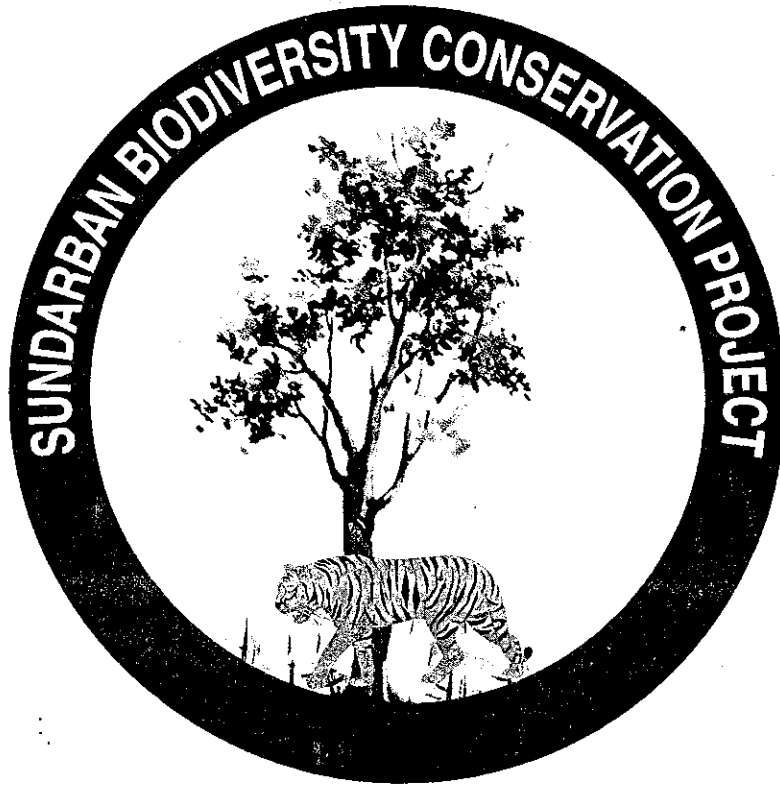


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Government of Bangladesh  
Ministry of Environment and Forests  
Dhaka, Bangladesh

Asian Development Bank  
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SUNDARBAN BIODIVERSITY CONSERVATION PROJECT

# Wildlife Management Plan of the Bangladesh Sundarban Forest



Technical Report TR - No. 23

By Floris Deodatus, SBCP

March 2003

Arcadis Euroconsult, The Netherlands  
Winrock International, USA  
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## SUMMARY

The Sundarban ecosystem combines a number of attributes, giving it a high priority for wildlife conservation:

- it is the largest and one of the most important mangrove habitats in the world,
- it is a vast mangrove area where biodiversity conservation and natural resource use is potentially compatible,
- it harbours a number of critically endangered species, such as tiger, marine turtles, dolphin species, monitor lizards, several bird species,
- it is a key habitat for a number of migratory species,
- it is the last large wilderness area of significant natural beauty in Bangladesh catering for the increasing demand from Bangladesh urban populations with regard to recreation.

The main threats of wildlife are:

- non controlled/illicit extraction,
- indirect impact of human utilisation (tourism, resource extraction),
- pollution (upstream, Mongla port).

The overall goal of wildlife management in the Sundarban is to preserve the biological and genetic diversity of the Sundarban ecosystem, in order to maintain its biological productivity and ecological services, to ensure sustainable use of its resources and other functions, such as extraction, recreation, science, cultural functions and education.

Direct objectives of this wildlife management plan are:

- minimizing external impacts (uncontrolled extraction, pollution),
- a sustainable management system (capacity building, research),
- improved conservation of focus species (e.g. tiger, crocodile, turtle, dolphin).
- optimising ecological functions and revenues through improved habitat management,

The expected outputs are:

### *(1) Wildlife management capacity*

Establishing an institution within FD (Wildlife Division), which is able to carry out all activities required for wildlife management, ensuring the development and maintenance of all required skills and expertise. The key to this result is an adequate HRD policy, including recruitment planning, rational staffing, training based on function requirements, limiting shifting of staff, sufficient operational facilities, including budgets. Special attention is required for working & living conditions of field staff.

### *(2) Species management*

A number of Species Conservations Plans will be elaborated for different focus species. Some species need special attention, e.g. restocking of the depleted crocodile population (and possibly turtle), reintroduction of extirpated species to restore disturbed food chains, and management of human-tiger conflicts. The only feasible forms of sustainable wildlife utilisation are deer harvesting and crocodile ranching. However, it is not recommended to develop these activities until full control of hunting and trade is established. Deer and crocodile farming do not contribute to conservation, unless the market value of its products is lower than the price of these products originating from the forest. Wildlife control is only required for problem tigers roaming in the Impact zone.

### *(3) Habitat management*

The key to effective conservation is effective control, implying surveillance and effective prosecution of offenders at all levels. The protected area system needs to be extended with one more sanctuary in the North to cover the low salinity habitat. A zoning plan orients management measures and land use. Special attention is required for the control of fishing, being a serious threat to crocodile, turtle and dolphins. Proper grassland management will increase the carrying capacity of the Sundarban for deer and thus the tiger. Tourism is an important asset, but management of the increasing flow of tourists is a point of concern, requiring sufficient facilities and an adapted control system.

### *(4) Adequate monitoring*

A monitoring system should be established, based on indicators related to direct objectives and measures/results. Monitoring of the overall objective is difficult, as it is difficult to unravel short-term ecosystem oscillations and externally induced effects, and therefore, output will be difficult to link to management. Hence, monitoring should target focus species and management efforts. End of food chain species (tiger, dolphin, crocodile, birds of prey) are good indicators of pollution, but also direct monitoring of water quality in such an area of biodiversity importance deserves priority. If necessary a follow up is needed to identify pollution sources.

The main precondition for effective management is stable resources (budget, qualified staff) and sufficient time to develop and implement a management system.



## CONTENTS

Summary .....	2
<b>1. Introduction .....</b>	<b>8</b>
1.1 Purpose and process .....	8
1.2 Approach .....	9
1.3 Wildlife management planning model .....	10
1.4 Sundarban Forest Wildlife management planning efforts .....	12
1.5 Management integration .....	14
<b>2. Baseline and context .....</b>	<b>15</b>
2.1 Sundarban location and ecosystem dynamics .....	15
2.2 Biodiversity status .....	16
2.3 Resource use .....	17
2.4 Ecosystem assessment & analysis .....	18
2.5 Research and information requirements .....	19
2.6 Legal framework .....	21
2.7 International commitments .....	22
2.8 Threat analysis .....	22
<b>3. Management objectives .....</b>	<b>25</b>
3.1 Background and scope .....	25
3.2 Habitat management priorities and approach .....	26
3.3 Species management priorities and approach .....	27
3.4 Participation and economic incentives for conservation .....	27
3.5 Knowledge and capacity development .....	28
<b>4. Wildlife management capacity .....</b>	<b>29</b>
4.1 Wildlife Division .....	29
4.2 Wildlife management tasks and responsibilities .....	30
4.3 Human resource development .....	31
4.4 Field staff living conditions .....	33
4.5 Logistics and equipment .....	33
4.6 Other facilities .....	33
<b>5. Species management .....</b>	<b>35</b>
5.1 Species database .....	35
5.2 Tiger conservation programme .....	35
5.2.1 <i>Current position of tiger</i> .....	35
5.2.2 <i>Legal status of tiger</i> .....	36
5.2.3 <i>Conservation priority of tiger</i> .....	36
5.2.4 <i>Management objectives for tiger management</i> .....	36
5.2.5 <i>Strategy and actions for tiger management</i> .....	36
5.2.6 <i>Required resources/capacity</i> .....	37
5.2.7 <i>Research and monitoring of the tiger population</i> .....	38
5.3 Deer conservation programme .....	38

5.3.1	Current position of deer.....	38
5.3.2	Legal status of deer.....	39
5.3.3	Conservation priority of deer.....	39
5.3.4	Objectives for deer management.....	40
5.3.5	Strategy and actions regarding deer management.....	40
5.3.6	Required resources/capacity.....	40
5.3.7	Monitoring and research of deer.....	41
5.4	Crocodile conservation programme.....	41
5.4.1	Current position of Bangladesh crocodiles.....	41
5.4.2	Legal status of Bangladesh crocodiles.....	42
5.4.3	Crocodile conservation priority.....	42
5.4.4	Crocodile management objectives.....	42
5.4.5	Strategy and actions for crocodile management.....	43
5.4.6	Required resources/capacity.....	43
5.4.7	Research/monitoring.....	43
5.5	Marine mammal conservation programme.....	43
5.5.1	Current Position of marine mammals.....	44
5.5.2	Marine mammals legal status.....	44
5.5.3	Marine mammals conservation priority.....	45
5.5.4	Marine mammals management objectives.....	45
5.5.5	Strategy and actions related to marine mammals management.....	45
5.5.6	Required resources and capacity for management of marine mammals.....	46
5.5.7	Review and monitoring of marine mammals.....	46
5.6	Marine turtle conservation programme.....	46
5.6.1	Current Position of marine turtles.....	46
5.6.2	Marine turtles legal status.....	47
5.6.3	Marine turtles conservation priority.....	47
5.6.4	Marine turtles management objectives.....	47
5.6.5	Strategy and actions of marine turtle management.....	47
5.6.6	Required resources and capacity for marine turtle management.....	48
5.6.7	Research and monitoring of marine turtles.....	48
5.7	Other species programmes.....	48
5.8	Wildlife ranching/harvesting.....	49
5.9	Domestic species control.....	49
5.10	Wildlife species control.....	50
5.11	Reintroduction of extirpated species.....	52
6.	<b>Habitat management.....</b>	<b>52</b>
6.1	Zoning plan for the Sundarban and related management objectives.....	53
6.2	Zoning inside the Sundarban Sanctuaries.....	54
6.3	Boundary demarcation.....	54
6.4	Vegetation survey.....	55
6.5	Review of sanctuary boundaries.....	56
6.6	Vegetation/habitat management interventions.....	59
6.7	Production zone management.....	59
6.8	Wildlife protection strategy.....	60
6.9	Tourism management.....	61
6.10	Public awareness.....	62
7.	<b>Monitoring and review.....</b>	<b>62</b>
7.1	What and why of monitoring.....	62
7.2	Wildlife monitoring.....	63
7.3	Monitoring of terrestrial mammals combined with PSP data collection.....	63
7.4	Sighting records.....	64
7.5	Habitat monitoring.....	64
7.6	Monitoring of threats and impacts.....	64



7.7	Independent biodiversity conservation monitoring.....	65
7.7	Management plan review .....	65
<b>8.</b>	<b>Directives for annual work planning .....</b>	<b>67</b>
8.1	General elements in the Wildlife Division workplan.....	67
8.2	Special actions to enhance the management system .....	70
8.3	Monitoring.....	73
<b>9.</b>	<b>Funding .....</b>	<b>75</b>
9.1	Previous estimations for wildlife management funding.....	75
9.2	Budget requirements of the Wildlife Management Plan .....	75
9.3	Existing and expected funding sources .....	76
9.4	Funding opportunities .....	77
	<b>References.....</b>	<b>78</b>
	<b>Appendices.....</b>	<b>82</b>
1.	Map of the Sundarban Sanctuaries, Production Zone, Impact Zone and Marine Zone .....	82
2.	Comparing legal sections of existing and proposed legislation referring to the main issues related to wildlife management .....	83
3.	Status (March 2003) of Sundarban wildlife studies and surveys .....	84
4.	Staff, equipment and logistics requirements of the Wildlife Division .....	88
5.	Staff requirements of the Wildlife Division after proposed integration with other Environment and Wildlife Divisions and excluding the Tourism Unit.....	89
6.	Operational Guidelines for the Implementation of the World Heritage Convention. ....	90
7.	List of selected Fauna found in the Sundarban .....	94

## LIST OF TABLES

1.	Strengths and weaknesses of the Conservation Management Plan of the Wildlife Sanctuaries in the Sundarban Forests .....	13
2.	Proposed model for management planning integration.....	14
3.	Forest types in the Sundarban Forest according to FRMP/RIMS .....	16
4.	Estimated legal and illegal revenues from Sundarban Forest in 1997 .....	17
5.	Estimated minimum annual offtake by 159 hunters interviewed in the Sundarban Impact Zone. ....	18
6.	Ranking of different conservation values, according to the participants of the Wildlife Management Planning workshop .....	26
7.	Comparison of different sanctuary extensions using Forest Type areas .....	56
8.	Prescription matrix for habitat management and other human activities in different management zones from the wildlife management perspective. ....	68
9.	Special actions related to capacity and institutional development .....	70
10.	Special actions related to species management and research priorities .....	71
11.	Special actions related to habitat management priorities .....	72
12.	Special actions related to coordination, participation, cooperation legislation and monitoring.....	73
13.	Schedule for wildlife management related monitoring .....	74

## LIST OF FIGURES

1.	Wildlife management planning process .....	9
2.	Wildlife management system .....	11
3.	Structure of the Wildlife Division .....	30



## 1. INTRODUCTION

### 1.1 Purpose and process

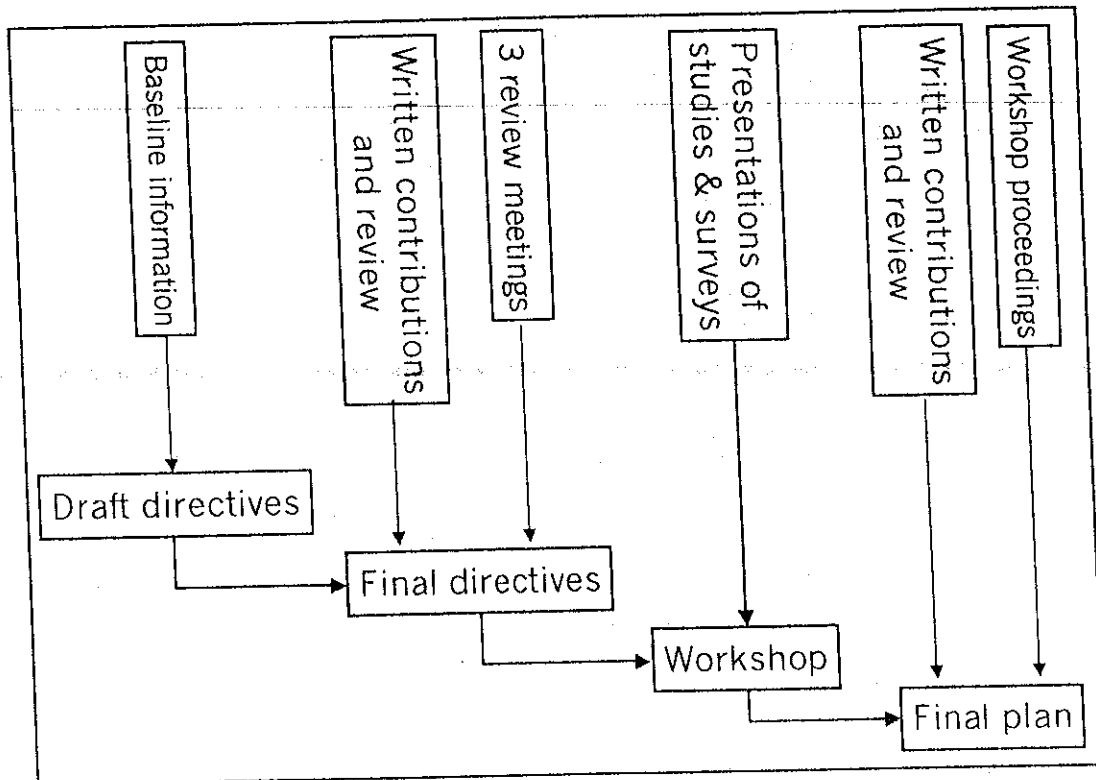
At the time of the elaboration of the present wildlife management plan, no Wildlife Management Plan was effective for the entire Sundarban Forest. A number of wildlife management plans prepared previously have not been adopted or are expired (section 1.4). Hence, a management plan is badly needed for the following reasons:

- (1) to achieve an effective and integrated approach for the conservation of wildlife in the Sundarban Forest, countering the increasing pressure on its natural resources;
- (2) to coordinate the various recent donor efforts focusing conservation in the Sundarban (e.g. SBCP/TAG, SBCP/IUCN, Tiger project/USFWS, UNF) and the FD work plans;
- (3) to effectively support and implement the institutional changes that are taking place in the FD.

To be effective a wildlife management plan should be elaborated in consultation as far as possible with all actors involved in the management of the concerned area, including the projects mentioned above under (2). The Forest Department should play a central role in this process. The current plan has been developed in a step-wise consultative process (Figure 1). A first draft was completed in early February 2002 (Deodatus & Ahmed 2002a) and circulated for comments among the following organisations and services: FD Khulna Circle, FD Wildlife Circle, SBCP/PD, SBCP/TAG, IUCN, NCS, FRMP/WB, UNF/UNDP Sundarban Biodiversity Management Project (Two Country Approach), some members of the Biodiversity Network. Extensive written comments were contributed by: (a) Forest Department, Dhaka, (b) IUCN Dhaka, (c) University of Dhaka, (d) University of Jahanginagar, (e) SBCP/TAG, (f) SSC Cetacean Specialist Group, (g), University of Minnesota USA. Presentations and meetings were organised with Forest Department (in Dhaka and Khulna) and IUCN to discuss the contents of the plan. The wildlife plan was further elaborated on the basis of these reviews and consultations, and has circulated again among a wider group of involved institutions. In November 2002 a workshop was organised for the main actors (Communica 2003) to update integration of study results, to develop management objectives and to focus conservation programmes. To ensure compatibility with earlier management planning initiatives (IRMP, FRMP, FSP), the document was reviewed by R. Salter.

In the FD consultation meeting as well as in several written comments it was emphasized that the final plan should be concise, comprehensive and target the Sundarban managers and therefore be practical. Consequently, issues have to be prioritised rigorously and the final management plan focuses on systems and not too much at species level.

Figure 1. Wildlife management planning process



## 1.2 Approach

Natural resources management has undergone a true evolution during the last 50 years, due to the increasing demand for resources and the increasing awareness regarding the negative side effects of population increase and industrial growth. Keywords in this development were:

- 1960s nature conservation
- 1970s sustainability
- 1980s integrated conservation & development
- 1990s biodiversity conservation
- 2000s ecosystem approach.

The common element developed in all concepts, is that they all try to find a balance between the ecological perspective and the socio-economical perspective. During the course of time, however, the emphasis is shifting from pure preservation to a more holistic approach (Jorgensen 2000), well reflected in the fundamentals of the Ecosystem Approach mentioned above (World Resources Institute):

- integrated approach,
- reorients boundaries,
- takes a long view,
- includes the people,
- maintains the productive potential.

A framework for ecosystem management has been described by Kay & Schneider (1994) :

- (1) defining the ecosystem (base line study, surveys),
- (2) describing ecosystem as a self-organizing entity,
- (3) evaluating ecosystem integrity,
- (4) threat analysis,
- (5) maintaining ecosystem integrity (management plan, management measures).

It is recommended to adopt this approach for the management of Sundarban Forest as it addresses more functions and dimensions of its ecosystem than an approach that is mainly based on the management of species. In this context it is eminent that the Bangladesh national policy regarding conservation and wildlife should be reviewed soon. In the current framework (section 2.6) wildlife is defined as mammals, birds, amphibians, reptiles and crustaceans. Nowadays, the meaning of the word "wildlife" is usually much wider and may even include wild plants. Possible consequences of this shift for policy and legislation were addressed earlier by FRMP, but not adopted as yet (Ali 1997).

### 1.3 Wildlife management planning model

Tree models for protected area management planning are considered for the format of the Sundarban Wildlife Management Plan: (a) the model described in the IUCN Protected Area Manual (MacKinnon et al 1986) (b) the model described in the Conservation Management Plan Manual (Rosario 1997), and (c) the model described in The Conservation Handbook (Sutherland 2000). Briefly, the models present as follows:

#### *MacKinnon*

- (1) National and regional background,
- (2) Description and inventory of the area,
- (3) Management considerations and objectives,
- (4) Management programmes,
- (5) Development programme.

#### *Rosario*

- (1) Introduction,
- (2) Biodiversity and land base,
- (3) Issues and management considerations,
- (4) Management goals,
- (5) Conservation management plan,
- (6) Working plan,
- (7) Administrative and data management systems.

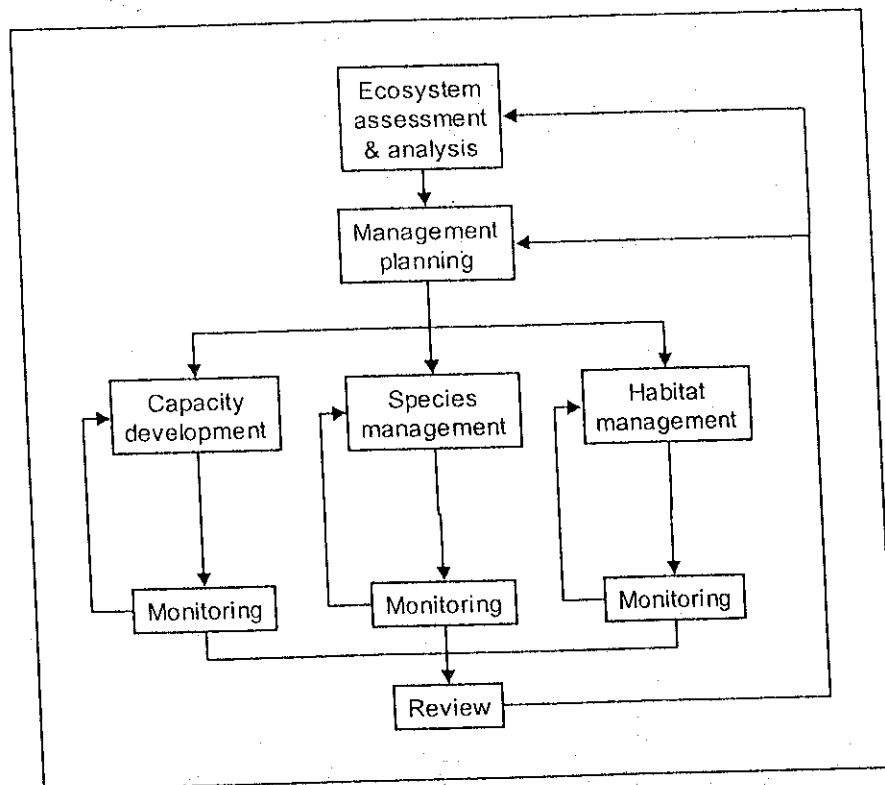
#### *Sutherland*

- (1) Current position,
- (2) Objectives,
- (3) Broad policies,
- (4) Actions (habitat management, species management, tourism, public awareness, public relations, education, estate service and machinery, research, surveys),
- (5) Monitoring of management system and its components,
- (6) Review of the management plan.

All models have principally the same components and have a comparable structure, although Sutherland's model is somewhat more elaborated. The strong side of Rosario's model is its emphasis on zoning, whereas its weakness consists of a strong focus on rigorous habitat management instead of ecosystem management (section 1.4). The Forestry Sector Project (FSP) has drafted a number of management plans for Bangladesh protected areas according to McKinnons model (TECSULT 2002a and 2002b).

The proposed Sundarban Wildlife Management Plan (Figure 2.) combines these models, but sections on research requirements (ecosystem assessment & analysis) and capacity development have been elaborated to frame a broad plan covering actions at all working levels. Feedback mechanisms (monitoring and review) ensure long-term flexibility of the system (Hockings et al 2000). To achieve maximum effectiveness, the "Adaptive Management Framework" is recommended (Sutherland 2000). In this system the broad lines of the management plan are laid out and reviewed for a longer period (5 to 10 years), but at field level management measures are annually evaluated and adapted if necessary. The evaluation of the effects of management measures generates more understanding of the ecosystem, which can be used to understand the relation between fluctuating ecological conditions and wildlife population levels, and contribute to improvement or reorientation of management measures. This approach is more realistic and practicable than classic models targeting fixed population levels based on carrying capacity models (see also section 6.6).

