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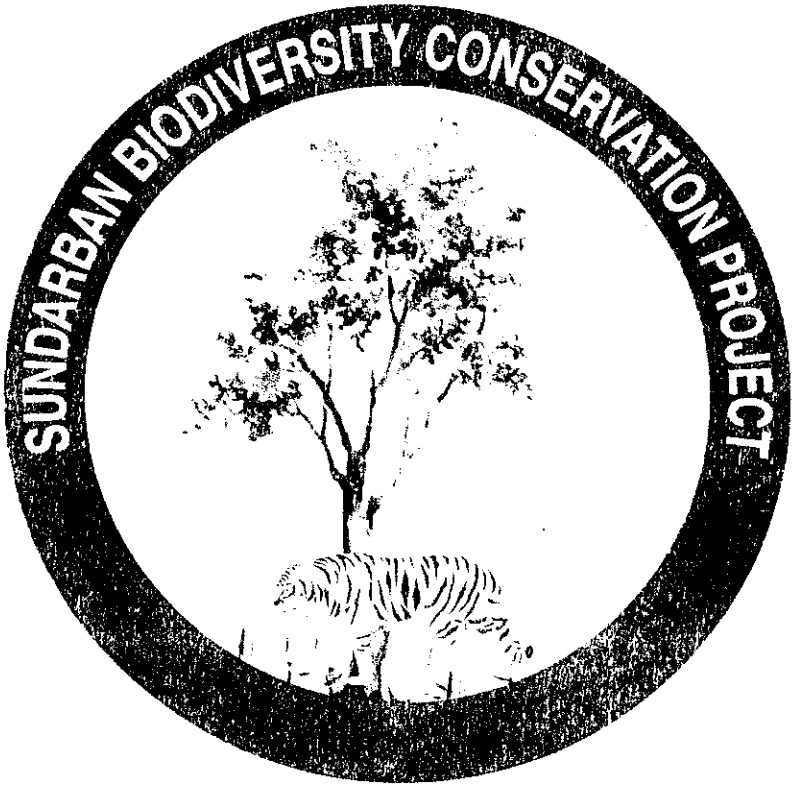

Wildlife Training Manual for Basic Ecology, Wildlife Management and survey techniques

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SUNDARBAN BIODIVERSITY CONSERVATION PROJECT

WILDLIFE TRAINING MANUAL FOR BASIC ECOLOGY, WILDLIFE MANAGEMENT AND SURVEY TECHNIQUES

by
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December 2002

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1. INTRODUCTION TO THE MANUAL

1.1 Background

A new integrated management approach is needed in the Sundarban to counter the increased pressure on its resources, involving a shift from wood to other resources and more attention to biodiversity and wildlife conservation. Training is required for FD staff to support the implementation of such a new management system.

The current institutional reforms of the Forest Department Khulna Circle involves increasing capacity for wildlife management and the establishment of a Division responsible for wildlife management. So far training in specific wildlife management practices has received very little attention in field staff curricula. Therefore a training programme is being developed by the Forest Department and the Sundarban Biodiversity Conservation Project for the upgrading of field staff in wildlife management.

The total number of field staff (not taking into account boatmen) in the Sundarban is in the order of 400. Wildlife training is important for all staff posted in the sanctuaries and in the production zone, as both areas have wildlife. ACFs, Forest Rangers and some special trainers will mainly provide training to field staff and training will be implemented in the field, which is by far the best context for this type of training.

In the period July – December 2001 a training programme has been developed for the training of FD field staff in wildlife management skills. During this period a *General Wildlife Course* (1 week, 24 trainees) and a *Training of Trainers Course* (2 weeks, 8 trainees) were conducted. Another output of this training was a training manual and other materials that will be used in future training for field staff. The *Field Staff Course* will have duration of one week (4 days course work and 1 day field trip) and evaluation will take place at the end of the course. Main aim of this course is to enrich field staff (Forester and forest guard) in survey techniques and basic wildlife ecology of the Sundarban. This course will focus the following fields:

- basic understanding of ecology
- field techniques
- observation and identification methods
- survey techniques
- data recording
- wildlife legislation

A Bengali version of this manual is prepared for the use by the participants during this Training course. This manual is designed to fulfill all the objectives of the course. For easy understanding the manual focuses more on diagram than description. The chapters of this manual can be grouped into three categories. Some of the chapters explain basic component of the Sundarban ecosystem; some are describing how to study these components and some chapters are describe why and how to manage this ecosystem. Thus the manual will be useful for understanding the Sundarban ecosystem, familiarization with a number of field skills, the understanding of relevance of surveys and studies, and the understanding of conservation and its relation to development. Apart from this course, other training courses

will be implemented for the field staff (e.g. wildlife care, handling and health; first aid; fire arms utilization and maintenance).

1.2 Contents of the course

The content of the course is based on a number of lectures that have been conducted in a general course on wildlife management techniques from a September 2001 for mid-management staff of the Khulna Circle of the Bangladesh Forest Department. Subject matter has been simplified to make it comprehensible for field staff. An outline of the subjects addressed in this course is given in Table 2 at the end of this chapter.

1.3 Course lay out

Class work

Four days will be spent in a classroom situation. Five lectures will be given in each day and each lecture will take 45 minutes (table 1).

Table 1. Overview of the field staff wildlife management course

Days	Lecture-1	Lecture-2	Lecture-3	Lecture-4	Lecture-5
Day-1	Introduction to course	Introduction to Ecology	Introduction to Ecology	Use of basic field equipment	Use of basic field equipment
Day-2	Field observations and taking notes	Field observations and taking notes	Field observations and taking notes	Vegetation analysis	Vegetation analysis
Day-3	Introduction to the wildlife of the Sundarban	Wildlife survey	Wildlife survey	Wildlife survey	Wildlife survey
Day -4	Field work	Field work	Field work	Field work	Field work
Day-4	Wildlife management	Wildlife management	Legislation	Discussion about field work	Discussion about field work

Fieldwork

The main aims of the fieldwork are (1) the integration of the class work and (2) survey exercises. Remember that outdoor means "wet" in the Sundarban and the trainees have to be prepared for such conditions.

Fieldwork schedule

(1) Wildlife surveys

- Bird identification early in the morning
- Survey techniques of indices of presence (Sample plot 10X20 m^2).

- Survey techniques of animal footprints (Sample plot 10X20 m^2).
- Crocodile survey techniques by spotlight near the training station.
- Pugmark survey techniques along a canal.

(2) Vegetation survey techniques

Using plot survey techniques of vegetation using:
- Structural approach (% of aerial cover by tree layer, shrub layer, herb layer),
- Floristic approach (% of aerial cover of different plant species).

Evaluation

The courses will be completed with a course evaluation, based on:
(a) questions after the sessions
(b) final evaluation questions
(c) presence of participants.

Table 2. Subjects addressed in the wildlife course for mid-management staff

Topics	Elements	Trainers
Opening and introduction	brief opening and explanation course objectives and setup	S. Huda (PD), F. Deodatus (SBCP)
Introduction SBCP	history, institutional setting, objectives, funding	T. Warner (SBCP)
Conservation	biodiversity, sustainable management, participatory management	A. Nishad (IUCN, Dhaka)
International conservation conventions	WHC, CITES, Bonn, Ramsar, Rio, GEF	A. Nishad
National legislation	land status, user rights, illegal use	B.U.. Khan (SBCP)
Forest legislation	user rights, illegal rights, law enforcement	B.U. Khan
Curriculum development	TNA, programme development, training materials	T. Warner
Research fundamentals	fundamental vs. applied research, relation research/management, difference between surveys and research, monitoring,	N.A. Siddiqi, (BFRI, Chittagong)
Ecology	ecosystem, food chains, predation, competition, facilitation, population biology	N.A. Siddiqi
Ecology	herbivory and vegetation	N.A. Siddiqi
Wildlife management	habitat management	F. Deodatus
Wildlife management	protection, wildlife control, restocking, habitat management, planning, monitoring	F. Deodatus
Survey techniques animals	objectives, sampling, analysis	F. Deodatus
Survey techniques animals	direct methods, distance counts, capture/recapture, aerial counts	F. Deodatus
Survey techniques animals	indirect methods, footprints, pellet counts	Z.U. Ahmed (FD, Khulna)
Data collection	observation forms, note books, computers	Z.U. Ahmed
Survey techniques vegetation	relevee, cover estimation, classification, mapping	F. Deodatus (SBCP)
Survey techniques vegetation	tree inventories, RIMS classification	R. Mohainen (RIMS, Dhaka)
Field orientation	map interpretation, legends, coordinate systems, mapping	R. Mohainen
Field orientation	compass, gps	R. Mohainen
Field orientation	remote sensing	R. Mohainen
Animal health	parasitology, life cycles, immunity, non-parasitic diseases, animal diseases dangerous for humans	M. Shahidullah (Dhaka Zoo)
Bird identification	taxonomy, morphology, ecology	S.U. Sarker (Un. Dhaka)
Specimen collection		S.U. Sarker
Field trip	field orientation, bird identification, survey techniques animals and vegetation	S.U. Sarker, F. Deodatus
Analysis Field trip	analysis of data sheets	F. Deodatus
Closure		PD (SBCP)

2. BASIC ECOLOGY

2.1 Introduction

Generally, matters in nature can be classified into two major groups: (1) biotic or living components (all plants and animals) and (2) abiotic or non-living components (e.g. soil, water, air). The living organisms exist in an environmental setting of which they are a part. The environment refers to the things and conditions around the organisms, which directly or indirectly influence the life and their development and their populations. Organisms and environment are two non-separable factors. The environment influences every aspect of life and the activities of organisms themselves affect their environment.

2.2 Ecology

Ecology is an aspect of biology, which deals with the inter-relationship between biotic and abiotic components as well as the relationships among the individuals of the biotic component. The word 'ecology' is derived from Greek words:

- *oikos* - meaning the dwelling place or home, and
- *logos* - meaning the discourse or study.

Thus the word ecology literally means the study of living organisms, both plants and animals in their natural habitats or homes. It can also be defined as the study of the reciprocal relationship between living organisms and their environment. Some ecologist study inter-relationship between individual species or its population and its environment. On the other hand, some deals with systems of many species- whole communities or major fractions of communities and ecosystems.

2.3 Ecosystem

The ecosystem is the basic functional unit of organisms and their environment interacting with each other and their own components. In other words, an area of nature composed of living organisms and non-living elements interacting with each other is an ecosystem. The structure of an ecosystem is related to species diversity. The more complex its structure, the greater is the diversity of the species in the ecosystem. The functions of an ecosystem are related to the flow of energy and cycling of materials through its structural components.

In the broadest sense, there are two major types of ecosystems namely terrestrial and aquatic. They can further be classified in other more defined ecosystems. An (incomplete) example of some types of ecosystems is given below:

(1) Terrestrial ecosystem

- Forest ecosystem
- Grassland ecosystem
- Desert ecosystem
- Artificial ecosystems which are man-made e.g. crop fields and gardens

(2) Aquatic ecosystem
- Fresh water ecosystem (ponds &lakes, rivers)
- Marine or oceanic ecosystem (estuaries, coastal, ocean)

Ecosystem structure

The structure of an ecosystem is basically a description of the organisms and physical features of the environment, including the amount and distribution of nutrients in a particular habitat. Principal components of an ecosystem are:

(1) Abiotic components: soil, water, air, temperature, light,
(2) Biotic components: producer (green plants), consumers (e.g. insects, deer, rodent, snake, tiger etc), decomposer (e.g. bacteria, termites, ants)

Ecosystem processes

The principal processes occurring within an ecosystem form a cycle:
- The reception of radiant energy of the sun by green plants;
- The synthesis of organic materials from inorganic materials by green plants (producers);
- Consumption of herbivores (deer etc.) by carnivores and further digestion of consumed materials;
- After the death of producers and consumers, complex organic compounds are degraded and finally converted by decomposers into a state which is suitable for reutilization by the producers.

Energy flow in ecosystems

When the sunlight (radiant energy) falls on the green surfaces of plants, a part of light energy is transformed into chemical energy (fixed energy), which is stored in various organic products (e.g. sugars, fats and proteins) in the plants. Herbivores (primary consumers) use this chemical energy by consuming plant as food. This energy is transferred from the herbivorous to the primary carnivores (secondary consumers) by the consumption of the former by the latter (predation). Similar transfer occurs when primary carnivorous are consumed by the secondary carnivorous (tertiary consumers). Energy is lost at each step of energy transfer.

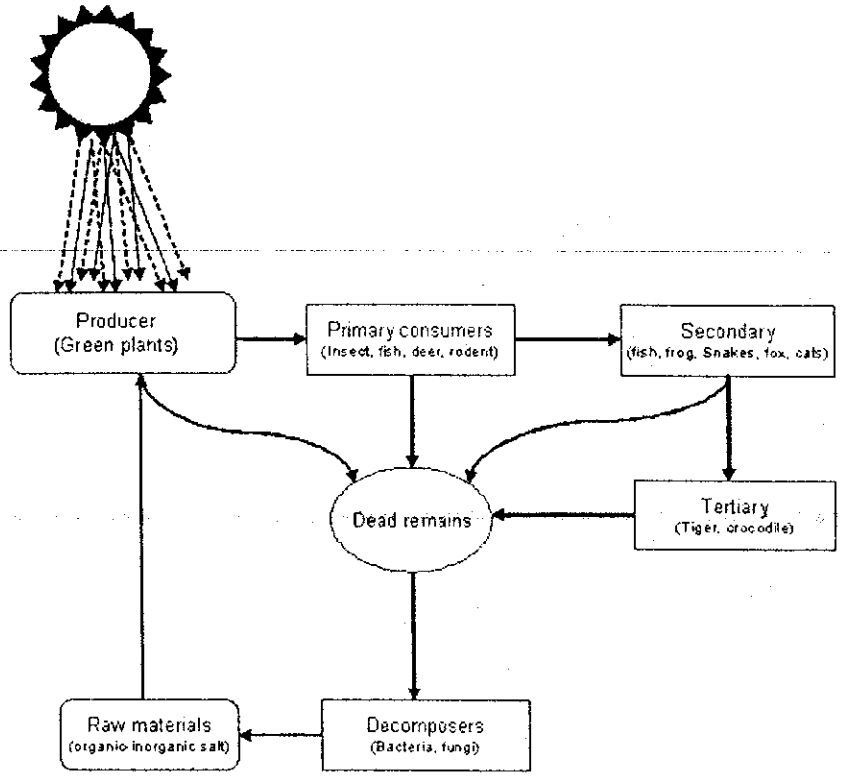


Figure 1. Flow of energy at different levels of the ecosystem

Food chain

A food chain may be defined as the transfer of energy and nutrients through a succession of organisms through repeated process of eating and being eaten. There are two types of food chains:

(1) Grazing food chain: The grazing food chain starts from green plants and goes from herbivores (primary consumers) to primary carnivores (secondary consumers) and then to secondary carnivores (tertiary consumers) and so on.

(2) Detritus food chain: The dead organic remains of organisms include still metabolic wastes and exudates derived from the grazing food chain and are generally termed the detritus food chain. The energy contained in detritus is not lost in the ecosystem, rather it serves as a source of energy for a group of organisms called detrivores. Bacteria, termites, ants etc. are involved to this type of food chain.

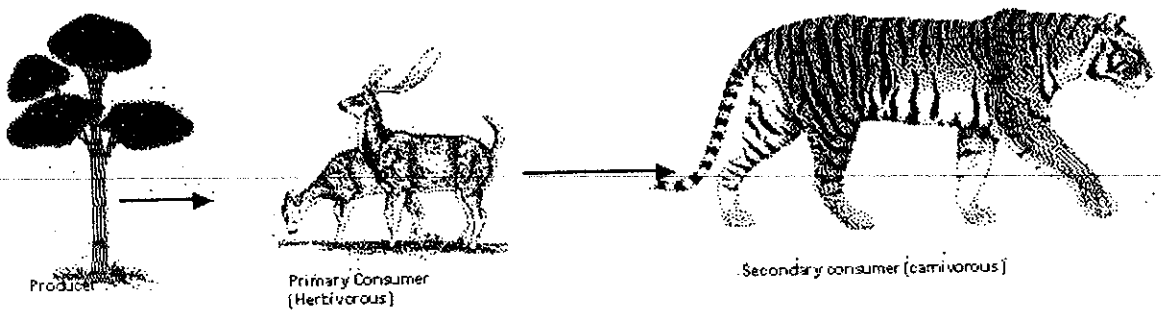


Figure 2. A grazing food chain

Food web

Many food chains exist in an ecosystem, but as a matter of fact these food chains are not independent. In an ecosystem, one species does not depend entirely on just one other species. The resources are shared specially at the beginning of the chain. The marsh plants in the Sundarban are eaten by a variety of insects, birds and mammals and several predators eat some of these animals. Some of these predators are also preyed upon by other predators. As a result food chain become interlinked. A complex of interrelated food chains makes up a food web.

