub	2
Araceae	*Colocasia nymphaefolia*	herb	2
Boraginaceae	*Cordia dichotoma*	shrub	2
Zingiberaceae	*Costus speciosus*	herb/grass	1
Liliaceae	*Curculigo orchioides*	herb	2
Zingiberaceae	*Curcuma aromatica*	herb	2
Poaceae	*Daemonorops jenkinsiana*	grass	2
Leguminosae	*Derris trifoliata*	climber	1
Dilleniaceae	*Dillenia pentagyna*	tree	2
Dilleniaceae	*Dillenia scabrella*	tree	2
Dioscoreaceae	*Dioscorea bulbifera*	climber	2
Dipterocarpaceae	*Dipterocarpus turbinatus*	tree	1,2,3
Asclepiadaceae	*Doemia extensa*	climber	1
Liliaceae	*Dracaena spicata*	shrub	2
Elaeocarpaceae	*Elaeocarpus floribundus*	tree	2
Leguminosae	*Entada phaseoloides*	climber	2
Myrtaceae	*Eucalyptus* spp.	tree	3
Compositae	*Eupatorium odoratum*	shrub	2
Euphorbiaceae	*Euphorbia* sp.	shrub	1
Moraceae	*Ficus carica*	tree	1
Moraceae	*Ficus hispida*	tree	2
Moraceae	*Ficus racemosa*	tree	2
Guttiferae	*Garcinia cowa*	tree	2
Euphorbiaceae	*Glochidion lanceolarium*	tree	2
Verbenaceae	*Gmelina arborea*	tree	2,3
Tiliaceae	*Grewia microcos*	tree	2
Bignoniaceae	*Heterophragma adenophyllum*	tree	2

Family	Scientific Name	Growth form	Source
Moraceae	*Hevea brazilensis*	tree	3
Malvaceae	*Hibiscus* sp.	shrub/tree	1
Apocynaceae	*Holarrhena antidysenterica*	tree	2
Gramineae	*Hygroryza* sp.	grass	1
Aquifoliaceae	*Ilex godajam*	tree	2
Poaceae	*Imperata cylindrica*	grass	1
Convolvulaceae	*Ipomoea maxima*	climber	2
Lythraceae	*Lagerstroemia parviflora*	tree	2
Lythraceae	*Lagerstroemia speciosa*	tree	2,3
Leeaceae	*Leea crispa*	shrub	2
Lauraceae	*Litsea angustifolia*	shrub/tree	1
Euphorbiaceae	*Macaranga roxburghii*	shrub	2
Asclepiadaceae	*Marsdenia* sp.	tree	1
	Mayeeae sp.	herb/grass	1
Poaceae	*Melocanna baccifera*	grass	1,2
Magnoliaceae	*Michelia champaca*	tree	3
Compositae	*Mikania cordata*	shrub	1
Compositae	*Mikania scandens*	climber	2
Rubiaceae	*Mitragyne parviflora*	shrub	2
Rutaceae	*Murraya* sp.	shrub	1
Poaceae	*Neohouzeaua dulloa*	grass	2
Bignoniaceae	*Oroxylum indicum*	tree	2
Euphorbiaceae	*Phyllanthus embelica*	tree	1,2
Piperaceae	*Piper sylvestre*	climber	2
Polygonaceae	*Polygonum tomentosum*	herb	1
Araceae	*Pothos scandens*	climber	1
Sterculiaceae	*Pterospermum acerifolium*	tree	2
Poaceae	*Saccharum spontaneum*	grass	2
Theaceae	*Schima wallichii*	shrub	1,2
Dipterocarpaceae	*Shorea robusta*	tree	2,3
Liliaceae	*Smilax macrophylla*	climber	2
Liliaceae	*Smilax zeylanica*	climber	1
Sphenocleaceae	*Sphenoclea zeylanica*	climber	1
Anacardiaceae	*Spondias mangifea*	tree	3
Anacardiaceae	*Spondias pinnata*	tree	2
Sterculiaceae	*Sterculia villosa*	tree	2
Bignoniaceae	*Stereospermum* sp.	tree	1
Meliaceae	*Swietenia mahogoni*	tree	3
Myrtaceae	*Syzygium cumini*	tree	1
Myrtaceae	*Syzygium formosanum*	tree	2
Myrtaceae	*Syzygium grande*	tree	1,2,3
Verbenaceae	*Tectona grandis*	tree	1,3
Combretaceae	*Terminalia belirica*	tree	1,2
Acanthaceae	*Thunbergia grandiflora*	climber	2
Poaceae	*Thysanolaena maxima*	grass	2
Cucurbitaceae	*Trichosanthes palmata*	climber	1
Malvaceae	*Urena lobata*	shrub	2
Compositae	*Vernonia cinerea*	herb/grass	1
Verbenaceae	*Vitex altissima*	tree	2
Verbenaceae	*Vitex peduncularis*	tree	2
Verbenaceae	*Vitex pinnata*	tree	2
Rubiaceae	*Xeromphis spinosa*	tree	2
Leguminosae	*Xylia dolabriformis*	tree	3
Zingiberaceae	*Zingiber purpureum*	herb	2
Rhamnaceae	*Zizyphus oenoplia*	tree	2
Rhamnaceae	*Zizyphus rugosa*	tree	1,2

Notes:

1. Nomenclature is based on original sources (as cited).
2. This list is incomplete and additional survey work is required. Nomenclature needs to be cross-checked and verified.
3. The Extended Natural Resources Survey carried out under FRMP (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) included three sample points within the Sanctuary, two within the proposed 1 km-wide Buffer Zone, and one in the remainder of Tarap Hill RF, as follows:

Sample Point	Longitude D M S	Latitude D M S
720	91 38 40	24 11 40
760	91 38 40	24 09 40
800	91 37 00	24 10 10
840	91 38 20	24 06 30
880	91 38 00	24 08 10
920	91 36 40	24 09 20

However, it has not been possible to disaggregate the species lists, which are compiled in the RIMS database only at the strata and Division level, into species lists that are specific to Rema-Kalenga Wildlife Sanctuary and the immediately adjacent area.

4. A more complete and authenticated list based on comprehensive specimen collection is expected to be included in:

Uddin, Md. Z. (*in prep.*). Exploration, documentation and germplasm collection of plant genetic resources of Rema-Kalenga Wildlife Sanctuary (Habiganj) in Bangladesh. PhD Thesis, Botany Department, Dhaka University.

Annexure 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 rem ved 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 FSP-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 FSP-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 - 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	-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

6.2.1.3 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 FSP-supported conservation areas are managed under FD's territorial 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. FSP planning completed to date indicates a need for new or renovated accommodation for all staff levels, including higher level officers (ACFs, Forest Ecologists, Social Scientists) 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.*, 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	-permit occupation of staff quarters by other than assigned staff and immediate family members -permit unauthorised construction of outbuildings or other structures

Suggested minimum area standards for staff accommodation:
ACFs, Forest Ecologists, Social Scientists: 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 FSP-supported conservation areas, with the exception of Himchari, 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.