Figure 2. Wildlife management system



#### 1.4 Sundarban Forest Wildlife management planning efforts

The main wildlife management planning efforts in the Sundarbans so far are:

- 1978 (WWF) The Sundarbans Wildlife Management Plan. Emphasis: tiger management, staff development, law enforcement, research, tourism, public awareness, facilities/infrastructure (Seidensticker & Hai 1978)
- 1984 (FAO) Integrated Development of the Sundarbans. Emphasis: current and potential wildlife utilisation (Salter 1984).
- 1985 (ODA) Sundarbans Forest Inventory Project – Wildlife Conservation in the Sundarbans. Emphasis: ecosystem description, recommendations on law enforcement, protection, tourism and research (Blower 1985).
- 1994 (UNDP/FAO) Wildlife Management Plan for the Sundarbans Reserved Forest. Emphasis: research (pellet counts for deer, pugmark tracing of tigers, tiger conflicts), zoning, legislation, organisation, monitoring, tourism (Tamang 1994).
- 1997 (World Bank) Conservation Management Plan of the Wildlife Sanctuaries in the Sundarbans Forests (including 5 year working plan). Emphasis: values, tourism, biodiversity conservation, species protection, habitat management, zoning, demarcation, ecological monitoring, research, public awareness, capacity building, infrastructure (Anon. 1998, Rosario 1997).
- 1993-97 (GOB) Development of Wildlife Conservation and Management. Infrastructure development for rearing and ranching of turtles and crocodiles, development of new sanctuaries in wetlands, management existing sanctuaries, surveys, awareness.

There are several reasons that none of these plans is effective anymore:

- they were all prepared for a limited period of time and/or never reviewed and updated,
- some were too ambitious and/or not compatible with available resources,
- during the preparation of some, consultation was inadequate and therefore support was insufficient,
- some were not approved due to lack of response from the Government for several reasons (see above and below),
- there has been a period during the 1980s and 90s that wildlife management had a low priority in the Bangladesh government policy, resulting in abolishing the Wildlife Circle and consequently a lack of drive to approve and implement wildlife management plans.

A review of the Conservation Management Plan of the Wildlife Sanctuaries in the Sundarbans Forests (Rosario 1997c) is presented in Table 1. Conclusions of this review are processed in the species and habitat management programmes of the present plan (Chapters 5 and 6).

Table 1. Strengths and weaknesses of the Conservation Management Plan of the Wildlife Sanctuaries in the Sundarban Forests (Rosario 1997)

Management issue	Strong elements	Weak elements
Context, background	<ul style="list-style-type: none"> <li>▪ most required aspects covered</li> </ul>	<ul style="list-style-type: none"> <li>▪ no appropriate analysis of present and required legal framework</li> <li>▪ threat analysis inadequate</li> </ul>
Objectives	<ul style="list-style-type: none"> <li>▪ covers the principal elements of biodiversity conservation (see section 3.1)</li> </ul>	<ul style="list-style-type: none"> <li>▪ unclear how the objectives are related to national policy framework</li> <li>▪ unclear how sanctuaries fit in the conservation framework of the entire Sundarban management system</li> </ul>
Species management	<ul style="list-style-type: none"> <li>▪ some measures for tiger, turtle and deer management proposed</li> </ul>	<ul style="list-style-type: none"> <li>▪ insufficient specific species conservation programmes</li> <li>▪ contains a number of irrelevant measures (e.g. clinics, demarcation of tiger territories)</li> <li>▪ development of game farm debatable</li> <li>▪ no human wildlife conflict strategy</li> </ul>
Habitat management	<ul style="list-style-type: none"> <li>▪ strong emphasis on zoning</li> <li>▪ demarcation</li> <li>▪ detailed enumeration of actions for habitat improvement</li> <li>▪ tourism and public awareness addressed extensively</li> <li>▪ clear directives for landuse inside sanctuaries</li> <li>▪ proposed interventions for grassland and drinking water</li> </ul>	<ul style="list-style-type: none"> <li>▪ proposed buffer zone concept needs review (section 6.1 and 6.2)</li> <li>▪ too much focus on the need for human intervention in natural processes</li> </ul>
Institutional and managerial arrangements	<ul style="list-style-type: none"> <li>▪ development of field staff training programmes</li> <li>▪ management monitoring system</li> <li>▪ review cycle of 5 years</li> </ul>	<ul style="list-style-type: none"> <li>▪ no detailed law enforcement strategy</li> <li>▪ unnecessary emphasis on infrastructure and equipment</li> </ul>
Research, wildlife monitoring and surveys	<ul style="list-style-type: none"> <li>▪ recommends collaboration with universities, BFRI and other institutions regarding research</li> </ul>	<ul style="list-style-type: none"> <li>▪ no wildlife monitoring programme</li> <li>▪ insufficiently elaborated research plan</li> </ul>

## 1.5 Management integration

The introduction of a system of Integrated Resource Management is supposed to be one of the principal project outputs of SBCP. However, so far no clear and feasible procedure has been adopted to achieve such an ambitious result. As yet the main effort in this regard has been laid out in the SBCP Internal Note No. 38: Towards Integrated Management of Sundarban Resources (Zon 2001). This document recommends the development of (1) long term management objectives, (2) a short-term planning period of 10 – 15 years and (3) presents a format for management plans of different components, which does, however, not match any of the models described in section 1.3 (Table 2).

Generally spoken, integration of sectorial management planning intersects (a) at the level of management objectives and (b) at operational level. At the level of management objectives of an integrated plan, the priorities of different biological, cultural and economical aspects have to be determined, depending on conservation status and socio-economic values. At operational level, attention needs to be given to friction between different management aspects. A critical issue in this process is the definition of stakeholders, which can vary between the area managers, surrounding populations, business men involved in resource extraction, tourists/visitors, all the people of Bangladesh, countries sharing ranges of migratory species and even future human populations. Just as an example, at management objectives level the importance of economic outputs needs to be determined for different economic outputs of the area (fisheries, timber extraction, tourism, etc.), whereas at operational level negative and positive interactions between these aspects need to be identified and used and reduced where possible. Assessing economic values in this process is relatively easy, but it is far more difficult to take into account aspects such as the value of biodiversity conservation (including the tiger!), recreational areas, green space, the presence of a buffer between the Bay of Bengal and settled land.

The consultation phase for the drafting of the wildlife management plan enabled inclusion of other management aspects and integration of objectives and measures. So far a Fisheries Management Plan and Tourism Management Plan have been completed. The main connection between the management plans at operational level should be realised by a zoning system describing management characteristics and staff responsibilities for each zone in relation to the management objectives (section 6.1 and 6.2).

Table 2. Proposed model for management planning integration (Zon 2001)

Title	Contents
1. Data	where, how and whom
2. Policies	national, local, international obligations
3. Legislation	as far as relevant for management, gaps
4. Operations	zoning, type of products, sustainable quantities, carrying capacity, timeframes, beneficiaries
5. Procedures	measures, licences, monitoring, data management
6. Responsibilities	planning, implementation, monitoring, enforcement, extension/awareness
7. Implementation	phasing, institutional arrangements, manpower, capabilities/training, facilities, equipment, funds
8. Monitoring	warning systems and their relation to management



permanently water logged environment, which is more and more determined by rain water than by saline river water. Under these conditions mangrove plant species are replaced by swamp species, and therefore the areas concerned, which are mainly found in the Northern Sundarban, can be regarded as the terminal stage of the mangrove ecosystem.

Table 3. Forest types in the Sundarban Forest according to FRMP/RIMS

Forest type (FRMP/RIMS)	Area (ha)
Gewa Goran	34,604
Gewa Sundri	75,703
Gewa/Gewa Mathal	21,520
Goran	8,269
Goran Gewa	56,537
Keora	8,287
Passur-Kankra, Passur-Kankra-Baen, Baen	4,030
Sundri	74,992
Sundri Gewa	105,973
Sundri Others	9,556
Others (Grassland, bare land, sandbar)	11,762
Total	411,234

## 2.2 Biodiversity status

A total of 334 plant species have been recorded in the Sundarban and adjacent forests, of which at least 123 occur in the Bangladesh Sundarban (Hussain & Acharya 1994). Dominant tree species are *Heritiera fomes* (Sundri) in the fresh water zone, *Excoecaria agallocha* (Gewa) in the moderate salt-water zone, *Ceriops decandra* (Goran) in the salt-water zone and *Sonneratia apetala* (Keora) on the newly accreted land.

The fauna of the Sundarban counts possibly as many as 400 fish species, at least 35 reptile species, over 290 bird species and 42 mammal species, representing 28-30% of all Bangladesh reptiles, 36-37% of its birds and 33-34% of its mammals (Appendix 7). The following critically endangered animals occur in (Akonda 2000): tiger (*Panthera tigris*), common otter (*Lutra lutra*), Irrawaddy dolphin (*Orcaella brevirostris*), and Melon-headed dolphin (*Neophocaena phocaenoides*). Some critically endangered reptiles are Saltwater crocodile (*Crocodylus porosus*), River terrapin (*Batagur baska*). Critically endangered birds are Pallas's Fish eagle (*Haliaeetus leucoryphus*), Greater adjutant (*Leptotilos dubius*). A great number of vertebrate species is considered as endangered according to the IUCN Red List.

The following large and medium vertebrates are reported to be extinct in the Sundarban (Hussain & Acharya 1994): Indian one-horned rhino (*Rhinoceros unicornis*), Javan rhino (*Rhinoceros sondaicus*), Wild buffalo (*Bubalis bubalis*), Swamp deer (*Cervus duvauceli*), Sambar (*Cervus unicolor*), Hog deer (*Axis porcinus*) and Marsh crocodile (*Crocodylus palustris*).

Little is known about the status of invertebrates in the area, but particularly the crustaceans, accounting for the largest proportion of animal biomass (Hindrichs 1975), play without doubt an important ecological role. Fish is also a very significant ecological group with a high diversity. No special attention has been given to fish in the Wildlife Management Plan, as its management is covered by the Aquatic Resources Management Plan (Bernacsek & Haque 2001). However, fishing practice will be discussed where potential conflicts with wildlife occur.

### 2.3 Resource use

The Sundarban has many natural resources, generating revenues for local populations and the country as whole. On the one hand, the economic revenues are an important mechanism to gain support for conservation. On the other hand, resource use has in some occasions a serious negative impact on wildlife (section 2.7).

Several types of wood products have been extracted in the past, such as Passur and Sundri for timber, Gewa for timber and pulp and Goran and other species for fuel. Non-timber products are Nypa, Honey and Grass/reeds. Wood extraction is banned (except Goran and Gewa), since 1989, but illegal exploitation is still ongoing in some areas. The exploitation of other products is controlled through a licence system. Hunting is prohibited since 1974, but illegal hunting, primarily of deer (table 5), is taking place and deer meat is available on the markets around the Sundarban. According to an economic analysis of forest revenues carried out by ANZDEC (Anon. 1997) the economic value of illegal wildlife off take was close to 10 % of the total economic production of the Sundarban in 1997.

Fish is currently the most important resource in terms of revenue and employment. A main seasonal fishing centre is located on Dubla Char.

All resource use is seasonal, resulting in significant fluctuations of resource user presence in the area with a maximum approaching 300,000 people during the dry season (Anon. 1997).

Table 4. *Estimated legal and illegal revenues from Sundarban Forest in 1997 (Anon. 1997)*

Resource category	Annual value (million Tk)	%
Wood products	678	20
Fisheries	1840	55
Non wood products	533	16
Illegal hunting	296	9
Total	3347	100

Table 5. *Estimated minimum annual offtake by 159 hunters interviewed in the Sundarban Impact Zone (JJS 2003a).*

*The total offtake of wildlife by hunters is probably much higher, as this group does not cover all hunters in the Sundarban.*

Species	No.
Spotted Deer	647.4
Birds	206.9
Wild Boar	0.6
Rhesus Macaque	0.6
Tiger	0.3
Crocodile	25.0

## 2.4 Ecosystem assessment & analysis

A management plan cannot be elaborated before sufficient baseline information is available. Six basic areas of information requirement, essential for management planning, can be identified (McKinnon et al 1986):

- |                                      |   |
|--------------------------------------|---|
| (1) <i>Inventory.</i>                | Which plants, animals and other resources are present;                                  |
| (2) <i>Quantification.</i>           | What numbers of each species are present and how is the distribution in space and time; |
| (3) <i>Ecological relationships.</i> | Food chains, competition, etc.;   |
| (4) <i>Species needs.</i>            | Habitat requirements, food preference, reproduction;                                    |
| (5) <i>Dynamics of change.</i>       | Succession, geomorphologic changes (rivers!), invasions, reproduction;                  |
| (6) <i>Ecosystem engineering.</i>    | Effect of external influences and interventions.  |

The main purpose of applied wildlife studies is to reveal the relationships between ecological processes, population trends and external factors. Therefore, absolute population numbers on itself as outputs from research and surveys, have little relevance for the understanding and management of an ecosystem. The same applies to correlated figures, as they do not necessarily imply a causal relation between variables.

Surveys need to be carried out with the following objectives:

- (1) to assess the current status of the Sundarbans,
- (2) to develop a methodology for a monitoring system as an integral part of the management,
- (3) to test and orient management measures.

Research and surveys are important tools for better understanding of the ecosystem. The acquired knowledge, however, will only contribute to conservation when the managers of the area internalize it. Therefore, the following approach should be applied:

- involvement of FD staff in studies and surveys to enhance their understanding of the ecosystem that they are managing,

- improved collaboration with local organisations and institutes, particularly universities to make optimal use of resources and to reinforce local capacity,
- stimulate international networks.

So far wildlife research and surveys have been fragmentary. Some projects, however, (FRMP, IRMP) produced very useful results on wildlife habitat. Future research needs a focus on ecological relations and on the integration of research efforts and outputs. GIS should play a key role in the integration of the various information sources (biotic, abiotic and socio-economic). Ecological zoning (landscape classification) supported by GIS is a powerful tool for the interpretation of survey data, management planning and monitoring. The FRMP/RIMS classification is the most detailed effort in this respect so far. However, this classification has been developed for forest management and more ecological dimensions (e.g. herbs, grasses, geomorphology) have to be included to make it appropriate for other applications such as wildlife management and conservation. To enable incorporation of research results an adaptive approach is essential (section 1.3).

The number of ecological and other aspects/issues is endless, therefore, all stakeholders (particularly researchers) should realize that time and funds are limited and research priorities need to be established. Priorities for wildlife studies are elaborated in the next section (2.5) and an overview of the proposed wildlife research programme is presented in Appendix 3.

## 2.5 Research and information requirements

To complement the current understanding of the Sundarban ecosystem a number of studies and surveys deserves priority:

### *(a) Surveys and studies related to the tiger, herbivore and vegetation food chain*

Elaborate understanding of the main terrestrial food chain relationships of the Sundarban is necessary, involving several important species, particularly tiger and deer. The purpose of this research component can be summarized as: (a) identify the main management issues, (b) recommendation of management measures and (c) development of a monitoring model. Specific elements are:

- Vegetation composition and dynamics (surveys),
- Deer – vegetation interaction study,
- Deer habitat utilisation study,
- Deer population dynamics and distribution (surveys),
- Tiger relative abundance and population structure study. Additional ecological information on tigers will be provided by other components of the Tiger Project (funded by USFWS).

*(b) Crocodile surveys*

Crocodile is often considered as a flagship species of the Sundarban Forest (after the tiger of course). Conservation measures appear necessary, but little is known about its ecology. Extensive surveys are to be carried out to understand:

- distribution,
- population dynamics,
- reproduction biology and nesting areas,
- threats,
- feasibility of ranching.

*(c) Wildlife – human interface*

As a follow up of the SBCP socio-economic base-line survey, an in-depth study on the wildlife-human interface has been carried out, involving the following elements:

- hunting take-off, geographic dimension and organisation,
- trade and consumption of wildlife products,
- wildlife impact (crop damage, human casualties).

*(d) Collection of data from FD stations*

Hundreds of FD staff witness daily incidents that, if systematically recorded, can provide information useful for the understanding of biodiversity, population trends, ecosystem threats and conservation efforts. Some of this information is collected, but it is worthwhile to elaborate a data collection system. The main categories of data that should be covered are:

- animal sightings,
- legal and illegal off-take,
- arrests and other law enforcement related incidents,
- confiscations and collected dead and alive animals, particularly for tiger, deer, crocodiles, marine mammals.

*(e) Other species surveys and studies*

Other systematic groups need to be addressed to identify conservation priorities and for monitoring. However, it is required to set research priorities as:

- (1) the number of species is considerable,
- (2) the number of relevant research aspects as well,
- (3) budget and capacity for research are limited.

Species groups to consider are:

- reproduction and mortality of marine turtles,
- diversity and distribution of birds (with emphasis on threatened and rare species such as Lesser Adjutant Stork, Masked finfoot and Pallas's Fish eagle),
- abundance of marine mammals,
- diversity of insects,
- ecological role of mud crabs,
- other animals such as otters, monitor lizard, boar, monkey and other smaller mammals.

## 2.6 Legal framework

The Bangladesh Forest Act dates from 1927 (Indian Forest Act). This Act was modified in 1965 after separation from India. The Forest Act was revised in 2000. The main objective of this revision was to adapt the act to new concepts related to social forestry, particularly sharing responsibilities and revenues of village forests among communities and the state (community based conservation).

The current Wildlife Act dates from 1974. Since then, the population of the country has doubled, increasing the pressure on natural resources and both national as well as international policies regarding conservation and environment have changed considerably. A revision of this act is envisaged by FRMP to make wildlife legislation compatible with the present context (Ali 1997), but the recommendations presented have not yet been implemented. An important reference point for revision should be the new integrated management framework developed for the Sundarban, which is the most important wildlife area in Bangladesh in terms of size and biodiversity conservation priorities.

The Forest and Wildlife Acts are in fact a framework in which the responsible government services have an extensive mandate for "legal fine tuning" by Notifications and Rules, which are published in the Bangladesh Gazette. These texts regulate for example the rates for harvesting forest products and the interdiction of use of specific resources. In 1989 a Presidential Order prohibited all hunting of mammals, birds and reptiles in Bangladesh.

Other relevant legal texts that apply in the Sundarban are:

- Arms and Ammunition Act,
- Fish Preservation Act (1950),
- Environment Conservation Act (1995).

Wildlife legislation should address the following issues (MacKinnon et al 1986):

- (1) Protection status of land areas, including protected areas,
- (2) Protection status of all plant and animal species,
- (3) Procedures to change protection status of land and wildlife species, including the role of inventories and surveys,
- (4) User rights of all population categories regarding wildlife,
- (5) Procedures related to access to user rights, including activities related to habitat management such as grass cutting in PAs,
- (6) Rights and limitations regarding use and possession of all categories of arms,
- (7) Mandate of wildlife officers and other persons responsible for wildlife management,
- (8) Prosecution and penalties for offences regarding wildlife,
- (9) Applicability of international conventions,
- (10) Financial and fiscal provisions,
- (11) Protection of persons and property against animals,
- (12) Trade and possession of wildlife products.

In Appendix 2. an overview is presented on the relation between these legal wildlife issues and the current and proposed legislation. The main gaps in the present legislation are:

- the absence of legislation regarding the protection of plants and several important invertebrate taxonomic groups,
- no management plan requirement for PAs,
- user rights addressed in forest management plan, but not in acts,
- no provisions for wildlife control and compensation,
- no provisions for captive-breeding
- no provisions for participatory wildlife management.

The new proposed Act (1997) covers most of these gaps.

## 2.7 International commitments

Bangladesh has ratified the following international conventions:

- International Plant Protection Convention (Rome 1951), ratified in 1978,
- International Convention for the Prevention of Pollution of the sea by oil (London 1954), ratified in 1981,
- Plant Protection Agreement for South East Asia and the Pacific region (Rome 1956), ratified in 1974,
- Convention of Wetlands of International Importance (Ramsar 1971) ratified in 1992,
- Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris 1972) ratified in 1983,
- Convention on the International Trade in Endangered Species of Flora and Fauna (CITES – Washington 1973) ratified in 1982,
- Convention of Biological Diversity (Rio de Janeiro 1992) ratified in 1994.

The Sundarban Forest is listed under the RAMSAR Convention and under the World Heritage Convention. To remain on these lists the areas need to fulfil certain criteria and reporting is required to the respective organisations. See Appendix 6 for the WHC reporting format. There is no reporting requirement on individual sites to the Ramsar Convention. Every three years, however, each country that is a Party to the Convention compiles a National Report for the Conference of the Parties, in which they are expected to discuss achievements and problems at their own Ramsar sites, but how that information is conveyed from the site managers to the national government is a matter to be worked out between those bodies (Ramsar Office pers. com.).

## 2.8 Threat analysis

An analysis of potential threats to the Sundarban (Hussain & Acharya 1994) reveals a number of issues that bring about danger to wildlife:

### *(1) Non-controlled hunting*

Illegal hunting is taking place in the Sundarban, but little is known about its actual extend and impact. Most of the hunting (95%) seems to be concentrated on deer (JJS 2002), but concern remains about the threat of poaching on other species, particularly tiger, due to the high value

of tiger products on the (illegal) market. Preliminary results from the same study show that at least 4-5 tigers are killed yearly, due to human-tiger conflicts (poaching and killing of problem tigers by villagers).

*(2) Direct impact of resource utilization*

The impact of the activities related to resource extraction are not fully clear, but certain activities (e.g. fishing, wood collection, Nypa collection etc.), cause erosion of riverbanks and disturbance of wildlife along watercourses. (Illegal) cutting of large trees reduces potential nesting and den sites. Conversely, exploitation inside the forest, such as grass cutting and even tree cutting may have a positive effect on wildlife, particularly terrestrial herbivores. Fishing has a direct impact on breathing vertebrates (turtles, crocodiles, sea snakes, dolphins), which are frequently drowning in nets. In most waterways free movement of these animals is limited due to nets.

*(3) Impact of tourism,*

Over 40,000 tourists are visiting the Sundarban yearly (Chaves 2002). Tourism is an important asset, contributing revenues and support for conservation, but the presence and movement of tourist has also negative side effects, such as pollution, erosion and wildlife disturbance. Many of the vessels used at present are not compatible with sustainable tourism. Insufficient and inadequate tourist facilities and lack of information to tourists, results in disturbing behavior of tourists and leads sometimes even to dangerous situations.

*(4) Habitat degradation/fragmentation due to land use*

Encroachment across the boundaries is as yet hardly taking place in the Sundarban, apart from the (legal) non-permanent fishing settlements and one permanent settlement on Dubla Island. Potentially, there is risk in the future along some of the northern boundaries, which are not clearly delimited by large rivers. Except for Dubla, habitat degradation and fragmentation is not a threat as long as forest exploitation is controlled and no non-palatable species (such as Eucalyptus) are planted.

*(5) Salinity increase / sweet water availability decrease*

Due to the natural eastward movement of the Padma-Bramaphutra delta and due to hydraulic engineering interventions upstream, there is a tendency of increasing salinity and decrease of fresh water supply in the Sundarban. This process is supposed to be responsible for a shift to more halophytic species and the loss of the freshwater-minded species. Reduction of fresh drinking water availability also limits wildlife populations.

*(6) Upstream water pollution*

A wide range of industrial and household toxic agents are draining into the upstream catchment area extending into India and Nepal. Some of these products degrade very slowly



and accumulate in the soil, finding their way in the food chain through crustaceans and other benthic organisms. Many products, including dioxins, pyrethrum and benzoates are known to be very harmful to both humans and animals. Usually, animals at the end of the food chain such as birds of prey and mammalian predators (dolphin, tiger!) are the first to be affected, as the accumulation rate is higher at the higher trophic levels. Recent water quality tests at 13 locations in the Sundarban (Bhuiyan et al. 2001) revealed that levels of BOD, COD, NH<sub>3</sub>, Hg, Pb and Oil were above acceptable quality standards (EQS).

#### *(7) Impact of Mongla port*

The presence of Mongla port and its associated shipping and industry on the edge of the Sundarban constitutes a direct and constant source of pollution. Regularly the result of oil spilling can be seen on the water surface. The marine transport of toxic products including hydrocarbons entails the risk of a large-scale ecological disaster (Anon. 2001).