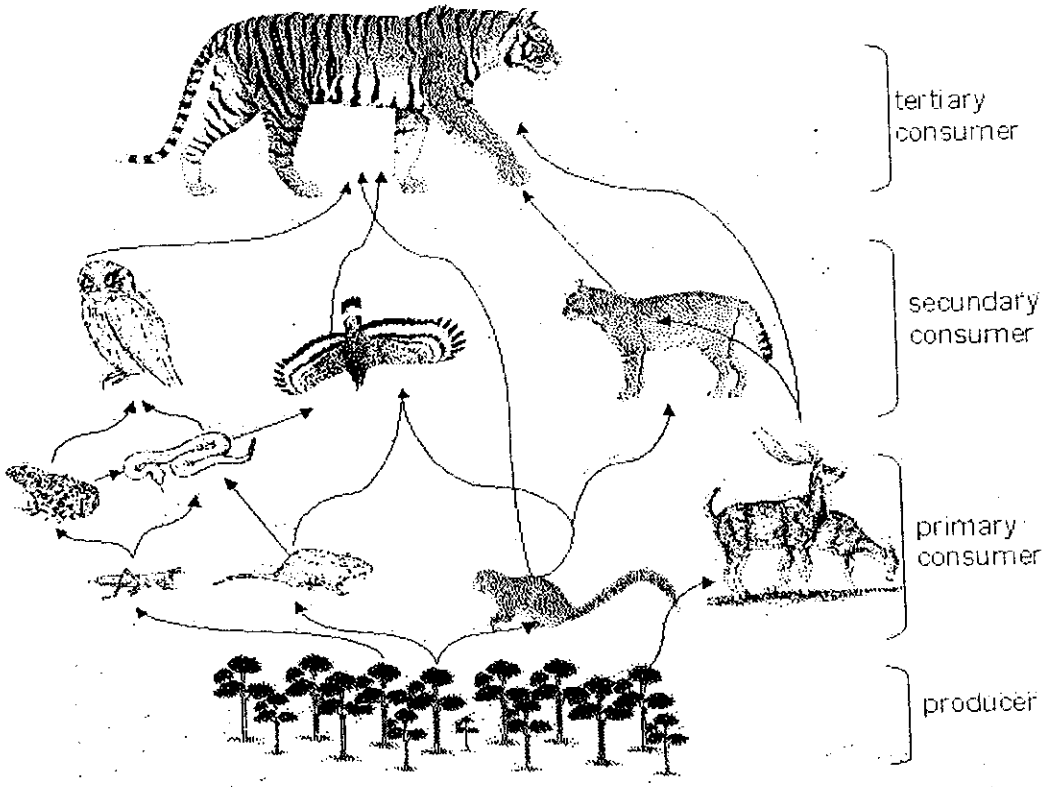


Figure 3. Diagram of a hypothetical food web.
(No real food web would be as simple as this)

2.4 Population Biology

A population is a group of individuals of a particular species occupying a delimited space in which the individuals live and have contact with each other. A population can be divided into small subgroups called local populations. The subject of population ecology is very wide but only the following aspects of population biology will be discussed here:

- Population characteristics,
- Causes of population change.

Population characteristics

The population has the following characters:

(a) Population density : Population density refers to the size of any population (total number of individual of the same species) in relation to some unit of space in a unit of time. It can be calculated by the following equation:

$$D = n/a/t$$

where *D* is population density; *n* is the number of individuals; *a* is area and t is unit time.

(b) Natality: Natality refers to the rate of reproduction or birth per unit time. It can be calculated by the following equation:

$$X = b/n$$

Where *X* is natality; *b* is number of births per unit time; *n* is total population

(c) Mortality: Mortality refers to the number of deaths per unit time. It can be calculated by the following equation:

$$Mt = D/t$$

Where *Mt* is mortality; *D* is the number of deaths; *t* is the unit of time

Causes of population change

Major causes of population change are:

- Migration, immigration, emigration,
- Reduce breeding facilities,
- Predation, starvation disease, hunting,
- Climate fluctuation, fires, pollution, habitat destructions, succession, and natural calamity.

3. WILDLIFE OF THE SUNDARBAN

3.1 Introduction

The Bangladesh Sundarban represents 44% of the total forested area of the country. This large diverse habitat supports more than 47% of the wildlife species of the country. The forests and waterways of the Sundarban support a wide range of fauna, including a large number of endangered and globally threatened wildlife species. This area is used as a nesting ground by several endangered aquatic reptiles e.g. estuarine crocodile, olive ridley turtle, green turtle, hawksbill turtle, and loggerhead turtle. The aquatic endangered mammals like Gangetic dolphins thrive within mangrove creeks close to sea. Several monsoon heronaries as well as winter swamps are formed in the Sundarban, which support trans-Himalayan migratory birds.

3.2 Extinct fauna

At the beginning of the 19th century, the Sundarban included much wider area than it does today, had a more diverse habitat variety and supported a much richer and diverse fauna. There were extensive swamp lands in the north inhabited by several mega herbivorous species most of which are extinct now viz. the one-horned Javan rhino (*Rhinoceros sondaicus*), water buffalo (*Bubalus bubalis*), swamp deer (*Cervus duvaucelí*), hog deer (*Cervus porcinus*) etc. According to the Bengal District Gazetteer, both rhino and buffalo had become very rare by 1904 and become extinct thereafter. The mars crocodile (*Crocodilus palustris*), which does not exist in the Sundarban at present, was reported in the early 19th.

3.3 Present wildlife species

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. The following critically endangered animals occur in the Sundarban: tiger (*Panthera tigris*), common otter (*Lutra lutra*), Irriwaddy dolphin (*Orcaella brevirostris*), and Melon-headed dolphin (*Neophocaena phococaenoides*). Some critically endangered reptiles are Saltwater crocodile (*Crocodilus porosus*), River terrapin (*Batagur baska*). Some critically endangered birds are Pallas's Fish eagle (*Haliaeetus leucoryphus*) and Greater adjudant (*Leptotilos dubius*). A great number of vertebrate species is considered as endangered according to the IUCN Red List.

Table 3 Number of wildlife species found in the Sundarban

Species	No. of species found in Bangladesh*	No. of species found in the Sundarban**	No. of species only found in the Sundarban than other areas of the country
Amphibians	22	7-8	1
Reptile	126 [17]	44-60	9
Bird	628 (240)	174-315	6
Mammal	113 [3]	43-49	1

[ ] Marine
( ) Migratory species
*IUCN-Bangladesh 2000
** Hendrichs, 1975; Seidensticker, 1987; Hussain & Acharya, 1994; FRMP, 1997; IRMP, 1998

3.4 Threats

The major threats for the survival of the wildlife of the Sundarban are:

- Habitat changes and loss,
- Pollution,
- Over exploitation,
- Poaching/hunting,
- Natural calamities,
- Unintentional disturbance by people,
- Diseases (baiting, domestic animals),
- Sea level rise,
- Upstream land use effect,
- Natural gas exploitation,
- Introduction and reintroduction of local/alien species,
- Uncontrolled tourism.

3.5 Basic characteristics of important fauna of the Sundarban

Some basic morphological, ecological and behavioral information of important fauna of the Sundarban is listed below.

Bengal Tiger

- Sexual maturity reached at 3-4 years
- Mating season: not seasonal
- Gestation period: 95-112 days
- Mating period: 5-7 days
- No. of cubs: 1 to 5 (usually 2/3 cubs/ pregnancy)
- Life span: 20-22 years
- Territoriality: a male tiger may occupy territories 10-60 km^2, probably a male territory covers several female territories.
- Food: 70% spotted deer, 30% wild boar, rhesus macaques and other.

Spotted Deer

- The rutting stage has a loud harsh bellow and combats between the males for the possession of the hinds are fierce and frequent.
- Mating is during March-May.

- Gestation period 6-7 months.
- Usually the mother gives birth to a single fawn
- Spotted deer are prolific breeders, which may lead to more than one reproduction cycle within a year.
- Females give birth at quiet and higher ground in the forest
- Maturation completes between 1-2 years.
- Herbivorous
- Non-territorial

Masked Finfoot

- A large, about 56 cm in length, bird with huge yellow or orange bill and day-glow green legs and feet
- The bird has a black facial mask and throat, which is bordered by a narrow white line.
- Legs are short and very strong, toes fringed with a lobed web, wings rounded, tail broad and stiff, flight strong but low and prolonged
- Shy and secretive coot-like bird inhabiting dense swampy mangrove forest and creeks, takes shelter in the waterside bushes when alarmed.
- Feeds on mollusks, crustaceans, insects, small fishes and vegetation.
- Nest is a circular pad of twigs, placed upon 1-3 m above water on a horizontal branch or fallen tree, is 30 cm in diameter, with a central depression.
- Clutch size 5-6, creamy in color, incubation by both sexes.
- Breeding season is July-August.

Painted stork

- A large, about 93 cm in length, bird with large down curved heavy yellow bill, bare face is orange –yellow, neck is long.
- It has black flight feathers, with white barring on mainly black base colour, largely pink tertials and black barring across the breast.
- Legs are long, toes long and slender, hind toes well developed, on the same plane as others, delicate rose pink near the tail.
- Feeding habit is foraging by wading slowly in shallow water, often stirs the water with its foot and occasionally flicks a wing to drive prey between its mandibles.
- Nesting season is August – January, varying locally according to the water conditions.
- Number of eggs 2-5 , dull sullied white, incubation nest feeding and by both sexes.

Lesser Adjutant

- A very large bird, about 110-120cm in length, both the bills are large with straighter ridge to clumen and has a pale greenish-brown or yellowish tan frontal plate.
- Upper parts glossy bluish black and under parts white.
- Lack of gular pouch in the neck.
- Sparse hair like feathers on almost naked reddish yellow head and neck.
- Inhabits mainly in marshes, forest pools, flooded fields lakes and drying riverbeds.
- Usually solitary and shy. Forages by walking slowly and grabs prey with its bill, feeds on fishes, frogs, reptiles and invertebrates.
- Breeding season is November- January.
- Eggs are 3-4, white in color.

Ruddy Kingfisher

- Eggs are 3-4, white in color.
- A medium sized about 26cm in length, reddish kingfisher with a white rump conspicuous in flight, bill and feet bright red.
- Head, neck and mantle light rufous-chestnut. Middle of lower back and rump white, under parts rufous.

- Inhabits mainly in pools and streams of dense broadleaved evergreen tropical, subtropical and mangrove swamp.
- Feeds on fishes, crabs, beetles, insects, etc.
- Breeding season is March-April.
- Nest is composed of an egg chamber and a tunnel into an overgrown ravine bank.
- Eggs are 5-6, glossy white in color, incubation by both sexes.

White-bellied sea eagle

- A large bird about 66-71 cm in length, has comparatively narrow wings, fairly long tail and noticeably protruding head and neck
- Feeds mainly on fishes and sea snakes, which are scooped up in its talons.
- Breeding season is March-April.
- Eggs are 2, white in color.

Estuarine crocodile

- Female breeding territories are established in fresh water areas
- Female reach sexual maturity at lengths of 2.2 to 2.5m (10-12 years old)
- Male mature at 3.2m (16 years old)
- 40-60 eggs are usually laid in mound nests made from plant matter and mud. These are constructed between the months of May and September during the wet season.
- Juvenile hatch after around 90 days, although this varies with nest temperature.
- Salt-water crocodile take a variety of prey- insects, amphibians crustaceans, small reptiles, fish, vertebrates (turtles, snakes, shore, wading, bird, livestock, boar, deer, etc.)

Ring lizard

- It is the largest among the Indian monitor lizard, reaching a total length of 2.5m.
- Dorsal surface usually dark brown or blackish with yellow ocelli
- A black temporal streak bordered by a yellow band, which occasionally extends along the side of neck.
- Ventral surface yellow, abdominal scales feebly keeled and mid-body scales in 85-95 rows.
- Tail is strongly compressed, keeled above.
- It is highly aquatic; found in freshwater as well as in salt water and feeds on crustaceans, molluscs, frogs etc.
- Breeds at the beginning of the rains and 25-30 eggs are laid in holes, in banks, in tree holes or in termite nests.

King cobra

- Flat head is little wider than the neck; snout rounded and eyes moderately round with round pupil.
- A pair of occipital shields is present.
- Head scales edge is black, adults ranging from 3-4.5 m in length with blackish brown with lighter yellow bands round the body.
- The 'hood' is relatively les dilatable than in the cobra
- Largely diurnal and feeds mainly on snakes and occasionally lizards.
- Clutch size is 40-51 and eggs are laid in nests in April to July.

River Terrapin

- Head is small, covered with smooth skin and snout is strongly projected with denticulated ridge on both jaws.
- Tail is very short.
- Digits are entirely webbed and 4 claws are present instead of five claws on the forelimb.
- Smooth and heavy carapace with uniform brown to gray-olive colour and head is also brown.

- Highly aquatic and maximum length is 60cm.
- Clutch size is 10-30 and lays usually 3 clutches in a season between January and early March.

Rock Python

- It is massively built snake, ranging 6-7.5m in length; body is rounded in outline, thickest in the middle and tapering towards head and anus.
- Scales are smooth, head is flattened with a long snout and distinct neck and tail is short and prehensile.
- Ground colour is grayish, whitish or yellowish in adults and a dark oblique band from eye to gape.
- The body is with a series of large, roughly quadrate patches from neck to tail dorsally; outline of the patches are black to blackish
- It is slow moving snake and feeds on mammals, birds and reptiles.
- Eggs are soft, white and laid during March to June; clutch size is 8-100.

4. WILDLIFE MANAGEMENT

4.1 Introduction

Working with wildlife, the question may arise: What is wildlife? Several replies may be given:
(1) all wild animals ?
(2) all large wild animals ?
(3) all terrestrial wild animal species ?
(4) threatened wild animal species ?
(5) all wild plant and animal species ?
(6) or other definitions

Most commonly, definition (1) or (5) are applied.

What is wildlife management?

"Management is the process of planning, organizing, implementing, and controlling the efforts of organizational resources to achieve stated organizational goals". "Wildlife management" is an art and science of manipulation of wild animal populations and their habitats and interaction between the two, in order to achieve pre-defined objectives. Again, wildlife management is the management of wildlife populations.

The ecosystem approach

The Ecosystem approach, which is at present more and more applied to wildlife management, is based on the following assumptions:
- individual animal species depend on other species (predation, facilitation),
- animal species depend on the habitat (herbivory, shelter, etc.),
- the state and survival of a specific ecosystem depends very much on the role of the human society.

Therefore wildlife management requires an approach that takes into account management of animal species, habitat and human factors such as land use, land use policy, socio-cultural context etc.

Conservation Objectives

Conservation" means prevention of loss, waste, destruction, and management of natural environment. The main concept of conservation is the sustainable use of natural resources, such as wildlife and forest, which implies the maintenance of these resources to ensure future use.

The following aspects may be covered in the objectives of protected areas and conservation policies:
(a) Maintenance of environmental services
(b) Preservation of species and genetic diversity
(c) Sustainable use of resources from natural ecosystem
(d) Maintenance of cultural/traditional attributes.

(e) Scientific research
(f) Education
(g) Protection of specific natural/cultural features
(h) Wilderness protection
(i) Tourism and recreation

Specific objectives may require different priorities for wildlife species and habitat conservation.

4.2 Planning process of wildlife management

The principal steps in the management planning process are (Figure 4):

(1) Identification
(2) Feasibility study
(3) Boundary proposal
(4) Buffer zone proposal
(5) Zoning plan
(6) Site plan
(7) Master plan
(8) Management plan

Before a management plan is elaborated, the existing context is determined in which it should be implemented, e.g.:

- local setting (land use, user rights, tenure)
- regional development plans
- legislation
- Habitat survey and mapping
- Wildlife survey

Usually a management plan consists of 3 components:

Part 1. Descriptive (topography, geology, climate, hydrology, soils, ecology, human factors)
Part 2. Management objectives
Part 3. Management Programme

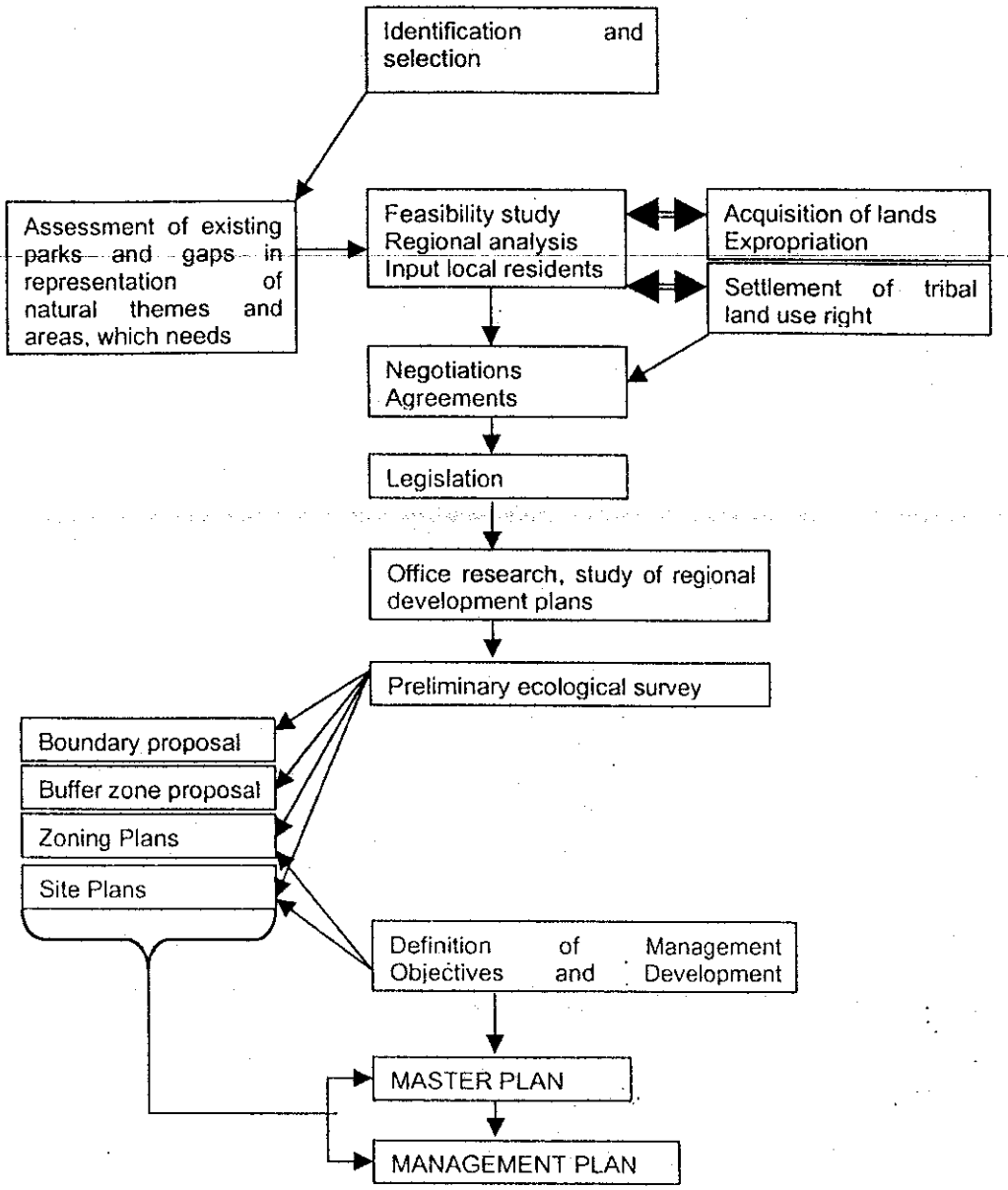


Fig. 4. Different steps of the wildlife management planning process

4.3 Wildlife species management implementation

Management objectives

Possible objectives for the management of species are:

(1) to increase/maintain biodiversity
(2) to conserve endemic species
(3) to conserve rare species
(4) to conserve valuable species
(5) to conserve migratory species

Protection

Specific programmes for the protection of species are elaborated according to a Threat Analysis and the development of management measures:

Threats	Measure
illegal hunting	law enforcement
pollution	monitoring animal health and water quality
habitat degradation	land use monitoring and control
disease	prohibit entry of any domestic animal, elimination
natural disasters, environmental change	limited possibility of local level measures
exotic species	elimination

Vaccination of wild animals is generally not recommended. Vaccination may help individual animals against parasites, but it will on the long term reduce the natural resistance to animal diseases of the populations.