FSP planning completed to date has identified a need for additional resthouses in Himchari NP, Teknaf GR, Chunati WS and Hazarikhil WS, primarily for the use of FD staff, NGO staff and others working on a short-term basis in these revised/expanded areas. 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 FSP/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 building design - implement a regular inspection and maintenance programme to ensure that all visitor accommodation is kept in clean and well-maintained condition	-use visitor accommodation for other purposes (*e.g.*, staff housing) -initiate construction unless adequate capital and maintenance funds are available

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 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	-permit litter collection sites to become general dumping areas for domestic waste; confine use to conservation area visitors only

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 FSP-supported conservation areas are managed under FD's territorial 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, Forest Ecologist, Social Scientist, 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 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	-use security fencing; this gives the wrong message to the public -initiate construction unless adequate capital and maintenance funds are available

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 FSP-supported areas, Madhupur NP and to a lesser extent Lawachara NP already are 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 - implement a regular inspection and maintenance programme	-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

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 FSP-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 three FSP-supported national parks, 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 FSP-supported national parks (and possibly to a limited extent in wildlife sanctuaries), 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 FSP-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 FSP-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

Annexure 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 mitigation 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.

Annexure 8

HABITAT SUITABILITY INDEX MODELS AND EXAMPLE APPLICATIONS

PART ONE

MODEL DEVELOPMENT CONCEPTS AND PROCEDURES

1.0 INTRODUCTION

The capped langur has been selected as a key species for use in the development and implementation of forest management and conservation measures during the Management Plan period. This leaf-eating and fruit-eating primate is able to utilise a variety of forest types, including plantations and regenerating forest areas, and hence is generally representative of a broad spectrum of forest-dwelling wildlife species.

A Habitat Suitability Index (HSI) model developed for the capped langur will provide both a conceptual and practical basis for decisions on how to manage the Sanctuary's forest cover. This Annex describes the methodology used in developing and applying this model, and includes a description of the model rationale and mechanics.

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

Rema-Kalenga Wildlife Sanctuary supports a broad diversity of plant and animal species. For example, 167 species of birds, 35 mammal species, 25 species of reptiles and amphibians and 109 plant species have been recorded in the area to date (see Volume 2, List of Wildlife Species and List of Plant Species), 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 critically important 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 Lists (WCMC 1998; IUCN Bangladesh 2000a, 2000b, 2000c)).

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 Rema-Kalenga Wildlife Sanctuary was limited to one –the capped langur. A number of criteria were taken into account in selecting this species (Table 1a).

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

Criterion	Degree to which criterion is fulfilled:
	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 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 Lists as globally Vulnerable and nationally Endangered - easily observable and photogenic
- habitat requirements (food, cover, space) should be well known	- published research studies available - research locations include Rema-Kalenga WS
- 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
- populations should be viable in the long-term, within the available or potentially available habitat area	- population is largely isolated within Tarap Hill 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	- model also is being applied in Lawachara National Park - model is proposed for application in Madhupur NP, Hazarikhil WS, Chunati WS, Himchari NP and Teknaf GR
Conclusion:	- selected as broadly representative of forest-dwelling species, including 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's global Red List but considered nationally Endangered	- widely distributed across South and Southeast Asia - easily observable - not included on IUCN's global Red List but considered nationally Endangered
- 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 Rema-Kalenga
- populations should be viable in the long-term, within the available or potentially available habitat area	- Tarap Hill Reserved Forest provides an important block of habitat, with natural immigration and emigration probably occurring through neighboring Tea Estates, plantations and secondary vegetation	- individuals are highly mobile and thus not restricted to Tarap Hill 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 FSP protected areas or elsewhere in Bangladesh	- not proposed for application in other FSP protected areas or elsewhere in Bangladesh
Conclusion:	- habitat use is generally too broad to be representative of target habitat types (evergreen and semi-evergreen forests) - requirements for dense cover and food at ground layer (fallen fruits, herbaceous vegetation) are adequately covered by capped langur HSI model and associated management measures	- mobility makes occurrence haphazard and thus not necessarily indicative of habitat quality - requirements for an abundance of fruiting trees are adequately covered by capped langur HSI model

Capped langurs are primarily 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 Sanctuary 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).

The capped langur is 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 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 Sanctuary 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 Sanctuary 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) are the best predictors of habitat suitability for capped langurs. 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, and what additional variables if any needed to be included in the model 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 Sanctuary 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 Tarap Hill Reserved Forest (including all of the Sanctuary and most of the proposed buffer zone) 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,
- it includes information on year of establishment and major species planted for all plantation areas.

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 matches capped langur habitat requirements. For example, agricultural areas provide only very marginal langur habitat (used primarily when adjacent forests are food-poor and/or degraded), and hence a very low HSI value (0.1) was assigned to this polygon type. Conversely, natural high forest would be expected to best provide the requisite food trees, sleeping trees and closed canopy required for travel, and the highest possible HSI value (1.0) was therefore assigned to this polygon type. The HSI assignment tables are included under the model descriptions (Part 2 of this Annex).

2.3 MODEL APPLICATION

For purposes of this example application the capped langur HSI model was applied to three scenarios:

- a “pre-development” scenario representing a recreation of conditions that would prevail had no agriculture, 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 the model description.

3.0 REFERENCES CITED

Burley, J. and I. Gauld. 1995. Measuring and monitoring forest biodiversity. A commentary. Pages 19-37, *in:* T.J.B. Boyle and B. Boontawee. (eds.). Measuring and monitoring biodiversity in tropical and temperate forests. Proc. of a IUFRO Symposium held at Chiang Mai, Thailand, August 27th-September 2nd, 1994.

Heywood, V. H (ed.). 1995. Global biodiversity assessment. Published for the United Nations Environment Programme by Cambridge University Press.

Irwin, L.L. 1994. A process for improving wildlife habitat models for assessing forest ecosystem health. J. Sustain. For. 2:293-306.

IUCN Bangladesh. 2000a. Red book of threatened birds of Bangladesh. IUCN – The World Conservation Union. xi + 116 pp.

IUCN Bangladesh. 2000b. Red book of threatened mammals of Bangladesh. IUCN – The World Conservation Union. xii + 71 pp.

IUCN Bangladesh. 2000c. Red book of threatened amphibians and reptiles of Bangladesh. IUCN – The World Conservation Union. xi + 95 pp.

Roloff, G.J. and J.B. Haufler. 1997. Establishing population viability planning objectives based on habitat potentials. Wildlife Society Bulletin 25(4):895-904.

U.S. Fish and Wildlife Service. 1981. Standards for the development of habitat suitability index models. U.S. Dept. Int. Fish Wildl. Serv. Rel. No. 1-81, 103 ESM.