#### *(8) Wildlife diseases*

Diseases are usually not harmful for natural populations in a protected ecosystem, as host and parasite populations co-exist in a more or less fluctuating equilibrium (Caughly & Sinclair 1994). However, when exotic parasites enter in relatively small isolated host populations, being the case of Sundarban tiger, the impact can be very severe and in extreme situations lead to extinction. The risk of transfer of diseases varies and depends on specific characteristics of parasites. Humans, domestic animals and bait may act as dispersion vector.

#### *(9) Sea level rise.*

As the Sundarban is located just above sea level, it is very vulnerable to sea level rise. An average sea level increase of one meter would probably cause submersion of most of the Sundarban area. However, as long as natural siltation exceeds sea level rise, the risk of loss of any land is negligible. Hence, sufficient sediment supply is crucial for the survival of the Sundarban.

#### *(10) Natural gas exploitation*

The sub-soil of the Sundarban contains significant quantities of natural gas and the Bangladesh Government has sold gas concessions to exploitation companies. Experiences in other areas (e.g. Niger Delta, Nigeria) have learned that mineral oil or gas exploitation may lead to:

- ground level descent,
- explosion and fire related catastrophes,
- air, water and noise pollution,
- increased illegal use of natural resources.



### 3. MANAGEMENT OBJECTIVES

#### 3.1 Background and scope

Management objectives of protected areas address different values (MacKinnon et al 1986):

- (a) Maintenance of ecological services,
- (b) Preservation of species and genetic diversity,
- (c) Protection of specific natural/cultural features,
- (d) Sustainable use of resources from natural ecosystems,
- (e) Tourism and recreation,
- (f) Maintenance of cultural/traditional attributes,
- (g) Scientific research,
- (h) Education,
- (i) Wilderness protection,

Some ranking of importance is possible in this list, but it should not be absolute, as normally for conservation all these values should be covered as much as possible and most of them are usually compatible.

The management objectives of the Sundarban Forest should fit in a framework that has been defined in current policies and legislation, such as the Forest and Wildlife Act and the National Conservation Strategy. However, the evolution of human needs, the environment and the perspective on conservation in this context requires a dynamic and interactive process involving modification and development of the policy and legislation framework when necessary.

A comprehensive and practical approach is the formulation of objectives at two levels (Sutherland 2000):

- (1) *The overall goal.* Highlights mainly the general approach and concept, addressing issues such as duration of the plan, conservation dimensions (biodiversity, landscape, species, ecosystem, etc.) and human dimensions (revenue generation, sustainable use, education, recreation, etc.).
- (2) *The specific objectives (purpose).* Determines conservation priorities, e.g. particular plant communities, certain species, but also for example management capacity and facilitation of tourism development.

In the following sections the scope of management objectives is elaborated as a result of a consultative process leading to this management plan (section 1.1). As a start, the general appreciation for different conservation values was assessed during the wildlife management

planning workshop organised in November 2003 (Table 5. - Communica 2003). Although user groups were only indirectly represented in this workshop and tourists/visitors not at all, it should be noted that sustainable use and tourism were ranked relatively high.

As a result, the overall goal of wildlife management in the Sundarban is to preserve the biological and genetic diversity of the Sundarban ecosystem, in order to maintain its biological productivity and ecological services, to ensure sustainable use of its resources and other functions, such as extraction, recreation, science, cultural functions and education.

Table 6. *Ranking of different conservation values, according to the participants of the Wildlife Management Planning workshop (Communica 2003)*

Values	Votes
(1) Preservation of species and genetic diversity	29
(2) Sustainable use of resources from natural ecosystems	26
(3) Scientific research	19
(4) Wilderness protection	16
(5) Tourism and recreation	14
(6) Maintenance of environmental services	15
(7) Protection of specific natural/cultural features	08
(8) Maintenance of cultural/traditional attributes	05
(9) Education	05
(10) Disseminate Information*	02

\* value proposed by participants

### 3.2 Habitat management priorities and approach

To conserve the health and integrity of the unique mangrove ecosystem of the Sundarban, priority should be given to maintenance of characteristic processes such as hydrological dynamics, erosion/accretion, vegetation succession and natural dynamics of animal populations. This implies that we should not consider the ecosystem as a static system, which a priori needs to be stabilised by human interventions. Criteria to focus management measures are:

- (1) minimizing external impacts ( e.g. illegal and non-rational off-take, pollution),
- (2) optimising ecological functions and revenues (e.g. habitat quality, production of resources, tourism),
- (3) sustainability.

To ensure survival of species and to maintain the overall values of the Sundarban, specific objectives have to be formulated for habitat management (see chapter 6). As the fully protected portion of the Sundarban (the sanctuaries) is too small for the long-term conservation of larger species such as tiger and deer, the management plan should target the Sundarban Forest as whole. An appropriate zoning plan is required to minimize frictions between conservation and revenue generation. Specific management objectives for different management zones are elaborated in sections 6.1 and 6.2, and a review of the current protected area system and existing boundaries in section 6.5.

### 3.3 Species management priorities and approach

A number of specific objectives and outputs need to be elaborated for the management of wildlife species in Sundarban Forest, including also plant species. At this level, the following criteria have to be applied to determine conservation priorities:

- (1) increase/maintain biodiversity,
- (2) conserve endemic species,
- (3) conserve rare species,
- (4) conserve valuable species,
- (5) conserve migratory species,
- (6) reduction of adverse effects of wildlife.

As a result of this selection process a number of species are identified that deserve a special focus regarding management efforts, such as tiger, crocodile, marine turtles, marine mammals, migratory birds, birds of prey, and endemic species (chapter 5). Management of focus species needs to be supported by special Species Conservation Plans. The tiger, the flagship species of the Sundarban that supports the largest population of this critically endangered species in the world, obviously needs special emphasis.

### 3.4 Participation and economic incentives for conservation

According to Hunter (1996), groups of people who live in the same area, who share common resources, who are confronted with common problems, or who share common interests can be a very effective force for conservation. Moreover, experiences all over the world have shown that local resource users are more committed to sustainable use, when they have a long-term perspective in sharing the benefits of natural resources. These considerations have brought about that nowadays most conservation strategies emphasize participation of local users in resource management. Community based management is the ultimate state of this approach.

Presently, there are no permanent settlements in the Sundarban Forest apart from accommodation for government services and support staff. All resource users have their permanent residence outside the forest, many of them even far from the area, residing inside the forest only during their harvest season. Most of them live on their boats most of that time and only in the South on Sela and Dubla Char a number of temporary settlements exist for sea going fishermen. These settlements are obligatory abandoned during the off-season. An increasing number is coming from other corners of the country in search of employment. Most of them work on contract for businessmen. Resource use is regulated through a licence system, but all hunting is banned.

Altogether, the situation in the Sundarban is very particular and does not compare easily to most other protected areas where participatory management was successfully applied. In many cases user groups are easier to locate and historically more bound to the area, fitting better in Hunter's criteria mentioned above.

Nevertheless, participation and benefit sharing should be addressed in the final Integrated Management Plan of the Sundarban Forest to achieve a sustainable management system. Initial achievements have already been booked in this field by SBCP contracting NGOs to organise Resource User Groups and to develop "common property use agreements".

To more or less extent, local and national populations do benefit from a wide range of economic assets of the Sundarban Forest, particularly fishing, wood products, non wood products, and tourism. In the present situation (ban on hunting and no "scientific" evidence yet to decide to lift it), opportunities for participation in specifically wildlife management are very limited. The following issues need further consideration and elaboration:

- involvement of local people in sustainable tourism,
- involvement of local people in management and research practice,
- feasibility of involvement of traditional hunters in conservation.

Future opportunities for sustainable wildlife use may be (Salter 1984, Whitaker 1982):

- deer harvesting,
- commercial crocodile farming.

### 3.5 Knowledge and capacity development

The achievement of the objectives is determined by physical, ecological and technical limitations, such as climate change, sea level rise, wildlife diseases and the human response to these limitations. Therefore, it is essential (a) to expand our knowledge of the ecosystem and (b) to establish the capacity to manage it. Good conservation is based on good science (Maehr et al 2001), but management is the principal function of the managers. Capacity building has to focus, therefore, management skills and facilities in the first place. Research capacity should be realised by developing collaborative networks with universities and other research institutes. Long-term successful management is only achievable when both managers and researchers interact closely in an adaptive management process.



## 4. WILDLIFE MANAGEMENT CAPACITY

### 4.1 Wildlife Division

A Wildlife Circle in charge of wildlife related activities existed until the beginning of the 1980s, but was then abolished due to a reform of the government structure. In the early 1990s the Wildlife Management & Nature Conservation Circle (WMNCC) was reinitialised by GoB in the shape of a project. This initiative progressed slowly, but in 2002 a DFO Wildlife Management & Nature Conservation was posted to represent this circle at the level of Khulna District. The Forest Resources Management Project (FRMP, funded by WB) established in 1995 the Environment Planning Division (EMD), mainly responsible for the management of the Sanctuaries. This Division has been continued after closure of this project (Dec. 2001) at a limited GoB budget. In the earliest design of SBCP, it was envisaged that its wildlife activities would be pursued by EMD (without creating a new division) and this division was supposed to be supported and extended accordingly (Anon. 1997). Neither SBCP, nor FD has taken action to support this formula, as it was later decided that one of the planned project outputs of SBCP would be the development of a revised organisational structure for the management of Sundarban, envisaging a new Division for the Sundaraban wildlife management. This new Wildlife & Tourism Division (WTD) was established in 2001. The institutional reform was still in process during the drafting of the present Wildlife Plan and described in some detail in the documents generated by workshops organized in this context (Anon. 2001a).

As a result, by 2002 there were 3 divisions in Khulna District responsible for wildlife management, each having different hierarchical lines with the FD central level in Dhaka:

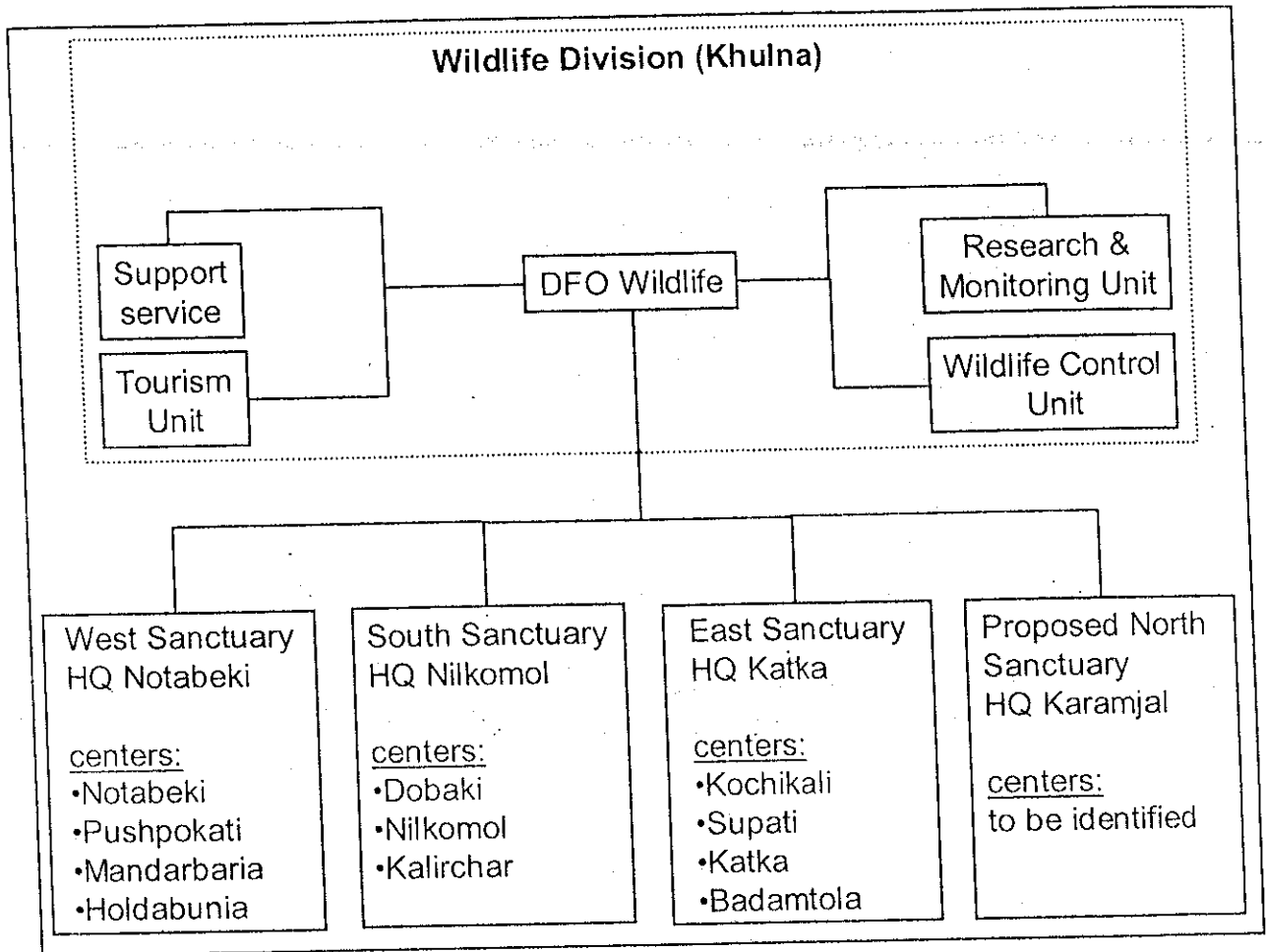
- (1) Wildlife & Tourism Division (SBCP),
- (2) Environment Management Division (FRMP),
- (3) Wildlife Management & Nature Conservation Division (GoB).

Three different structures for wildlife management cause friction and confusion regarding responsibilities, decision-making and allocation of budgets. To avoid conflicting competences, priority has to be given to the complete integration of these structures at both Khulna and Dhaka level. The name of Wildlife Management & Nature Conservation Division deserves preference as it indicates a more appropriate scope of responsibilities. Moreover it is more viable, being initiated by FD itself and not imposed. A point of attention of such an integration is the position of the Tourism Unit, which is included in the SBCP Wildlife & Tourism Division, but not in the Wildlife Management & Nature Conservation Division to be established under the Circle of the same name.

The new Wildlife Division (what ever its name) will be headed by a DFO (Figure 3), supported by 4 special units in Khulna (Support Service, Tourism Unit, Research & Monitoring Unit and Wildlife Control Unit) and a number of field stations in the sanctuaries subdivided in three management units, or four after the establishment of a new North

Sanctuary (section 6.5). The headquarters of these management units are: (a) Notabeki in the West Sanctuary, (b) Nilkomol in the South Sanctuary, (c) Katka in the East Sanctuary and (d) Karamjal of the proposed North Sanctuary (section 6.5). Sanctuary Staff number requirements are listed in Appendix 5.

Figure 3. Structure of the Wildlife Division after the proposed integration of WTD, EMD and WM&NCD



#### 4.2 Wildlife management tasks and responsibilities

The main tasks of the Wildlife Division involve:

- (1) Management planning (drafting, review),
- (2) Elaboration of work plan
- (3) Administration and logistic support,
- (4) Wildlife control and species management,
- (5) Habitat management,
- (6) Protection,
- (7) Research, surveys and monitoring,
- (8) Public relations & awareness.

After integration of the new Wildlife Division will be responsible for the management of all sanctuaries. In the Production and Impact Zone, Wildlife Division will be responsible for wildlife control and species management (task 4) and for wildlife research, surveys and monitoring (task 7). All tasks will be executed in close cooperation with other specialised units within the FD, SBCP and Khulna Circle: Data Unit, Liaison, Extension & Education Unit (LEE), Aquatic Resources Division (ARD) and the Sundarban East and West Divisions (SED and SWD). WTD will play an advisory role to ARD, SED and SWD regarding wildlife habitat management (task 4).

Apart from overall supervision and coordination of all the tasks mentioned above, the main tasks of the DFO are his involvement in management planning (task 1), drafting annual work plans (task 2), initiation and coordination of its implementation and review. General public relations will also be taken care of by the DFO, whereas the LEE and the Tourism Unit will mainly carry out Public Awareness activities following his advise.

Administration and logistic support (task 3) will be mainly provided by the Support Service of his Division, but also by other facilitating offices such as the CF and PD offices. The functions of the Tourism Unit in relation to wildlife are described in section 6.8 and in the Tourism Management Plan (Chaves 2001). The Research and Monitoring Unit will organise and coordinate all FD research, survey and monitoring activities in this field (task 7). Research projects carried out by third parties such as Universities should be accomplished in consultation with the Research and Monitoring Unit. For data analysis, they will be supported by the Data Unit, which should have sufficient GIS and data analysis capacity to provide this support. The Wildlife Control Unit is supposed to be based in Khulna, but operates in the field for all activities dealing with direct handling of animals such as translocation, and killing or removal of problem animals (task 4). The staff of the field stations will implement all other field tasks, being species management (task 4), habitat management (task 5) and protection (task 6).

### 4.3 Human resource development

Recent developments regarding conservation of Sundarban Forest, such as increased pressure on resources, the shift from wood to other resources, more attention to biodiversity and wildlife conservation, integrated sustainable management, and institutional reform require a different approach and institutional organisation of FD. Institutional reform generally involves (a) a different organisation, (b) different tasks, and hence (c) different training requirements (TECSULT 2000c). Proper Training Needs Assessment (TNA) is required to match training objectives with the training requirements. Presently, most of the FD staff had limited or even no training at all in wildlife management. Emphasis is required on field training.

Proposed training courses for wildlife staff are:

- (1) *General Wildlife Course (1 week) for mid-management staff; training objectives:*
- understanding of conservation and its relation to development,
  - understanding of relevance and methodology of surveys and studies,
  - familiarization with a number of field skills.



- (2) *Training of Trainers Course (2 ½ weeks,) for trainers; training objectives:*
- identify training needs (TNA),
  - development of training programme,
  - training skills,
  - development of training materials.
- (3) *Field Staff Course (5 days;) training objectives:*
- field techniques,
  - observation, identification methods,
  - survey techniques,
  - data recording.
- (4) *Field Staff training management implementation (3 days); training objectives:*
- legislation,
  - surveillance,
  - species and habitat management practice,
  - tourism.
- (5) *Wildlife care, handling and health (5 days); training objectives:*
- understand basic animal health care,
  - animal keeping and rearing,
  - trapping and transporting live animals,
  - basics in immobilisation and collaring.
- (6) *Natural history and ecology of species (3 days) for field staff; training objectives:*
- general aspects of natural history and ecology of species.
- (7) *First aid (3 days) for all staff; training objectives:*
- identification and basic diagnostics,
  - first aid to victims of accidents and disease,
  - transport and care,
  - first aid in remote areas.
- (8) *Fire arms utilisation and maintenance (4 days) for all staff; training objectives:*
- ballistics,
  - cleaning and maintenance,
  - handling of arms during service and patrols,
  - shooting.
- (9) *Computer training for mid-management staff (2 weeks):* text processing, spreadsheets, statistical analysis, basic GIS.
- (10) *Overseas training* in different fields of wildlife management is recommended for mid-management staff with a target of 4-6 month training per ACF and MSc Wildlife Management for the DFO for the coming 5 years. The emphasis should be on management skills.

All training should be supported by appropriate training materials, including manuals and booklets that can also be used by the staff back in the field after the training.

#### 4.4 Field staff living conditions

The living conditions for field staff are hard. Most of the centres are very remote, and have no special medical and social facilities. For several reasons it is in most cases impossible to sustain a family in the field stations. Moreover, field staff in Sanctuaries feel themselves in a disadvantageous position in comparison to staff from revenue stations as they are much further away from social and economic facilities outside the Sundarban, and as they do not have any other benefits from their job. Kumar & Wright, discussing anti-poaching strategies for tiger in India (Seidensticker et al 1999), state that optimal conditions for field staff are a prerequisite for effective poaching control. It is therefore recommended to develop a number of measures to improve their living conditions and reverse the feeling of being disfavoured.

The following types of measures should be considered and developed:

- (1) mobile medical facilities,
- (2) improved drinking water supply,
- (3) field staff rotation,
- (4) hardship allowances,
- (5) facilitation of family visits,
- (6) free accommodation.

Guidelines for infrastructure development in Bangladesh protected areas are developed by TECSULT (2001).

#### 4.5 Logistics and equipment

Both field staff and support staff need to be sufficiently equipped to perform their tasks. Appendix 4 presents an overview of the different needs in this respect. An equipment inventory is needed covering all units after the Wildlife Division has taken its final shape.

An issue of special concern is the state of the arms. Most of the arms are over 50 years old. Replacement is desperately needed. The calibre currently used (.303) is adequate for law enforcement and the shooting of the type of animals present in the Sundarban. However, in view of the increasing incidence of criminals (dacoits) in the forest, it is required to have a type of gun that can be fired repeatedly without recharging (e.g. six-shooter).

In the Mandarbaria Wildlife centre a cyclone shelter is needed.

#### 4.6 Other facilities

##### *Veterinary clinic*

A veterinary clinic as suggested earlier in the SBCP Inception Report is not found to be useful. In a natural ecosystem healthy and strong animals survive while weak and old animals

die. This keeps populations healthy and prevents the population size to exceed the carrying capacity. Interventions at individual level of animals do usually not contribute to a better survival of populations or ecosystems or may even have a reverse effect. However, improving exchange and collaboration with existing wildlife veterinarians and laboratories (e.g. Dhaka Zoo) is useful to monitor diseases, particularly for populations at risk such as tiger.

#### *Research station*

Better understanding of the Sundarban ecosystem is required for a more adapted management system. This will only be achieved by a sound long-term research programme focussing ecological relationships, and not by scattered and repeated surveys. The earlier suggested wildlife research station is very valuable and would be a good catalyser for the development of a coordinated research programme. A research station should serve FD in the first place, but be open to other research institutes such as national and international universities (e.g. tiger project). Research fees can cover the costs. The station should provide research facilities (e.g. a laboratory) and accommodation for researchers. If support for the suggested Research Station mentioned above is insufficient, a simple lab should be equipped for WTD to facilitate the activities of the Research and Monitoring Unit.



## 5. SPECIES MANAGEMENT

### 5.1 Species database

The species database developed by the SMU Data Unit (Warnaar 2001a, 2001b) is an important tool for the species management programme:

- to assist determination of priority species,
- as a backup of basic ecological information and references,
- to support public awareness activities and training.

To be effective the following conditions have to be fulfilled in the species database management system:

- regular updating of information in consultation with resource persons,
- compatibility with the demand,
- accessibility for users (being all stakeholders in and outside FD).

### 5.2 Tiger conservation programme

#### 5.2.1 Current position of tiger

The tiger is critically endangered all over the world and it is declining in most of its range. Based on the dispersion of tiger pugmarks, the tiger occurs throughout the Sundarban and individuals occasionally visit the Impact Zone. Estimates of the Bangladesh Sundarban tiger population vary between 350 (Hendrichs 1975) and 430-450 (Gittins 1980). No recent accurate estimates of the population exist, but in the framework of SBCP and the Tiger Project new data are collected that will reveal the present situation. It is assumed that the joint India-Bangladesh Sundarban population accounting for approximately 10 % of the world tiger population, is together with the Amur tiger population in Russia the largest in the world (Seidensticker et al 1999).

The main prey species of tiger is spotted deer, probably constituting 70-80 % of its diet, followed by wild boar, Rhesus macaque and smaller vertebrates (Johnsingh 1992, Reza, 2000, Stoen and Wegge 1996). Potential threats to tiger are poaching, prey reduction, diseases, pollution and inbreeding. The extend of these threats has not yet been fully quantified. The SBCP hunting study revealed that a number of specialised tiger poachers killed 23 tigers the last 5 years. The real number of tigers killed would certainly be higher. Recently a number of tigers died having liver anomalies, which could indicate effects of pollution. Poachers target mainly (95%) deer, but the actual off-take is not known. Deer poaching may, therefore, be a serious danger for the Sundarban tigers too, as deer is its main food source, and alternative prey availability is limited.

### 5.2.2 Legal status of tiger

The Bengal tiger is listed in the Third Schedule of the Bangladesh Wildlife Act (1974), implying its full protection by interdicting hunting, killing and capturing. Tiger is included in CITES Appendix I, completely interdicting international trade.