Wildlife control

Occasionally wildlife population numbers may be reduced by shooting (or other elimination methods) for the following two reasons:

(1) *To restore/maintain what some people call "ecological balance".* However, in nature "ecological balance" is rarely stable. Populations fluctuate up and down as a result of changing resource and parasite levels. Control is usually driven by the desire to maintain a certain state of an ecosystem not determined by "natural" or "ecological" rules but by subjective criteria of certain human groups (e.g. farmers, hunters, wildlife managers).

(2) *To reduce wildlife human conflict.* The elimination of problem animals may reduce the incidents in which people are disadvantaged by wildlife. It may also reduce the emotional or political tension that is often associated with the wildlife human conflicts, particularly when human casualties are involved.

Alternative methods are:
- fencing
- trapping
- immobilization
- animal transfer

Wildlife harvesting is the reduction of populations for commercial purposes. A scientific approach enables sustainable harvesting.

Restocking, (re)introduction

Restoring biodiversity by reintroduction or restocking is nowadays more and more applied for the following reasons:.
(1) .. to improve the biological stability and productivity of the ecosystem
(2) .. to increase the aesthetic and/or the economic value of the ecosystem

Usually restocking/reintroduction is carried out in 3 phases:

(1) protected rearing to reduce mortality during first life cycle stages,
(2) habituation, offering some protection and shelter,
(3) full release.

Sundarban animals to be considered for restocking are:

Marsh crocodile
Extinct in the Sundarban, but some appropriate habitat my still be available in the North.

Estuarine crocodile
Numbers are low, but potentially the area could contain a much larger population

Rhino
Javan rhino was present in the Sundarban in the past. The touristic value of this animal is high, but habitat requirements and management are relatively complicated.

Buffalo (Bubalis bubalis)
Domesticated water buffalo is resident in the area, but wild buffalo has been extinct many years ago. In the Northern Sundarban some good habitat may be available. The animal would be a good variety on tiger's menu, which is now dominated by just one medium size herbivore species (spotted deer).

Other deer species
Swamp deer, sambar, and hog deer are according to IUCN extinct in the area. Reintroduction (if feasible) of these animals would increase the diversity of the herbivore assemblage and may have a positive effect on the tiger population and the vegetation diversity.

4.4 Habitat management implementation

The principal habitat functions are:
- resource provision for wildlife (food and water)
- space (reproduction, migration, ruminating, resting, ...)
- shelter for biological and physical threats
- aesthetic value (tourism)

Habitat protection is implemented at the following levels:
- land use control (cultivation, logging, fire, livestock grazing, ...)

- herbivore control (fencing, culling, trapping)
- erosion control

Habitat modification may be applied by human intervention to improve the carrying capacity for specific wildlife species:

- fire, mowing
- improve or reduce (!) soil fertility
- drinking water availability
- hydrology (salinity, water table manipulation)

4.5 Monitoring

What and why of monitoring

Monitoring is the regular assessment of the state of a specific subject.

The following issues may be subject to monitoring:
(1) degree of achievement of management objectives (effectiveness),
(2) management/implementation (efficiency),
(3) threats and impacts.

Management monitoring

The efficiency of management can be monitored at financial and operational level:

- at financial level - comparing expenditures and budgets,
- at operational level- number of patrols, arrests, other field activities.

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:

- surveys,
- sightings (staff, visitors).

Wildlife survey techniques are explained in chapter 8.

Monitoring of threats and impacts

The monitoring of threats and impacts enables anticipating management measures to mitigating measures. At animal level occurrence of diseases and mortality changes are the main indicators used. Water quality can be measured to assess pollution levels. Effects of ecological changes and landuse on the habitat are monitored by direct observations on the vegetation and terrain and by using remote sensing techniques.

5. USE OF BASIC FIELD EQUIPMENT

5.1 Introduction

Appropriate use of the equipment is the pre-requisite for data collection in the field. For the best field work and data collection the use of maps and compass is very important. A map is like an aerial photograph of the landscape. A map and compass tell us the location where we are and how to get to the place where we want to go. The map allows us to know to pinpoint locations of animals, animal signs and key habitat features. Major landforms may be indicated on a map.

The proper use of map, compass and other field equipment is the basis of good fieldwork, of which all field staff should have good command.

5.2 Map

A map is a representation of the earth's surface plotted to a particular scale in a miniature form. Maps provide comprehensive and logistical information of an area. Maps help to navigate, conduct research, plan and manage protected areas. Maps also allow us to record information (habitat types, land use, wildlife sightings) about what is going on in the field. With complete graphic maps, properly interpreted and accompanied with pictorial illustrations and descriptions, one could have a good impression of land and landscape and good map interpretation may feel as traveling through the actual landscape.

Map Interpretation

To make good use of map, we must know how to read the map. Cartographers or mapmakers use symbols to represent major features such as railway lines and quarries. They may also use colour coding to show the height of land. Map reading is, therefore, the interpretation of the various symbols used in the composition of maps, or in the other words it is the translation of these symbols and colours and conventional equivalents back to the original features which they represent.

Map features

Title, legend, scale, map history and north arrow included in the map layout, are important features describing the principal characteristics of a map.

(a) The Title indicates the name of the map and is usually positioned at the top of a map and includes normally a reference to the geographic area covered.
(b) The Legend is a kind of table explaining what the symbols and colours mean. These symbols save space, so that mapmakers can include more information. Vegetation types normally express with the help of colour combinations.
(c) The Scale is usually indicated by a graduated line showing the real distance that one centimeter or one inch represents on the map. A map scale is the ratio between any

small distance on the map and the corresponding distance on the earth's surface. A scale is a system by which actual distances- for example one mile or one kilometer-are shown by much smaller distances-such as one inch or one centimeter. This means that many miles can be reduced to a size that will fit on a page.

(d) The Map history shows when, how and by whom the map is prepared, usual information here is: the base map source (e.g. satellite imagery, aerial photography), name of cartographer, date of compilation)

(e) The North Arrow indicates the direction of the North on the map.

Coordinate system

The world has spherical shape, like a ball, but it is slightly flattened at the north and South Pole and bulges a little at the Equator. To ensure that countries and continents can be located systematically, a number of imaginary curved lines are drawn on a globe to divide the world into many sections. These lines are latitudes and longitudes. A location on a map can be indicated in terms of latitude and longitude. Latitude is the distance of a point north or south of the equator. Lines of latitude, called parallel lines, run east-west, parallel to the Equator. The Equator is called the 0° latitude and each half of the world or hemisphere splits into 90 slices, so the North Pole is 90° north and the South Pole is 90° south. Lines of latitude show how many degrees north or south we are.

In order to pinpoint exactly where the location of a place on the earth's surface another sets of lines running from the north to south are needed. These lines of longitude are called meridians. Longitude is the distance of a point is to the east and west of one particular meridian called the prime meridian, which passes through Greenwich, England. The prime meridian extending from pole to pole is the zero line for measuring longitudinal distances 180° east and 180° west.

If the same system of longitudes and latitudes, representing curved lines along the earth surface, would be projected on a map, they would be curved as well. To allow the most accurate distance estimation on maps, usually an evenly spaced grid system is drawn on the map. These lines are straight, but approach the real longitude and latitude lines. A complex formula is required to convert them into the real values, but this automatically done by GPS (see 5.8). To avoid confusion about these different projection systems, a number of worldwide standard projection systems have been developed, such as Universe Transverse Mercator (UTM) and Indian-Bangladesh Projection.

Types of maps

Several types of maps are used for different purposes:

- Planimetric map- shows important features such as rivers but no relief (vertical in terrain level differences).
- Topographic map- shows terrain and landforms in measurable form
- Photomap- reproduction of aerial photos or photo mosaic. Usually used to look closely at small areas.
- Satellite maps-showing large areas for regional resource evaluation. These maps are useful in evaluating habitat types, land use patterns, and in monitoring habitat changes.
- Thematic map, indicating certain themes, such as geology, soil, vegetation or socio-economic aspects of the area covered.

There are three types of map in the Forest Department. These are:

1. RIMS Vegetation map 1:50,000

2. SRF Inventory map, FRMP 1:100,000
3. PSP map 1:250,000

5.3 Compass

A compass is a magnetized piece of metal inside a protective housing. The orientation of that piece of metal, however, is affected by anything generating a magnetic field. The needle inside a magnetic compass is in fact a thin, light magnet, balanced so that it swings freely. The needle's North Pole points normally towards the Earth's magnetic North Pole, which is very close to geographical north. However, other (artificial) magnetic fields generated for example by iron objects or electric power may change its orientation.

Walking compass bearings

Walking a bearing means, to follow a compass reading, from one point to another. This is used for activities such as census transects, boundary cutting and for hiking cross-country. Since it is difficult to maintain a straight line for very far in most field conditions, we can use an alternate method. Use the compass to sight an easily identifiable object (large tree, stone etc.) that is along the bearing. Walk to that object by the easiest path (may not necessarily be the straightest). Before setting out again make certain we are on the right track by taking a "back- bearing", or making sure we are exactly in line with the point from where we started out. It is done by adding 180° to the compass setting if it is below 180°, or subtracting 180° to the compass setting if it is above 180° (just stay within 0-360°). We sight in on the point from where we just came. This will keep us exactly on track. Repeat this procedure until we have traveled the desired distance and we will have walked the equivalent straight-line bearing.

5.4 Map and compass together

Identification of one's position in the field in relation to the map position can follow two procedures:

(a) association method: lining up prominent features on the map with the same features in the field (this method is useful when no compass is available);
(b) compass method: orienting the map according to the compass direction we are facing and determining position by identification of field features;
(c) triangulation (see below).

Accurate determination of location by triangulation

Sometimes it is necessary to determine exactly where we are in the field, or mark a location where we found something of significance (an illegal animal kill or tree felling, a water source, a mineral lick), so that we can return to the site. In that case compass bearings of landmarks in the field have to taken, which are easily identifiable on the map, such as mountaintops or buildings. Plot the back-bearings from the identified landmarks on the map. The location of the area of interest on the map is found where the back-bearings intersect (triangulation) as shown in Figure 5.

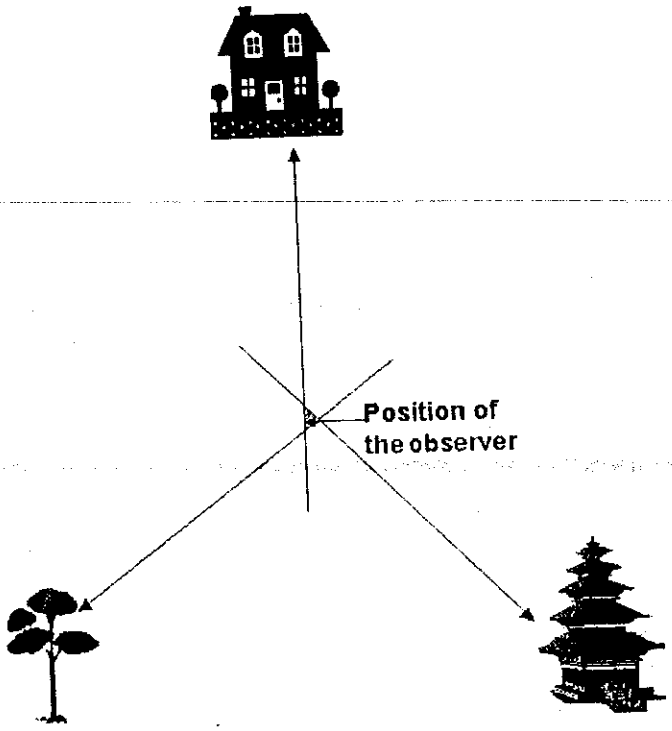


Figure 5. Triangulation method for accurate determination of location

3.5 Other field equipment

Several other types of equipment may be used in the field. Some of them are briefly described below.

Binoculars

Light, small and inexpensive binoculars are sufficient for most fieldwork. Moisture, fungus etc affect the lens and hence reduce the quality of the binoculars.

Rangefinder

Rangefinders are used to determine distances in the field. They can be used for wildlife census and for mapping. There are two different types:

- Optical rangefinder (parallax based), and
- Laser/digital rangefinders, which are more accurate.

Camera

A photo camera can be used for photo-documentation of wildlife habitat, predator kills, poached wildlife, illegal encroachment and forest cover measurements. It provides archival information for management strategies and for monitoring changes over time.

GPS

The position of a person can exactly be determined in the field by using GPS (Global Positioning System), which uses 24 spacial satellites for calculating the position. It's convenient and simple to use, rugged and reliable. Manuals for GPS use are available in SBCP and Forest Department.

Salinity meter

The salinity meter is used for measuring the concentration of salt (Salinity) in the water. There are optical (refracto) salinity meters and electrical salinity meters. Salinity is an important variable in vegetation and water quality analysis.

6. FIELD OBSERVATIONS AND TAKING NOTES

6.1 Introduction

Generally we find considerable differences between what people see in the field and what they describe as having seen. Because of poor visibility inside the Sundarban, ignorance or carelessness, field staff often miss or ignore seemingly minor details of events and objects, such as animal behaviour, traces or habitat features. Assumptions are often recorded as facts or objective observations. Similarly, without having detailed observations of the characteristics of animals or habitat, mistakes may be made. In the field it is essential to distinguish between seeing something happen, versus observing and accurately recording what is taking place. For systematic observations, assumptions or opinions must be separated from objective recordings. The process of taking good notes and making official records are important components of wildlife fieldwork. Important data are constantly lost or recorded incorrectly due to improper, sloppy and subjective note taking and field reporting. The recording of wrong data will create errors in their analysis.

6.2 General guidelines for field observations and notes

Use available information

Use existing field guides, checklists, handbooks, reports (e.g. management plans), etc. Update checklists for known animals. Using checklists is a way of keeping records and monitoring species presence or absence. Review and discuss the most obvious distinguishing features of the different animal groups (taxonomic classes) in the Sundarban. Vegetation maps (e.g. RIMS Forest map) provide information, which is relevant for habitat descriptions. Local people (fishermen, wood cutters, honey hunters) have a lot of local knowledge, which can be very useful additional information for field observations and surveys.

Careful field observation

Don't just 'look', but try to 'watch'. Try to be very quiet while observing animals, blend in with the surroundings and make no abrupt movements when traveling through the forest. Try to focus on key characteristics of animals. Observe general marking patterns, facial patterns, size, colour, habit and appendages. Note plumage, tail, wing/bill shape and size, marking around throat and eyes, fight patterns, habit and habitat for birds.

Taking notes

Good field notes depend on good observation. It is better to record nothing than to record incorrectly. Good wildlife management, protection and conservation efforts hinge on accurate information regarding presence/absence and relative abundance patterns of wildlife species. Field notes can be divided into three categories: numerical values, sketches and explanatory notes. Accuracy, integrity, legibility, arrangement and clarity are the basic features of a good field notes. Some basic guidelines for taking good field notes are as follows:

- Use a pencil or waterproof black ink for notes.
- Make sure a field notebook is titled and the owner's name and return address is written at front.
- Leave a page at the beginning for an index to the field notes.
- If notes become illegible, make a copy and mark it COPY in the field notebook.
- It is often useful to have a field notebook, which can become wet or dirty and a final notebook in the station in which field notes are legibly transcribed everyday.
- If a page is to be voided, draw diagonal lines from opposite corners and mark the page VOID. Do not tear the page out.
- Always record directly in the field book, not on a scrap of paper for copying later.
- Do not erase figures. Never write a figure on top of another.
- Always record field notes at the time of observation.