Verner, J., M.L. Morrison and C.J. Ralph. 1986. Wildlife 2000. Modeling habitat relationships of terrestrial vertebrates. University of Wisconsin Press, Madison.

WCMC. 1998. IUCN Red List of threatened animals (http://www.wcmc.org.uk). World Conservation Monitoring Centre, Cambridge, U.K.

PART TWO

CAPPED LANGUR HABITAT SUITABILITY INDEX MODEL

1.0 GENERAL BACKGROUND

The capped langur (*Trachypithecus (Presbytis) 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). Its status within Bangladesh is rated as Endangered (*i.e.*, not Critically Endangered, but facing a very high risk of extinction in the wild in Bangladesh in the near future (IUCN Bangladesh 2000)).

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]		
Leguminosae	*Acacia falcataria*	L/P/Sh[1]		
Leguminosae	*Acacia pinnata (?)*		U[4]	
Leguminosae	*Acacia* sp.		L[2]	
Rubiaceae	*Adina cordifolia*		L[2]P[2]NR[3]	
Leguminosae	*Albizia mollis*		NR[3]	
Leguminosae	*Albizia procera*		Se[5]NR[3]	
Leguminosae	*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]
Moraceae	*Artocarpus chaplasha*	Fr[1]		
Moraceae	*Artocarpus lakoocha*	Fr[1]	Fr[2] P[2]	
Moraceae	*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]		
Fagaceae	*Castanopsis tribuloides*	Fr[1]		
Lauraceae	*Cinnamomum* sp.	Se[1]		
Connaraceae	*Connarus paniculatus*	Se[1]		
Cordiaceae	*Cordia* sp.	Fr[1]		
Papilionaceae	*Dalbergia* sp.		L[2]	
Papilionaceae	*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]		
Moraceae	*Ficus hispida*	Fr[1]		
Moraceae	*Ficus racemosa*	Fr[1]		
Moraceae	*Ficus* sp.	Fr[1] (1 species)	NR[3]	
Burseraceae	*Garuga pinnata*		NR[3]	
Burseraceae	*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]	
Lythraceae	*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]	
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]	

Family	*Species*	Location and part eaten		
		Lawachara NP	Madhupur NP	Other areas
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]		
Smilaceae	*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]	
Myrtaceae	*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]	
Combretaceae	*Terminalia belerica*	Fr[1]	NR[3]	
Combretaceae	*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 (FSP observations). 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 (FSP observations) 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 FSP 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). Although travel along the ground and away from tree cover 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), 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, all are 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 some areas of Sylhet FD 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 Sylhet FD, some potential capped langur food trees (*e.g.*, *Garuga* spp., *Vitex* spp.) are illegally harvested for house poles (Ahsan 1995); 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.

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.

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	low-moderate	0.6
Scattered trees	mid	open	low-moderate	0.4
Scrub, bamboo	young	no canopy	low	0.2
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	low-moderate	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, cane plantations	mid-old	open-closed	low-moderate	0.4
Failed plantations	young	no canopy	low	0.2
Rubber plantations	young-mid	open	nil	0.0
Murta plantations	young	none	nil	0.0
Agriculture	not applicable	not applicable	nil	0.1
Encroached	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 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 degraded or converted areas (scrub and bamboo, young and/or exotic plantations, agriculture, encroached areas) provide much reduced or no 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.

Assigned HSI values for bamboo and cane plantations are based on the assumption that they are primarily underplanted in mature forest or plantation cover, and that this canopy layer retains some habitat value.

Failed plantations are assumed to develop natural secondary vegetation cover, and hence to be roughly equivalent in value to degraded natural habitats (scrub and bamboo).

Rubber plantations and murta planations are planted in even-aged monocultures which provide no food for capped langurs, and are therefore assigned zero habitat value.

Agricultural lands are assigned a very low HSI value on the assumptions that use occurs only when adjacent forest habitats are degraded, that such use is limited to feeding in a very narrow zone along the forest/cropland edge, 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. Rema-Kalenga 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. 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 all polygons (standard HSI multiplied by area) is reduced by an arbitrary value of 10% to account for reduced utilisation by capped langurs in response to human presence.

The capped langur population in Rema-Kalenga is not subjected to significant levels of mechanical noise either from road traffic or other sources, and hence effects of avoidance of mechanical disturbance are not built into the model application. 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 occasional 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, 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.

In any case the extent of transportation corridors within and adjacent to Rema-Kalenga is currently very limited, consisting only of narrow, unpaved forest roads and foot trails. These are unlikely to represent a major barrier to langur movements at present, but expansion of the road network, and/or widening of existing roads, will need to be minimised in order to continue to avoid such effects in future.

Habitat Fragmentation

Manipulation of vegetation cover at Rema-Kalenga has resulted in a mosaic of short-rotation and long-rotation plantations of various ages in the northern and western portions of of Tarap Hill RF, in the Buffer Zone, and to some extent in adjacent parts of the Sanctuary. Other land use types resulting from human modification of vegetation cover (e.g., scattered trees, agriculture) have developed throughout the area. Many of these types have low value as capped langur habitat (Table 2), which may effectively inhibit 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. Where tree cover has been all or mostly removed (e.g., in agricultural areas), the effect may be similar to the barrier effect described above.

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 Rema-Kalenga Wildlife Sanctuary:

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 (see Volume 1, Appendices 1 and 2). For purposes of this scenario, current vegetation cover in all 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 the area under agriculture within the Sanctuary will be reduced to 103 ha (see Volume 1, Table 5), but that the area under agriculture in the Buffer Zone and remainder of Tarap Hill RF will remain at current levels.

- that 86 ha currently under agriculture within the Sanctuary will be converted to participatory woodlot plantations, and will have HSI values equivalent to short-rotation plantations (0.1 at 10 years, 0.2 at 25 and 50 years).

- that 17.5 ha currently under agriculture within the Sanctuary will be converted to forest cover using framework species, and will have HSI values equivalent to long-rotation, mixed species plantations.

- that low forest will, as a result of protection, attain an HSI value equivalent to high forest after 10 years.

- that scattered tree cover will, as a result of enrichment planting and protection, attain HSI values equivalent to low forest after 10 years and high forest after 25 years.

- that current areas of failed plantations will be planted to long-rotation species and will attain HSI values equivalent to long-rotation, mixed species plantations.

- that short-rotation plantations in the Buffer Zone will be maintained at an average age of more than 10 years, and hence will maintain the same HSI value (0.2) after 10, 25 and 50 years of Management Plan implementation.

- that short-rotation plantations in the remainder of Tarap Hill RF will be maintained at an average age

of less than 10 years, and hence will maintain the same HSI value (0.1) after 10, 25 and 50 years of Management Plan implementation.

- that all long-rotation plantations located in the Sanctuary and Buffer Zone will be maintained without felling and will attain HSI values equivalent to current age plus 10, 25 and 50 years.