### 5.2.3 Conservation priority of tiger

The Royal Bengal Tiger (*Panthera tigris*) is the flagship species of the Sundarban Forest. For several reasons the conservation of the tiger deserves high priority:

- the tiger is endangered world wide,
- the Sundarban population is one of the largest populations in the world,
- it plays a key role in the Sundarban ecosystem being the largest predator,
- its charisma potentially attracts many tourists,
- the danger of its presence reduces human intrusions in the forest and hence contributes to its conservation,
- it is an important national symbol,
- it has, however, also an adverse effect on populations around the Sundarban due to human tiger incidents.

### 5.2.4 Management objectives for tiger management

A tiger action plan should encompass the following objectives:

- diversification of prey,
- reduction of human tiger conflicts
- improvement of protection
- monitoring of health and disease
- improved understanding of population dynamics and distribution

### 5.2.5 Strategy and actions for tiger management

Per definition, many activities concerning ecosystem management in the Sundarban Forest are directly or indirectly related to tiger conservation, but special attention to tiger management will be given through:

#### (1) Improvement of prey base.

The availability of alternative prey can be increased by the reintroduction of extirpated herbivores such as Swamp deer, Hog deer and Buffalo (section 5.11). A diversification of prey availability would increase the viability of the tiger population. A sound feasibility study

in this regard is required. Prey density will be further increased by improved grassland management, a key factor in the carrying capacity.

(2) *Protection strategy and capacity.*

See section 6.8 for an improved protection strategy.

(3) *Strategy to address human-tiger conflict.*

Several studies have been carried out on the human-tiger conflict (Hussain & Acharya 1994, JJS 2003b). From 1999 – 2002, averagely 50 people were attacked by tiger yearly, of which most cases occurred inside the forest and app. 75 % resulted in death of the victims. Nypa and honey collectors appear to be more confronted with tiger attacks. No scientific evidence exists for a relationship between tiger attacks and the water salinity level. Two types of incidents occur regarding casualties and strategies have to be adapted accordingly:

<i>type of incident</i>	<i>type of tiger</i>	<i>victims</i>	<i>strategy</i>
(a) tigers roaming out of the forests entering villages and killing/injuring humans and domestic animals	usually old tigers driven from their territories by healthier congeners	any villager, but often people trying to chase or kill the tiger	removing tiger from the area, informing people how to avoid contact, compensation
(b) people attacked by tigers inside the forest	any tiger, but normally adults	usually resource extractors entering forest	informing forest users about risk reduction, no compensation

In India, problem tigers are immobilized by darting first, subsequently they are examined and it is decided which procedure has to be followed. Old animals in a bad condition may be shot, but young good conditioned animals can be transferred to a "non-conflict" area. Transfer to a zoo or another captive situation is a third option. To enable this approach in Bangladesh a mobile wildlife control unit has to be established. The Wildlife Control Unit has a principal role in dealing with tiger problems. Other strategies are public awareness campaigns, zoning and fencing (section 6.3).

It would be very helpful in this respect to develop exchange and cooperation with the services engaged in management of tiger in the Indian Sundarban.

### 5.2.6 *Required resources/capacity*

A specific requirement for tiger conservation is a team, which is capable to deal with live tigers (trapping, translocating, collaring, tracking). The position of such a unit (Wildlife Control Unit) is described in Figure 3 and section 4.2. All tasks related to tiger management will be taken care of by the Wildlife Division and other supporting Divisions and Units of FD.

A four-year research plan for tiger has been drafted by the Tiger Project, which has an approximate budget of US\$ 500,000. Different components will be covered by USFWS, UNF and SBCP.

### 5.2.7 Research and monitoring of the tiger population

The Wildlife Division has developed a method for deer and tiger survey, which is based on indirect counting methods, using frequency of tigers crossing water ways (10-30 m wide) as an indicator of relative density (Deodatus and Ahmed 2002). For the monitoring of the tiger population this method should be applied annually in all Sanctuaries (including North), additionally every 5 years the entire Sundarban should be covered. Additional information will be produced by the Tiger Project.

Current and future research efforts on tiger target the following outputs:

- the distribution and relative abundance of tiger and its prey in the Sundarbans,
- an estimate of numbers and population trends of tiger and prey populations,
- understanding of genetic variation and diseases.
- reviewing the monitoring model for tiger and prey,
- recommendations for management,
- better understanding of tiger behaviour, particularly in relation to man-eating,
- an elaborated tiger action plan addressing both protection and tiger-human conflicts,
- contributions to the Sundarban integrated management plan.

## 5.3 Deer conservation programme

### 5.3.1 Current position of deer

The natural distribution of Spotted deer (*Axis axis*) is limited to the Indian Sub Continent, although successful introductions occurred elsewhere (Geist 1999, Seidensticker et al 1999). The Sundarban is on the eastern edge of its range.

Spotted deer is found throughout the Sundarban Forest, but the population density seems to be higher in the South, and particularly concentrated in the marine grassland areas (Hendrichs 1975, Deodatus & Ahmed 2002). Population estimates so far vary between 52,600 (Khan 1986, cited in Hussain & Acharya 1994) and 80,000 (Hendrichs 1975). WTD surveys in 2002 even indicate a figures over 100,000. These figures suggest that this ungulate is doing relatively well, despite the difficult conditions of the area (e.g. salinity, flooding, poaching). Lack of inter-specific competition may be a reason, but it could also indicate an effective adaptation due to its long presence in this environment. The absence of large grazers in the system, however, may also indicate that the utilisation of grasslands is still below optimum, as Spotted Deer is supposed to prefer small grasses over browsing (Geist 1999, Schaller 1967). Deer is the main target of poachers (section 5.2), but the rate of annual off-take is still a matter of speculation, varying from low (a few percent) to high (approaching 20 %). Based on (a) a population size of 300-400 tigers, (b) a food preference of 70 % for deer, and (c) assumptions laid out by Schaller (1967) regarding food requirements of tiger, the annual off-

take by tiger predation may be in the order of 13,000 to 21,000 deer. Although the reproduction rate of this deer species is potentially very high, poaching may be an important limiting factor for both deer and tiger. Pollution could be another major threat to deer. Habitat degradation, on the other hand, is not a probable threat as deer feeding is facilitated in secondary vegetation and habitat reduction does not occur in the Sundarban Forest.

Barking deer (*Muntiacus muntiac*) occurs in much lower numbers in mainly the Northern and Eastern Sundarban. No reliable population estimates exist on this species. In contrast with Spotted deer, Barking deer is a solitary animal and restricted browser, mainly found in closed vegetation. Having less management priority at this stage, Barking deer is not taken into account in the further sections, as it is not endangered and plays a less significant ecological role in the food chain.

### 5.3.2 Legal status of deer

Spotted deer is listed in the Third Schedule of the Bangladesh Wildlife Act (1974), implying its full protection by interdicting hunting, killing and capturing.

### 5.3.3 Conservation priority of deer

Although the deer population in the Sundarban appears not to be at risk, its conservation deserves priority for the following reasons:

- its significant ecological role in the ecosystem, being the most important link between primary production and the tiger,
- its presence plays a key role in the structure of the vegetation due to its different preferences for food plant species and plant parts,
- the dependence of tiger on deer, being its primary prey,
- its abundance makes it one of the most conspicuous attractions for tourism,
- its potential for consumptive sustainable utilisation (section 5.8).

### 5.3.4 Objectives for deer management

Sustainable management of deer implies that, on the long term deer populations, predator populations and the primary resource fluctuate within the limits that occur in natural ecosystems. Deer management should focus:

- improved protection,
- improved habitat management,
- improved understanding of population dynamics and distribution.

Although some favourable habitats are intensively used by deer, there are no indications that deer browsing causes degradation of forest. This is also not expected, as habitat degradation by wildlife usually only occurs when habitat compression (by changing land use) reduces the range of herbivores. And this is not the case in the Sundarban. Therefore, no control of deer numbers is necessary from the habitat management perspective.



### 5.3.5 Strategy and actions regarding deer management

Section 6.8 describes improvement of protection. A number of habitat improving measures for deer is described in section 6.6, the feasibility and necessity of deer ranching is discussed in sections 5.8, and measures to enhance the herbivore assemblage by reintroduction is addressed in section 5.11.

Utilisation through culling or ranching is expected to have an adverse impact on deer conservation in the current context (illegal off-take, illegal trade, lack of control) and therefore not recommended. On the long term however it is possible to develop a situation in which these forms of utilisation could be allowed, creating opportunities to increase the benefits from the Sundarban Forest. When better deer management results in an increase of the deer population and improved deer recruitment, and when illegal use is under control, it could be considered to develop a sustainable deer harvesting programme (section 5.8). Ranching is not an appropriate sustainable use approach in the Sundarban, as this would be most probably economically not feasible due to the hard environment and this could result in undesirable changes of the ecosystem. However, an increased reproduction of deer could also be entirely made available for increasing the tiger population. This aspect needs to be reviewed during the next management cycle within five years.

### 5.3.6 Required resources/capacity

All tasks related to deer management will be covered by the Wildlife Division and other supporting Divisions and Units of FD. Feasibility studies and cost estimates for special measures such as herbivore reintroduction have to be carried out. A research budget of US\$ 69,000 for deer research has been programmed. Improved collaboration with universities and research institutes is crucial for successful implementation of a sound research programme.

### 5.3.7 Monitoring and research of deer

The Wildlife Division has developed a method for deer surveys, which is based on indirect counting methods using presence of tracks and defecations as an indicator for relative abundance (Deodatus and Ahmed 2002). It is recommended to apply this method for deer (and other footprints such as boar and tiger) jointly with the annual data collection of Permanent Sample Plots (PSP), which is carried for forest management purposes. Around each PSP 4 sample plots have to be taken.

Better understanding of deer ecology is required for both tiger conservation and vegetation management. Deer research and surveys should focus:

- distribution and relative abundance,
- habitat utilisation and food preference,
- deer - vegetation dynamics,
- population dynamics,

- illegal off-take and other impacts,
- testing and management prescriptions
- review monitoring model for deer.

## 5.4 Crocodile conservation programme

### 5.4.1 Current position of Bangladesh crocodiles

Three crocodile species naturally occur in the region: (a) the Estuarine or Saltwater Crocodile (*Crocodylus porosus*) ranges from the North East India to Northern Australia, whereas (b) the Marsh Crocodile or Mugger (*Crocodylus palustris*) and Garial (*Gavialis gangeticus*) are limited to the Indian Sub-Continent only (Thorbjarnarson et al 1992, Webb & Manolis 1998).

Some Garial occur only in the North West of Bangladesh, but the Sundarban is generally considered outside its ecological range due to the salinity. However, one not confirmed record has been reported. The marsh crocodile is extinct from the Sundarban already for decades but some individuals survive in a pond near Bagarhat not far from SRF (Rahman 1990, Sarker 1997). Saltwater crocodile still occurs, but the population appears to be far below its potential. Population estimates vary between 40 and 200 (Khan 1982, Hussain & Acharya 1994, Rahman 1990, Sarker 1986). Comparable areas have a much higher density. In the Northern Australian mangroves and swamps for example 1 – 30 estuarine crocodiles per km of waterway are found.

Intensive commercial hunting in the past is probably the main reason for the bad state of the crocodile population. Its protected status since 1973 however did apparently not result in a recovery. At present, hunting on crocodile may be insignificant (JJS 2003). The main threat to crocodiles is nowadays incidental mortality due to fishing with nets. Commercial fishing has expanded dramatically and even in the Sanctuaries some illegal fishing is taking place. Crocodiles, particularly juveniles frequently drown in fishing nets. A second threat to crocodiles may be pollution, which may reduce reproductivity and the availability of fish, its main prey.

Occasionally crocodiles kill people, mainly fishermen. From 1999 – 2000, averagely 1 person a year was killed by crocodile per year. This number of casualties is insignificant compared to tiger incidents.

### 5.4.2 Legal status of Bangladesh crocodiles

All three crocodile species occurring in Bangladesh are listed in the Third Schedule of the Bangladesh Wildlife Act (1974), implying their full protection by interdicting hunting, killing and capturing. Garial, Estuarine crocodile and Marsh crocodile are included for Bangladesh in CITES Appendix I.

### 5.4.3 Crocodile conservation priority

A rigorous conservation programme for Estuarine crocodiles is needed to avoid this species from becoming extinct in the Sundarban, half a century after the extinction of Marsh crocodile. The period from 1973 to present has shown that the population has not the capacity to recover on its own.

### 5.4.4 Crocodile management objectives

The following objectives are recommended for crocodile management:

- improved protection,
- ranching and restocking to recover the natural population,
- feasibility study on the reintroduction of Marsh Crocodile,
- improved understanding of population dynamics, distribution and breeding biology,
- public awareness.

A detailed conservation plan for crocodiles has been drafted (Halder & Deodatus 2003), elaborating approach and management measures.

### 5.4.5 Strategy and actions for crocodile management

#### (1) Protection

Protection measures for crocodile should target fishing activities in the Sundarban, mainly by reinforcing the interdiction of fishing in Sanctuaries and by closing smaller canals for fishing in the Production Zone. Closure of fishing is particularly useful for nesting areas. These sites, however, have still to be identified in surveys.

#### (2) Ranching & restocking

Ranching/restocking has proved to be the best tool for crocodile population restoration in many countries. For this purpose a new crocodile rearing station has been constructed in the Karamjal Visitors Center with a capacity of 110 crocodiles. The establishment of this facility has been given priority as it takes at least 3 years before the first crocodiles can be released. Hatchlings will be obtained from the wild. The collection of eggs from the wild is dissuaded at the present state of experience as this may involve too much risk for the current endangered population. A crocodile-breeding programme with imported crocodiles will also be started in the Visitor Center. Details for both activities are given in the Master plan for the Visitor Center and the Establishment Plan for the Crocodile Rearing Station (Chaves 2001, Deodatus 2001). A key issue is the development of a financial mechanism to cover the operation cost using revenues from the visitor center. Building experience in crocodile rearing for conservation would simultaneously, contribute to the development of commercial crocodile farming in Bangladesh in the future.

### (3) Feasibility study on reintroduction of Marsh Crocodile

Reintroduction of extirpated species is discussed in section 5.11.

#### 5.4.6 Required resources/capacity

The Wildlife Division and other supporting Divisions and Units of FD will cover all tasks related to crocodile management. Collaboration with ARD is needed for data collection on crocodile mortality due to fishing. Infrastructure for crocodile rearing is constructed in the Karamjal Visitor Centre (budget Tk 1,200,000). For food and maintenance related to crocodile rearing an annual budget of Tk 350,000 is needed. A breeding programme would require an additional Tk 350,000 per year. For operation, specific training in crocodile rearing is essential. To achieve a sustainable operation it is crucial to develop a formal mechanism to use visitor revenues to cover operation cost. Under SBCP a survey and research programme has been budgeted (Tk 1,000,000).

#### 5.4.7 Research/monitoring

Crocodile surveys should be carried out to assess state and trends of the population. Spotlight counts are the most commonly used practice. Aerial surveys of breeding areas, day surveys during the cold season and sighting records would provide valuable additional information. Main expected outputs of research:

- population dynamics and distribution,
- causes of mortality, extend of by-catch,
- breeding biology,
- simple monitoring system.

For monitoring a number waterways in the Sanctuaries (including North Sanctuary) need to be covered with spotlight counts annually.

## 5.5 Marine mammal conservation programme

### 5.5.1 Current Position of marine mammals

The only confirmed records of marine mammals in the Sundarbans are three delphinids from the Order Cetacea: the Ganges river dolphin or shushuk (*Platanista gangetica*), Irrawaddy dolphin (*Orcaella brevirostris*), and Indo-Pacific humpback dolphin (*Sousa chinensis*). Based on a 20-day sighting survey during March 2002, covering most navigable waterways of the Sundarbans in Bangladesh, the shushuk was the most common cetacean observed in eastern portion (characterized by low salinity waters) and the Irrawaddy dolphins was the most common cetacean in the western portion (characterized by high salinity waters). Both species were fairly abundant. A single confirmed sighting was made of Indo-Pacific humpback dolphins, the first record of the species in Bangladesh. Estimates of population size and quantitative information on habitat preferences and distributional overlap with fishing gears

known to harm dolphins will be available for both shushuks and Irrawaddy dolphins as soon as data from the survey are analysed – preliminary report should be available in September 2002.

Previous reports of the occurrence of melon-headed whales (*Peponocephala electra*) and short-fin pilot whales (*Globicephala macrorhynchus*) in the Sundarbans are undoubtedly erroneous; both species occur only in deep offshore waters (see Jefferson et al. 1993 and other references describing the distribution of these species). Records of melon-headed whales from the Sundarbans (and for Bangladesh) are probably based on misidentifications of two skulls in the Bangladesh National Museum, which are actually Irrawaddy dolphins. Although there are no definitive reports of finless porpoises *Neophocaena phocaenoides* occurring in the Sundarbans, there are confirmed records of this species from the coast near Cox's Bazaar (Haque 1982) and on St. Martin's Island (Zahirul Islam Jewel, pers. comm.), and the species is known to occur in similar delta environments in Asia (e.g., Indus Delta; Pilleri and Gühr 1974). Dugongs have been reported from the Chittagong coast (Frazier and Mundkur 1990) but almost certainly do not occur in the Sundarbans due to the absence of suitable sea grass bed habitat.

In the IUCN Red List, Ganges river dolphins are considered Endangered (EN) and Indo-Pacific humpback and Irrawaddy dolphins are considered Data Deficient (Hilton-Taylor 2000), although the population of Irrawaddy dolphins in the Mahakam River, Indonesia was recently listed as Critically Endangered (CR), and others populations of the species are expected to be listed as CR or EN as quantitative studies on their status are completed (e.g., those in Malampaya Sound, Philippines and Songkhla Lake, Thailand; see Smith and Jefferson 2002).

### 5.5.2 Marine mammals legal status

Ganges river dolphin is included in CITES Appendix I, and it is listed in the Third Schedule of the Bangladesh Wildlife Act (1974), implying their full protection by interdicting hunting, killing and capturing. Irrawaddy dolphin and Indo-Pacific humpback dolphin are not listed at all in the BWA, indicating the Second Schedule, but should be added to the Third Schedule.

### 5.5.3 Marine mammals conservation priority

Dolphins are among the most visible wildlife elements in the Sundarbans and their conservation requirements closely reflect the resource needs of aquatic biodiversity and the environmental conditions necessary to sustain productive fisheries (Smith et al. 1998). These animals make ideal flagship species for highlighting the importance of maintaining healthy freshwater and marine environments. Preliminary data from the dolphin survey conducted in March 2002 indicate that the relative densities of Ganges and Irrawaddy dolphins can be used to monitor changes in physical and ecological characteristics, especially those related to freshwater inputs and salinity fluxes. As top carnivores in the aquatic food chain, their ecological role can be considered akin to tigers in the terrestrial environment. Despite their strong function in structuring of waterways within the Sundarbans and their potential attraction for nature tourism, until very recently, no dedicated studies were conducted to

assess their status. From both ecological and economic points of view, shushuks and Irrawaddy dolphins should be considered as focal species to be included explicitly as part of the SBCP.

#### *5.5.4. Marine mammals management objectives*

Management objectives for conserving dolphins in the Sundarbans include:

- Monitoring dolphin distribution, abundance, accidental and deliberate killing;
- Assessing and reducing the potential of over-fishing and the widespread use of mosquito nets for catching shrimp fry to deplete dolphin prey;
- Reducing incidental killing in gillnets and deliberate killing for dolphin oil;
- Using the relative densities of Ganges and Irrawaddy dolphins to monitor the ecological effects of salinity changes.

#### *5.5.5 Strategy and actions related to marine mammals management*

Strategies for accomplishing the above objectives include:

- Empowering, educating, and equipping forest department officers to enforce fisheries regulation;
- Educating fishermen on fisheries regulations and the need to manage fisheries for long-term sustainability;
- Creating gillnet free zones or establishing time/area closure in areas where dolphins are found in particularly high densities (this should be coordinated with the overall strategy for fisheries management);
- Enforcing existing fisheries regulations that prohibit the use of mosquito nets to catch shrimp fry;
- Training and involving local tourist operators and forest department officers to monitor dolphin populations and incidences of accidental and deliberate killing;
- Conducting bi-yearly dolphin and fishing gear surveys using trained local scientists;
- Maintaining a GIS data base of dolphin sightings and mortalities, salinity measurements, and locations of non-selective fishing gears; and
- Establishing a network among local fishermen for reporting dolphin kills.

#### *5.5.6 Required resources and capacity for management of marine mammals*

- Funds for training forest department officers and nature oriented tourism operators;
- Funds for hiring local staff and chartering a research vessel for dedicated surveys and, at least for the first couple of years, an external consultant;
- Sighting identification sheets, GPSs, refractometers, and binoculars for forest rangers and nature tourism operators; and
- Vessels and manpower for fisheries enforcement.

### 5.5.7 Review and monitoring of marine mammals

- Dolphin survey design and results can be reviewed through the IUCN Species Survival Commission Cetacean Specialist Group;
- Populations and mortality should be monitored on a continual basis through the involvement of nature tourism operators and forest rangers, and on a bi-yearly basis with a dedicated sighting survey using a team of local scientists.
- Systematic records should be kept and the results should be reviewed on an annual basis.
- Expert advice should be incorporated during the initial two years of the program as local scientists are trained to take the lead on the dolphin-monitoring component.
- Management should be considered iterative such that the results from each year of monitoring populations and mortality will guide management actions taken in subsequent years.

## 5.6 Marine turtle conservation programme

### 5.6.1 Current Position of marine turtles

The Olive Ridley (*Lepidochelys olivacea*) is considered fairly common in the Sundarban and breeds on Mandarbaria Island and some breeding was reported in the East Sanctuary (Gani 2000). The breeding period is from February to April, and a maximum number of nests recorded was 23 in 1999. The green turtle (*Chelonia mydas*) is rare and Hawksbill (*Eretmochelys imbricata*), and Loggerhead (*Caretta caretta*) turtles are not common, although some observations have been reported. The Common Batagur or River Terrapin, occurring in the main rivers, is critically endangered. Systematic marine turtle surveys have never been carried out in Sundarban. The threats to marine turtles are (illegal) commercial exploitation by catching and egg collection, and the (side)effects of commercial fishing (Hussain & Acharya 1994). The IUCN Red List classifies Olive Ridley and Loggerhead "Endangered", and Green turtle and Hawksbill "Critically endangered".

The Environment Management Division Khulna under Forest Resource Management Project (GOB/WB) implemented a marine turtle conservation programme involving data collection on nests and nest protection using net fences. Due to funding limitations the activities were only confined in the Sundarban West Sanctuary (Mandarbaria Wildlife Centre) focussing Olive Ridley. Experiences of the last three years experience have shown that:

- the main the period January - March is the principal period for ponding eggs of these turtle,
- predators like wild boar, Monitor lizard and some birds of prey destroy many eggs.

### 5.6.2 Marine turtles legal status

Turtles inhabiting the coastal areas are protected under the Bangladesh Wildlife Act (Hussain & Acharya 1994), which has banned hunting until further notice. However, none of the species is listed in the Third Schedule.

### 5.6.3 Marine turtles conservation priority

The main reasons to give emphasis to marine turtle conservation are:

- the species are endangered or critically endangered world wide,
- marine turtles suffer dramatically from intensive marine fisheries,
- they are potentially attributing tourism value,
- some of the conservation methods are simple, cheap and straightforward.

### 5.6.4 Marine turtles management objectives

Objectives for turtle management are:

- understand the current distribution of sea turtle breeding sites,
- understand status and population trends of marine turtles in the Sundarban Forest,
- improve survival of turtles by mitigating impacts of commercial fisheries and predation,
- improve support for turtle conservation by raising people's awareness.

A detailed conservation plan for marine has been drafted (Ahmed & Deodatus 2002), elaborating approach and management measures.

### 5.6.5 Strategy and actions of marine turtle management

The following actions could be considered for improved management:

- Nest protection is realised through net fencing and regular monitoring.
- Feasibility study on rearing and restocking will reveal the necessity of a rearing/restocking programme and compare its potential results with the current methods. There is no experience with Marine turtles rearing in Bangladesh. As FD does not have experience in this field, technical assistance is required.
- Motivation & public awareness targeting fishing communities and the market
- Evaluation and development of other protection measures, such as turtle excluding devices (TED).