Designing and using data sheets

The design of data sheets depends on what you are studying in the field. Data sheet for animal observation is obviously different from the sheet used or wildlife census. There are many possible formats of data sheet, but certain types of information are crucial. General information to be used in most types of data sheets may be:

- Observer(s)
- Team number (if applicable)
- Date, time
- Weather
- Time start/finish
- Specific location and/or direction of sighting or sign (preferably GPS coordination)
- Forest type, habitat

Other categories on data sheets may include the following:

- Species name (local/English/scientific name)
- Detailed description (size, shape, colour, special marking)
- Type of animal sign observed (if the animal is not seen)
- Measurements of sign (feces, tracks etc)
- Height above ground (if applicable)
- Remarks (notes on associated species, if any)

Information related to animal behavior and group structure and particularly relevant for surveys:

- age (direct observation, antlers, teeth, bones)
- sex
- physical condition (visual assessment, laboratory analysis)
- behaviour (drinking, eating, resting, moving, mating, fighting, etc.)

See Annex 1 - 4 for different data sheets used for various purposes during the fieldwork in the Sundarban.

Field sketch

Sketches are important for noting particular features or markings and to avoid confusion in terminology. Show scale and indicate key characteristics. Make sketches immediately after observations of animals or habitat are made.

6.3 Identification and measurement of different wildlife species

It is important to identify and classify animals before doing any observation or collecting any other information. An overview of different animal groups is presented below.

6.3.1 Mammals

Mammals are warm-blooded vertebrates, which possess hair at some stage of their life cycle, and all female mammals have mammary gland, which produce milk for their young.

Basic morphological characters for identification:

- The skin is more or less covered with hairs (except Cetacea).
- Sweat glands and sebaceous (oil) glands are present in the skin.
- Mammary gland present in females.
- External ears (pinnae) are present.
- Teeth are differentiated in to incisors, canines and molar).
- The digits in the fore and hind limbs are never more than five, but often reduced.
- Penis is always present in males.

Basic measurement for mammals:

(a) Total length (TotL; Figure 6).
(b) Head and body length (HBL; Figure 6)- not including tail.
(c) Tail length (TL; Figure 6)- base to tip, no hairs.
(d) Ear length (EL; Figure 7)- from notch to tip, both ears.
(e) Grith (G) – Circumference of the body, measured behind the front legs at heart level.
(f) Hind foot length (HFL; Figure 7) – heel to end of longest digit, or in ungulates.
(g) Shoulder height (SH) – top of ridge between shoulder bones to base of foot, including the hoof.
(h) Height at hindquarters-spine to base of foot
(i) Horn length (HL) - over outer curve.
(j) Antler measurements (Figure 8)
(k) Weight (Wt)- live weight or body weight just after death.

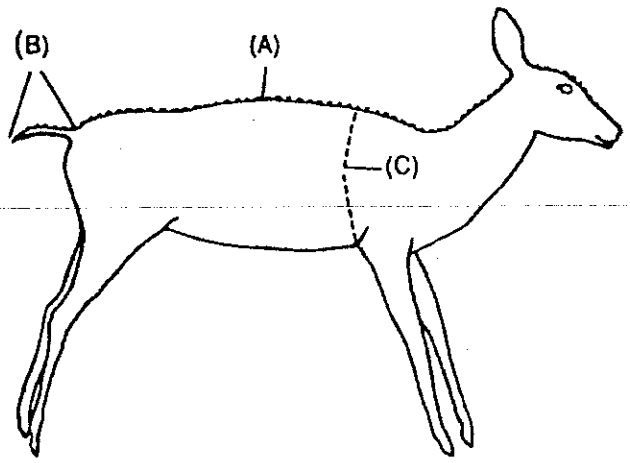


Figure 6. Method of measuring total length (A), tail (B) and girth(C)

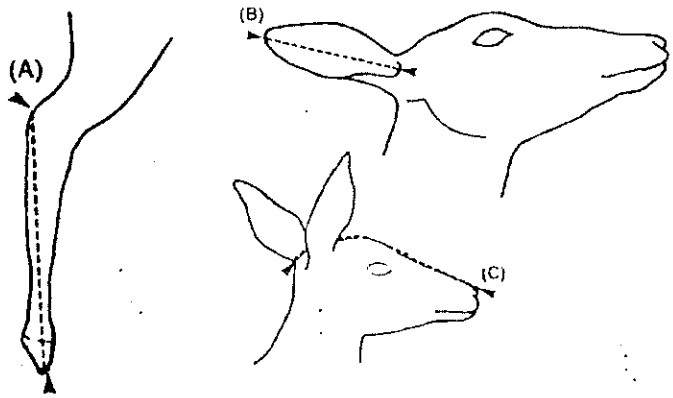


Figure 7. Hind foot length (A), ear length (B) and head length (C)

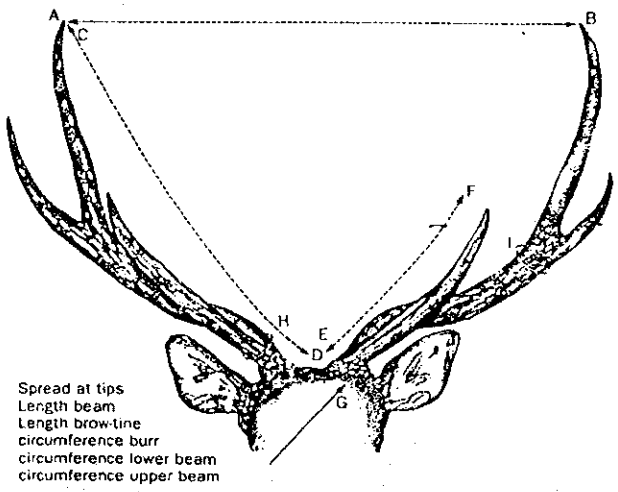


Figure 8. Method of measuring antlers

6.3.2 Birds

Basic morphological characters for identification

- feathers are present in birds,
- the forelimbs are modified into wings each provided with feathers for flight,
- the hind-limbs are adapted for walking, perching or swimming and bearing four toes,
- birds have no teeth. a horny beak is present,
- sexes are separate and sexual dimorphism is well marked.

Basic measurements for birds

(a) Live weight,
(b) Total length (Figure 10),
(c) Wing length (Figure 10),
(d) Wing span,
(e) Tail length (Figure 10),
(f) Color of iris,
(g) Tarsus (Figure 11),
(h) Bill (Figure 10),
(i) Feet,
(j) See Figure 9 for basic parts of a bird. Foot, tail and bill of birds are often adapted for various reasons and their shape is typical for identification (see Figure 11 to 13).

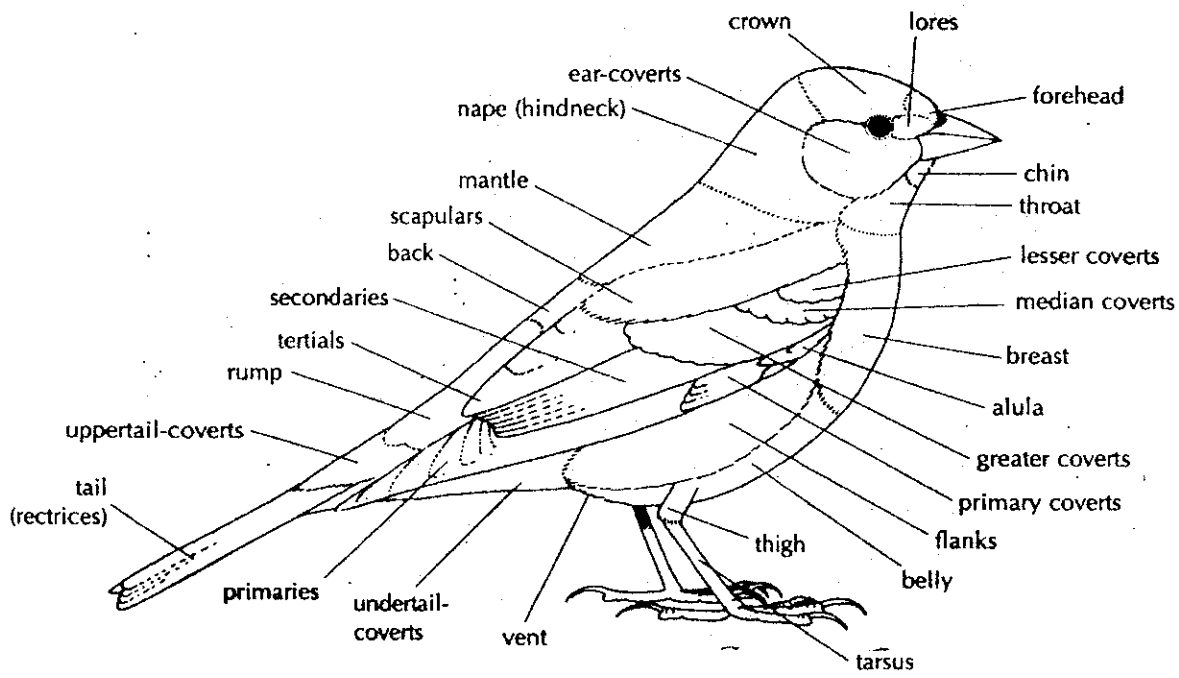


Figure 9. Different parts of a typical bird

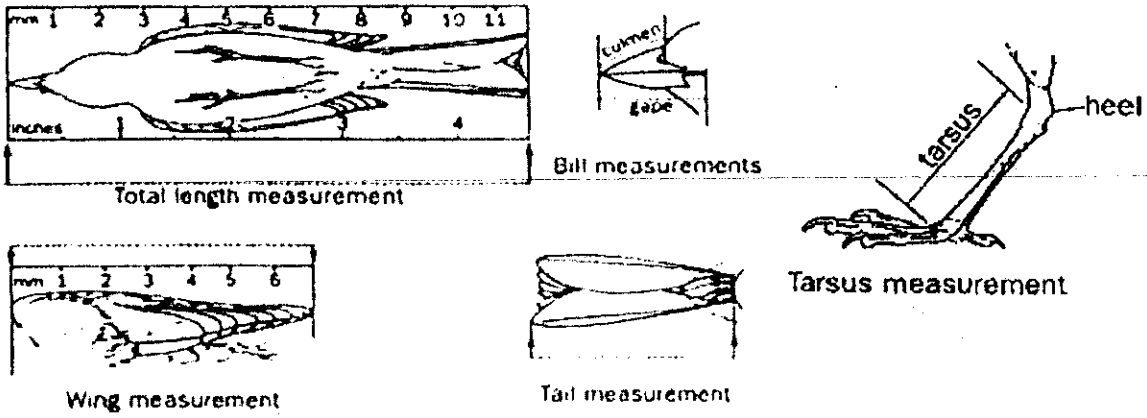


Figure 10. Measurements of different body parts

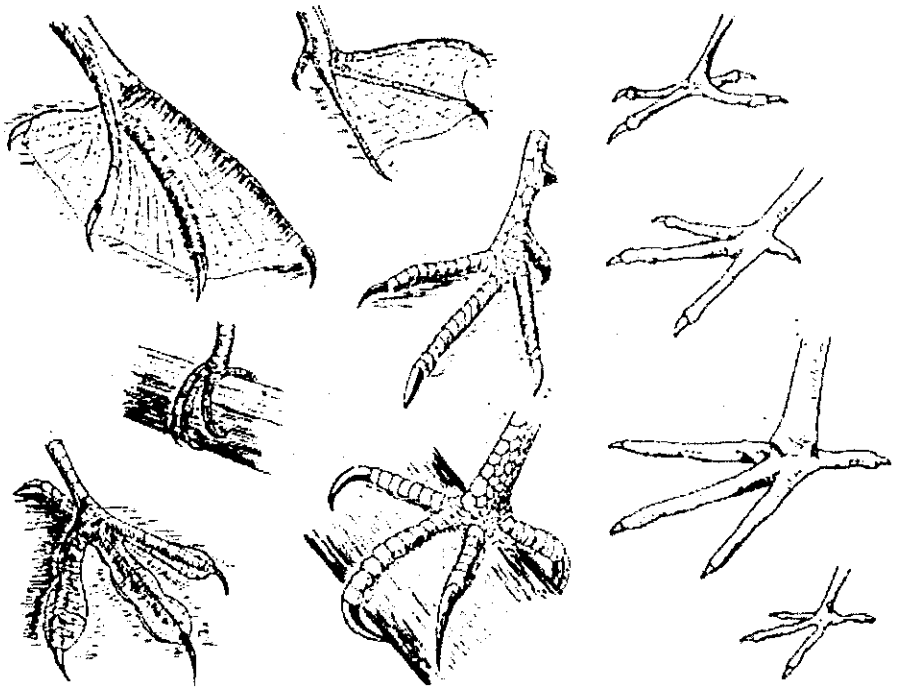


Figure 11. Different types of feet in birds

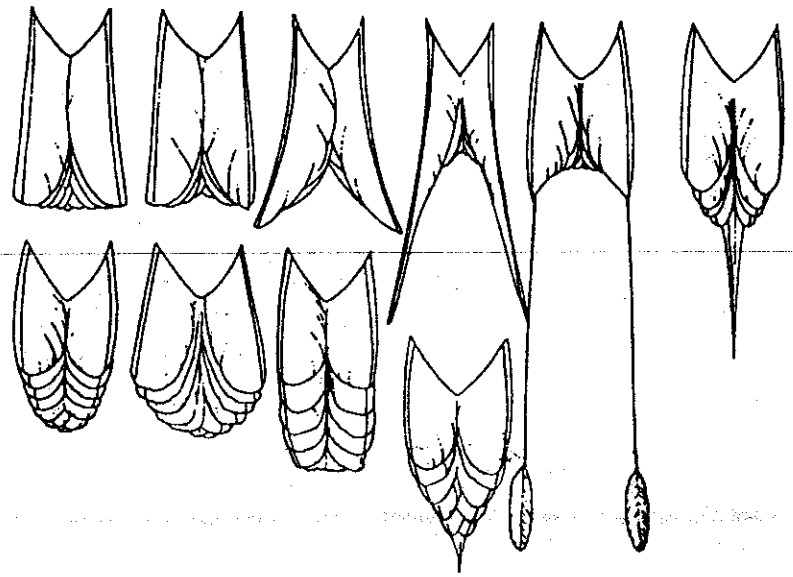


Figure 12. Different types of tail found in birds

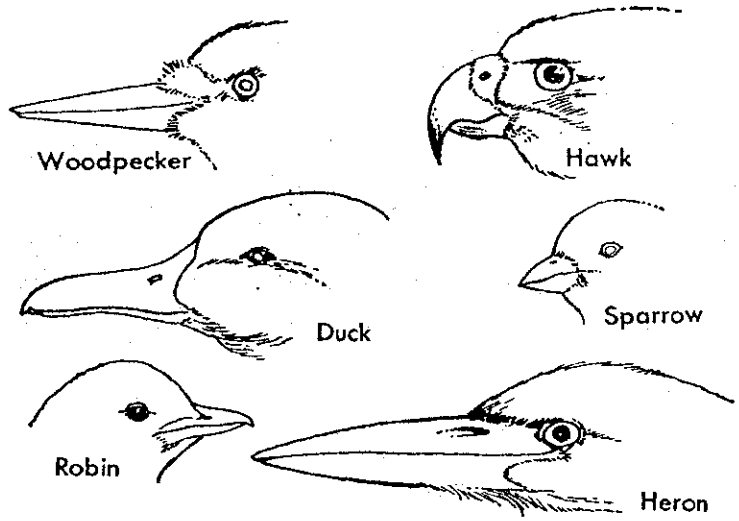


Figure 13. Different types of bill

6.3.3 Reptiles

Basic morphological characters for identification:

- The body is covered with horny scales or scutes.
- The skin is dry and skin glands are absent

Body parts of different reptiles of the Sundarban are shown in Figure 14 - 16.