- that long-rotation plantations located in the remainder of Tarap Hill RF and having a current age of >50 years will be maintained without felling, and will attain HSI values equivalent to current age plus 10, 25 and 50 years.

- that long-rotation plantations located in the remainder of Tarap Hill RF and having a current age of <50 years will be harvested at age 50, and will thereafter be replanted and will have HSI values equivalent to their actual age.

- that the "disturbance effects" (minus 10% of habitat value) related to human presence will be largely removed from the Sanctuary within 10 years, but, as a result of permitted subsistence use, will remain in the Buffer Zone and the remainder of Tarap Hill RF throughout the Management Plan implementation scenario.

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 and % of pre-development totals ()			
	Notified Area	Proposed Buffer Zone	Remainder of Tarap Hill RF	Total
Pre-development	1795	1172	3265	6232
Current	1375 (77%)	594 (51%)	854 (26%)	2822 (45%)
Management Plan implementation (10 years)	1548 (86%)	631 (54%)	1084 (33%)	3263 (52%)
Management Plan implementation (25 years)	1605 (89%)	699 (60%)	1104 (34%)	3408 (55%)
Management Plan implementation (50 years)	1610 (90%)	733 (63%)	903 (28%)	3246 (52%)

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 45% of the original (pre-development) capped langur habitat that occurred in Tarap Hill Reserved Forest remains (*i.e.*, 2823 of 6232 HUs).

2. Of the currently available habitat (2823 HUs), most is located within the notified Sanctuary boundaries (1375 HUs, or 49%) and the proposed Buffer Zone (594 HUs, or an additional 21%). However, even within these areas capped langur habitat has been reduced to below pre-development levels (to 77% of original habitat within the Sanctuary and 51% of original habitat within the Buffer Zone). The remainder of Tarap Hill RF also retains some habitat value (854 HUs, or 30% of total currently available habitat), but this area has been greatly modified and currently available habitat is only an estimated 26% of the pre-development level.

3. Currently available habitat is a mosaic of primarily low, moderate and high suitability areas. Within the Sanctuary, <1 ha (<1% of area) is currently classified as non-habitat (HSI=0.0), 211 ha (12%) as low suitability habitat (HSI=0.1-0.3), 122 ha (7%) as moderate suitability habitat (HSI=0.4-0.6) and 1461 ha (81%) as high suitability habitat (HSI=0.7 or more). Current habitat distribution within the Buffer Zone is <1 ha (<1% of area) of non-habitat, 356 ha (30%) of low suitability habitat, 394 ha (34%) of moderate suitability habitat and 421 ha (36%) of high suitability habitat.

4. Most of the best (high suitability) habitat occurs in a largely contiguous block which is already included in the Sanctuary and proposed Buffer Zone, precluding the need for further extension of the Sanctuary or Buffer Zone areas.

5. Non-habitat areas are limited primarily to rubber plantations and murta plantations in the northern part of Tarap Hill RF. However, it needs to be emphasised that except for edge areas bordering forest, most agricultural lands also are essentially non-habitat areas. These agricultural lands are widely distributed in the northern part of the Sanctuary and Buffer Zone and may represent barriers to langur movements between adjacent blocks of otherwise suitable forest habitat areas. Hence, the planned conversion of selected agricultural lands to forest cover and participatory woodlot plantations would most usefully focus on linking currently separated blocks of high suitability capped langur habitat.

6. Implementation of the Management Plan could potentially increase capped langur habitat availability within the Sanctuary and Buffer Zone by a predicted 210 HUs after 10 years, 335 HUs after 25 years, and 374 HUs after 50 years, representing an increase of up to 19% over current levels. This increase will be achieved by improving the suitability of current habitat areas. Achievement of gains in capped langur habitat will require close adherence to the forest management prescriptions outlined in the Management Plan. Chief among these (see Volume 1, Appendices 1 and 2) are:

- retaining all existing mature/maturing forest cover;
- retaining all existing long-rotation plantations without felling (but note that incremental replacement of teak with indigenous species in medium-aged (25-50 years old) and young (<25 years old) teak-dominated plantations in the Buffer Zone would eventually result in additional gains of approximately 139 HUs over current levels);
- limiting agriculture and subsistence use of forest products to specified and agreed areas;
- converting selected areas to mature forest cover by planting framework species;
- using selected capped langur food plants as framework species; and,
- avoiding creating gaps in forest cover, especially linear or otherwise extensive openings.

7. Implementation of the Management Plan could also result in modest gains in capped hangur habitat availability within the remainder of Tarap Hill RF. Application of the model suggests potential increases of 250 HUs after 25 years of management, but much of this gain will subsequently be lost as long-rotation plantations reach maturity and are felled within the 25-50 year management period.

8. Predicted capped langur habitat availability within the Sanctuary and proposed Buffer Zone after 50 years of management represents approximately 90% and 63%, respectively, 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 (*i.e.*, 0.8 ha of Intensive Use Zone), or such that their value as capped langur habitat will remain static (*i.e.*, within much of the 206.5 ha Village Use/Sustainable Use Zone and the 1172 ha Buffer Zone). The potential for further gains in capped langur habitat is limited given current and expected future land use demands within the Sanctuary and Buffer Zone areas.

9. As noted in Part One, Section 2.1.2 above, the capped langur was selected as a key species representing the biodiversity of dense, mature evergreen and semi-evergreen forest cover and earlier seral stages. As such, retention and expansion of these habitat types is expected to benefit all other included species.

6.0 REFERENCES CITED

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

Akonda, A.W., S.M.A. Rashid and C.B. Stanford. 1986. Capped langur *(Presbytis pileatus)* in the Madhupur National Park. Paper presented at International Seminar cum Workshop on Conservation of Wildlife in Bangladesh, December 1-4, Dhaka.

Bauchop, T. and R.W. Martucci. 1968. Ruminant-like digestion of the langur monkey. Science 161:698-700.

Craig, B.S. 1991. The capped langur in Bangladesh: behavioural ecology and reproductive tactics. Contributions to Primatology 26. S. Karger, Basel.

Das, S. 1998. Depredations on crops by langurs in Tripura. Tigerpaper XXV(4):29-31.

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.

Gittins, S.P. 1980. A survey of the primates of Bangladesh. Project Rep. to the Forest Department, Bangladesh.

Gittins, S.P. and A.W. Akonda. 1982. What survives in Bangladesh? Oryx XVI(3):275-281.

Government of the People's Republic of Bangladesh. 1992. Forestry Master Plan. Conservation. Asian Development Bank TA No. 1355-BAN.

Green, K.M. 1978. Primates of Bangladesh: a preliminary survey of population and habitat. Biol. Cons. 13:141-160.
Islam, M.A. and K.Z. Husain. 1982. A preliminary study on the ecology of the capped langur. Folia primatol. 39:145-159.