### 5.6.6 Required resources and capacity for marine turtle management

All tasks related to crocodile management will be taken care of by the Wildlife Division and other supporting Divisions and Units of FD. The marine turtle conservation plan development by the Wildlife Division requires a preliminary budget of Tk 600,000.



### 5.6.7 Research and monitoring of marine turtles

- Survey of potential nesting areas, to be carried out in beach areas and islands such as (i) Demer Char, (ii) Pokhir Char, (iii) Kochikhali, (iv) Katka sandy beach area, (v) Dubla & adjoining sandy beach areas, (vi) New Char near Putney Island, (vii) Bahir Mandarbaria.
- A study on the impact of fishing on turtle mortality, to be carried out during Dubla fishing season to find out the intensity of turtle death in the nets of sea going fishermen
- A study on ecological variables determining nest site selection and hatching success. For this purpose a number of variables needs to be measured such as salinity, soil composition, distance to seashore, distance to nearest terrestrial vegetation, and soil temperature.
- Development of a monitoring system.

### 5.7 Other species programmes

The preceding sections of this chapter address the priority wildlife species of which conservation strategies are developed or should be developed within short term. However, special management measures should not remain limited to these species only. During implementation and review of the management plan the necessity of special measures and programmes for other species should be considered. Some species to be taken into consideration are: Adjudant stork, large raptors such as White-bellied and Pallas sea eagle, Masked finfoot, Otter, and several reptiles (Monitor, Cobra, Python) and amphibians (Green frog, Tree frog).

A number of measures and strategies focussing groups of species are given in the remaining sections of this chapter.

### 5.8 Wildlife ranching/harvesting

The SBCP inception report and also earlier projects (particularly FAO) proposed to develop commercial farming of wild animals such as crocodile and deer. The current government policy in this regard is not very clear, but (legal) direct economic use of wildlife could increase the commitment of both government and population for sustainable management.

Experiences in other countries have shown, however, that it is not always evident that commercial wildlife farming/ranching contributes to conservation. Preconditions for success are: (a) full control of market and trade, (b) clear mechanism that makes hunters feel that they are compensated if they abandon their illicit activities, (c) strong law enforcement in protected areas. The second condition is usually achieved by involving them in legal commercial wildlife operations. Generally it is not expected that the current conditions in Bangladesh are favourable for sustainable commercial wildlife operations.

The following guidelines should be followed until appropriate control of hunting and trade are established:

- Commercial crocodile ranching will certainly increase the risk of poaching of crocodile eggs and hatchlings to supply the commercial farms, therefore it should not be allowed.

- Any consumptive use of deer (farming, ranching, culling) should not be allowed as long as the trade in deer products is not fully under control.

In relation to future development of commercial utilisation the following considerations should be made:

- Setting up a deer ranch inside the Sundarban Forest is not desirable as it requires fencing and hence it limits movement of other species and hinders optimal habitat use.
- From the conservation point of view, the only justification for animal fencing may be for tourism (to make sure that tourist can see animals), protection of villages along the boundary and to assist reintroduction of extirpated herbivores.
- Due to the difficult environmental conditions in the Sundarban, ranching is most probably economically not beneficial.
- Culling of deer is ecologically and economically a better option than ranching, but both ranching and culling are conflicting with optimal food availability for tiger.
- Farming in the impact zone will be ecologically feasible, but a feasibility study should be carried out to clarify if this type of farming is economically compatible with livestock farming.

## 5.9 Domestic species control

The presence of domestic animals is in most cases bad for natural ecosystems as they interfere in natural food chains and they contribute to the transfer of parasitic diseases (Caughly & Sinclair 1994). Generally, domestic animals reduce biodiversity. Therefore, all domestic animals (dogs, cats, livestock, poultry) should be kept out of protected areas as much as possible. As movement of animals increases particularly spread of contagious diseases, this should also apply for domestic animals of tourists and for the use of bait for photography, filming and research. Baiting for research purpose may be exempted in case it is found that the objective of the project in question is important for the management of the Sundarban ecosystem and no alternative is available.

## 5.10 Wildlife species control

The control of natural populations such as herbivores and predators to alter species assemblage composition is usually not desirable. Only in some cases species control is justified to "restore ecological balance" or reverse overgrazing. This can be particularly the case during periods in which the free range of wild animals is reduced and/or fragmented (compression) due to human land use extension. Naturally however, ecosystems have their own mechanisms for "balancing", and moreover natural ecosystems are not static but they are characterised by fluctuating population levels. "Over grazing" as such is not defined by ecological criteria but by human factors. According to current ecological science (Caughly & Sinclair 1994), herbivore population levels are not in the first place determined by predation, but by resource availability and parasitism. Therefore, only in case of habitat reduction it may be decided to control species to accelerate readjustment of population levels to declining resources (for example to reduce wildlife human conflicts or erosion). This is not the case in the Sundarban.

### 5.11 Reintroduction of extirpated species

The principal aims of reintroduction are:

- to improve biological stability and productivity of the ecosystem by increasing the biodiversity and utilisation of ecological niches,
- to increase the aesthetic and/or economic value of the ecosystem.

The reintroduction of animals is a risky and costly operation that requires a sound feasibility study, careful planning and an implementation period of several years (Maehr et al 2001). For example, a successful reintroduction project of Elk in the US Apalachia did cost app. US\$ 1.5 million over a 9-year period. Earlier, only two out of six reintroduction attempts in the United States were successful. Some of the problems complicating reintroduction are insufficient habitat quality, inadequate adaptation, diseases, casualties due to translocation and poor follow-up measures.

Despite the difficulties to be countered, animal reintroduction is a valuable measure to consider for the maintenance of isolated protected areas such as the Sundarban, and certainly it is the only way to restore some of its original biodiversity. It would optimise the use of primary production, particularly in grasslands and have a positive effect on both the herbivore assemblage and the tiger population.

An herbivore reintroduction feasibility study and planning should encompass the following components:

- (1) determination of the current regional herbivore status and potential stock supply,
- (2) literature review on habitat requirements,
- (3) habitat mapping,
- (4) proposal of management options and cost,
- (5) analysis of cost, risks and impacts,
- (6) consultative workshop to orient the reintroduction programme,
- (7) project formulation and planning.

Generally, the reintroduction of animal species follows three steps:

- (1) protected rearing reducing mortality during first life stages, or capture of wild stock elsewhere,
- (2) habituation of the stock population to the new environment, by releasing it under controlled conditions,
- (3) full release of stock,
- (4) monitoring.

Reintroduction efforts should target only species previously occurring in the area concerned. Therefore, a reintroduction feasibility study should in the first place reveal which species are extirpated and which factors are responsible for their extinction. The following large and medium vertebrates are reported extinct in the Sundarban (Akonda 2000, Rosario 1997, Tamang 1994): (a) Indian one-horned rhino (*Rhinoceros unicornis*), (b) Javan rhino (*Rhinoceros sondaicus*), (c) Wild buffalo (*Bubalis bubalis*), (d) Swamp deer (*Cervus duvauceli*), (e) Sambar (*Cervus unicolor*), (f) Hog deer (*Axis porcinus*), (g) Marsh crocodile (*Crocodylus palustris*). Buffalo, swamp deer and hog deer appear to be the most likely species to take into consideration for reintroduction on the short term (Khan 2003), because:

- (1) their habitat requirements do probably still match with the freshwater zone in the Northern-Sundarban, which has presently a very low abundance of larger herbivores;
- (2) they would be a very good alternative prey for tiger, which is now mainly dependent on spotted deer for its food;
- (3) particularly deer species are relatively flexible in their habitat requirements, which increases success.
- (4) the reintroduction of one of the rhino species is not recommended in the near future as its reintroduction involves more complications in all respects.

The reintroduction of marsh crocodile can be taken into consideration after the restocking programme of saltwater crocodile has been taken off and practical experience has been developed in the field of crocodile management. In a later stage also reintroduction of Javan rhino could be considered, at least to contribute to the prestige of the Sundarban, but of course as well to the conservation of this critically endangered animal.

A prerequisite for the proposed reintroduction programme is the gazetting of a Sanctuary in the Northern Sundarban, offering sufficient and protected habitat (see section 6.5). In view of the time and funds involved it will be necessary to make a funding plan of a reintroduction programme for at least 5 years.



## 6. HABITAT MANAGEMENT

### 6.1 Zoning plan for the Sundarban and related management objectives

Four main zones are distinguished in and around the Sundarban Forest (Appendix 1), which are proposed to have different management objectives (see Table 8 for management prescription matrix):

#### (1) Sanctuaries

The Bangladesh Wildlife Preservation Order 1973 (amended in 1974) defines a sanctuary as "... undisturbed ground primarily for the protection of wildlife inclusive of all natural resources such as vegetation, soil and water". The main functions of the sanctuaries are providing a "biodiversity reservoir" for the entire Sundarban protected area system and a safe abode for migratory species. Therefore, Biodiversity Conservation is the principle objective in the Sanctuaries, but non-consumptive use (education, tourism, filming) may be allowed. The management system should minimize intervention in natural processes such as erosion, land accretion, succession and population fluctuations of herbivore and predator populations. However, in some cases harvest of grasses and other interventions may be undertaken to improve habitat quality for selected species that are focussed by conservation. All commercial exploitation, including fishing and *Nypa* collection is prohibited. Controlled low impact harvest of some tree species could be allowed under certain conditions to stimulate regeneration and to generate revenues for conservation. The sanctuary system should represent as many different habitat types as possible (see also sections 2.4 and 6.5). A sub-zoning system for the sanctuaries is laid out in section 6.2.

#### (2) Production zone

In the Production Zone (Sundarban Reserved Forest) priority is given to controlled exploitation of renewable natural resources (fishing, timber, fire wood, grass, honey, etc.) in a sustainable manner. Biodiversity conservation is a second objective. Temporary measures may be taken locally to reduce impact of exploitation on certain resources, such as the current ban on timber exploitation, fishing in specific canals and so forth. Hence, the Production Zone has two main functions: (a) revenue generation and (b) a carrier function for biodiversity. Management interventions and exploitation should, therefore, minimize its impact on biodiversity. Permanent settlements should be avoided and temporary settlement has to be restricted to limited areas. Inside the Production zone, special areas (e.g. visitor centres) may be assigned to education, recreation and tourism. A sub-zoning plan for the Production Zone has to be elaborated in an integrated way with the other sectors. A

preliminary zoning is as follows: (a) Resource extraction zone, (b) Fishing excluded khals, (c) Special use zone, (d) Marine fishing temporary settlement zone (Dubla, Sela), (e) Hunting zone (if hunting would be adopted).

### (3) *Impact zone*

The impact zone is considered as a rural area, used for settlement, cultivation and exploitation of natural resources. However, compatibility with biodiversity conservation should be maximised and measures should be carried out to reduce the impact on Sundarban Forest (e.g. law enforcement operations, tree planting, public awareness). Conversely, measures should be taken to reduce the impact of wildlife from the Sundarban Forest (particularly tiger) on the population.

### (4) *Marine zone*

The marine zone can be subdivided into two sub-zones: one is related to the adjacent Sanctuaries and the other to the production zone. The management objectives of these sub-zones are similar to the respective zones to which they are connected: only protection in the section related to the Sanctuary and sustainable utilisation in the section related to the Production Zone.

### (5) *Impact zone*

The impact zone is inhabited by most of the resource users of the Sundarban Forest. Most of this zone is located around the forest. This zone does not directly is relevant for management, but it should be a target for law enforcement, public awareness activities and wildlife control.

## 6.2 Zoning inside the Sundarban Sanctuaries

According to the Sanctuary Conservation Management Plan (Rosario 1997) the following zones should be distinguished in and around the Sanctuaries:

- (1) Strict protection zone,
- (2) Rehabilitation zone, for areas considered as degraded,
- (3) Recreational zone,
- (4) Special use zone for infrastructure related to management and other purposes,
- (5) Buffer zone, of 5 km wide around sanctuaries, allowing controlled exploitation, including hunting (!).

The proposed system does not appear very appropriate for the Sundarban for several reasons. The distinction between (1) and (3) is not clear in the definitions and as (1) allows also recreation, there is no real "strict protection" zone in this system. Although some areas still show earlier presence of human settlements (mainly fishing camps), from the conservation point of view there is no obvious need for rehabilitation, and neither for classification of

this type of zone (2). The buffer zone concept (5) as proposed does not make sense in the Sundarban as the sanctuaries are not bordering settlement areas. An excellent buffer is already provided by the SRF in the North, the Golf of Bengal in the South, the Indian Sundarban in the West and the Baleshwar River in the East. Moreover, it is certainly not recommended to develop hunting in such a narrow buffer zone system as proposed. Actually, if hunting would be allowed in the future in the production zone, a buffer of 5 km should be established around the sanctuaries where hunting should be prohibited to achieve an adequate conservation system! A buffer zone needs only to be established where sanctuaries are directly bordering the Impact Zone, which will be case for the new North Sanctuary.

After the above considerations, the following revised zoning system is recommended (see Table 8 for management prescription matrix):

- (1) *Strict protection zone*, for conservation and scientific use and not allowing recreation,
- (2) *Intervention zone*, where habitat is maintained by grass cutting and other habitat interventions,
- (3) *Recreational zone*, for conservation and low impact tourism (noise limits, number limits, adequate facilities),
- (4) *Special use zone* for infrastructure related to protection and other purposes (e.g. FD, Coast Guard)
- (5) *Buffer zone* along land boundaries of Sanctuaries and Impact Zone, allowing only sustainable resource use, but not hunting.

### 6.3 Boundary demarcation

A zoning system works only when all users know the boundaries. Therefore, information materials have to be prepared in Bengali explaining the different zones, using maps and listing names of canals and areas of the different zones. Clear signs have to be located along the boundaries and specific management zones. Clearly visible buoys should be used to indicate boundaries in waterways and closed canals. The possibility of tiger fence to reduce tiger incidents along some of the northern boundaries may be studied.

### 6.4 Vegetation survey

Vegetation composition is a useful indicator of habitat characteristics. Therefore, vegetation classification and mapping is an essential tool for the planning, monitoring and research in protected areas (see also 6.1 (1), 2.4 and 6.5). Vegetation maps are the main tool for zoning and protected area system evaluation. Elaborated forest surveys have been carried out in the mid 1980s and mid 1990s. The results of these surveys are an excellent database for the above purpose.

An ecosystem component that needs more attention is the herb/grass stratum of the vegetation, in order to understand its potential and constraints for herbivores. It is recommended to expand the existing vegetation classification based on trees with the characteristics of the herb layer. A stratified sampling method, using the Londo Aerial Cover

Estimation, is efficient and convenient for this purpose. The contribution of a local plant taxonomist and the establishment of a field herbarium in Khulna are crucial for this activity.

## 6.5 Review of sanctuary boundaries

### *New North Sanctuary*

The Integrated Forest Management Plan (GoB/WB 1998) contains the following statements:

- (1) "The main thrust of biodiversity conservation in the Sundarbans shall be the preservation of the forest habitat and wildlife at the sanctuaries."
- (2) "The second thrust is to declare and integrate Compartments 1 & 2 into the protected area system to expand the coverage of conservation areas and to achieve a better representation of vegetation types."

The main objectives for sanctuary extension are:

- better biodiversity conservation by having a better representation of different habitat types in the sanctuaries,
- better protection of areas of specific interest such as nesting sites,
- more compatible with a resource use system shifting towards tourism.

A proposal for the sanctuary extension mentioned above has been prepared, submitted but not yet approved. However, there is a strong human pressure on compartments 1 and 2, and it appears likely that closing the entire Eastern Sundarbans by sanctuaries may degrade further the public relations. It would actually locate "the buffer zone" inside and the core zones along the boundary of the conservation area. Moreover, it is not evident that compartment 1 and 2 add significantly in terms of biodiversity to the existing sanctuary system.

A number of alternative sanctuary extensions have been suggested (Table 5). A simple analysis has been carried out comparing areas of different Forest Types (FRMP/RIMS) among the sanctuaries and the different extension options. Assuming that Forest Type variation correlates with biodiversity, it is plausible that option "North C" (compartment 25-28) add more than option "East Extension (comp. 1 and 2), and that the options "North A" (Comp. 29-31) and "North B" (Comp. 29-33) add even more than option "North C".

In Compartment 30 and to a lesser extent in compartment 31 vast glades are found, clearings covered with grasses (the dryer parts), or reeds and Typha (the wetter parts). This vegetation type is unique in the Sundarban and the area is diverse in amphibians, reptiles, birds and insects, and therefore a proposal for the establishment of a bird sanctuary has been submitted earlier. This vegetation may, moreover, also be appropriate habitat for the reintroduction of some extirpated species such as rhino, buffalo, swamp deer and marsh crocodile (see section 5.10). The various attributes of the area make it attractive for tourism and its location near the Karamjal visitor center and Mongla guarantees accessibility and facilitate protection.

A problem related to the establishment of a sanctuary in the North of the Sundarban is that this area has the highest abundance of Sundri, the main commercial tree species. To make this extension politically achievable after an eventual lifting of the ban on timber exploitation, it could be considered to make special arrangements for allowing low impact logging of only



this species. As the area has no large waterways, classifying this area as Sanctuary will not cause a significant limitation to fishery.

During the Wildlife Management workshop (Communica 2003) it was agreed by all participants that the establishment of a in the area described is desired for an improved protection area system in the Sundarban.

Table 7. Comparison of different sanctuary extensions using Forest Type areas

AREA (in ha)	Extension options				Existing sanctuaries		
	North A	North B	North C	East Extension	East	South	West
Compartments	29, 30, 31	29, 30, 31, 32, 33	25-28	1, 2	4, 5, 6	43, 44	53, 54, 55
Total	16,102	26,982	16,729	16,347	19,625	20,094	36,768
Others	380	407	493	922	1,010	1,334	1,784
Goran Gewa	0	0	0	0	0	566	25,391
Goran	0	0	0	0	0	335	5,388
Gewa Goran	0	0	0	0	30	4,212	3,252
Gewa Sundri	341	464	4,196	5,966	7,210	4,796	261
Gewa/Gewa Mathal	0	0	12	1,307	1,926	1,060	412
Keora	42	139	311	871	898	1,028	246
Passur Kankra/Passur Kankra Baen/Baen	154	327	79	0	77	106	0
Sundri Gewa	3,285	5,959	8,079	5,439	8,084	6,658	0
Sundri	11,186	14,712	3,559	1,844	389	0	2
Sundri Others	714	4,975	0	0	0	0	32

#### Merger of West and South Sanctuary

It is proposed that FD takes into consideration the merger of Sundarban West and South Sanctuary (section 4.1). Such a merger appears to be logistically feasible and it would release resources (e.g. 1 ACF, logistics) for the management of the proposed North Sanctuary. During the Wildlife Management workshop (Communica 2003) it was concluded by the participants that this merger should not be prioritized to improve the protection area system in the Sundarban.

#### 6.6 Vegetation/habitat management interventions

Carrying capacity is a theoretical concept that cannot simply be assessed or calculated as suggested in the work plan of the previous Sanctuary Conservation Management Plan (Rosario 1997), because it depends on numerous fluctuating biotic and a-biotic variables. The carrying capacity for specific species may be increased by management intervention (e.g.

planting, burning, grass cutting). Conversely however, this may reduce habitat quality for other species. Moreover, the Sundarban ecosystem is characterized by its ecological dynamics itself and interventions may have a limiting effect on natural processes such as succession. The main management objective of the Sundarban Sanctuaries is the conservation of a natural ecosystem and not to create a human made environment for the reproduction of artificially selected species (in other words a farm). Therefore, it is recommended to limit human interference. Targeted measures should be (a) justified by ecologically sound objectives, (b) related to the reduction of external impacts, (c) or related to management of certain species with a particular conservation focus, and (d) monitored.

The following guidelines are recommended for habitat interventions (see Table 8 for management prescription matrix):

### (1) Planting

Planting could be used in areas of strong human influence (mainly in Special Use Zone):

- to mask infrastructure,
- to camouflage observation sites,
- to prevent erosion on sites that are intensively used by people,
- generally to improve the environment of FD field stations.

### (2) Grass cutting

Grasslands provide the best food for grazers such as spotted deer in terms of quality and quantity (Schaller 1967, Geist 2000). Browsing of tree leaves is usually having less preference because of tannins. Cutting of perennial grasses induces regrowth of leaves of high nutritious value during the dry cold season. Moreover, it suppresses tree encroachment and thus inhibits successional shift from grassland to woodland. In the Sundarban there are four types of grasslands: (a) grassland along the land accretion side of canals, (b) grasslands along higher erosion sides of canals, (c) grassland on beach wall and valleys along the seaside, and (d) grasslands in the freshwater back swamps (glades or bheels) in the North of the Sundarban. Cutting grasses along canals (grassland type a and b) should be avoided, as it would reduce accretion. Controlled cutting of the beach wall and valley grasses (type c) will favour deer and also several bird species (e.g. blue tailed bee-eater) in that area. Therefore, the grass cutting should also be continued in the Sanctuaries and Production Zone. The back swamp grasslands (type d), are not occurring in the present Sanctuaries, but do occur in the proposed North Sanctuary and grass harvesting should also be continued here. To maintain the grasslands it is essential to remove all encroaching trees. Some trees may be left on sandy beach walls to prevent erosion. Grass cutters have to be obliged to cut also grass patches of no commercial interest. Grass cutting should be implemented annually in the beginning of the dry season.

### (3) Vegetation burning

Vegetation burning should be limited as forest fires have detrimental effect on mangrove species, which are usually not fire resistant. Generally it is used to remove the grasses, which are not commercially exploitable. To maintain grasslands it may be needed to use fire for

removal of tiger fern, if this species appears to be invasive. Fire should only be applied in the cold season with low wind velocities and the use of firebreaks is needed. Vegetation monitoring is essential to determine if fire management is the appropriate tool. In many cases tiger fern seems to occupy hydromorphic soils that are less convenient for grasses, in which case intervention is not desirable.

#### (4) *Nypa* collection

Discontinuing *Nypa* collection inside the Sanctuaries is recommended as this activity disturbs wildlife along shores of the canals, may increase erosion and complicates control.

#### (5) *Selective thinning*

The larger terrestrial herbivores (particularly deer) tend to have a preference for open areas, particularly for resting. Gewa forests appear to be preferred over Goran forests. On an experimental basis selective thinning could be applied (not close to canals), removing Goran in limited areas (2500-5000 m<sup>2</sup>) in order to shift the vegetation composition in favour of Gewa, creating open spaces in the forest and secondary vegetation. Monitoring is eminent.

#### (6) *Water holes*

If studies show that water is a limiting factor for wildlife, the establishment of water holes/ponds is a simple and low risk method of increasing the carrying capacity of the area. Mapping of existing water holes is required and a plan for water hole digging should be prepared.

#### (7) *Water management*

Freshwater habitat is found in the North of the Sundarban. Due to the increasing salinity of the Sundarban, there is a risk of decrease of this area or even complete disappearance. On experimental basis and on a limited scale interventions could be undertaken to develop a conservation method for this freshwater habitat. For this purpose in and out flow of water in these areas should be controlled. However, the risk should be taken into account that siltation reduction may lead locally to a relative decrease of land level on the long term. *Phragmites* is attributed to reduce soil salinity and accelerate siltation and therefore, the proliferation of this grass species should be stimulated.

The licence models for all modes of harvest of forest products need to be reviewed in the context of an integrated management plan and measures may have to be included to reduce ecological impact.

## 6.7 Production zone management

The management of the production zone should be as much as possible compatible with the requirements of wildlife. This implies (see Table 8 for prescription matrix):

- maintenance of the pioneer vegetation on newly accreted land,
- reduced impact logging,
- no planting of exotic species such as Eucalyptus,
- limiting fencing and other obstructions,
- limiting plantations,
- creation of water holes,
- continuation of grass harvest in the fresh water back swamps,
- reinforce turtle excluding device of fishing nets,
- closure of certain waterways for fishing (see fisheries management plan).