Basic measurement for reptiles:

- Live weight
- Total length
- Tail length
- Length of shell (turtles)

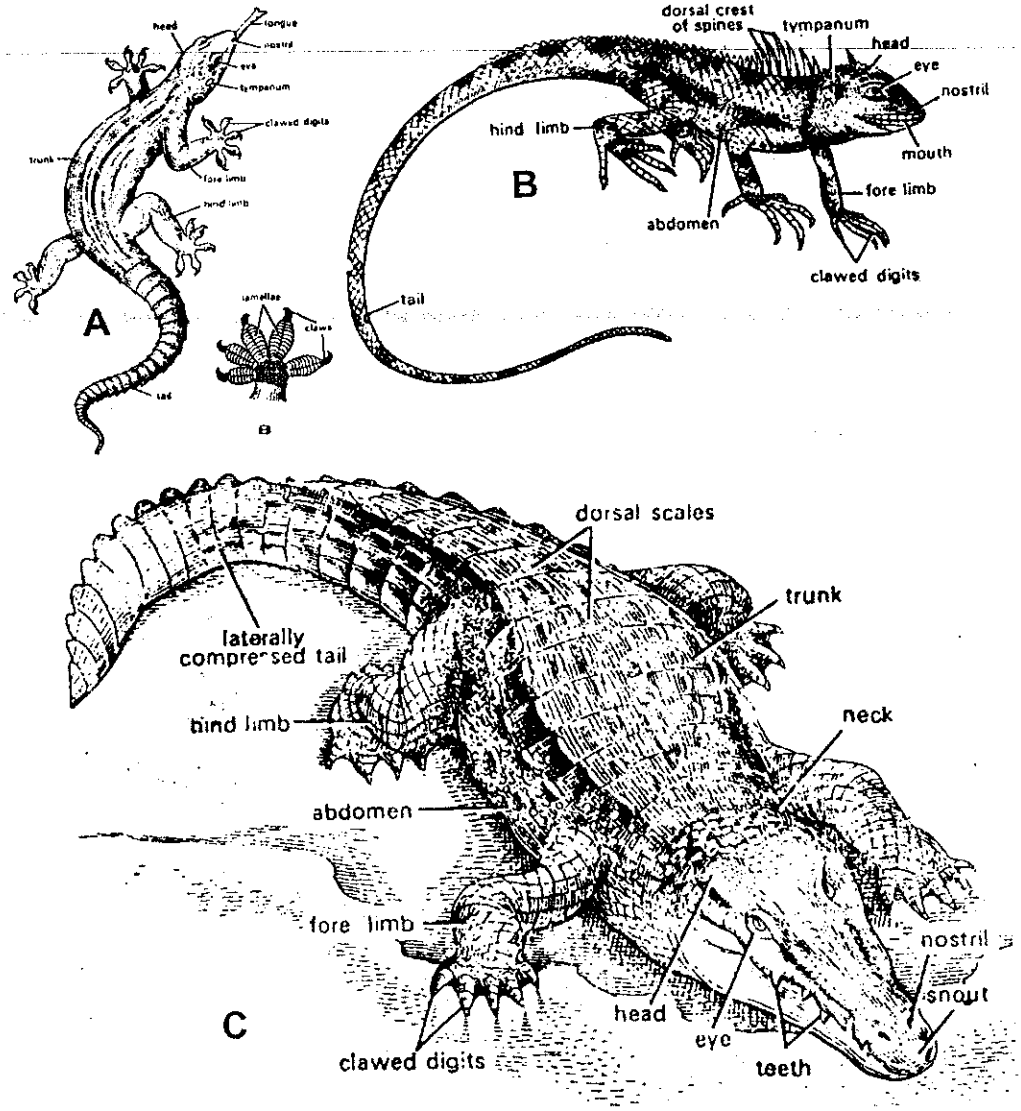


Figure 14. Different body pars of lizards found in the Sundarban
a. Hemidactylus; b. Calotes; c. Crocodylus

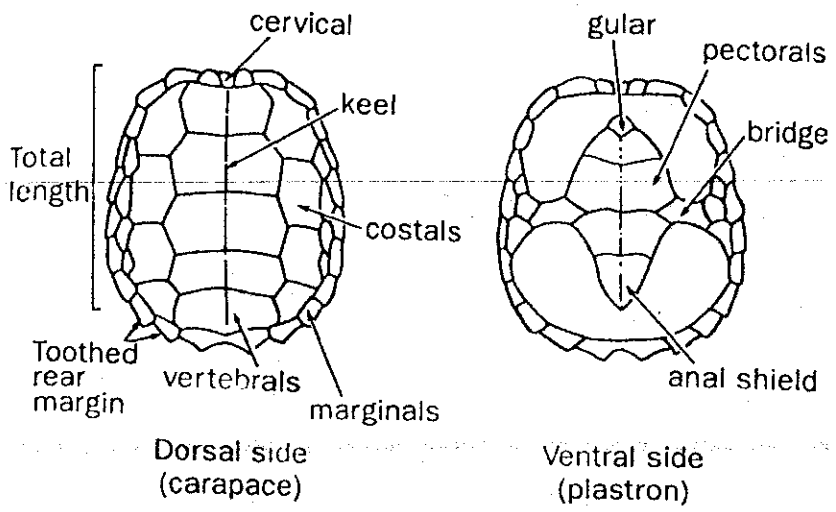


Figure 15. Parts of a typical turtle

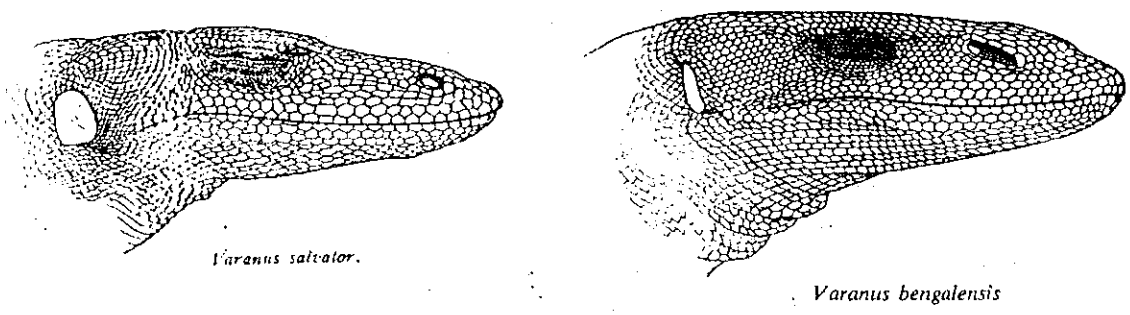


Figure 16. Different types of Monitor lizard found in the Sundarban

6.3.4 Identification of poisonous and non-poisonous snakes

The following key will serve to distinguish poisonous snakes from non-poisonous snakes (see Table 4. for a quick check):

A. If it is a marine snake with the tail laterally compressed it is poisonous (Figure 18).

B. If it is a terrestrial snake with the tail rounded or cylindrical and not compressed then examine its ventral scales (Figure 18).

   i. If all the ventral scales are small or the ventral scales are somewhat broad, then it is a non-poisonous snake (Figure 18).
   ii. If the ventral scales are large transverse plates extending fully across the ventral side or belly, the snake may be poisonous or non-poisonous. To find out examine the dorsal surface of the head (Figure 17).
      a. If all the dorsal scales of the head are small, then it may be a viper.
         If there is a loreal pit between the nostril and eye, then it is a pit viper.

If the sub-caudals are double and there is a loreal pit, then it is a Russel's viper.

b. If dorsal side of the head has both small scales and large shields, the snake may or may not be poisonous, to ascertain look at the side of the head.

C. If the third supra-labial shield touches the nostril and eye, then it is a poisonous snake, may be cobra, king cobra or coral snake (Figure 18).

D. If the upper side of the head has both small scales and large shields but there is no loreal pit and the third supra-labial shield does not touch the eye, then examine the back of the snake and ventral side of the lower jaw.

i. The middle row of scales on the back called vertebrals may be larger than other.
ii. Ventral side of lower jaw has fourth infra-labial shield larger than the others. If both (i) and (ii) characters are present, then it is a krait.

E. If the snake has small scales and large shields on the head but does not have the characters of cobra, krait or coral snake, then it is non-poisonous (Figure 18).

Table 4. Difference between poisonous and non-poisonous snake (for quick reference)

Characters	Non-poisonous snakes	Poisonous snakes
1. Colour	Not bright	Bright coloured
2. Shape of head	Elliptical	Posterior portion is broad
3. Hood	Absent	Present
4. Abdominal scale	Small	Large, extend from side to side
5. Head shield	Small	Very large
6. Loreal shield	Absent	Present, shapes may be variable
7. Mental shield	Small	Forth one is large
8. Teeth	Uniform	Maxillary teeth are large and are called 'Fangs'. Fangs are provided with groove or canal
9. Poison gland	Absent	Present
10. Streptostylism	Less marked	Well marked

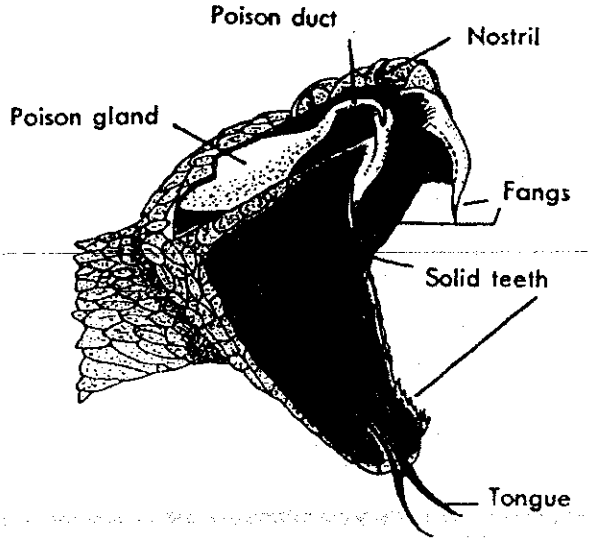


Figure 17. Mouth of a poisonous snake

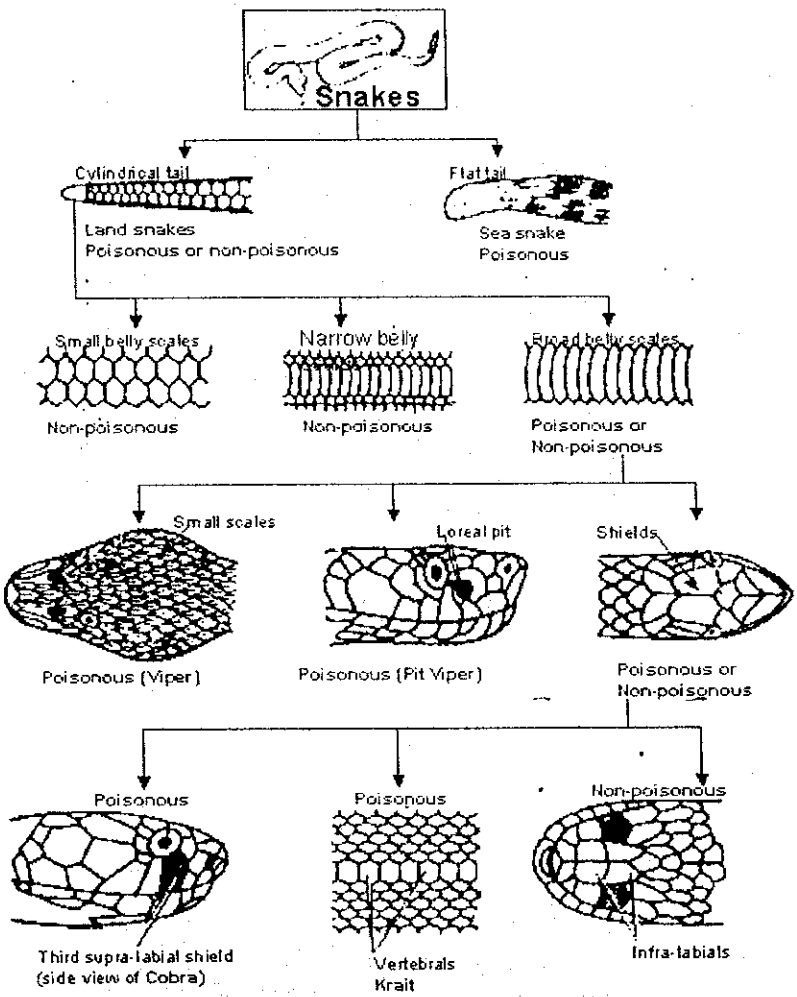


Figure 18. Identification key of poisonous and non-poisonous snakes.

6.3.5 Amphibians

Basic morphological characters for identification

- Skin smooth or rough, rich in glands, which kept it moist.
- Scales, if present, are hidden in the skin.
- 4 Limbs having 5 fingers each.

The following basic measurement for Amphibians can be taken (Figure 19):

- Live weight
- Total length
- Length of tibia
- Body length-minus legs

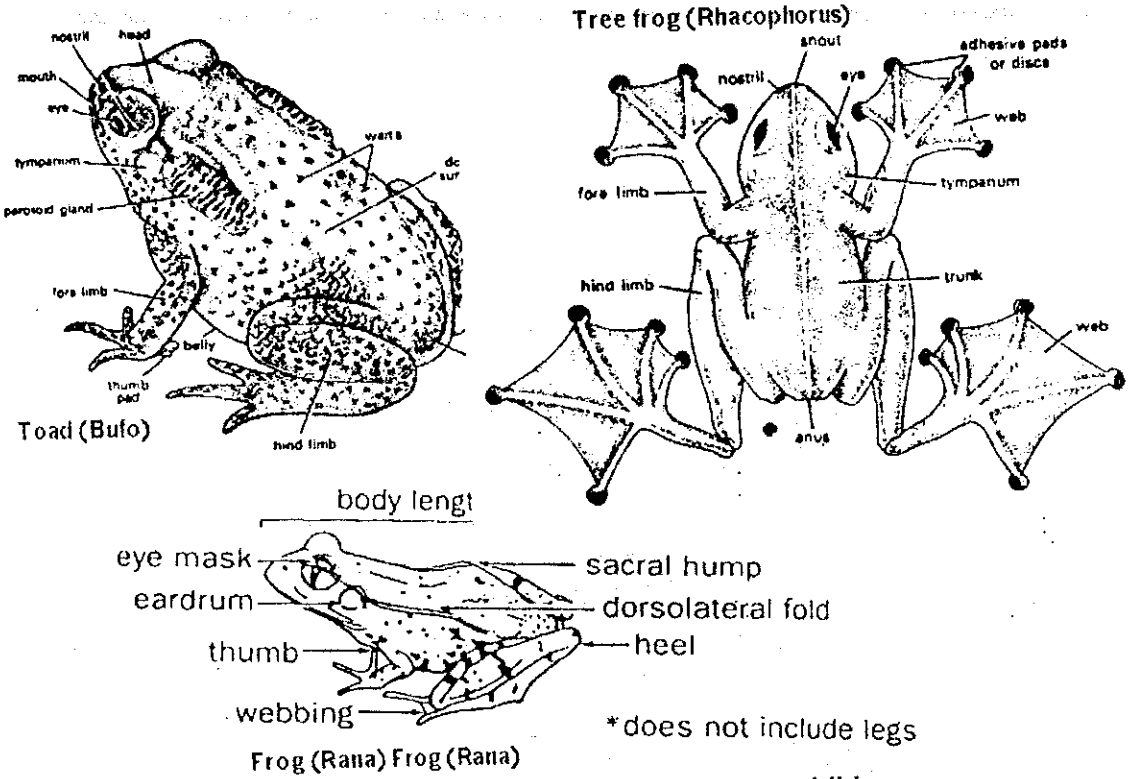


Figure 19. Body parts of different amphibians

6.4 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 tool to monitor the distribution of the larger animals species. Crucial is the regular collection of data from the field station.

7. VEGETATION SURVEYS

7.1 Introduction

Species diversity and population density of wild animals in a particular area depend on the site's vegetation. Vegetation is the assemblage of plants in a particular area in a particular time.

7.2 Why studying vegetation?

To develop a model for conservation and management of a particular ecosystem, it is essential to know the composition, structure and productivity of that ecosystem. However, the approach of vegetation studies is related to the purpose of the results of the study and hence depends on the question that needs to be answered. Therefore, the different users require different approaches:

- Ecologist prefers an approach based on floristic plant species composition.
- Autecologists require a measure of abundance or performance of a species.
- Synecologists deal with plant communities, vegetation variation and vegetation patterns in relation to biotic and abiotic factors.
- Production ecologist requires data about dry weight and calorific content (biomass).
- Wildlife managers are usually interested in vegetation structure in relation to animal requirements i.e. stratification, habitat diversity and quality.
- Resource surveyors prefer a quantifying approach for assessment of resources such as timber and range land carrying capacity.
- Soil scientists and Geologists require vegetation classification to produce mapping units, using vegetation as an indicator of the subsoil.
- Foresters use vegetation as an assessment of species composition to indicate site potential and to assist species selection for planting.

7.3 Methods for vegetation sampling

In relation to the purpose of vegetation surveys several approaches are available to describe or characterize vegetation. They can be applied on the vegetation as whole or just on selected species or species groups:

- Floristic composition
- Structural composition
- Seasonal productivity of plant parts (Phenology)
- Standing biomass

Sampling of vegetation in this context means that distinct units (often plots) are selected which are examined in detail. Sampling methods used for vegetation composition analysis can be classified as follows:

A Quadrat method (Plot sampling): The quadrat is a square sample plot or unit for a detailed analysis of vegetation. It may be a single sample plot or it may be divided into several sub-plots.

B. Intersect method: A line of fixed length (usually a rope) is poisoned in the study area. The total length of the parts of line intersecting specific plant associations (e.g. grass associations or trees) is recorded as an estimate of the cover of this association, by dividing it by the total length of the line. The result is a percentage, indicating the proportion of the area covered by the association.

C. Point method: In this method of sampling a fixed number of identifications of plant species are taken at each observation point. The observation points can be chosen systematically or randomly along a straight line.

D. Plot-less sampling (e.g. nearest neighbour): by taking the average distance of the nearest plants of the same species, the absolute density can be calculated of a species.

The location of vegetation survey samples can be planned according to the following sampling systems (see also next page):

- systematic sampling (using regular distances among samples)
- at random sampling (applying at random distances among samples)
- stratified sampling (planning more or less equal numbers of samples in preliminary vegetation classes)

The most commonly used parameters for vegetation surveys are:

- Density -number of individuals per area unit (/m^2, or /ha)
- Cover -proportion of area covered by stems (basal cover) or crown (crown or aerial cover) (in %)

7.4 Classification

Classification is the delineation of more or less homogeneous units of vegetation. Classes are characterized by:

- the association of certain species,
- specific patterns visible from the air (aerial photo's),
- the relation to other biotic and abiotic factors (water, soil, geomorphology).

Generally two approaches are used for the classification of vegetation:

- Structural approach: describing vegetation composition regarding life forms (trees, shrubs, herbs, etc.);
- Floristic approach: describing vegetation composition regarding different plant species.