Israel, S. and T. Sinclair (eds.). 1994. Indian wildlife (2nd ed. [revised]). Insight Guides, APA Publications (HK) Ltd.

Khan, A. 1986. Wildlife of Cox's Bazar Forest Division and its potential as a biodiversity reserve. Pages 118-123, *in:* Proc. of the First International Seminar cum Workshop for Conservation of Wildlife in Bangladesh. German Cultural Institute, Dhaka, 1-4 December 1986.

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.

Prater, S.H. 1971. The book of Indian animals. Bombay Natural History Society, Third (Revised) Edition.

Roonwal, M.N. and S.M. Mohnot. 1977. Primates of South Asia. Harvard University Press, Cambridge.

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

Stanford, C.B. 1986. The conservation of capped langur *(Presbytis pileata)* in Bangladesh. Paper presented at International Seminar cum Workshop on Conservation of Wildlife in Bangladesh, December 1-4, Dhaka.

Wahab, M.A. and M. Faizuddin. 1984. Mammals of Cox's Bazar Forest Division with their status and distribution. Univ. J. Zool. Rajshahi Univ. 3:35-41.

WCMC. 1998. IUCN Red List of threatened animals (http://www.wcmc.org.uk). World Conservation Monitoring Centre, Cambridge, U.K.

APPENDIX 1

APPLICATION OF CAPPED LANGUR HABITAT SUITABILITY MODEL IN REMA-KALENGA WILDLIFE SANCTUARY AND ADJACENT AREAS: POLYGON DESCRIPTORS, HSI AND HU VALUES FOR "CURRENT" SCENARIO

Polygon	Location	Land Use	Species	Planted	Zone	Area (ha)	HSI	HUs
2	OUT	RP				284.3	0.0	0.0
3	OUT	LR	Cr/Me/Cp/Py	93		45.6	0.2	9.1
4	OUT	En				37.6	0.0	0.0
5	OUT	LR	Tk	67		20.1	0.6	12.1
6	OUT	LR	Tk/Ja	68-70		7.6	0.6	4.6
7	OUT	SR	Eu	89		6.5	0.2	1.3
8	OUT	LR	Tk	65		14.0	0.6	8.4
9	OUT	FP				45.5	0.2	9.1
10	OUT	LR	Tk/Ja	68-70		56.4	0.6	33.8
11	OUT	LR	Tk/Ja	77-79		99.5	0.4	39.8
12	OUT	LR	Tk	80		36.1	0.4	14.4
13	OUT	Mu	Mu	91		5.5	0.0	0.0
14	OUT	LF				39.1	0.6	23.5
15	OUT	A				29.5	0.1	3.0
16	OUT	A				27.6	0.1	2.8
17	OUT	LR	Tk	78		3.1	0.4	1.2
18	OUT	LR	Tk/Ja	76		46.1	0.4	18.4
19	OUT	A				11.9	0.1	1.2
20	OUT	B_Pl	B	90		2.1	0.4	0.8
21	OUT	LR	Tk	79-80		31.0	0.4	12.4
22	OUT	A				156.5	0.1	15.7
23	OUT	SR	Eu	88		28.6	0.2	5.7
24	OUT	LR	Gr/Cp/Dj	90		29.1	0.2	5.8
25	OUT	SR	Ac/Mo	99		35.9	0.1	3.6
26	OUT	LR	Cp/Gr/Sl	96		20.9	0.2	4.2
27	OUT	LR	Gm/Cp/Ja	93		18.3	0.2	3.7
28	OUT	LR	Tk	78-79		46.9	0.4	18.8
29	OUT	SR	Mo/Eu	83		46.0	0.2	9.2
30	OUT	SR	Ac/Mo	96		31.4	0.1	3.1
31	OUT	LR	Cp/Gr/Me/Ar	94		75.0	0.2	15.0
32	OUT	SR	Mo	91		16.4	0.1	1.6
33	OUT	LR	Cp/Gr/Me	94		40.6	0.2	8.1
34	OUT	A				1.7	0.1	0.2
35	OUT	A				1.4	0.1	0.1
36	OUT	LR	Tk/Gr/Cp	35-42		31.2	0.8	25.0
37	OUT	SR	Ac/Mo	96		40.8	0.1	4.1
38	OUT	LR	CM/Cp/Ja	93		40.9	0.2	8.2
39	OUT	A				4.6	0.1	0.5
40	OUT	A				6.4	0.1	0.6
41	OUT	LR	Tk/Ja	49-59		35.9	0.6	21.5
42	OUT	LR	CM/Cp/Ja	93		3.6	0.2	0.7
43	OUT	A				3.7	0.1	0.4
44	OUT	LR	CM/Cp/Ja	93		9.1	0.2	1.8
45	OUT	LR	Tk	74-77		13.3	0.4	5.3
46	OUT	A				1.4	0.1	0.1
47	OUT	LR	Cp/Dj	29-31		34.6	1.0	34.6
48	OUT	LR	Tk	74-77		51.9	0.4	20.8
49	OUT	LR	Tk	74-77		1.4	0.4	0.6
50	OUT	Mu	Mu	91		6.5	0.0	0.0
51	OUT	LR	CM/Cp/Ja	93		3.7	0.2	0.7
52	OUT	LR	CM/Cp/Ja	93		2.6	0.2	0.5
53	OUT	LR	Tk/Gr	60-66		73.9	0.6	44.3