## 6.8 Wildlife protection strategy

Kumar and Wright (in Seidensticker 1999) mention the following points being crucial for effective poaching control:

- appropriate working/living conditions and incentives for field staff,
- to give priority to control trade and focus law enforcement particularly on big traders,
- to make sure that offenders are convicted,
- to inform the market,
- to offer alternatives to local communities involved in poaching.

The current wildlife protection strategy implemented by the Sundarban East and West Division and EMD is principally characterised by:

- daily patrols by boat from all centres and stations,
- checking outgoing boats at all entry/exit stations of SRF,
- search of houses and other locations in collaboration with police after receiving information on offences.

Improvements for the wildlife protection capacity are described in chapter 4. The following measures would enhance the effectiveness of the protection system:

- daily foot patrols of 3 – 5 km in areas with high poaching risk,
- night patrols by boat,
- establishment of an information network in the Impact Zone with incentives for information leading to disclosure of offences,
- searching of markets by joint police – FD teams,
- improved cooperation with Indian law enforcement services in the border area.

A prerequisite for effective protection is assuring that offences are followed by sanctions in all cases. In many cases this is not achieved. Active collaboration between forest staff, police and juridical authorities is required to improve the effectiveness of law enforcement.

A good relationship between FD and surrounding communities will generally facilitate law enforcement. This is achieved by avoiding unnecessary harassment and false prosecution, and moreover, by actively developing public relations, public awareness and creation of employment related to conservation and tourism.

## 6.9 Tourism management

Tourism management is important in relation to wildlife conservation for the following reasons:

- (1) to make the educational and recreational value of wildlife accessible to the public;
- (2) to generate revenues (directly by entry fees and indirectly by its economic multiplier effect) that can cover cost of sustainable management of wildlife and that justifies public expenses for conservation;
- (3) to limit the impact of the presence of tourists and tourism related infrastructure and activities on wildlife and the environment.

The most important issue that has to be addressed in a wildlife management plan is limitation of tourism impact (reason 3). The most common measures that are taken in this regard are: (a) zoning, (b) regulations for tourism movement and behaviour, and (c) reduction of impact (e.g. pollution and noise) from tourism infrastructure, circulation and transport.

A strategy for tourism development in the Sundarban is described in the Tourism Recreation and Ecotourism Management Plan for the Sundarban Reserve Forest (Chaves 2002). The document mainly focuses on improvement of marketing and service for eco-tourism in order to increase revenues, and also addresses a number of mitigating measures. The following sections of this plan are directly relevant for the reduction of impact to wildlife and environment:

- Tourism policy and strategy,
- Code of Conduct for Tourists,
- Code of Conduct for Tour Operators,
- Limiting criteria for tourism facilities (e.g. guest houses),
- Standards for tour operator licences to be renewed annually,
- Promotion of riverine tourism only,
- Establishment of restricted zones for tourism,
- Eco-guidelines for land use, design, construction, layout and materials of physical facilities and service infrastructure of the Sundarban Forest,
- Operations regulations and environmental management,
- Waste collection, disposal system and noise pollution.

Further development of the following aspects is needed:

- (1) an elaborated but comprehensive zoning plan addressing tourism, biodiversity conservation, and resource extraction in an integrated way;
- (2) a sound policy and strategy to deal with the increasing tourist numbers (mainly domestic).

Guidelines for infrastructure development in Bangladesh protected areas are developed in the context by FSP (TECSULT 2001).

## 6.10 Public awareness

Public awareness activities are an essential support for conservation. The DFO Wildlife and Tourism has to be involved in the development of a public awareness strategy of LEE. Specific issues to be addressed:

- the importance of the Sundarban Forest as an economic resource and the role of conservation,
- the relation between illegal wood extraction and degradation,
- the use of different fishing devises in relation to conservation of turtles, sea snakes and crocodiles,
- the tiger human conflict,
- zones and boundaries,
- endangered species,
- pollution.



## 7. MONITORING AND REVIEW

### 7.1 What and why of monitoring

Monitoring is the regular assessment of the state of a specific subject (ecosystem, management system). As indicated in Section 1.3, monitoring is a crucial link in an adaptive management process, allowing adjustment of the management system based on learning. The following aspects may be subject to monitoring (Hockings 2000):

- (1) degree of achievement of management objectives (effectiveness),
- (2) management/implementation (efficiency),
- (3) threats and impacts.

Wildlife and habitat monitoring are used to assess the effectiveness (1) of the management system.

The efficiency of management (2) can be monitored at financial and operational level. The most usual approach for management monitoring at financial level is comparing expenditures and budgets. At operational level, statistics on the number of patrols, arrests, and other field activities are adequate variables to be evaluated. Management monitoring using these indicators should be included in the FD reporting system.

### 7.2 Wildlife monitoring

Wildlife monitoring results are used to identify population trends in relation to management systems, measures and external factors. Two data sources are commonly used for wildlife monitoring: (a) regular and systematic surveys, and (b) recorded sighting data (staff, visitors).

Specific foci of a monitoring programme are the effectiveness of conservation of endangered or rare species such as tiger, crocodile and finfoot and ecologically associated species such as deer. Monitoring techniques for tiger, deer, crocodile and marine mammals are in development (Deodatus & Ahmed 2002, Smith et al 2002 – see also chapter 5 and section 7.3). Crocodile monitoring has been described in (Halder & Deodatus 2002 and section 5.4.7).

Birds are of particular interest for the monitoring of the state of the ecosystem and its biodiversity as:

- bird populations have a quick response to ecological changes because they have the option to move easily,
- it is a taxonomic group with a high niche variety of the different species,
- relatively easy to detect.

It is therefore suggested that bird surveys, not targeting particular species, but covering all bird species, be an integrated component of the BCM of Sundarban Forest (section 7.7). For species of particular interest such as eagles and finfoot, special studies may be required in relation to specific conservation programmes.

In some cases (e.g. tiger, dolphins, crocodiles) it may be necessary to apply specific monitoring methodologies for specific species for technical reasons (low population density, aquatic life form). In many cases, however, it is possible to use methods, such as direct transect counts, footprint counts and pellet counts that cover a number of species at the same time. Indirect counting methods are generally recommended for terrestrial animals in the Sundarban, because of limited visibility and accessibility.

### 7.3 Monitoring of terrestrial mammals combined with PSP data collection

Systematic monitoring of wildlife requires a lot of resources, logistics and manpower. Therefore a methodology needs to be applied, which is simple and cheap. At present FD monitors every five years the structure and composition of the woody ecosystem component, collecting data from 120 permanent sample plot (PSPs) dispersed in different vegetation types in the Sundarban. By using these locations for the monitoring of mammal species (e.g. deer, boar, tiger) existing logistics and manpower can be used. Moreover, other data from the PSPs would increase the dimensions of the analysis.

Data have to be collected according to the methodology developed by WTD (Deodatus & Ahmed 2002, Feeroz & Deodatus 2002), using 20 X 10 m plots to determine the relative abundance of mammal tracks and defecations. At each PSP site 4 plots have to be sampled, located within 30 m in 4 different directions of the PSP. PSP forestry data are collected every 5 years, but it is recommended to sample these sites at least every 2 years for wildlife.

### 7.4 Sighting records

Since December 1999 the FD has introduced a notebook including standard forms for the recording of wildlife observations by field staff in the Sanctuaries. The form covers the following fields: (1) date, (2) species, (3) no. of male, (4) no. of female, (5) total no., (6) no. sub-adult, (7) no. of juvenile, (8) no. of new born, (9) time of observation, (10) place, (11) name observer, (12) remarks. Later the format has been expanded with the following fields: (13) vegetation type and (14) geographic coordinates. The system should be used in stations all over the Sundarban and provides a very valuable additional tool to monitor the distribution of the larger animals species. Crucial is regular collection of data from the field stations. Moreover it is important to give the field staff feedback on the results in the form of a very small and simple booklet presenting tables and graphics that could be issued every year.



## 7.5 Habitat monitoring

Several habitat features require monitoring (see Feeroz & Deodatus 2002 for survey methods):

- (1) *Succession of grasslands.* A fixed line intercept method in selected areas is the simplest method to be applied. Mapping is another possibility, which requires however significantly more resources. Special attention is needed for encroachment of tiger fern and tree encroachment.
- (2) *Succession in woody vegetation.* Existing PSPs constitute an excellent tool, which should be complemented by RS/GIS analysis. The SBCP Data Unit and RIMS should implement this activity.
- (3) Changes in *vegetation cover* and *erosion/accretion*. For this purpose satellite images are nowadays the cheapest option. A time series of 1996, 2001 and 2006 multi-spectral images allows analysis of changes in vegetation occupation, vegetation structure and lateral movement of rivers. The SBCP Data Unit and RIMS should implement this activity.
- (4) Specific monitoring for *keystone species* (e.g. baen for tiger habitat, keora for deer, generally large trees such as Sundri for birds). Density measurement using Nearest Neighbour sampling (Moore & Chapman 1986) or GPS are the most efficient approaches for this purpose.
- (5) *Water quality.* SWMC is developing a water monitoring system, involving water quality and salinity, which is very crucial for monitoring environmental threats (see also section 7.6).

To facilitate integrated analysis of monitoring outputs, it is recommended to concentrate habitat monitoring activities targeting ecological trends and threats, where possible, in three selected sampling areas, which represent most of the aspects of the Sundarban ecosystem:

- (a) Jongra-Andaria, which represents the freshwater zone and which is characterised by the presence of fresh water back swamps;
- (b) Katka-Kochikhali, which is located in the medium saline zone and where specific marine vegetation types and soils are found (beach walls, grasslands);
- (c) Notabaki, located in the high salinity zone, characterised by Goran vegetation types.

## 7.6 Monitoring of threats and impacts

The monitoring of threats and impacts enables anticipating management measures (section 2.7):

- (1) At animal level, occurrence of diseases and mortality changes are the main indicators used (to be included in the FD reporting system), but also the presence of specific indicator species is possible in some cases (see BCM, section 7.7).

- (2) Water quality needs to be measured to assess pollution and salinity levels. A system of water quality monitoring including indicators and methodology will be one of the expected outputs from the SBCP/SWMC study (Bhuiyan et al 2001). For wildlife mainly heavy metals and toxic hydrocarbons are relevant.
- (3) Effects of ecological changes and land use on the habitat are monitored by direct observations on the vegetation and terrain and by using remote sensing techniques (see also section 7.5 (3)).

Newly planned activities expected to have an impact on the Sundarban, such as gas exploitation, rural development projects and other, should be accompanied by an EIA, resulting in funding for conservation activities if evidence is found of negative impacts on wildlife.

### 7.7 Independent biodiversity conservation monitoring

The SBCP inception report provides for independent Biodiversity Conservation Monitoring. The ADB has assigned the task to develop BCM system to IUCN Bangladesh (Anon. 2001c). The BCM system aims at assessing the evolution of the general status of the Sundarban ecosystem, using the occurrence of species as an indicator, without a focus on specific management measures. The adopted methodology provides for the identification of a number of indicator species, which enable a simple, feasible and adequate monitoring methodology.

The most important contribution of this activity is its wide focus, as it is not limited to a few species that have been prioritised in relation to management measures. Incorporation of BCM outputs during the wildlife management plan review phase would therefore enhance the quality of the wildlife management system. Furthermore it could act as an early warning system for major ecological changes.

In practice, however, it will be difficult to develop BCM and management oriented monitoring separately, because

- it has to be implemented by the same people (FD) as management oriented monitoring,
- resources for implementation are limited after SBCP phases out, and
- there is a significant overlap of species to be monitored both monitoring approaches
- BCM is only relevant for management purposes when the relation between biodiversity, ecosystem dynamics and management is clear.

It is therefore strongly recommended to strive for joint development of both.

### 7.7 Management plan review

SBCP Internal Notes 38 (Zon 2001) proposes a review cycle of 10 to 15 year. Several handbooks for protected area management however recommend shorter review cycles. MacKinnon et al (1986), Sutherland (2000) and Rabinowitz (1997) recommend 5 years, and Van Lavieren (1982) recommends 4 years. The Sundarban Forest Management Planning cycle has been 10 years for decades, but the Sanctuary Conservation Management Plan has a

5-year cycle. It is eminent that a consistent and practicable cycle is adopted for all management components.

During the FD consultation meeting in April 2002 and the Wildlife Management Planning Workshop (Communica 2002) it was suggested that during the initial implementation of the plan sufficient flexibility is needed to integrate (a) new views resulting from studies, (b) management experiences and (c) integration requirements related to other sectors. This flexibility should be provided in an adaptive management framework with a five-year review cycle of the management plan, leaving sufficient space for adjustments in the annual work plans. The current Wildlife Management Plan is legitimate until its next review.

## 8.2 Special actions to enhance the management system

During the wildlife management planning workshop in November 2002 a number of priority actions were determined to enhance the current wildlife management system (Communica 2003). The actions are grouped in four different categories and presented in tables 9 - 12.

Table 9. Special actions related to capacity and institutional development

Issue	What/How	When	Who (action, funding)	Monitoring Indicator
Training	<ul style="list-style-type: none"> <li>▪ For training programmes see section 4.3</li> </ul>	On-going from 2002	SBCP, other projects	Increased job performance measured through reviews
Improvement of field staff remuneration & living conditions	<ul style="list-style-type: none"> <li>▪ Salary suppletion (special allowances)</li> <li>▪ Travel allowance)</li> <li>▪ Safe Water</li> <li>▪ Improved free housing including sanitation and medical care</li> <li>▪ 3 Monthly leave</li> </ul>	End 2002	Minister MOEF (GoB), Paper to be prepared by SBCP	Better mental + physical health, Improved work efficiency
Institutional issues	<ul style="list-style-type: none"> <li>▪ Integrate 3 wildlife divisions (EMD, WTD, NCWD) by Govt. Decree.</li> <li>▪ Staff and equip</li> <li>▪ Define rules/responsibility</li> <li>▪ Sanctuaries entirely managed by Wildlife division</li> <li>▪ New wildlife division responsible for all wildlife tasks in entire Sundarban</li> </ul>	June 2003	Minister (MoE) Assisted by (GoB + SBCP)	One wildlife division functioning well
Institutionalise bio-diversity monitoring into F.D operations	<ul style="list-style-type: none"> <li>▪ Baseline survey on biodiversity</li> <li>▪ Ecosystem assessment</li> <li>▪ Establish and institutionalise a monitoring system including training</li> </ul>	2002-2006	IUCN (GEF), universities & other relevant institutes	Reports Acceptance
Authorization of wildlife division to use revenues	<ul style="list-style-type: none"> <li>▪ Revenue collection from tourism, etc. available for operation of Karamjal and other conservation related activities</li> <li>▪ Sustainable financing system for wildlife &amp; tourism facilities and programmes</li> </ul>	ASAP	Paper Prepared by FD/SBCP and approved by GoB	Revenue increased and available

Table 10. Special actions related to species management and research priorities

Issue	What/How	When	Who (funding, action)	Monitoring Indicator
Tiger research	<ul style="list-style-type: none"> <li>▪ Determine tiger population status (survey)</li> <li>▪ Determine prey species (survey)</li> <li>▪ Determine tiger habitat requirements/ecological study</li> <li>▪ Find out the threats of tiger and prey</li> </ul>	2003 - 2006	FD, SBCP, universities	Tiger & prey population trends
Tiger management	<ul style="list-style-type: none"> <li>▪ Establish wildlife control unit</li> <li>▪ Compensation system for human casualties by tiger outside forest</li> <li>▪ Awareness program</li> </ul>	End 2003	FD, NGOs	Reports, no. of incidences Receipts/records human attitude change Attitude/animosity change observed
Management of other species	<ul style="list-style-type: none"> <li>▪ Separate action plans under management plan for focus species</li> <li>▪ Individual species management programs for tiger, spotted deer and dolphins first, and for birds, monitor lizard, barking deer, and wild boar later.</li> <li>▪ Habitat improvement</li> </ul>	2003 - 2004 2004 - 2006	FD	Species population trend (status)
Animal health care	<ul style="list-style-type: none"> <li>▪ Coordination with Khulna and Dhaka Zoo.</li> <li>▪ Rely on natural resistance forces, no vaccination</li> <li>▪ Monitoring of diseases</li> </ul>	June 2003	FD Wildlife Division	Population trends, mortality reports
Options for reintroduction of extinct species	<ul style="list-style-type: none"> <li>▪ Is habitat of the species to be reintroduced sufficiently available?</li> <li>▪ Feasibility study</li> </ul>	2003 - 2006	FD, universities, research organizations	Feasibility report, reintroduction plans
Protection and rearing of threatened species	<ul style="list-style-type: none"> <li>▪ Protection of egg/young turtle, crocodiles, etc.</li> <li>▪ Rearing/restocking of crocodiles</li> </ul>	2003 and onwards	FD Wildlife Division	Species population status trend

Table 11. Special actions related to habitat management priorities

Issue	What/How	When	Who (funding, action)	Monitoring Indicator
New sanctuary in the North	<ul style="list-style-type: none"> <li>▪ Feasibility study,</li> <li>▪ survey, preparation of proposal &amp; Government approval,</li> <li>▪ Notification</li> </ul>	Dec. 2003	FD Wildlife Division, SBCP, MoEF	Feasibility Report Proposal Notification
Creation of buffer zone	<ul style="list-style-type: none"> <li>▪ Sanctuary bordering Human settlements need buffer zone</li> <li>▪ Case study</li> <li>▪ Incorporation in North Sanctuary Conservation Plan</li> </ul>	Dec. 2004	FD Wildlife Division, SBCP Data Unit	Sanctuary plan
Demarcation of sanctuaries into functional zones	<ul style="list-style-type: none"> <li>▪ Study and develop sanctuary zoning plan</li> </ul>	Dec. 2004	FD Wildlife Division, SBCP	Zoning Plan
Habitat Management Intervention + for Mgt.	<ul style="list-style-type: none"> <li>▪ Zoning plan and management prescriptions</li> </ul>	Dec. 2004	FD Wildlife Management, SBCP Data Unit	Management prescription matrix integrated in zoning plan
Evaluation of potential economic benefits	<ul style="list-style-type: none"> <li>▪ Economic, financial analysis</li> </ul>	Dec. 2004	SBCP	Reports

Table 12. Special actions related to coordination, participation, cooperation legislation and monitoring

Issue	What/How	When	Who (funding, actions)	Monitoring Indicator
Local participation and community awareness	<ul style="list-style-type: none"> <li>▪ Policy on participation</li> <li>▪ SAC formation</li> <li>▪ User's Institution Building</li> <li>▪ Workshop (Village, Union, Upazila level)</li> <li>▪ Development of flipchart, preparation of leaflet</li> <li>▪ Use of Mass media document, Audio cassettes on fisheries, plants and wildlife</li> <li>▪ Awareness training</li> </ul>	Dec. 2002 On going It is going on	FD LEE, SBCP	<ul style="list-style-type: none"> <li>▪ Formation of SAC</li> <li>▪ Report</li> <li>▪ Do</li> <li>▪ Documents, Meeting,</li> <li>▪ Minutes,</li> <li>▪ Monthly reports</li> <li>▪ Dissemination of Media Equipments</li> <li>▪ Training report</li> </ul>
Promotion of Alternative Livelihood	<ul style="list-style-type: none"> <li>▪ Generation of alternative lively hood for SRF resource extractor</li> <li>▪ Provision of Micro credit, training, awareness,</li> <li>▪ Entrepreneurship</li> <li>▪ Proper law enforcement</li> </ul>	On going	SBCP	<ul style="list-style-type: none"> <li>▪ Training Module, training report</li> <li>▪ Disbursement of Micro credit</li> <li>▪ Training</li> <li>▪ Skill development</li> </ul>
Amendment and enforcement of existing law	<ul style="list-style-type: none"> <li>▪ Provision of reward and punishment should be made</li> <li>▪ Compensation provision should be made</li> <li>▪ Delegation of authority to local offices to plough back of revenue for maintenance and development</li> </ul>	As early as possible	Ministry of Environment and Forest	<ul style="list-style-type: none"> <li>▪ Declining of Poaching</li> <li>▪ Compare record verification</li> <li>▪ Improvement/ Management of assets</li> <li>▪ Amendment of law</li> </ul>
Collaboration with other agencies	<ul style="list-style-type: none"> <li>▪ Study and research conducted by research institute, Universities, NGO's, IUCN, IWM</li> </ul>	On going	SBCP/FD (ADB)	<ul style="list-style-type: none"> <li>▪ Contract made</li> <li>▪ Report produced</li> </ul>
Monitoring and evaluation	<ul style="list-style-type: none"> <li>▪ Coordination meeting</li> <li>▪ Report preparation</li> <li>▪ Workshop</li> <li>▪ Field verification</li> </ul>	On going	SBCP, Partner organizations	<ul style="list-style-type: none"> <li>▪ Meeting held</li> <li>▪ Workshop held</li> <li>▪ Field verification</li> </ul>

### 8.3 Monitoring

A variety of monitoring activities will be carried out, in which several FD structures have to collaborate (Table 13).

Table 13. Schedule for wildlife management related monitoring

Species	Method	Coverage	Frequency	Responsibility	Section reference
Tiger	river crossing	Sundarban	5 year	Wildlife Division	5.2.7, 7.2
Tiger	river crossing	East, West and North Sanctuaries	1 year	Wildlife Division	5.2.7, 7.2
Terrestrial mammals	track and defecation survey	PSPs and selected sites in under represented vegetation types	2 year	Wildlife Division	5.3.7, 7.2, 7.3
Crocodiles	spotlight	Sundarban	5 year	Wildlife Division	5.4.7, 7.2
Crocodiles	spotlight	East, West and North Sanctuaries	2-3 years	Wildlife Division	5.4.7, 7.2
Birds	boat survey	East, West and North Sanctuaries	5 year	Universities, IUCN, Bird Society	5.7, 7.2
Turtle nesting	monitoring of nests	Mandarbaria, and eventual other nesting areas	1 year	Wildlife Division	5.6.7, 7.2
Turtle, crocodile and dolphin mortality	questionnaires for fishermen	entire Sundarban with special focus on Marine zone	1 year	ARD	5.4.7, 5.5.7, 5.6.7, 7.2
Marine mammals	boat survey	Sundarban	2 year	University scientist, Wildlife Div.	5.5.7, 7.2
Sighting records	data recording in forest stations	Sundarban	continuously	Data Unit	7.4
Wildlife mortality	station reports	Sundarban	continuously	Wildlife Div. assisted by SED, SWD	7.6
BCM	to be determined by IUCN	selected sites	to be determined by IUCN	to be determined by IUCN	7.7
Grassland succession	RS/GIS, vegetation survey		4-5 year	Data Unit, RIMS	6.4, 6.6, 7.4, 7.6
Woody vegetation succession	RS/GIS, PSP data collection	PSPs	5 year	Data Unit, RIMS	6.4, 6.6, 7.4, 7.6
Erosion/accretion	RS/GIS	Sundarban	4-5 year	Data Unit, RIMS	7.4
Plant keystone species	PSPs, vegetation survey		to be determined	Universities	7.4
Water quality	to be determined by IWM	to be determined by IWM	to be determined by IWM	to be determined by IWM	7.4, 7.6





## 9. FUNDING

### 9.1 Previous estimations for wildlife management funding

Leader Williams (1990) states that app. US\$ 400 per km<sup>2</sup> is annually needed for conservation of large mammals in protected areas. This estimation is not far from estimates of conservation costs in SRF (Anon. 1998). Accordingly, the implementation of a wildlife management plan for the Sundarban Forest (6000 km<sup>2</sup>) would cost annually Tk 140 million (US\$ 2.4 million), which would imply that at present approximately US\$ 3.5 million would be needed annually for a 5-year wildlife plan, taking into account an inflation rate of 2.5 %.

Three organisations have estimated financial requirements for the management of wildlife resources in the near past:

- Within the framework of the SBCP project planning, ANZDEC (Anon. 1997) estimated US\$ 10 million for a 10 year wildlife plan (=US\$ 1 million /year),
- UNDP/FAO (1998) estimated US\$ 2.1 million for a 5 year plan (= US\$ 0.42 million /year),
- The World Bank (1997) estimated US\$ 6.7 for a 5-year plan (= US\$ 1.34 million /year).

In comparison to this, the financial allocation directly earmarked for the current SBCP Wildlife Component (section 9.3) is quite limited.