Usually geomorphology and/or structure are used as a classification entry. Floristic characteristics are used at a lower distinction level. The RIMS Classification (Figure 20) uses basically a floristic approach but includes some structural elements.

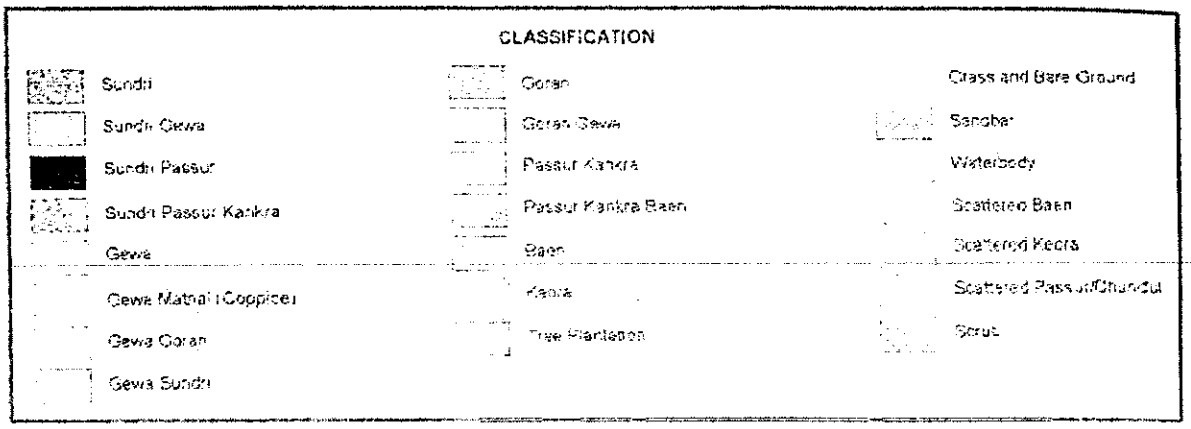


Figure 20. Classification of FRMP/RIMS map, commonly used the Sundarban

7.5 Vegetation mapping

Landscape patterns derived from aerial photos or satellite images and a vegetation classification resulting from a vegetation survey are combined in order to make a vegetation map. The following steps are commonly involved in a vegetation mapping survey:

(a) compiling a base map, based on aerial photo's or satellite images,
(b) pre-interpretation of aerial photos and identification of preliminary vegetation formations,
(c) elaboration of a preliminary legend based on the preliminary formations mentioned above,
(d) delineation of preliminary vegetation units, based on the preliminary legend mentioned above,
(e) elaboration of a vegetation sample plan,
(f) ground survey (stratified) ground thruthing
(g) final vegetation classification
(h) final legend
(i) final map and eventually other statistics

8. WILDLIFE SURVEYS

8.1 Survey objectives and planning

Before starting wildlife survey in a given area, it should determined what kind of information is required to be provided by this survey. Animal but also vegetation surveys are carried out for the following general reasons:

- to evaluate (1) state and (2) trends (changes) of specific populations
- to evaluate (1) state and (2) trends of specific ecosystems
- to evaluate management options and measures.

Specific results of wildlife surveys involve the following:

(a) Population structure: size of social groups and population composition (age groups and sex ratio);
(b) Species distribution in relation to habitat indicating habitat preference and suitability;
(c) Abundance to estimate absolute density (total number of individuals per species in the survey area);
(d) Relative abundance: estimating relative abundance using indices of presence;
(e) Population trends: temporal differences indicating the increase, decrease or stability of a population.

Since the methodology for systematic surveys for different purposes and of different wildlife species varies considerably, a successful survey requires careful and systematic planning. The methodology should be: standardized, facilitate repeatability, feasible in the habitat concerned, and finally, it should sometimes allow comparison with other surveys. Results need to have a known level of accuracy.

It is furthermore convenient to have a species checklist of the area, which can be obtained by consulting literature or carrying out field inventories before the survey is carried out. When the target species of a survey and their habits are known it is possible to adopt the most appropriate method.

During the planning process preceding a survey, the following questions should be addressed:

(1) Do we have a management related question that requires an indication of density?
(2) Is absolute density required or will an index of density suffice?
(3) Is a rough estimate sufficient or an accurate estimate required?
(4) Which method is biologically and statistically most appropriate?
(5) How much does it cost?
(6) How much money is available?
(7) Would money be better spent on answering other questions?

Discussion and brainstorming play an important roll in developing a good survey plan.

8.2 Sampling systems

According to biological, statistical and financial considerations a sampling system should be designed, involving the following choices:

- absolute or relative density?

- direct or indirect methods?
- transects or quadrates?
- random, systematic or stratified?

Wildlife surveys may be based on direct observations or on indices of presence (indirect observations).

Table 5. Examples of methods used for animal surveys

	direct methods	*indirect methods*
• Method	• transect counts • drive counts • total counts • aerial survey	• pellets, • footprints, • other presence indices • capture – recapture • catch per unit effort
• When	• good visibility • high density	• bad visibility • low density

Sampling accuracy

To reduce costs as much as possible the number of samples taken should be kept low. On the other hand a higher sample number will result in more accuracy of the results. A criterion should be set for the minimum number of samples to obtain an acceptable accuracy level. There are several statistical methods available (Figure 21).

The most simple are:
- plotting sample size against mean
- plotting sample number against mean

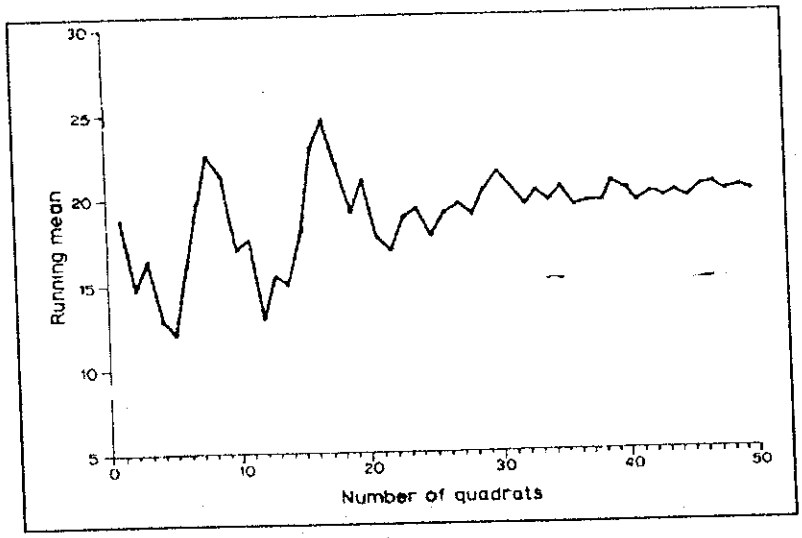


Figure 21. An example of measuring sampling accuracy.

8.3 Animal surveys: direct methods

8.3.1 Drive counts (total count)

Drivers or beaters, spaced regularly, walk in a line, driving the animals out of a demarcated survey area. Observers along the boundary record animals moved out of the census area. Animals returning back through the drive-line are recorded by the drivers, each recording to his left or right and subtracted from the number, which left the survey area (see Figure 22).

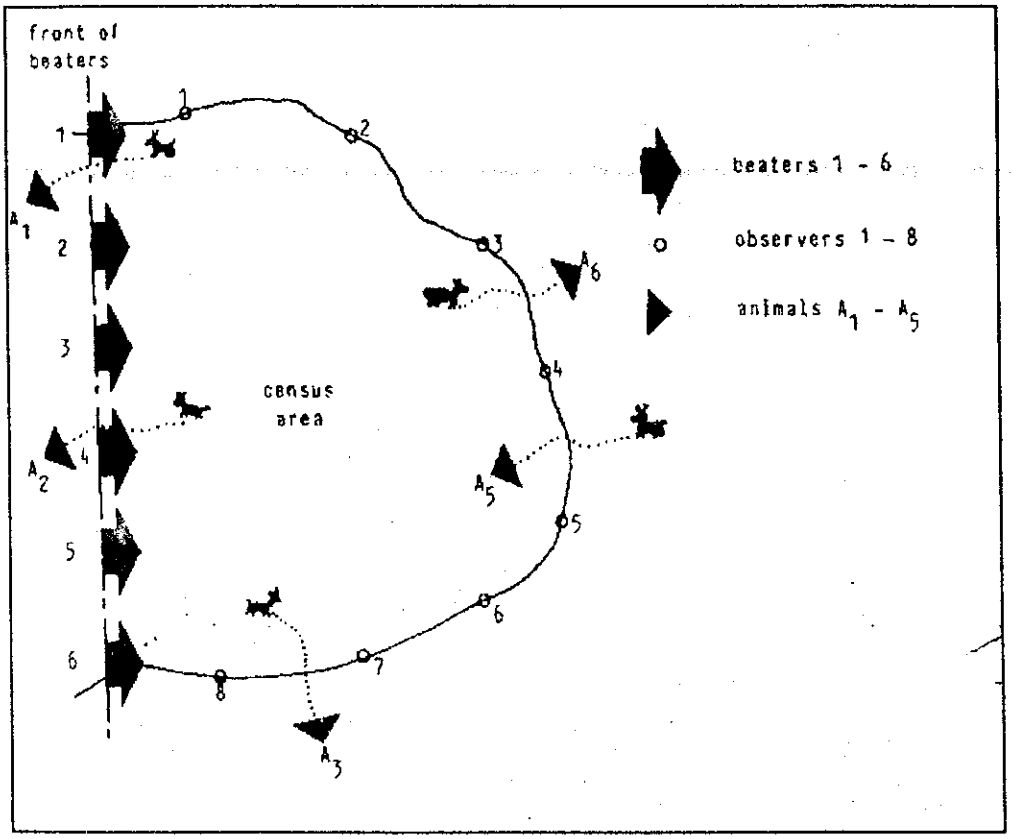


Figure 22. Drive count (total count) technique according to L.P. van Lavieren 1982

- Animals A_1 and A_2, breaking through the front of beaters, are recorded by beaters 1and 3 respectively.
- Animals A_3 and A_4, leaving the census area ahead of the beaters, are recorded by observers 7 and 3 respectively.
- Animal A_5, entering the census area during the census operation, is recorded by observer 4 and later subtracted from total.

8.3.2 Fixed band count (sample drive count)

A number of strip or parallel band shaped transects are drawn on a map of the survey or census area at regular distances (usually 1, 2, or 5 km depending on the size of the area). Each band is covered by a survey team of 3 persons (Figure 23). The person in the middle keeps the straight walking line of the team by using a compass. The people left and right of him maintain a constant distance between them and the central person (usually 20 – 100 m, depending on the visibility in the habitat on site). The persons left and right count all animals crossing the compass line in front, which is the limit of the strip. Animals entering are subtracted from animals leaving. Similarly, the central person counts all entries and exits of animals crossing the line between him and the persons left and right of him.

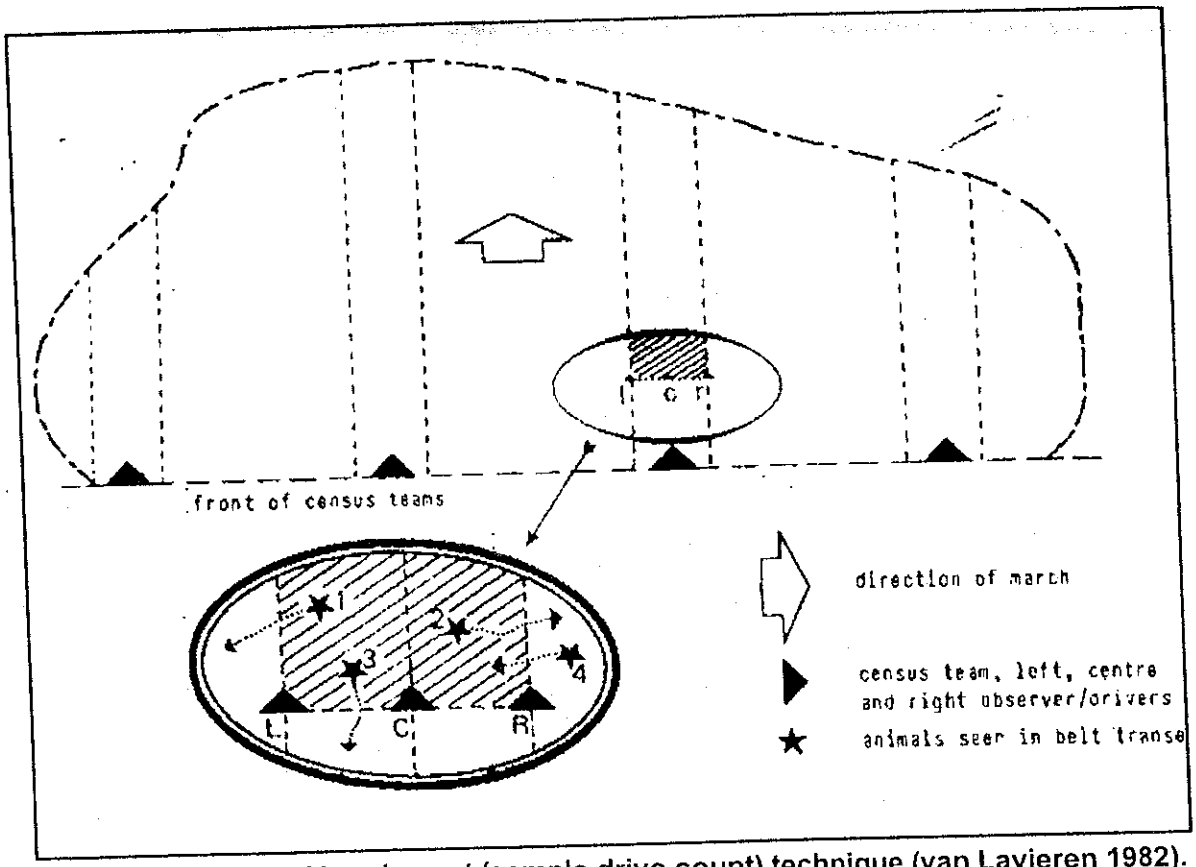


Figure 23. Fixed band count (sample drive count) technique (van Lavieren 1982).

Four teams of three observers walk four band transects simultaneously. The distance between left, central and right observers is fixed and depends on visibility.

- Animal 1 is recorded by **L** when passing his line of walk to the left.
- Animal 2 is recorded by **R** when passing his line of walk to the Right.
- Animal 3 is recorded by **C** when cutting back through the front of observers;
- Animal 4 is recorded separately by **R** when passing his line of walk to the left and subtracted from the transect total.

8.3.3 Line transect sample count (variable width transect count)

A number of parallel transect lines is drawn on a map of the survey area at regular distances (usually 1, 2, or 5 km). The starting points of all these transects are usually located along a road or water way (base line) and the orientation should be more or less perpendicular to this base line. In the field, survey teams of 2-3 people walk along these transects, using a compass to maintain the right direction (figure 24). This transect method has the following basic assumptions:

- Animals are detected by the observers following the transect line looking to their left, right and in front, however not all animals will be seen, as some will probably be overlooked due to obstructions in the landscape.
- The number of animals missed increases with their distance from the transect line.

Data collection

The survey teams identify and count all animals observed once. For each observation, they note the distance between the point where they themselves were located and the point where the animals were located at the moment of the first sighting. This distance is estimated using pacing, a rangefinder or visual estimation. Apart from that, for each observation the angle is determined between the transect (walking line) and the direction of the sighted animals.

Analysis

Both distance and angle of sightings are used in a formula to calculate the assumed average width of the transect, and from this the total area covered by one survey team can be derived, by multiplying the average width by the transect length. The animal density is calculated by dividing the total number of animals sighted by the calculated area covered.

Calculations

The data analysis is normally carried out by specialized staff back in the office assisted by a computer, and field staff have not to bother about the calculations involved. For those who are interested the method used is explained below.