Polygon	Location	Land Use	Species	Planted	Zone	Area (ha)	HSI	HUs
54	OUT	LR	Tk	74-77		2.2	0.4	0.9
55	OUT	LR	Tk	74-77		2.4	0.4	1.0
56	OUT	LR	Tk/Gr	64-66		34.6	0.6	20.8
57	OUT	A				6.9	0.1	0.7
58	OUT	BB				15.4	0.2	3.1
59	BUFFER	A			BZ	8.7	0.1	0.9
59	OUT	A				18.7	0.1	1.9
60	OUT	FP				1.8	0.2	0.4
61	OUT	CANE	Cn	90		2.1	0.4	0.8
62	OUT	A				5.1	0.1	0.5
63	OUT	Mu	Mu	90		5.3	0.0	0.0
64	OUT	FP				10.9	0.2	2.2
65	BUFFER	A			BZ	8.6	0.1	0.9
65	OUT	A				73.8	0.1	7.4
66	OUT	LR	Gm/Cr/Cp	92		1.4	0.2	0.3
67	OUT	LR	Gm/Cr/Cp	92		6.5	0.2	1.3
68	OUT	LR	Tk/Sl	51		4.4	0.6	2.6
69	OUT	A				40.9	0.1	4.1
70	BUFFER	LR	Tk/Gr	60-63	BZ	12.8	0.6	7.7
70	OUT	LR	Tk/Gr	60-63		48.9	0.6	29.3
71	OUT	Mu	Mu	93		3.1	0.0	0.0
72	OUT	A				0.4	0.1	0.0
73	OUT	LR	Tk	74-77		5.6	0.4	2.2
74	OUT	Mu	Mu	91		4.4	0.0	0.0
75	OUT	LR	CM/Cr/Cp	92		16.2	0.2	3.2
76	OUT	LR	Tk/Sl	51		3.4	0.6	2.0
77	OUT	LR	Gm/Cr	92		2.8	0.2	0.6
78	OUT	A				7.7	0.1	0.8
79	OUT	LR	Tk/Sl	51		2.9	0.6	1.7
80	OUT	LR	Gm/Cr	92		13.3	0.2	2.7
81	OUT	FP				18.6	0.2	3.7
82	IN	HF			HMZ	336.6	1.0	336.6
82	BUFFER	HF			BZ	97.9	1.0	97.9
83	BUFFER	A			BZ	5.2	0.1	0.5
84	BUFFER	LR	Gm/Cr	92	BZ	0.1	0.2	0.0
84	OUT	LR	Gm/Cr	92		13.2	0.2	2.6
85	OUT	LR	Tk/Sl	51		3.6	0.6	2.2
86	BUFFER	SR	Eu/Am/Ac	89	BZ	34.2	0.2	6.8
87	OUT	LR	Tk/Sl	76		3.1	0.4	1.2
88	OUT	FP				2.5	0.2	0.5
89	OUT	LR	Tk/Sl	51		12.3	0.6	7.4
90	IN	A			VUZ/SUZ	77.2	0.1	7.7
90	BUFFER	A			BZ	170	0.1	17.0
90	OUT	A				9.9	0.1	1.0
91	BUFFER	LR	Gm/Cr	92	BZ	7.0	0.2	1.4
91	OUT	LR	Gm/Cr	92		0.8	0.2	0.2
92	BUFFER	SR	Eu/Am/Ac	89	BZ	5.9	0.2	1.2
93	BUFFER	A			BZ	1.7	0.1	0.2
94	OUT	LR	Gm/Cr	92		1.2	0.2	0.2
95	BUFFER	SR	Eu/Am/Ac	89	BZ	7.5	0.2	1.5
96	IN	A			VUZ/SUZ	31.9	0.1	3.2
96	BUFFER	A			BZ	0.8	0.1	0.1
97	BUFFER	LR	Tk/Sl	51	BZ	5.6	0.6	3.4
97	OUT	LR	Tk/Sl	51		15.9	0.6	9.5
98	BUFFER	LR	Gm/Cr	92	BZ	3.3	0.2	0.7
99	BUFFER	LR	Gm/Cr	92	BZ	0.8	0.2	0.2
99	OUT	LR	Gm/Cr	92		0.5	0.2	0.1
100	BUFFER	LR	Tk/Sl	51	BZ	4.7	0.6	2.8
101	BUFFER	LF			BZ	10.5	0.6	6.3

Polygon	Location	Land Use	Species	Planted	Zone	Area (ha)	HSI	HUs
101	OUT	LF				2.7	0.6	1.6
102	OUT	ST				15.2	0.4	6.1
103	BUFFER	LR	Tk/Dj/Ka	77	BZ	1.7	0.4	0.7
104	OUT	SR	Mo	83		30.0	0.2	6.0
105	OUT	LR	CM/Cr/Cp	92		24.6	0.2	4.9
106	BUFFER	SR	Mo	82	BZ	17.9	0.2	3.6
106	OUT	SR	Mo	82		39.7	0.2	7.9
107	IN	LR	Tk	97	HMZ	2.0	0.2	0.4
107	BUFFER	LR	Tk	97	BZ	5.1	0.2	1.0
108	BUFFER	Mu	Mu	91	BZ	0.9	0.0	0.0
109	OUT	SR	Eu/Ac/Am	86		71.4	0.2	14.3
110	OUT	SR	Eu/Am	88		79.9	0.2	16.0
111	BUFFER	LR	Tk	23	BZ	1.6	0.8	1.3
112	IN	LR	Tk	97	HMZ	2.0	0.2	0.4
112	BUFFER	LR	Tk	97	BZ	4.0	0.2	0.8
113	OUT	LR	Ko/Ja/Cr	96		13.4	0.2	2.7
114	BUFFER	ST			BZ	4.5	0.4	1.8
115	BUFFER	ST			BZ	1.6	0.4	0.6
116	BUFFER	LR	Cp/Gr/Me/Pk	95	BZ	36.8	0.2	7.4
116	OUT	LR	Cp/Gr/Me/Pk	95		37.6	0.2	7.5
117	BUFFER	ST			BZ	1.5	0.4	0.6
118	BUFFER	LR	Tk	45-47	BZ	13.0	0.8	10.4
119	IN	HF			HMZ	305.5	1.0	305.5
119	BUFFER	HF			BZ	53.9	1.0	53.9
119	OUT	HF				0.8	1.0	0.8
120	OUT	LR	Me/Cr/Cp	95		32.6	0.2	6.5
121	OUT	SR	Eu/Am	90		38.5	0.1	3.9
122	OUT	SR	Ac/Mo	96		28.7	0.1	2.9
123	BUFFER	SR	Mo	82	BZ	5.9	0.2	1.2
124	OUT	SR	Eu/Am	87		68.8	0.2	13.8
125	IN	A			VUZ/SUZ	0.8	0.1	0.1
126	IN	LR	Tk/Sl	41-48	HMZ	4.4	0.8	3.5
127	OUT	LR	Me/Cr/Cp/Ja	96		22.4	0.2	4.5
128	BUFFER	LR	CM/Cr/Cp	92	BZ	1.7	0.2	0.3
128	OUT	LR	CM/Cr/Cp	92		14.4	0.2	2.9
129	IN	A			VUZ/SUZ	2.8	0.1	0.3
130	IN	LR	Tk/Sl	41-48	HMZ	15.3	0.8	12.2
131	IN	A			VUZ/SUZ	8.1	0.1	0.8
132	IN	LR	Tk/Sl	41-48	HMZ	1.0	0.8	0.8
133	IN	LR	Tk/Sl/Ja	40-48	HMZ	1.6	0.8	1.3
133	BUFFER	LR	Tk/Sl/Ja	40-48	BZ	70.3	0.8	56.2
133	OUT	LR	Tk/Sl/Ja	40-48		13.1	0.8	10.5
134	BUFFER	A			BZ	17.9	0.1	1.8
134	OUT	A				0.3	0.1	0.0
135	OUT	SR	Eu/Am	90		6.8	0.1	0.7
136	IN	A			VUZ/SUZ	2.3	0.1	0.2
136	BUFFER	A			BZ	8.9	0.1	0.9
137	BUFFER	LR	Tk/Dj	80-81	BZ	4.0	0.4	1.6
137	OUT	LR	Tk/Dj	80-81		59.6	0.4	23.8
138	IN	A			VUZ/SUZ	1.9	0.1	0.2
139	OUT	LR	Tk/Dj	84-85		66.0	0.4	26.4
140	IN	A			VUZ/SUZ	1.1	0.1	0.1
141	IN	A			VUZ/SUZ	1.9	0.1	0.2
142	IN	A			VUZ/SUZ	0.8	0.1	0.1
143	IN	A			VUZ/SUZ	1.8	0.1	0.2
144	IN	LR	Tk/Sl/Ja	40-48	HMZ	0.6	0.8	0.5
144	BUFFER	LR	Tk/Sl/Ja	40-48	BZ	85.9	0.8	68.7
145	IN	LR	Tk/Sl/Ja	40-48	HMZ	30.2	0.8	24.2
145	BUFFER	LR	Tk/Sl/Ja	40-48	BZ	0.5	0.8	0.4