### 9.2 Budget requirements of the Wildlife Management Plan

Detailed budgeting of wildlife management is complicated, as it is often not possible to isolate wildlife activities from other FD tasks (Forestry, Fisheries, Tourism, Resource extraction) at implementation level. Broadly four types of expenses are involved:

#### (1) Operational expenses (salaries, logistics and supplies)

The main proportion of this component would cover the operation of the Division responsible for implementing wildlife management that is EMD, WTD or WCNCD. ANZDEC (Anon. 1997) estimated an annual budget of Tk 26,113,333 (US\$ 460,000) from 1997 to 2005.

#### (2) Infrastructure and logistic investments

Total requirements for equipment and logistics (Appendix 4) are very roughly estimated at Tk 31,350,000 (US\$ 550,000). A detailed inventory is needed after completion of the institutional process to produce a more precise figure, based on actual requirements and current stock.

*(3) Research and monitoring*

An initial estimate for required research funding for SBCP is assessed at Tk 20,000,000 (US\$ 344,000) for 5 years. This is not including supplementary funds for tiger research not covered by SBCP (app. Tk 23,200,000 – US\$ 400,000 for 4 years) and Biodiversity Conservation Monitoring. Funding requirements for research & monitoring on birds, marine mammals, and reintroduction are not yet included in this estimate.

*(4) Capacity building*

Field training costs for field staff are estimated at Tk 4.3 million (US\$ 75,000) and for overseas training of 1 DFO and 4 ACF an amount of Tk 5.8 million (US\$ 100,000).

### 9.3 Existing and expected funding sources

At present the following budgets are available for wildlife management implementation, wildlife studies and monitoring:

*(1) Government of Bangladesh Revenue Budget*

At present no direct costs for wildlife management are covered by the Government Revenue budget. The EMD has always been on the development budget covered by WB and has now been suspended. Some GoB funding has continued to resume the FRMP-breeze project.

*(2) SBCP/ADB loan budget*

The SBCP provides funds for infrastructure and equipment, but app. US\$ 23,000 (out of US\$ 50 million) is earmarked for specific wildlife activities in the latest proposed PP.

*(3) SBCP/GEF grant budget*

According to the last (but not approved) version of the SBCP Project Proforma a total amount of 264 lakh Taka (app. \$ 480,000) is available for wildlife training, equipment and field operation. An additional amount of \$ 204,000 is available for research. Only Tk 200,000 (\$ 3500) is provided for field training.

*(4) ADB/IUCN budget.*

The total budget of the BCM component is app. Tk 58 million (US\$ 1 million).

*(5) Other funds*

The US Fish and Wildlife Services granted US\$ 70,000 for tiger research for one year (Tiger Project) and may continue on an annual basis. Other external funds were expected to become available in the near future from the Sundarban Biodiversity Management Project (Two Country Approach), funded by UNF/UNDP and UNESCO. The current projected budget of the Bangladesh component of this project is US\$ 1.5 million for five years, however it appears that the project's donors are withdrawing. Finally, the follow up of World Bank's FRMP project may be starting. The focus of the eventual UNF and WB projects with respect to wildlife is not very clear.

#### 9.4 Funding opportunities

For the long term financial sustainability of the management of the Sundarban (including its wildlife) financial mechanisms should be developed and adopted by the Government that allow partial use of revenues directly for management. The Tourism Management Plan (Chaves 2002) estimates a total revenue of Tk 49 million within 2 years, of which FD would capture 10%. A significant proportion of this amount should be used to cover costs of wildlife management, as wildlife is a primary attribute for tourism.

By involving external institutes such as local and foreign universities in research supplementary funds for research could be mobilised. The current Tiger Project is a clear example. The tiger is certainly an important factor to attract funds, but also other prestigious projects and activities potentially bring about opportunities for external contributions (e.g. reintroduction, crocodile restocking). The proposed research facility (section 4.6) would be a catalyser in this process.

External threats have to be assessed. Newly planned activities expected to have an impact on the Sundarban, including gas exploitation, rural development projects and other, should be accompanied by an EIA, resulting in funding for conservation activities if evidence is found of negative impacts on wildlife.

Other future opportunities are consumptive wildlife utilisation and establishment of trust funds.



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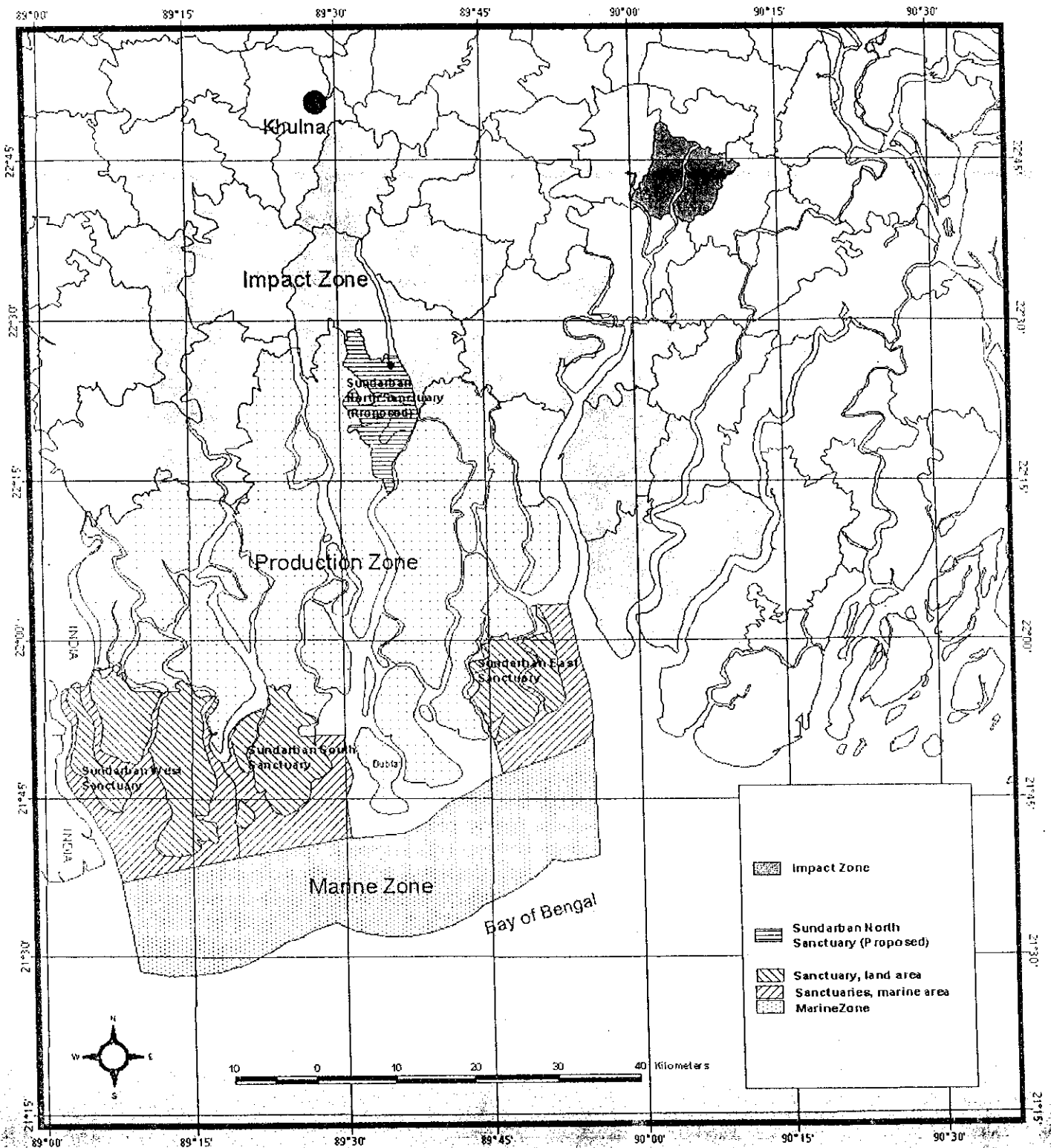
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# APPENDICES

**Appendix 1. Map of the Sundarban Sanctuaries, Production Zone (Sundarban Reserved Forest), Impact Zone and Marine Zone**



Prepared by: GIS Section, Planning Monitoring & Research Unit, SBCP  
Date: February 3, 2002



## Appendix 2. Comparing legal sections of existing and proposed legislation referring to the main issues related to wildlife management

Issues	Forestry Act Sections 1965	Wildlife Act Sections 1974	Proposed Prot. area man. and wildlife Act 1997	Observations
Protection status of land	3, 12 - 27, 28, 35	23, 24	9-20, 33-54	<ul style="list-style-type: none"> <li>WA 1974 recognizes wildlife sanctuaries, national parks, private game reserves</li> <li>FA recognizes reserved forests, village forests, protected forest</li> <li>Village Forest regulations by Provincial Governments</li> <li>Prop. WA 1997 recognizes Nat. Parks, Game sanctuaries, Bird sanctuaries, Game reserves, Closed areas and Safari parks</li> </ul>
Protection status plants and animals		5	21, 25	<ul style="list-style-type: none"> <li>WA covers only crustaceans, amphibians, reptiles, birds and mammals</li> <li>WA does not cover plants</li> <li>No legislation for protection of plant species in present legislation</li> <li>Proposed Act 1997 addresses protection of plants</li> <li>Prop. Act 1997 covers insects, molluscs, crustaceans, vertebrates, except fish</li> </ul>
Procedures to change protection of land and wildlife species	4, 5, 6, 7, 11, 27, 29, 30, 31, 84	23, 24, 46	10 -17, 33-40, 51-54	<ul style="list-style-type: none"> <li>no procedure for changing species schedules in WA 1974</li> <li>Prop. Act 1997 prescribes management plan</li> </ul>
User and other rights of population regarding wildlife	9, 10	8, 21	17	<ul style="list-style-type: none"> <li>since the introduction of the new WA all hunting is prohibited</li> <li>Prop. Act 1997 emphasizes participation in planning</li> </ul>
Procedures on user rights and management related off-take	12 - 20, 32	6, 45	22-24,	<ul style="list-style-type: none"> <li>addressed by notifications and rules</li> </ul>
Rights, limitations use & possession of arms		6, 7, 37	50	<ul style="list-style-type: none"> <li>mainly in Arms Act</li> </ul>
Mandate of wildlife officers and other officers regarding protection	8, 34, 53, 62, 63, 65, 68, 72-75	3, 4, 16, 17, 19, 20, 27, 29, 31, 32, 33, 38, 39, 40, 41, 42, 43, 44	3-8, 70-80	<ul style="list-style-type: none"> <li>MOEF has a wide mandate to adapt legislation by notifications and rules</li> </ul>
Prosecution and penalties	26, 33, 36, 52-69,	26, 28, 29, 30, 34, 35, 36	71	
International conventions				<ul style="list-style-type: none"> <li>The following international conventions were ratified: CITES, CB, Ramsar, WHC</li> </ul>
Financial and fiscal provisions	39-40			<ul style="list-style-type: none"> <li>by notifications and rules, e.g. Rules of Transit</li> </ul>
Protection of persons & property against animals				<ul style="list-style-type: none"> <li>No legal provisions available for wildlife control</li> </ul>
Trade and possession of wildlife products	42	8, 9, 10, 11, 12, 13, 14, 15, 18, 22	26-32, 55-68, Chapter V	<ul style="list-style-type: none"> <li>Proposed Act 1997 has provisions for captive breeding, Wildlife Act 1974 has not</li> </ul>

## Appendix 3. Status (March 2003) of Sundarban wildlife studies and surveys

Study/Component	Activity	Implementation	Planning	Status	Remarks
1.1 Tiger study, Tiger Ecology	Home range size and utilization using GPS-collars	Wildlife & Tourism Division, University of Minnesota	4 years	PhD operational, trapping has started	funded by USFWS, more funding required
1.2 Tiger study, Camera trapping	Population dynamics in selected areas	Cambridge University, Wildlife Conservation International	4 years	PHD completed field work	funded by USFWS and probably UNF, participation of one FD staff cancelled due to shifting of post
1.3 Tiger study, Relative abundance	Tiger foot print surveys covering entire Sundarbans to assess relative abundance using a landscape approach. Tiger monitoring system to be developed	Wildlife & Tourism Division, Data Unit	bi-annually	Methodology developed, staff training started. Main survey complete, final report complete. Some additional surveys in selected areas required	to be repeated every 2 years
1.4 Tiger study, GIS	Integration of survey data and landscape characteristics, investigation of influence of salinity, humans, drinking water, prey abundance	Wildlife & Tourism Division, SMU/Data Unit, University of Minnesota	4 years	one MSc of University of Minnesota operational	integrated as much as possible in Data Unit work plan, but partly executed at University of Minnesota with other funding
1.5 Tiger study, Prey base	Surveys of deer using sloth and dung counts and landscape approach	Wildlife & Tourism Division, SMU/Data	bi-annually	Methodology developed, staff training started. Main survey complete, final report complete. Some additional surveys in selected areas required	to be repeated every 2 years
3.1 Deer study, Distribution and relative density	covered in 1.5	Wildlife & Tourism Division, SMU/Data Unit	bi-annually	Methodology developed, staff training started. Main surveys complete, final report complete. Some additional surveys in selected areas required	to be repeated every 2 years

Study/Component	Activity	Implementation	Planning	Status	Remarks
3.2 Deer study, Habitat utilisation	food preference, habitat preference, diurnal activity cycles in relation to habitat, seasonal activity cycles in relation to habitat, herd composition in relation to habitat, the role of the availability of drinking water in activity cycles.	Jahangirnagar University	Feb – June 2002	Proposal accepted and contracted, fieldwork complete, final report in preparation	follow up needed to cover all seasons
3.3 Deer study, Deer and vegetation dynamics	The role of deer and other herbivores regarding: (1) regeneration of specific tree species, (2) structural vegetation composition, (3) floristic vegetation composition, (4) habitat value of the vegetation.	SMU/Wildlife & Tourism Division, BFR/SD, Bangladesh National Herbarium	July 2001 – October 2002	Data collection complete.	
3.4 Deer study, Population dynamics	partly covered in ToR of activity 3.2	SMU/Wildlife & Tourism Division, Jahangirnagar University	Feb 2002 – June 2003	ToR for complementary study yet to be developed	Will be partly covered by 3.2
4. Wildlife Sightings	Collection of animal sightings in forest stations	SMU/Wildlife & Tourism Division	ongoing, permanent	App. 15,000 data records entered, new data sheets developed.	since Nov. 2001 no more initiatives from implementing services
5. Crocodile survey	Relative abundance of crocodiles in Sundarban Forest	SMU/Wildlife & Tourism Division, TAG	February 2001 – April 2003	Methodology developed, East Sanctuary completed, staff training started.	survey plan included in conservation plan

Study/Component	Activity	Implementation	Planning	Status	Remarks
5.1 Reintroduction study, Current regional herbivore status and stock supply	The current status of the following herbivores in South East Asia: <i>Rhinoceros unicornis</i> , <i>Rhinoceros sondaicus</i> , <i>Bubalis bubalis</i> , <i>Cervus duvauceli</i> , <i>Cervus unicolor</i> , and <i>Axis porcinus</i> . Potential stock populations of these species. A review of reintroduction projects.	IUCN Dhaka	Feb. - June 2002	Final report in preparation,	follow up needed
5.2 Reintroduction study Literature review on habitat requirements	No ToR yet	IUCN, Universities of Dhaka or Jahangirnagar	April- May 2002	No ToR yet, waiting completion of 5.1	
5.3 Reintroduction study Habitat/vegetation survey	A floristic classification of the vegetation in the Jongra area based on trees and herbs A vegetation map (scale 1 : 10,000) of an area of 5 by 8 km, including legend Survey data and statistics, including areas and standing biomass of mapped vegetation units	EGIS, SMU/Data Unit, Bangladesh National Herbarium, Khulina University	November 2001	Survey and analysis completed, final report completed	
6. Sanctuary boundary revision	Comparing representation of vegetation classes in Sundarban Forest components. Should be matching habitat requirements for the reintroduction of extirpated species (act 5.3)	SMU/Data Unit, Wildlife & Tourism Division	results included in management plan	preliminary analysis using RIMS classification completed, field survey covered in activity 5.3	

Study/Component	Activity	Implementation	Planning	Status	Remarks
7. Marine mammals	no ToR yet	IUCN, Wildlife & Tourism Division,	survey in March 2002, follow up in September 2002	first surveys completed in March and September 2002	in cooperation with IUCN input, funding from BCM budget
8. Bird surveys	No ToR yet main outputs required: (1) updated birds checklist including seasonal occurrence, (2) bird monitoring system	WTD, IUCN	not planned yet	experts contacted and supplementary funding searched, mainly included in BCM (IUCN)	partly funded by BCM budget
9. Turtle	Nest protection and recording of hatching success	FD/Wildlife & Tourism Division	ongoing	ongoing, conservation plan completed	not directly supported by SBCP (technically and financially)
10. Habitat classification	As a base for all surveys and monitoring a Habitat classification (ecological zoning) is required, based on the existing RIMS classification, but extended for other habitat characteristics	SMU/Data Unit, SMU/Wildlife & Tourism Division, (and BCM - IUCN)	planning pending completion activity 5.3	methodology developed during activity 5.3 and some data collected	intensive coordination required with activities 1.3, 1.4 1.5, and BCM
11. Species data base	Database development and data entry	SMU Data Unit, University of Dhaka, National Herbarium	Vertebrate and higher plant species data to be entered before June 2002	Structure complete, animal data ready and to be reviewed, plant data entry not yet complete	

**Appendix 4. Staff, equipment and logistics requirements of the Wildlife Division**  
(including North Sanctuary)

Unit	Staff in charge	Logistics	Equipment
DFO Office	1 DFO	launch, 4x4 car, 2 speedboat,	2 VHF, 1 HF, 1 computer, 3 zoom photo camera,
Support Service			2 computers, photocopier, fax
Tourism Unit	to be specified in tourism management plan	to be specified in tourism management plan	to be specified in tourism management plan
Research and Monitoring Unit	1 ACF	DFO vehicles	2 computers, software for statistical analysis and basic GIS, camera traps, GPS collars, 8 GPS, spotlight for night surveys, maps, telescope, 2 binoculars, 1 rangefinder 10 compass, measuring tape, etc.
Wildlife Control Unit	1 Wildlife Ranger	1 pickup car and using DFO speedboat	animal capture equipment, VHF, 6 guns
Sanctuary HQ (4)	4 ACF	4 trawlers, 4 speedboat 25 HP, 4 engine country boat	12 guns, 8 VHF, 4 HF, 4 binoculars,
Wildlife Centres (14)	14 Deputy rangers	14 trawlers	42 guns, 28 VHF, 14 binoculars

**Appendix 5. Staff requirements of the Wildlife Division after proposed integration with other Environment and Wildlife Divisions and excluding the Tourism Unit (North Sanctuary not included)**

	Name of post	Number	
Technical staff	SDFO	1	
	ACF	4	
	Field Investigator (FR)	1	
	Coordinator (DR)	3	
	Deputy ranger	8	
	Wildlife Assistant	3	
	Forester	4	
	Forest Guard	26	
	Wildlife Scout (FG)	5	
	Boat man	20	
	Trawler driver	8	
	Lasker	8	
	Engine man	8	
	MLSS	8	
	Support staff	Head Assistant	1
		Accountant	1
Steno typist		1	
Surveyor		1	
Driver		2	
Speed Boat Driver		3	
Office Assistant		1	
Data Entry Operator		2	
Sweeper		1	
MLSS		3	
Night Guard		2	
TOTAL		125	

## Appendix 6. Operational Guidelines for the Implementation of the World Heritage Convention.

Source: Intergovernmental Committee for the protection of the World Cultural and Natural Heritage, 1999, Doc. WHC 99/2, UNESCO, Paris

### Chapter II. REACTIVE MONITORING AND PERIODIC REPORTING

#### A. Reactive monitoring

68. Reactive monitoring is the reporting by the World Heritage Centre, other sectors of UNESCO and the advisory bodies to the Bureau and the Committee on the state of conservation of specific World Heritage properties that are under threat. To this end, the States Parties shall submit to the Committee through the World Heritage Centre, specific reports and impact studies, each time exceptional circumstances occur or work is undertaken which may have an effect on the state of conservation of the property. Reactive monitoring is foreseen in the procedures for the eventual deletion of properties from the World Heritage List as set out in paras. 48-56. It is also foreseen in reference to properties inscribed, or to be inscribed, on the List of World Heritage in Danger as set out in paras. 86-93.

#### B. Periodic reporting

69. The Eleventh General Assembly of States Parties to the World Heritage Convention and the twenty-ninth General Conference of UNESCO examined the matter of the periodic reporting under Article 29 of the World Heritage Convention. The General Conference adopted a resolution in which it:

*Invited the States Parties to the Convention for the protection of the World Cultural and Natural Heritage to submit to it in accordance with Article 29 of the Convention, through the World Heritage Committee, via its secretariat the UNESCO World Heritage Centre, reports on the legislative and administrative provisions they have adopted and other actions which they have taken for the application of the Convention, including the state of conservation of the World Heritage properties located on its territories;*

and

*requested the World Heritage Committee to define the periodicity, form, nature and extent of the periodic reporting on the application of the World Heritage Convention and on the state of conservation of World Heritage properties and to examine and respond to these reports in accordance with the principle of State sovereignty;*

70. The Committee, at its twenty-second session held in December 1998 took decisions on the periodicity of the periodic reporting, the handling and examination of the periodic reports and the format for these periodic reports.

71. The objectives of periodic reporting are:

To assess the overall application of the World Heritage Convention by States Parties, as well as to assess whether the World Heritage value(s) for which a property was inscribed on the World Heritage List is(are) maintained over time with a view to contribute to :

World Heritage property: Improved site management, advanced planning, reduction of emergency and ad-hoc interventions, and reduction of costs through preventive conservation.



State Party: Improved World Heritage policies, advanced planning, improved property management and preventive conservation.

Region: Regional co-operation, regional World Heritage policies and activities better targeted to the specific needs of the region.

Committee/Secretariat: Better understanding of the conditions of the properties and of the needs on the site, national and regional levels. Improved policy and decision making.

72. It is the prime responsibility of the States Parties to take appropriate provisions and actions for the application of the Convention and to put in place on-site monitoring arrangements as an integral component of day-to-day conservation and management of the sites. States Parties should do so in close collaboration with the site managers or the agency with management authority. It is necessary that every year the conditions of the property be recorded by the site manager or the agency with management authority.

73. The States Parties are invited to submit to the World Heritage Committee through the World Heritage Centre, every six years, a periodic report on the application of the World Heritage Convention, including the state of conservation of the World Heritage properties located on its territories. To this end, the States Parties may request expert advice from the Secretariat or the advisory bodies. The Secretariat may also commission expert advice with the agreement of the States Parties.

74. To facilitate the work of the Committee and its Secretariat and to achieve greater regionalization and decentralization of World Heritage work, these reports will be examined separately by region as determined by the Committee. The World Heritage Centre will synthesize the national reports by regions. In doing so, full use will be made of the available expertise of the Advisory Bodies, States Parties, competent institutions and expertise available within the regions.

75. The Committee will decide for which regions the periodic reports should be presented to its forthcoming sessions. The States Parties concerned will be informed immediately of the Committee's decision so as to give them sufficient time to prepare the state of conservation reports.

76. The Secretariat will take the necessary measures for adequate World Heritage information collection and management, making full use, to the extent possible, of the information/documentation services of the advisory bodies and others.

### C. Format and content of periodic reports

77. The Committee approved at its twenty-second session held in December 1998 a format for the periodic reports. This format consists of two sections:

- Section I constitutes the State Party's report on the application of relevant articles of the World Heritage Convention, including those referring to the identification of properties of cultural and/or natural value; protection, conservation and presentation of the cultural and natural heritage; international co-operation and fund raising; and education, information and awareness building.
- Section II refers to the state of conservation of specific World Heritage properties located on the State Party's territory.

Its main objective is to obtain an assessment of whether the World Heritage value(s) for which a property was inscribed on the World Heritage List is(are) maintained over time.

In addition, States Parties are requested to provide up-dated information on the management, factors affecting the property and monitoring arrangements.