The following variables were recorded on the data sheets:

- z_i The number of animals in an observed group;
- d_i The sighting distance, being the distance from the observer to the animal at the moment of detection;
- α_i The sighting angle, which is the angle between the direction of the transect and the direction of the sighted animals at the moment of detection (L=O when the animal is seen on the transect line);
- **X** Transect length;
- **i** is the serial number of observations;

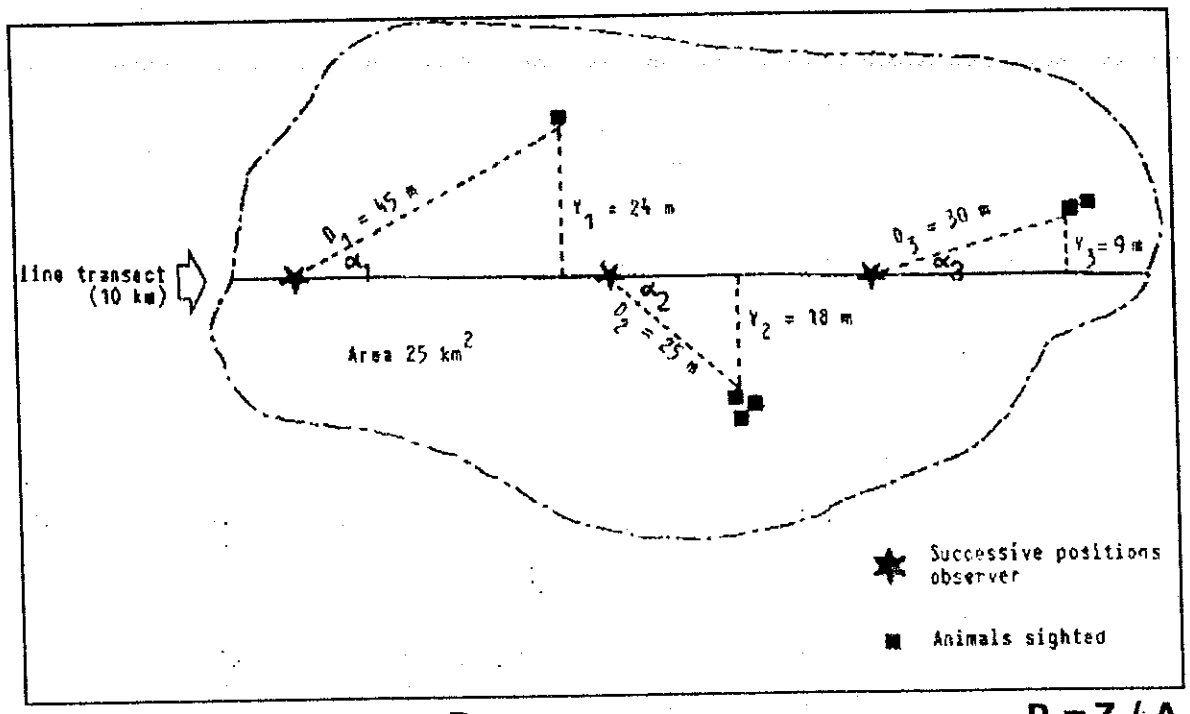
The following variables have to calculated after the survey:

- y_i The perpendicular distance, from the transect line to the point where the animals was first observed (y= '0' when the animal is seen on the transect line);
- **Y** The mean perpendicular distance;
- **Z** The total number of animals observed;

Calculate of the perpendicular distance (y_i) for each observation: $y_i = d_i * \sin\alpha_i$

Calculation of mean perpendicular distance (Y): $$Y = \frac{z_1 * y_1 + z_2 * y_2 + \ldots + z_i * y_i}{Z}$$

Calculation of area covered (A): $A = X * 2 * Y$



Calculation of population density (P): $P = Z / A$

Figure 24. Simplified example of data collection along transect of line transect count

8.3.4 Crocodile spotlight surveys

Nighttime spotlight counts are often used to assess the abundance and distribution of crocodiles. The advantages of this method are:

(1) most crocodiles are usually active in the water at night,
(2) most of this time is spend on the water surface,
(3) the reflections of all size crocodiles are easily detected.

The surveys are carried out as follows. A small survey team (3-4 people) navigates along a waterway in a small boat (e.g. trawler, country boat, slow speedboat). A handheld spotlight is directed to the front and moved slowly to and fro (between app. 45° left and right of de course of the boat) over the water surface about 50 m away and further. All crocodiles

sighted are noted and GPS locations are taken as well as the starting and ending points of the survey. Crocodile density is usually expressed as linear density, which is the number of crocs per 1 or 10 km length of waterway. Often it is possible to "catch" a crocodile in the light beam. In that case, it can be caught by a large (square) hand net, measured, marked and returned to the water.

The spotlight crocodile surveys are difficult on larger waterways (> 100 m) due to waves and limited viewing distance. Counting basking crocodiles during the cold season in the daytime is an alternative approach, but the disadvantage of this method is that usually only adult crocodiles are seen.

8.4 Animal surveys: indirect methods

8.4.1 Background

Indirect survey methods have to be used when the visibility of animals is limited due to the landscape, vegetation, nocturnal behavior or low animal density. In dense forests such as the Sundarban, indirect methods are usually more convenient than direct methods. A number of this type of methods will be described in the following sections:

(a) Pellet counts
(b) Track counts
(c) Catch per unit effort.
(d) Presence – absence frequency.
(e) Density classes.
(f) Nest counts.
(g) Burrow counts.
(h) Capture – recapture. (Petersen Estimate)

8.4.2 Dung counts

The number of an animal's fecal deposits (pellets, dung) can be used as an indicator of its abundance. When the average number of defecations per animal (defecation rate) is known, the number of defecations per unit area can be converted into density (number of animals per unit area). The defecation rate is established by (1) direct observations of individual animals during long periods, or (2) by total drive counts in areas where pellet counts have been carried out. Dung counts are done in plots of various shapes and sizes. Sampling system varies as well according to the purpose of the survey (at random, systematic, stratified). For the Sundarban a method has been developed, which is explained in detail below. In this particular case a method has been developed that combines dung and track counts (see also 8.4.3).

Plots are laid out of 10 X 20 m with measuring tape, and marked by positioning 4 survey team members or clearly visible flags on its corners. All mammal defecations are identified and counted inside the plots and registered on a data sheet (Survey of indices of presence, Appendix 5). Groups of deer pellets, which are considered as the result of one defecation only, are counted as one (1). Apart from this the following information was noted:

Code	record identification code for GPS use
Location	name of nearest river

Date and Time	date and time of observation
GPS	North and East coordinates in decimals
Compartment	Compartment code
Forest type	observed forest type defined by the three dominant forest species
RIMS	RIMS forest class according to FRMP/RIMS map
Soil	soil type (clay, sand, silt, silty clay, sandy clay, clay silt, sandy silt, clay sand, silty sand, loam)
Inundation	inundation type (permanent, daily, two-weekly, seasonal, none)
Last flooded	number of hours or days since last inundation
Species	species related to indices of presence
Type	type of species (deer, boar, tiger etc.)
N	number of indices
Remarks	any particularity

8.4.3 Foot print/Track counts

Animal tracks on the ground can be principally used for two different purposes:

(1) determination of the relative density of animal species in an area or habitat – for this purpose usually entire tracks crossing a transect line are usually counted,

(2) evaluation of the characteristics of individual animals and deducting group composition (age classes, sex ratio) and homerange use – for this purpose normally single footprints are examined (shape, size).

A large variety of methodologies have been developed for track counts. Sampling system varies as well according to the purpose of the survey (at random, systematic, stratified). Three different methods, specifically developed for deer and tiger surveys in the Sundarban, will be explained in detail in the following sections.

(a) animal track counts to determine relative density of various mammals

This method is usually combined with a dung count using a 10 x 20 m plot for the same species (see also 8.4.2). In the field the count is carried as follows. Plots are laid out of 10 X 20 m with measuring tape, and marked by positioning 4 survey team members or 4 clearly visible flags on its corners. All crossing mammal tracks on both long sides of the plots (which are considered as two separate transects) are identified, counted and registered on a data sheet (Survey of animal foot prints - Appendix 4). Apart from this the following information was noted:

Code	record identification code for GPS use
Location	name of nearest river
Date and Time	date and time of observation
GPS	North and East coordinates in decimals
Compartment	Compartment code
Forest type	observed forest type defined by the three dominant forest species
RIMS	RIMS forest class according to FRMP/RIMS map
Soil	soil type (clay, sand, silt, silty clay, sandy clay, clay silt, sandy silt, clay sand, silty sand, loam)
Inundation	inundation type (permanent, daily, two-weekly, seasonal, none)
Last flooded	number of hours or days since last inundation
Species	species related to track
N	number of tracks
Remarks	any particularity

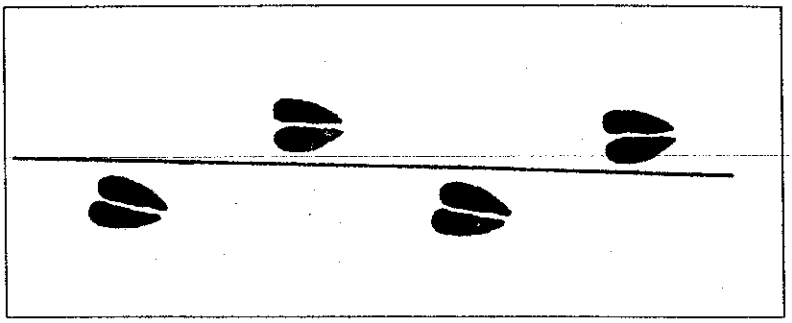


Figure 25. One deer track composed of several footprints is counted as one!

(b) Encounter rate of recent tiger tracks crossing medium sized waterways

The encounter rate of recent tiger tracks crossing canals is used as an index for the relative density, enabling comparison of tiger densities in different locations and population trends over time.

Canals between 8 and 30 m wide are selected for these surveys. The starting point of each survey canal (usually the confluent) is marked and coded using GPS. Subsequently, the canal is surveyed with an average speed of 6 to 8 km/hr, observing the side of the canal where visibility conditions (light, vegetation) are the best. Only one side is surveyed at the time, but if visibility conditions change the observation should be shifted to the other side. The end of each survey canal is again marked and coded using GPS. During the survey all tiger tracks crossing the river are marked by GPS and the following information is noted on a form (Appendix 2):

Date	survey date
Code	code of GPS waypoint
Time	time of observation
Location	name of river
Distance covered	distance cover from survey starting point to end in km
Last high tide	time of last high tide
River side	side of river on which pugmark was observed (left, right)
Compartment	compartment number
Forest type (RIMS)	forest type according to FRMP/RIMS forest map
Observed forest type	observed vegetation type defined by the three dominant forest species
River width (m)	local width of river
GPS coordinates	latitude (dd'mm.dec), longitude (dd'mm.dec)
Age class	age class of pugmark (see section 2.3)
Observation	type of observation: beginning of survey (start), end of survey (stop), tiger leaving water (up), tiger entering water (down)
Remarks	any particularity

After the survey the number of crossings per km can be calculated by dividing the total number of crossings by the length of the canal.

(c) Tiger pugmark tracing and measurement

The purpose of the pugmark tracing method is the determination of a size index of the tiger. The results can be used for population structure analysis, comparing different areas and trends.

During the pugmark surveys all clear pugmarks are traced as far as possible using a pugmark tracer, which is a 3 mm plate (25 X 25 cm) of perspex with 2 cm long support legs. The tracer is positioned above pugmarks and an A4 size transparent overhead sheet is attached with masking tape. Subsequently, contours of pad and toes are traced with a fine permanent marker on the sheet. The following information is noted on an accompanying data sheet (Appendix 3):

Sheet code	code used for GPS and tracing sheet
Date, Time	observation date and time
Observer	survey team
Tracer	name of tracer
Location	name of river
Coordinates (N/E)	GPS coordinates
Last flood	last inundation in hours and days
Compartment	forest compartment number
Forest type observed	observed forest type defined by the three dominant forest species
Forest type (RIMS)	forest type according to FRMP/RIMS map
Soil	soil type soil type (clay, sand, silt, silty clay, sandy clay, clay silt, sandy silt, clay sand, silty sand, loam)
Estimated age pugmark	estimated time between passage of tiger and observation according to survey team members (consensus)
Age class pugmark	age class system according to classification described in section 2.3
Direction of walk	direction of walk in degrees
Step	distance between pad tips of left and right hind paw
Normal stride left-left	distance between pad tips of left front and hind paw
Normal stride right-right	distance between pad tips of right front and hind paw
Slow/Normal/Fast	estimated speed according to Singh (1999)
Gap (cm)	closest distance between pad tips of left front and hind prints or right front and hind prints – in case of overlapping prints, gap is 0

After the survey the following parameters were measured on the tracing sheets and the results were added to the data sheet (Figure 26, Appendix 3):

PMB (cm):	pugmark breath
PML (cm):	pugmark length
TTB (cm):	toe to toe length
PTL (cm):	pad to toe length

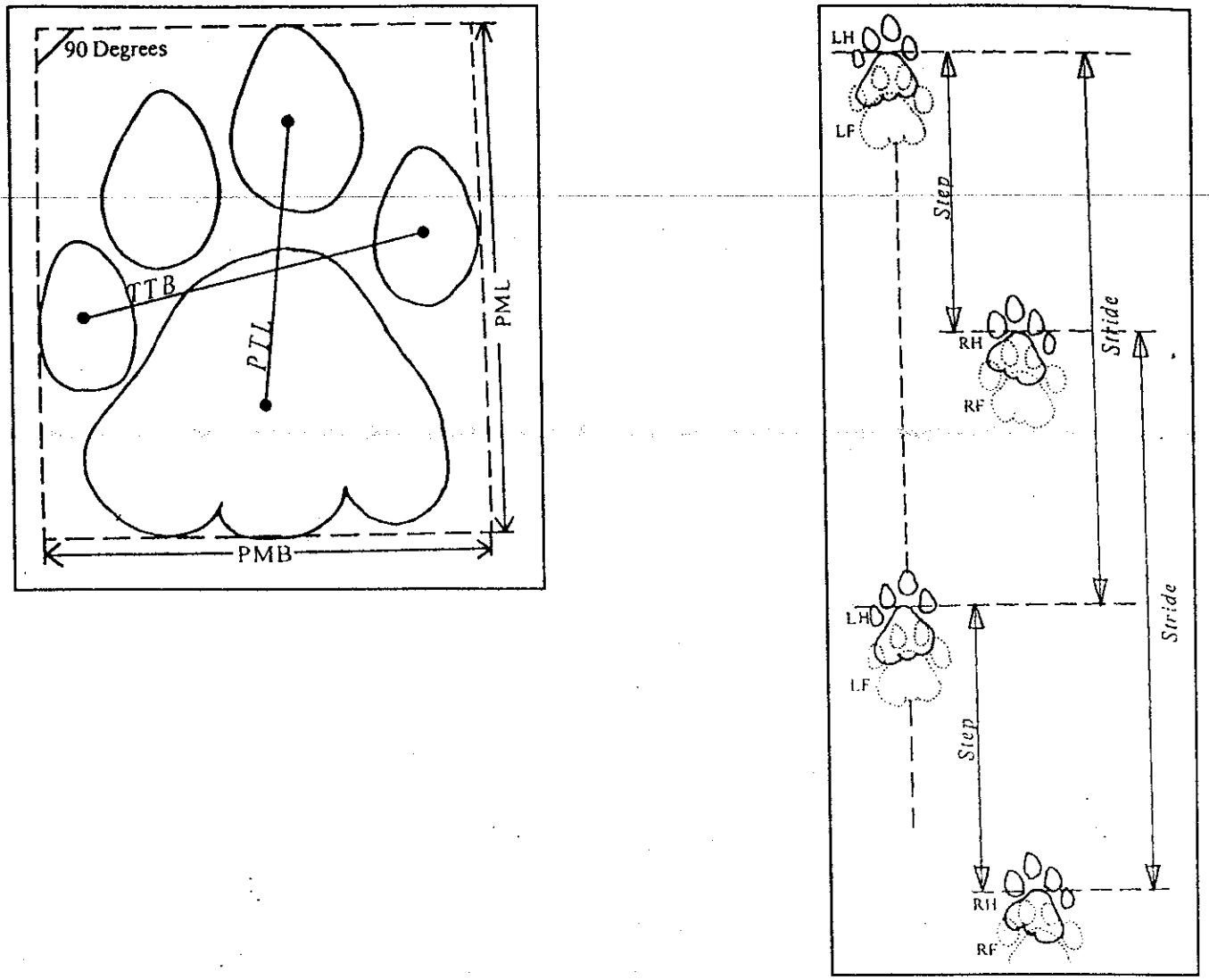


Figure 26. Pugmark tracing measurements

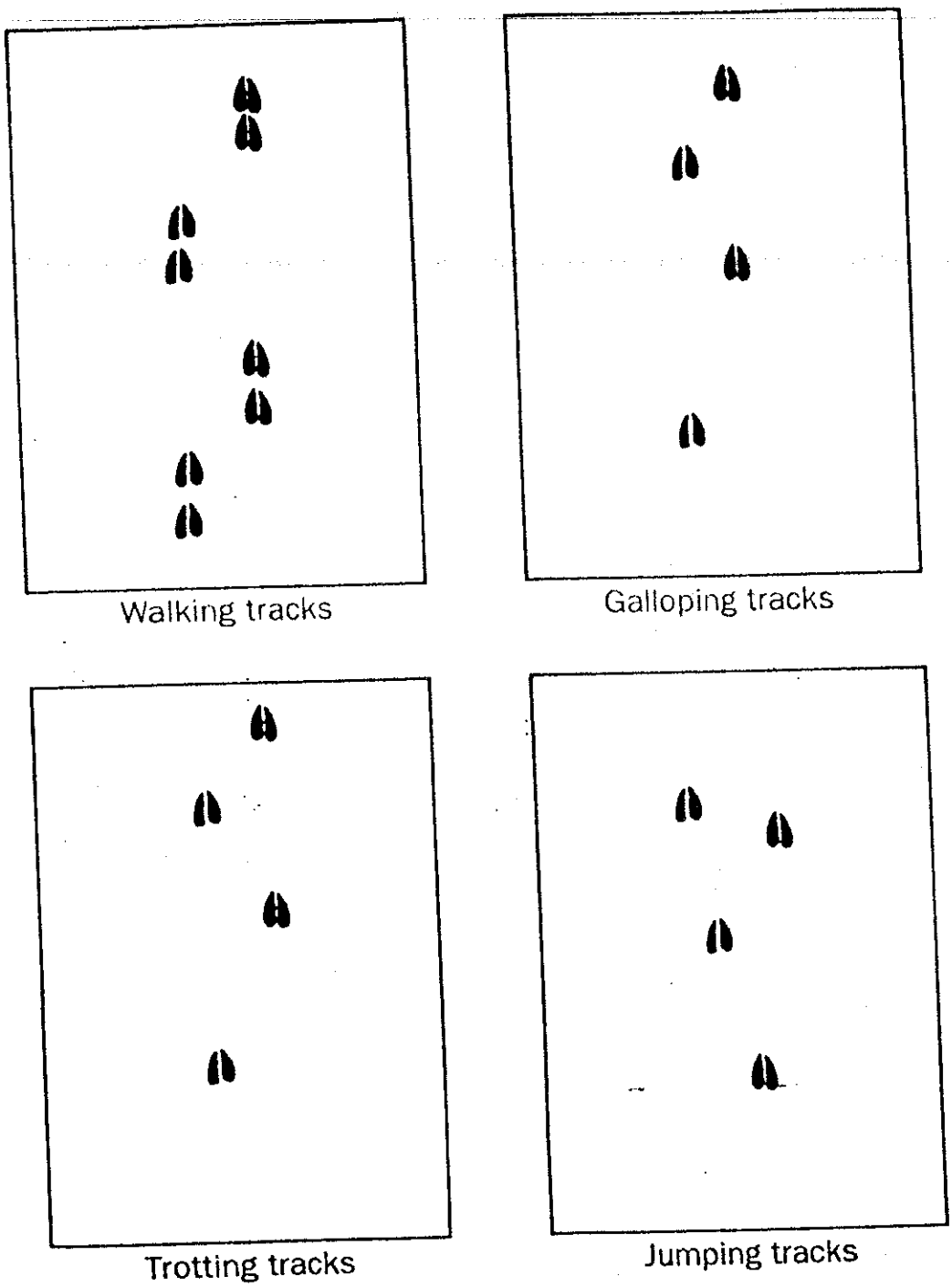


Figure 27. Different pattern of footprint

8.4.4 Other indirect survey methods for animals

(a) Catch per Unit Effort

A number of traps are set in a systematic or random pattern depending on the animal distribution pattern. Captured animals are removed and traps are reset and checked again at regular intervals; trapping effort must be constant throughout the experiment. The number of captures during any capture operation is proportional both to the trapping effort and to the size of the population. By holding the trapping effort constant, successive catches will give us the approximate size of the population.