Polygon	Location	Land Use	Species	Planted	Zone	Area (ha)	HSI	HUs
146	IN	A			VUZ/SUZ	8.3	0.1	0.8
146	OUT	A				0.1	0.1	0.0
147	IN	A			VUZ/SUZ	0.9	0.1	0.1
148	BUFFER	LR	Tk	74-77	BZ	0.4	0.4	0.2
148	OUT	LR	Tk	74-77		45.2	0.4	18.1
149	OUT	LR	Tk/Ja/Cp	83		28.3	0.4	11.3
150	IN	HF			HMZ	157.0	1.0	157.0
150	OUT	HF				0.3	1.0	0.3
151	IN	A			VUZ/SUZ	1.8	0.1	0.2
152	IN	A			VUZ/SUZ	1.2	0.1	0.1
153	OUT	LR	Dj/Me	86		52.8	0.6	31.7
154	IN	A			VUZ/SUZ	1.3	0.1	0.1
155	IN	A			VUZ/SUZ	1.0	0.1	0.1
156	IN	A			VUZ/SUZ	4.6	0.1	0.5
157	IN	A			VUZ/SUZ	49.3	0.1	4.9
158	BUFFER	LR	Tk	70-73	BZ	14.2	0.6	8.5
158	OUT	LR	Tk	70-73		152.4	0.6	91.4
159	BUFFER	A			BZ	0.9	0.1	0.1
160	OUT	A				1.4	0.1	0.1
161	IN	A			VUZ/SUZ	3.3	0.1	0.3
161	BUFFER	A			BZ	3.1	0.1	0.3
162	OUT	A				2.7	0.1	0.3
163	IN	A			VUZ/SUZ	1.9	0.1	0.2
164	IN	LR	Tk/SI/Ja	40-48	HMZ	3.3	0.8	2.6
164	BUFFER	LR	Tk/SI/Ja	40-48	BZ	0.5	0.8	0.4
165	IN	ST			HMZ	11.3	0.4	4.5
166	IN	HF			HMZ	7.7	1.0	7.7
167	IN	LR	Tk/SI/Ja	59-60	HMZ	1.2	0.6	0.7
167	BUFFER	LR	Tk/SI/Ja	59-60	BZ	56.4	0.6	33.8
167	OUT	LR	Tk/SI/Ja	59-60		0.8	0.6	0.5
168	OUT	A				2.3	0.1	0.2
169	OUT	A				10.7	0.1	1.1
170	IN	LR	Tk	66-69	HMZ	33.1	0.6	19.9
170	BUFFER	LR	Tk	66-69	BZ	0.2	0.6	0.1
171	BUFFER	LR	Tk/Ja/Dj	69-70	BZ	31.3	0.6	18.8
171	OUT	LR	Tk/Ja/Dj	69-70		7.7	0.6	4.6
172	IN	A			VUZ/SUZ	2.3	0.1	0.2
173	OUT	A				10.0	0.1	1.0
174	IN	LR	Tk/SI/Ja	61-63	HMZ	2.2	0.6	1.3
174	BUFFER	LR	Tk/SI/Ja	61-63	BZ	40.4	0.6	24.2
175	OUT	ST				3.9	0.4	1.6
176	OUT	A				4.7	0.1	0.5
177	OUT	A				14.9	0.1	1.5
178	BUFFER	LR	Tk/SI	68	BZ	13.7	0.6	8.2
178	OUT	LR	Tk/SI	68		13.5	0.6	8.1
179	IN	LR	Tk/Ja	64-65	HMZ	0.3	0.6	0.2
179	BUFFER	LR	Tk/Ja	64-65	BZ	68.2	0.6	40.9
179	OUT	LR	Tk/Ja	64-65		13.1	0.6	7.9
180	IN	HF			EMZ	598.1	1.0	598.1
180	IN	En			IUZ	0.8	0.0	0.0
180	BUFFER	HF			BZ	97.7	1.0	97.7
181	OUT	A				0.6	0.1	0.1
182	OUT	LR	Tk/Ja	64-65		1.4	0.6	0.8
183	OUT	LR	Tk/Ja	64-65		1.8	0.6	1.1
184	IN	LR	Tk/Cr/Dj	87	HMZ	0.7	0.4	0.3
184	BUFFER	LR	Tk/Cr/Dj	87	BZ	47.6	0.4	19.0
184	OUT	LR	Tk/Cr/Dj	87		10.0	0.4	4.0
185	BUFFER	LR	Dj/Cr/Py	88	BZ	32.8	0.6	19.7
185	OUT	LR	Dj/Cr/Py	88		16.2	0.6	9.7

Polygon	Location	Land Use	Species	Planted	Zone	Area (ha)	HSI	HUs
186	BUFFER	LR	Cr/Py/Me	89	BZ	41.5	0.6	24.9
186	OUT	LR	Cr/Py/Me	89		15.4	0.6	9.2
186	OUT	LR	Cr/Py/Me	89		0.0	0.6	0.0
187	BUFFER	A			BZ	0.2	0.1	0.0
187	OUT	A				2.2	0.1	0.2
188	IN	ST			EMZ	73.6	0.4	29.4
Totals						6231.9		3135.7
Total HUs minus disturbance factor (10% of HUs)								2822.1

Key to Abbreviations

Location

IN	within notified area of Sanctuary
BUFFER	within 1 km-wide Buffer Zone
OUT	within remainder of Tarap Hill Reserved Forest

Species

Ac	*Acacia auriculiformis*	(akashmoni)
Am	*Acacia mangium*	(mangium)
Ar	*Spondias mangifera*	(amora)
B	Bamboo	
CM	*Michelia champaca*	(champa)
Cn	*Calamus* spp.	(cane)
Cp	*Artocarpus chaplasha*	(chapalish)
Cr	*Chikrasia tabularis*	(chikrassy)
Dj	*Syzygium grande*	(dhakijam)
Eu	*Eucalyptus* spp.	(eucalyptus)
Gm	*Gmelina arborea*	(gamar)
Gr	*Dipterocarpus turbinatus*	(garjan)
Ja	*Lagerstroemia speciosa*	(jarul)
Ka/Ko	*Albizia* spp.	(koroi)
Me	*Swietenia mahogoni*	(mahogony)
Mo	*Albizia falcataria*	(molucanna)
Mu	*Clynogene dichotoma*	(murta)
Py	*Xylia dolabriformis*	(pynkado)
Sl	*Shorea robusta*	(sal)
Tk	*Tectona grandis*	(teak)