78. Although it is recognised that all properties have specific characteristics, States Parties are encouraged to provide information and documentation on the following items:

## SECTION I: APPLICATION OF THE WORLD HERITAGE CONVENTION BY THE STATE PARTY

### I.1. Introduction

- a. State Party
- b. Year of ratification or acceptance of the Convention
- c. Organization(s) or entity(ies) responsible for the preparation of the report
- d. Date of the report
- e. Signature on behalf of State Party

### I.2. Identification of cultural and natural heritage properties

- a. National inventories
- b. Tentative List
- c. Nominations

### I.3. Protection, conservation and presentation of the cultural and natural heritage

- a. General policy development
- b. Status of services for protection, conservation and presentation
- c. Scientific and technical studies and research
- d. Measures for identification, protection, conservation, presentation and rehabilitation
- e. Training

### I.4. International co-operation and fund raising

### I.5. Education, information and awareness building

### I.6. Conclusions and recommended action

- a. Main conclusions
- b. Proposed future action(s)
- c. Responsible implementing agency(ies)
- d. Timeframe for implementation
- e. Needs for international assistance.

## SECTION II: STATE OF CONSERVATION OF SPECIFIC WORLD HERITAGE PROPERTIES

### II.1 Introduction

- a. State Party
- b. Name of World Heritage property
- c. Geographical co-ordinates to the nearest second
- d. Date of inscription on the World Heritage List

Family	Common Name	Scientific Name	National Status
Hydrophidae	Hoknosed Sea Snake	<i>Enhydrina schistosa</i>	*
	Black-headed Sea Snake	<i>Hydrophis nigrocinctus</i>	*
	Estuarine Sea Snake	<i>Hydrophis obscura</i>	*
	Malacca Sea Snake	<i>Hydrophis caeruleus</i>	*
	Common Narrow-headed Sea Snake	<i>Microcephalophis gracilis</i>	*
	Cantor's Narrowheaded Sea Snake	<i>Microcephalophis cantoris</i>	*
Natricidae	Checkered Keelback	<i>Xenochrophis piscator</i>	NO
	Dark-bellied Marsh Snake	<i>Xenochrophis cerasogaster</i>	VU
	Stripped Keelback	<i>Amphiesma stolata</i>	NO
	Olive Keelback	<i>Atretium schistosum</i>	NO
Homalopsidae	Glossy Marsh Snake	<i>Gerardia prevostianus</i>	DD
	Common Smooth Water Snake	<i>Enhydris enhydris</i>	NO
	White-bellied Mangrove Snake	<i>Fordonia leucobalia</i>	DD
	Dog-faced Water Snake	<i>Cerberus rhynchops</i>	VU
Colubridae	Rat Snake	<i>Colubermucosus</i>	VU
	Common Vine Snake	<i>Ahaetulla nasustus</i>	VU
Boidae	Common Sand Boa	<i>Eryx conica</i>	DD
	Rock Python	<i>Python molurus</i>	EN
Viperidae	Russell's Viper	<i>Vipera russellii</i>	CR
	Spot-tailed Pit Viper	<i>Trimeresurus erythrurus</i>	EN
Typhlopidae	Slender Worm Snake	<i>Typhlops porrectus</i>	DD
	Common Worm Snake	<i>Ramphotyphlops braminus</i>	NO
Dipsadidae	Common Wolf Snake	<i>Lycodon aulicus</i>	VU
Acrochordidae	Wart Snake	<i>Acrochordus granulatus</i>	DD
Crocodylidae	Estuarine Crocodile	<i>Crocodylus porosus</i>	CR

## Birds

Family	Common Name	Scientific Name	National Status
Phasianidae	Red Junglefowl	<i>Gallus gallus</i>	NO
Dendrocygnidae	Lesser Whistling Duck	<i>Dendrocygna javanica</i>	NO
Anatidae	Northern Pintail	<i>Anas acuta</i>	*
	Garganey	<i>Anas querquedula</i>	*
	Bar-headed Goose	<i>Anser indicus</i>	*
	Spot-billed Duck	<i>Anas poecilorhyncha</i>	NO
	Common Teal	<i>Anas crecca</i>	*
	Common Pochard	<i>Aythya ferina</i>	*
	Cotton Pygmy-goose	<i>Nettapus coromandelianus</i>	NO
Picidae	Eurasian Wryneck	<i>Jynx torquilla</i>	*
	Greater Yellownape	<i>Picus flavinucha</i>	NO
	Black-rumped Flameback	<i>Dinopium benghalensis</i>	NO
	Common Flameback	<i>Dinopium javanense</i>	NO
	Greater Flameback	<i>Chrysocolaptes lucidus</i>	NO

Family	Common Name	Scientific Name	National Status
Picidae	Grey-headed Woodpecker	<i>Picus canus</i>	NO
	Streak-throated Woodpecker	<i>Picus xanthopygaeus</i>	NO
	Fulvous-breasted Woodpecker	<i>Dendrocopos macie</i>	NO
	Yellow-fronted Pied Woodpecker	<i>Dendrocopos mahrattensis</i>	DD
	Grey-capped Pygmy Woodpecker	<i>Dendrocopos canicapillus</i>	NO
	Brown-capped Pygmy Woodpecker	<i>Dendrocopos nanus</i>	DD
	Rufous Woodpecker	<i>Celeus brachyurus</i>	NO
Megalaimidae	Lineated Barbet	<i>Megalaima lineata</i>	NO
	Coppersmith Barbet	<i>Megalaima haemacephala</i>	NO
Upupidae	Common Hoopoe	<i>Upupa epops</i>	NO
Coraciidae	Indian Roller	<i>Coracias benghalensis</i>	NO
Alcedinidae	Common Kingfisher	<i>Alcedo atthis</i>	NO
	Stork-billed Kingfisher	<i>Halcyon capensis</i>	NO
	Black-capped Kingfisher	<i>Halcyon pileata</i>	NO
	Brown-winged Kingfisher	<i>Halcyon amauroptera</i>	NO
	Ruddy Kingfisher	<i>Halcyon coromandra</i>	VU
	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	NO
Halcyonidae	Collared Kingfisher	<i>Todiramphus chloris</i>	NO
Cerylidae	Pied Kingfisher	<i>Ceryle rudis</i>	NO
Meropidae	Green Bee-eater	<i>Merops orientalis</i>	NO
	Chestnut-headed Bee-eater	<i>Merops leschenaulti</i>	NO
	Blue-tailed Bee-eater	<i>Merops philippinus</i>	NO
Centropodidae	Pied Cuckoo	<i>Clamator jacobinus</i>	NO
	Indian Cuckoo	<i>Cuculus micropterus</i>	NO
	Common Hawk Cuckoo	<i>Hierococcyx varius</i>	NO
	Asian Cuckoo	<i>Eudynamis scolopacea</i>	NO
	Green-billed Malkoha	<i>Phaenicophaeus tristis</i>	NO
	Greater Coucal	<i>Centropus sinensis</i>	NO
Psittacidae	Rose-ringed Parakeet	<i>Psittacula krameri</i>	NO
Apodidae	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	NO
	House Swift	<i>Apus affinis</i>	NO
Tytonidae	Barn Owl	<i>Tyto alba</i>	NO
Strigidae	Jungle Owlet	<i>Glaucidium radiatum</i>	NO
	Brown Fish Owl	<i>Ketupa zeylonensis</i>	VU
	Spotted Owlet	<i>Athene brama</i>	NO
	Great Horned Owl	<i>Bubo bubo</i>	
Caprimulgidae	Indian Nightjar	<i>Caprimulgus asiaticus</i>	NO
	Large-tailed Nightjar	<i>Caprimulgus macrurus</i>	NO
	Grey Nightjar	<i>Caprimulgus indicus</i>	EN
Columbidae	Emerald Dove	<i>Chalcophaps indica</i>	NO
	Rock Pigeon	<i>Columba livia</i>	NO
	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	NO

Family	Common Name	Scientific Name	National Status
Columbidae	Spotted Dove	<i>Streptopelia schinensis</i>	NO
	Mountain Imperial Pigeon	<i>Ducula badia</i>	DD
	Yellow-footed Green Pigeon	<i>Treron phoenicoptera</i>	NO
	Red Collared Dove	<i>Streptopelia tranquebarica</i>	NO
	Green Imperial Pigeon	<i>Ducula aenea</i>	DD
	Spotted Dove	<i>Streptopelia schinensis</i>	NO
	Heliornithidae	Masked Finfoot	<i>Heliopais personata</i>
Rallidae	White-breasted Waterhen	<i>Amourornis phoenicurus</i>	NO
	Water Cock	<i>Gallicrex cinerea</i>	NO
	Common Moorhen	<i>Gallinula chloropus</i>	NO
	Common Coot	<i>Fulica atra</i>	*
Scolopacidae	Common Sandpiper	<i>Actitis hypoleucos</i>	*
	Sanderling	<i>Calidris alba</i>	*
	Little Stint	<i>Calidris minuta</i>	*
	Ruddy Turnstone	<i>Arenaria interpres</i>	*
	Curlew-sandpiper	<i>Calidris ferruginea</i>	*
	Fantail Snipe	<i>Gallinago gallinago</i>	*
	Pintail Snipe	<i>Gallinago stenura</i>	*
	Black-tailed Godwit	<i>Limosa limosa</i>	*
	Eurasian Curlew	<i>Numenius arquata</i>	*
	Whimbrel	<i>Numenius phaeopus</i>	*
	Wood Sandpiper	<i>Tringa glareola</i>	*
	Greenshank	<i>Tringa nebularia</i>	*
	Green Sandpiper	<i>Tringa ochropus</i>	*
	Marsh Sandpiper	<i>Tringa stagnatilis</i>	*
	Common Redshank	<i>Tringa totanus</i>	*
Jacaniidae	Bronze-winged Jacana	<i>Metopidius indicus</i>	NO
Burhinidae	Eurasian Thick-knee	<i>Burhinus oedicephalus</i>	DD
	Great Thick-knee	<i>Esacus recurvirostris</i>	DD
Charadriidae	Red-wattled Lapwing	<i>Vanellus indicus</i>	NO
	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i>	NO
	Eurasian Oystercatcher	<i>Haematopus ostralegus</i>	*
Glarecolidae	Small Pratincole	<i>Glareola lactea</i>	NO
	Kentish Plover	<i>Charadrius alexandrinus</i>	*
	Little Ringed Plover	<i>Charadrius dubius</i>	*
	Lesser Sand Plover	<i>Charadrius mongolus</i>	*
	Greater Sand Plover	<i>Charadrius leschenaultii</i>	*
	Pacific Golden Plover	<i>Pluvialis dominicus</i>	*
Laridae	Gull-billed Tern	<i>Gelochelidon nilotica</i>	NO
	Indian Skimmer	<i>Rynchops albicollis</i>	EN
	Black-bellied Tern	<i>Sterna acuticauda</i>	EN
	Little Tern	<i>Sterna albifrons</i>	NO
	River Tern	<i>Sterna aurantia</i>	NO
	Rosy Tern	<i>Sterna dougallii</i>	-
	Whiskered Tern	<i>Chlidonias hybridus</i>	*
	Herring Gull	<i>Larus argentatus</i>	*
	Brown-headed Gull	<i>Larus brunicephalus</i>	*
	Black-headed Gull	<i>Larus ridibundus</i>	*
	Common Tern	<i>Sterna hirundo</i>	*

Family	Common Name	Scientific Name	National Status
Accipitridae	Shikra	<i>Accipiter badius</i>	NO
	Black-shouldered Kite	<i>Elanus caeruleus</i>	NO
	Crested Goshawk	<i>Accipiter trivirgatus</i>	*
	White-backed Vulture	<i>Gyps bengalensis</i>	NO
	Eurasian Griffon	<i>Gyps fulvus</i>	DD
	White-bellied-Sea Eagle	<i>Haliaeetus leucogaster</i>	ER
	Pallas's Fish Eagle	<i>Haliaeetus leucoryphus</i>	CR
	Grey-headed Fish Eagle	<i>Ichthyophaga ichhyaetus</i>	NO
	Brahminy Kite	<i>Haliaster indus</i>	NO
	Black Kite	<i>Milvus migrans</i>	NO
	Greater Spotted Eagle	<i>Aquila clanga</i>	*
	Lesser Spotted Eagle	<i>Aquila pomarina</i>	*
	Eastern Steppe Eagle	<i>Aquila rapax</i>	*
	Oriental Honey-buzzard	<i>Pernis ptilorhyncus</i>	DD
	Crested Serpent Eagle	<i>Spilornis cheela</i>	NO
	Changeable Hawk Eagle	<i>Spizaetus cirrhatus</i>	NO
	Western Marsh Harrier	<i>Circus aeruginosus</i>	*
	Pallid Harrier	<i>Circus macrourus</i>	*
	Eurasian Sparrowhawk	<i>Accipiter nisus</i>	*
	Booted Eagle	<i>Hieraaetus pennatus</i>	*
	Black Eagle	<i>Ictinaetus malayensis</i>	*
Osprey	<i>Pandion haliaetus</i>	*	
Falconidae	Common Kestrel	<i>Falco tinnunculus</i>	*
Anhingidae	Darter	<i>Anhinga melanogaster</i>	VU
Phalacrocoraci- dae	Little Cormorant	<i>Phalacrocorax niger</i>	NO
Ardeidae	Grey Heron	<i>Ardea cinerea</i>	NO
	Indian Pond Heron	<i>Ardeola grayii</i>	NO
	Cattle Egret	<i>Bubulcus ibis</i>	NO
	Little Heron	<i>Butorides striatus</i>	NO
	Great Egret	<i>Casmerodius albus</i>	NO
	Black Bittern	<i>Dupetor flavicollis</i>	DD
	Little Egret	<i>Egretta garzetta</i>	NO
	Intermediate Egret	<i>Mesophoyx intermedia</i>	NO
	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	NO
Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>	NO	
Ciconiidae	Lesser Adjutant	<i>Leptoptilos javanicus</i>	EN
Irenidae	Golden-fronted Leaf Bird	<i>Chloropsis aurifrons</i>	NO
	Blue-winged Leafbird	<i>Chloropsis cochinchinensis</i>	NO
Laniidae	Long-tailed Shrike	<i>Lanius schach</i>	NO
	Brown Shrike	<i>Lanius cristatus</i>	*
Corvidae	Jungle Crow	<i>Corvus macrorhynchos</i>	NO
	House Crow	<i>Corvus splendens</i>	NO
	Rufous Treepie	<i>Dendrocitta vagabunda</i>	NO
	Common Iora	<i>Aegithina tiphia</i>	NO
	Black-headed Oriole	<i>Oriolus xanthornus</i>	NO
	Eurasian Golden Oriole	<i>Oriolus oriolus</i>	DD
	Bronzed Drongo	<i>Dicrurus aeneus</i>	NO
	Black Drongo	<i>Dicrurus macrocercus</i>	NO
Spangled Drongo	<i>Dicrurus hottentottus</i>	NO	

Family	Common Name	Scientific Name	National Status	
	Grey Drongo	<i>Dicrurus leucophaeus</i>	*	
	Lesser Raquet-tailed Drongo	<i>Dicrurus remifer</i>	DD	
	Greater Raquet-tailed Drongo	<i>Dicrurus paradiseus</i>	NO	
Corvidae	Ashy Woodswallow	<i>Artamus fuscus</i>	NO	
	Large Cuckooshrike	<i>Coracina macei</i>	NO	
	Small Minivet	<i>Pericrocotus cinnamomeus</i>	NO	
	Scarlet Minivet	<i>Pericrocotus flammeus</i>	NO	
	Large Woodshrike	<i>Tephrodornis gularis</i>	NO	
	Common Woodshrike	<i>Tephrodornis pondicerianus</i>	NO	
	Bar-winged Flycatcher-shrike	<i>Hemipus picatus</i>	NO	
	Black-napped Monarch	<i>Hypothymis azurea</i>	NO	
	Mangrove Whistler	<i>Panchycephala grisola</i>	DD	
	White-throated Fantail	<i>Rhipidura albicollis</i>	NO	
	White-browed Fantail	<i>Rhipidura aureola</i>	DD	
	Muscicapidae	White-rumped Shama	<i>Copsychus malabaricus</i>	NO
		Oriental Magpie Robin	<i>Copsychus saularis</i>	NO
Blue-throated Flycatcher		<i>Cyornis rubeculoides</i>	*	
Verditer Flycatcher		<i>Eumyias thalassina</i>	*	
Red-throated Flycatcher		<i>Ficedula parva</i>	*	
Grey-headed Canary Flycatcher		<i>Culicicapa ceylonensis</i>	NO	
Orange-headed Thrush		<i>Zoothera citrina</i>	*	
Common Stone Chat		<i>Saxicola torquata</i>	*	
Blue Rock Thrush		<i>Monticola solitarius</i>	*	
Ferruginous Flycatcher		<i>Muscicapa ferruginea</i>	-	
Little Pied Flycatcher		<i>Muscicapa westermanni</i>	*	
Sturnide	Jungle Myna	<i>Acridotheres fuscus</i>	NO	
	Bank Myna	<i>Acridotheres ginginianus</i>	NO	
	Common Myna	<i>Acridotheres tristis</i>	NO	
	Asian Pied Starling	<i>Sturnus contra</i>	NO	
	Asian Glossy Starling	<i>Aplonis panayensis</i>	DD	
	Chesnut-tailed Starling	<i>Sturnus malabaricus</i>	NO	
Sittidae	Chestnut-billed Nuthatch	<i>Sitta castanea</i>	DD	
	Velvet-fronted Nuthatch	<i>Sitta frontalis</i>	NO	
Paridae	Great Tit	<i>Parus major</i>	DD	
	Wire-tailed Swallow	<i>Hirundo smithii</i>	DD	
Hirundinidae	Barn Swallow	<i>Hirundo rustica</i>	*	
Pycnonotidae	Red-vented Bulbul	<i>Pycnonotus cafer</i>	NO	
	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	NO	
Zosteropidae	Oriental White-Eye	<i>Zosterops palpebrosus</i>	NO	
Sylviidae	Common Tailorbird	<i>Orthotomus sutorius</i>	NO	
	Common Babbler	<i>Turdoides caudatus</i>	DD	
	Striated Babbler	<i>Turdoides earlei</i>	NO	
	Jungle Babbler	<i>Turdoides striatus</i>	NO	
	Abbot's Babbler	<i>Malacocincla abbotti</i>	NO	
	Striped Tit Babbler	<i>Macronous gularis</i>	NO	
	Brown Bush Warbler	<i>Bradypterus luteoventris</i>	*	

Family	Common Name	Scientific Name	National Status
Sylviidae	Tickell's Leaf Warbler	<i>Phylloscopus affinis</i>	*
	Plain Leaf Warbler	<i>Phylloscopus inornatus</i>	*
	Common Chiffchaff	<i>Phylloscopus collybita</i>	*
Cisticolidae	Rufous-vented Prinia	<i>Prinia burnesii</i>	DD
	Yellow-bellied Prinia	<i>Prinia flaviventris</i>	DD
	Grey-breasted Prinia	<i>Prinia hodgsoni</i>	NO
	Ashy Prinia	<i>Prinia socialis</i>	DD
Alaudidae	Zitting Cisticola	<i>Cisticola juncidis</i>	NO
	Rufous-winged Bushlark	<i>Mirafra assamica</i>	NO
Nectariniidae	Purple Sunbird	<i>Nectarinia asiatica</i>	NO
	Purple-rumped Sunbird	<i>Nectarinia zeylonica</i>	NO
	Pale-billed Flowerpecker	<i>Dicaeum erythrorhynchus</i>	NO
	Scarlet-backed Flowerpecker	<i>Dicaeum cruentatum</i>	NO
	Orange-bellied Flowerpecker	<i>Dicaeum trigonostigma</i>	DD
Passeridae	Tawny Pipit	<i>Anthus campestris</i>	*
	Paddyfield Pipit	<i>Anthus refulus</i>	*
	Olive-bached Pipit	<i>Anthus hodgsoni</i>	*
	Forest Wagtail	<i>Dendronanthus indicus</i>	*
	White Wagtail	<i>Motacilla alba</i>	*
	Grey Wagtail	<i>Motacilla cinerea</i>	*
	Citrine Wagtail	<i>Motacilla citreola</i>	*
	Yellow Wagtail	<i>Motacilla flava</i>	*
	White-browed Wagtail	<i>Motacilla maderaspatensis</i>	NO
	Scaly-breasted Munia	<i>Lonchura punctulata</i>	NO
	White-rumped Munia	<i>Lonchura striata</i>	NO
	House Sparrow	<i>Passer domesticus</i>	NO
	Baya Weaver	<i>Ploceus philippinus</i>	NO

## Mammals

Family	Common Name	Scientific Name	National Status
Soricidae	Grey Mask Shrew	<i>Suncus murinus</i>	NO
Tupaiaidae	Common Tree Shrew	<i>Tupaia glis</i>	DD
Pteropodidae	Flying Fox	<i>Pteropus giganteus</i>	NO
	Short-nosed Fruit Bat	<i>Cynopterus sphinx</i>	DD
	Fulvous Fruit Bat	<i>Rousettus leschenaulti</i>	DD
Rhinopomatidae	Lesser Rat-tailed Bat	<i>Rhinopoma hardwickii</i>	DD
Megadermatidae	False Vampire	<i>Megaderma lyra</i>	NO
Hipposideridae	Tailless Leaf-nosed Bat	<i>Coelops frithii</i>	DD
Vespertilionidae	Indian Pipistrelle	<i>Pipistrellus coromandra</i>	NO
	Indian Pygmy Pipistrelle	<i>Pipistrellus mimus</i>	NO
	Greater Yellow Bat	<i>Scotophilus heathii</i>	DD
	Asiatic Lesser Yellow Bat	<i>Scotophilus kuhlii</i>	NO
Cercopithecidae	Rhesus Macaque	<i>Macaca mulatta</i>	VU
Felidae	Bengal Tiger	<i>Panthera tigris</i>	CR
	Jungle Cat	<i>Felis chaus</i>	EN



Family	Common Name	Scientific Name	National Status
	Leopard Cat	<i>Prionailurus bengalensis</i>	DD
	Fishing Cat	<i>Prionailurus viverrinus</i>	EN
Canidae	Jackal	<i>Canis aureus</i>	VU
	Bengal Fox	<i>Vulpes bengalensis</i>	VU
Herpestidae	Small Indian Mongoose	<i>Herpestes auropunctatus</i>	NO
	Common Mongoose	<i>Herpestes edwardsi</i>	VU
Mustelidae	Smooth-coated Otter	<i>Lutra perspicillata</i>	VU
	Clawless Otter	<i>Aonyx cinerea</i>	EN
Viverridae	Large Indian Civet	<i>Viverra zibetha</i>	EN
	Small Indian Civet	<i>Viverricula indica</i>	VU
	Common Palm Civet	<i>Paradoxurus hermaphroditus</i>	VU
Suidae	Wild Boar	<i>Sus scrofa</i>	NO
Cervidae	Spotted Deer	<i>Axis axis</i>	NO
	Barking Deer	<i>Muntiacus muntjak</i>	EN
Sciuridae	Five-striped Palm Squirrel	<i>Funambulus pennanti</i>	NO
Muridae	Bandicoot Rat	<i>Bandicota indica</i>	NO
	Lesser Bandicoot Rat	<i>Bandicota bengalensis</i>	NO
	House Mouse	<i>Mus musculus</i>	NO
	Common House Rat	<i>Rattus rattus</i>	NO
	Long-tailed Tree Mouse	<i>Vandeleuria oleracea</i>	DD
Hystriidae	Indian Porcupine	<i>Hystrix indica</i>	EN
Leporidae	Rufous-tailed Hare	<i>Lepus nigricollis</i>	EN
Dolphinidae	Common Dolphin	<i>Delphinus delphis</i>	DD
	Irrawaddy Dolphin	<i>Orcaella brevirostris</i>	CR
	Indian Pilot Whale	<i>Globicephala macrorhynchus</i>	DD
	Melon-headed Dolphin	<i>Peponocephala electra</i>	CR
Phocoenidae	Little Porpoise	<i>Neophocaena phocaenoides</i>	EN
Platanistidae	Ganges River Dolphin	<i>Platanista gangetica</i>	EN