(b) Presence – absence frequency

A series of plots are located at random in an area. Each plot is visited and checked for the presence or absence of the animal. The proportion of visited plots is an indicator of relative abundance.

(c) Density classes

When only rough estimates of animal density are required we may use simple quantifications such as 'common', 'rare', 'abundant', 'absent', etc. Care should be taken in using the quantification 'absent': it means 'none were seen' rather than 'none were there'.

(d) Nest counts

Nests can be counted while walking along transects which are systematically or randomly.

(e) Burrow counts

Burrows may be counted along line transects in strip transect or in sample plots.

(f) Capture – Recapture method

The method involves trapping animals live and releasing them again after marking into the population. From the frequencies of recaptures of marked individuals during the trapping program, an estimate can be made of the total population size.

A number of animals (M) are captured, marked and released again. After a certain period of time, a second sample of animals is captured (n), including some (m) which had been marked before. The population estimate (N) is calculated as

$$N = \frac{Mn}{m}$$ (Petersen estimate)

The principal assumption is that the proportion $\frac{m}{n}$ is a good estimator for $\frac{M}{N}$.

9. LEGISLATION

9.1 Introduction

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 wildlife, and both national as well as international policies regarding conservation and environment have changed considerably. A revision of this act was envisaged by FRMP to make wildlife legislation compatible with the present context, but the recommendations presented have not yet been implemented.

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 (1) the rates for harvesting forest products, (2) the interdiction of use of specific resources, and (3) the interdiction of fishing in a number of Khals. In 1989 a Presidential Order prohibited all hunting of mammals, birds and reptiles in Bangladesh.

Other relevant legal Acts that apply in the Sundarban are:

- Arms Act,
- Fish Preservation Act,
- Environment Conservation Act.

9.2 Bangladesh Wildlife Act

9.2.1 Schedules

The Bangladesh Wildlife (Preservation) (Amendment) Act (1974) defines a number of groups in which wildlife has been classified. Each class is subject to different rules with respect to protection and use by humans.

First schedule

Part (1): List of crustaceans, amphibians, reptiles, birds and mammals of Bangladesh, which are open to shooting and may need an ordinary game hunting permit.

Part (2): List of mammals, reptiles and birds of Bangladesh for which hunting requires a special hunting permit.

Second Schedule

List of wild animals, trophies or meat requiring a certificate of lawful position for its possession, transfer or import.

Third Schedule

List of protected animals i.e., animals which shall not be hunted, killed or captured.

9.2.2 Definitions (Interpretation clauses)

The Act lists a number of definitions of concepts used in its text and necessary for its correct interpretation.

- **Wildlife sanctuary:** " Wildlife sanctuary " Means an area closed to hunting, shooting or trapping of wild animals and declared as such the Government as undisturbed breeding ground primarily for the protection of wildlife including of all natural resources , such as vegetation, soil, and water.
- **Wild Animal:** Wild Animals means any vertebrate creature, other than human beings and animals of usually domesticated species, and includes the eggs of birds and reptiles.
- **Trophy:** Trophy means any dead wild animal or any horn, antler, tooth, tusk, claw, skin, hair, feather, shell or other durable part of a wild animal whether or not included in a manufactured or processed article.
- **Game Animals:** The wild animals specified in the first schedule shall be known as "Game Animals" and shall not be hunted, killed or captured, unless in accordance with the term of a permit.
- **Protected animals:** The wild animals specified in the third schedule of the Act, shall be known as " Protected Animals" and shall not be hunted, killed or captured except when otherwise expressly provided in this act.
- **Offence:** "Offence" means an offence punishable under this act or under any rule made there under.
- **National Park:** National Park Means a comparatively large area of understanding science and natural beauty with the primary object of protection and preservation of scenery, flora and fauna in the natural state to which access of public recreation and education and research may be allowed .
- **Game Reserve:** A Game Reserve is an area declared by government for the protection of wildlife and increase of population of important species, wherein capturing of wild animal is unlawful.

9.2.3 Prohibitions and rights (Section 6 of Act)

In this section several activities related to wildlife are prohibited. The main prohibitions are shown below.

(a) (i) Hunt any wild animal by means of a set-gun, drop spear, dreadful gun-trap, an explosive, grenade, electrical contrivances, a baited hook or any other trap whatsoever.

(ii) Hunt any game animal by means of an automatic weapon of a caliber used by Bangladesh army, rifles or police, a shot gun, rifle of 22 caliber or less, or a projectile containing any drug or chemical substance having the property of paralyzing animals or affecting them otherwise, partly, or totally.

(b) (i) Use any motor vehicle, motor driven vessel, watercraft of any type or aircraft, or any other manually or mechanically propelled vehicle to pursue any game animal or drive to stampede game animals for any purpose whatsoever.

(ii) Use or Have in his possession any poison, for the purpose of hunting game animal

(iii) Shoot any game animal from any aircraft, motor vehicle, rail trolley cart, boats or any kind of watercraft or any other conveyance.
(iv) Hunt with the help of live decays, call birds, or any other artificial contrivances.

(c) Construct or use or have in his possession any pitfall, game pit, trench or similar excavation or any fence or enclosure, or set fire to any vegetation or any other contrivance for the purpose of hunting any game animal.

Forest Department may grant capture license and allow employment of a method of hunting.

The following actions are not considered as an offence in the Act (section 21):
(a) to kill any animals by any means in defense of his own life or that of other persons,
(b) for the owner of any standing crop and his employees to kill by any means within the bounds of such crops, any wild animal causing material damage to the crops
(c) for the owner of livestock or his employees to kill any wild animal causing damage to the livestock in any way within a reasonable distance of where livestock is grazing or where it is enclosed for the night.

Paragraphs (b) and (c) do not apply to any unlawful occupation or presence in a protected area. The killing of any wild animal of the first and third schedule should be reported immediately to the nearest Forest Station.

9.2.4 Prohibitions in Wildlife Sanctuaries

In Section 23(2) of the Act, several prohibited activities are described applicable to Wildlife Sanctuaries. No Person shall:
- Enter or reside in any wildlife sanctuary or,
- Cultivate any land in a wildlife sanctuary,
- Damage or destroy any vegetation of a wildlife sanctuary,
- Hunt, kill or capture any wild animal in or within one mile from the boundary of the wildlife sanctuary,
- Introduce any exotic species of animal in a wildlife sanctuary,
- Introduce any domestic animal in a wildlife sanctuary,
- Cause any fire in a wildlife sanctuary,
- Pollute water flowing through a wildlife sanctuary.

9.2.5 Power to arrest offenders

Under the Section 31 of the Act any officer not below the rank of forester or senior wildlife scout may, without order from a magistrate and without a warrant, arrest any person against whom a reasonable suspicion exists of his having been concerned in any offence under this act. Every officer making an arrest under this Article shall, without unnecessary delay and subject to the provisions of this as to release on bound, take or send the person arrested before the Magistrate having jurisdiction in the case or the officer in charge of the nearest police station.

9.3 Other relevant legislation

Other relevant legislation is mainly covered by Rules and Notifications:

- Rules prescribing procedures to be followed in case of fire arm use

- Notification Eviction at Encroacher – No. 1260/ For of 23/8/1958
- Notification Issue license – No.1 /For 99/73/740 of 27/12/1973
- Notification Meat or trophy treated as Government property & auction- No. 1/For 99/73/741 of 27/12/1974
- Notification Inspection power – No. 1/For 99/73/742 of 27/12/1973
- Notification Arrest without warrant – No. 1/For 99/73/743 of 27/12/1973
- Notification Power to firing Bengal government letter – No. 1297/For of 3/2/1940
- Notification Power to carry arms – No. 865 of 17/4/1959

9.4 International legislation and obligations

To coordinate conservation activities worldwide a number of international agreements (conventions) have been drafted and signed (ratified) by most countries in the world. By ratifying these conventions a country commits itself to the implementation of measures for the conservation of the environment and biodiversity. In return, these country receives international financial and technical support and trade benefits. Not respecting these conventions may have consequences, such as a trade embargo.

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.

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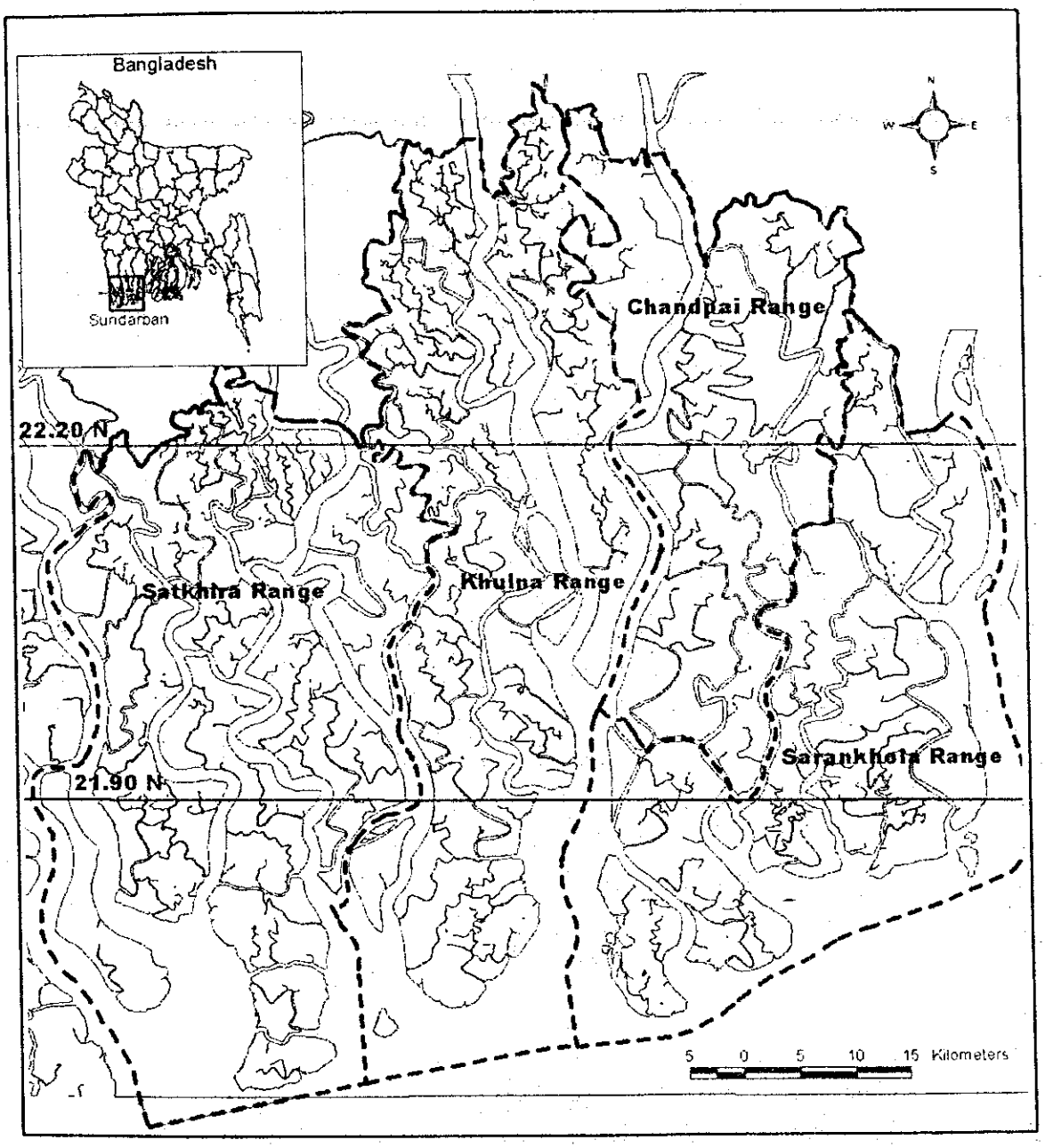
APPENDICES

Appendix 1. Map of the Sundarban Forest



Appendix 2. Survey data sheet for encounter rate of recent tiger tracks along medium sized water ways

(5) Tiger pugmark survey	Observers:
Date:	

Code	Time	Location (river)	Distance covered (km)	Last high tide	River side (left, right)	Comp't ment	Forest type (RIMS)	Forest type obser-ved	River width (m)	Lat. (dd'mm. dec)	Long. (dd'mm. dec)	Age class	Obser-vation (start/stop up/down)	Remarks

Appendix 3.Survey form for the recording of tiger pugmark tracing

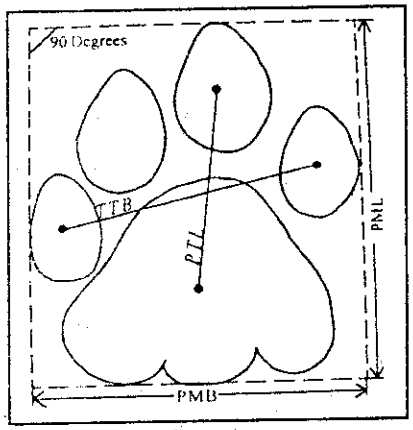
(8) Pugmark measuring and tracing

Sheet code:	
Date:	
Time:	
Observer:	
Tracer:	
Location:	
Coordinates (N/E)	
Last flood:	
Compartment:	
Forest type observed:	
Forest type (RIMS):	
Soil:	

Estimated age pugmark:	
Age class pugmark:	
Direction of walk:	

Step	
Normal stride left-left:	
Normal stride right-right:	
Slow/Normal/Fast	
Gap (cm)	

	LH
PMB (cm):	
PML (cm):	
TTB (cm):	
PTL (cm):	



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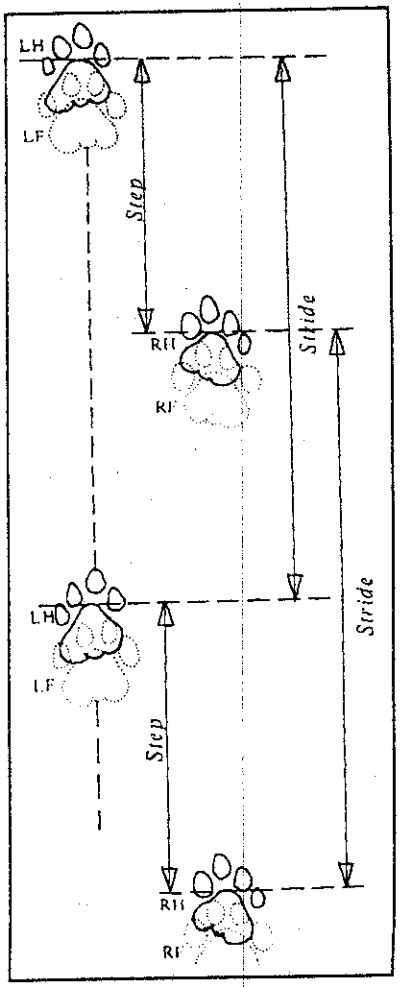

Appendix 4.Survey form for the recording of animal foot prints along 20 m transects

(2) Survey of animal foot prints (transect 20 m.)

Observers:

Codes	Location	Date	Time	GPS N	GPS E	Comp't	Forest type	RIMS class	Soil	Inun-dation	Last flooded	Species	N	Remarks

Appendix 5.Survey form for the recording of indices of presence in 10 X 20 m plots

(1) Survey of indices of presence (plotsize 10 X 20 m.)

Observers

Code	Location	Date	Time	GPS N	GPS E	Comp't	Forest type	RIMS class	Soil	Inun-dation	Last flooded	Species	Type	N	Remarks

Appendix 6. Survey form for structural and floristic vegetation survey

Vegetation survey	plot 10 x 20 m
Observers:	

Location	Date	Time

GPS N	GPS E

Code

Soil	Inun-dation	Salinity	Bare (%)	Herbs (%)	Shrubs (%) <2m	Trees (%) >2 m

Species	Code	Cover (%)	Species	Code	Cover (%)