Land Use

A	cultivation
B_Pl	bamboo plantation
BB	bamboo
CANE	cane plantation
En	encroached
FP	failed plantation
HF	high forest
LF	low forest
LR	long rotation plantation
Mu	murta plantation
RP	rubber plantation
SR	short rotation plantation
ST	scattered trees

Zone

BZ	Buffer Zone
EMZ	Ecosystem Management Zone
HMZ	Habitat Management Zone
IUZ	Intensive Use Zone
VUZ/SUZ	Village Use/Sustainable Use Zone

Other

ha	hectares
HSI	Habitat Suitability Index
HUs	Habitat Units (HSI value x area)

Annexure 9

SUMMARY OF PREVIOUS AND ONGOING RESEARCH
AND SURVEY ACTIVITIES

Dates	Description	Reference
1997-2000	• exploration, documentation and germplasm collection of plant genetic resources	Md. Zashim Uddin *pers. comm.*
1997-99	• resource division among primates	M.M. Kabir *pers. comm.*
1997	• inventory of plant and animal species	Leech and Ali 1997
1995-1997	• inventory of plant and animal species	BCAS 1997
1995	• wildlife survey (birds, mammals, reptiles and amphibians)	Roy and Azam 1995a
1995	• vegetation survey	Roy and Azam 1995b
1995	• turtle and tortoise survey	Roy and Azam 1995c
1995	• assessment of wildlife food habits	Roy and Azam 1995d
1995	• checklist of bird species, with abundance ratings	Thompson and Johnson 1999

References

BCAS. 1997. Biological survey. Final Report. Prep. for Forest Resources Management Project by Bangladesh Centre for Advanced Studies, Dhaka.

Kabir, M.M. (*in prep.*). (Behavioural ecology of two sympatric primate species: *Trachypithecus phayrei* and *T. pileatus*). PhD Thesis, Cambridge University.

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.

Roy, P.C. and M. A. Azam. 1995a. Wildlife survey in Rema-Kalenga Wildlife Sanctuary. Pages 1-10, *in:* Wildlife research activities of Sylhet Forest Division, 1994-95. Forest Department, Government of the People's Republic of Bangladesh.

Roy, P.C. and M. A. Azam. 1995b. Vegetation survey in Rema-Kalenga Wildlife Sanctuary. Pages 11-20, *in:* Wildlife research activities of Sylhet Forest Division, 1994-95. Forest Department, Government of the People's Republic of Bangladesh.

Roy, P.C. and M. A. Azam. 1995c. Turtle and tortoise survey in Rema-Kalenga Wildlife Sanctuary. Pages 21-23, *in:* Wildlife research activities of Sylhet Forest Division, 1994-95. Forest Department, Government of the People's Republic of Bangladesh.

Roy, P.C. and M. A. Azam. 1995d. Food and feeding habits of important wildlife of Rema-Kalenga Wildlife Sanctuary. Pages 24-30, *in:* Wildlife research activities of Sylhet Forest Division, 1994-95. Forest Department, Government of the People's Republic of Bangladesh.

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

Uddin, Md. Z. (*in prep.*). Exploration, documentation and germplasm collection of plant genetic resources of Rema-Kalenga Wildlife Sanctuary (Habiganj) in Bangladesh. PhD Thesis, Dhaka University

Annexure 10

Nishorgo Program
Forest Department

Code of Conduct for Forest Officials as Proposed by Range Officers, Deputy Range Officers and Beat Officers in NSP Orientation courses

1. Have a clear understanding of the Ministry of Environment and Forest approved Nishorgo Vision-2010.
2. Develop awareness about Nishorgo Program among community people living in and around the Protected Areas (PA).
3. Help people living in and around the PAs to get involved in alternative income generating activities and other such community development initiatives on education, health, drinking water, sanitation, etc.
4. Facilitate smooth functioning of Co-management Councils/Committees.
5. Create scope for women and ethnic people in PA management and show proper respect to them.
6. Develop gainful partnership with local people and ensure their participation in regeneration, conservation and development of the forests and biodiversity.
7. Develop close working relationships with people living within a defined landscape and provide support to them in getting involved in development initiatives.
8. Ensure Nishorgo conservation and the co-management of PAs with the help and participation of the members of the local government, local administration, NGOs and voluntary initiatives/institutions.
9. Achieve main objectives of Nishorgo Support Project by maintaining close relationships with program implementing agencies.
10. Maintain professional integrity and honesty while discharging official duties.

Annexure 11

Possible Financing Mechanisms

Financing Sources for Management Plans Implementation :

Possible sources for funding required for implementing the recommendations made under the management plans are listed as below :

1. Government of Bangladesh (GOB)

The budget is annually allocated by GOB in the ADP for the implementation of forestry schemes/projects. The development budget is an important source of funding for implementing many activities listed in the Management Plans. However, under the existing budget codes neither there is any specific budget head for PA allocations nor separate budget allocations are made for operational funds for the management of wildlife and PAs. A separate budget head may be essential in order to ensure a certain required level of annual financial stability for PA management.

The revenue budget from GOB are available mainly for meeting the salary needs of the FD staff working in Pilot PA areas.

2. Donors

Presently the following two donor funded projects are implemented by FD in the PAs :

i) ADB supported Forestry Sector Project (ending by June 2006) is supporting some activities (such as buffer plantations, user groups formation, motivation, etc.) in 7 PAs (including Lawachara, Rema-Kalenga and Teknaf covered under NSP), and;
ii) Nishorgo Support Project (NSP) is supporting co-management activities in 5 pilot PAs.

Possible future sources for external funding could include GEF, CDM, Carbon Funds, Multilateral Funds (World Bank, ADB, EC, UNDP, etc.), Bilateral Funding, Trust Funds, Foundations, etc.

3. Public-Private Partnerships

Nature conservation can progress rapidly when leading members of private sector and NGOs perceive nature conservation as good for the economic well being. 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, generates beneficial public image for the contributor and makes a long-term difference in forest conservation.

4. Internal Financing

Part retention (say 25%) of locally generated revenue from the visitors to PAs can be achieved (on the pattern of social forestry plantations – an account, opened on the pattern of TFF, can be managed by FD) for funding PA management actvities. Possible sources of revenue generation from entrance and special use may include:

i) Park Entry Fee
ii) Guest House Fee
iii) Hiking Fee,
iv) Fines,
v) Donations, etc