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An updated checklist of the mammals of West Bengal

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ABSTRACT

The Checklist of Mammalian fauna of West Bengal has been updated after more than two and half decades to include recent taxonomic changes, new additions and distribution records for West Bengal. In this checklist, 234 species (Extant 211, Extinct 23) and 215 sub-species, belonging to 137 genera, 39 families and 11 orders, are reported. The chiropterans represent maximum number of species (75) followed by rodents (50), carnivores (48), Artiodactyls (29), Eulipotyphla (11), Primates (8), Lagomorpha (5), Perissodactyla (3), Pholidota (2) Scandentia (2) and Proboscidea (1). Relative to the 1992 version, the gain in number of species is 46 (+24.46%), that of sub-species 70 (+48.27%), genera 31 (+29.24%) and families 7 (+21.87%). Following recent molecular evidences, Cetacea is reordered under Artiodactyla in the new version. There are, however, a few records that remain unresolved, doubtful or controversial.

Key words: checklist, mammals, taxonomy, distribution, habitat, status, conservation.

Abbreviations (Old names in parenthesis).

BWLS: Ballavpur Wildlife Sanctuary, Birbhum district
BBWLS: Bibhuti Bhushan (Parmadan) Wildlife Sanctuary, North 24-Parganas district
BDWLS: Bethuadahari Wildlife Sanctuary, Nadia district
BTR: Buxa Tiger Reserve, Alipurduar district.
CWLS: Chapramari Wildlife Sanctuary, Jalpaiguri district
CKWLS: Chintamani Kar (Narendrapur) Wildlife Sanctuary, South 24-Parganas district.
EKW: East Kolkata Wetlands, North and South 24-Parganas districts.
GNP: Gorumara National Park, Jalpaiguri district.
HIWLS: Halliday Island Wildlife Sanctuary, South 24-Parganas district,
JNP: Jaldapara National Park, Alipurduar district.
LIWLS: Lothian Island South 24-Parganas district.
MWLS: Mahananda (Mahanadi) Wildlife Sanctuary, Darjeeling district.
NVNP: Neora Valley National Park, Kalimpong district.
RWLS: Raiganj (Kulik) Wildlife Sanctuary, North Dinajpur district.
RBWLS: Ramnabagan Wildlife Sanctuary, Burdwan district.
SG: Sacred Groves
SNP: Singhalila National Park, Darjeeling district.
STR: Sundarban Tiger Reserve, North and South 24-Parganas districts.
SWLS: Senchal Wildlife Sanctuary, Darjeeling district.
SKWLS: Sajnakhali Wildlife Sanctuary, South 24-Parganas district.
ZSI: Zoological Survey of India, Kolkata.

INTRODUCTION

West Bengal falls in the transition zone between Peninsular Indian sub-region, Indo-Malayan sub-region of Oriental zone and Palaearctic region, resulting in great array of natural ecosystems embellished with ingress, colonization and interspersions of mammalian life-forms in the state from the entire adjoining regions. On the contrary, due to burgeoning population pressure, quite a number of mammal species have either become extinct from the state or lost large part of their erstwhile range and restricted to fragmented habitats with small threatened populations. Under the circumstances, periodical evaluation of their status is necessary, which will serve as an indicator to measure the habitat and habitant conditions in the state and prepare the management prescriptions or action plans to sustain the existing diversity in future.

The previous checklist of the mammals of West Bengal was published during the last decade of 20th century by Zoological Survey of India or ZSI (Agrawal et al. 1992). Thereafter, no exclusive study in this field was conducted to evaluate the current status of mammals by incorporating the new discoveries and taxonomic changes in West Bengal during the last 26 years. Hence, it was considered desirable to conduct an extensive study with a view to filling up the knowledge gap during the intervening period by preparing an updated checklist of mammals in the state.

MATERIALS AND METHODS

Study area

West Bengal is the only state in India, ranged between the (Eastern) Himalayas on the north and Bay of Bengal (coastline about 210 km) on the south, with Chhotanagpur plateaus, Gangetic plains and delta covering the remaining part harbouring rich mammalian diversity. Geographical area of the state is 88,752 km² (21°20'N-27°32'N, 85°50'E-89°52'E), which is administratively divided into 23 districts (Fig. 1). The state borders nationally with Odisha (south-west), Jharkhand (west), Bihar (west), Sikkim (north) and Assam (east) and internationally with Nepal (west), Bhutan (north-east) and Bangladesh (east). The districts that are located on the north of the Ganga Darjeeling (2,092.5 km²), Jalpaiguri (2,844 km²), Cooch Behar (3,387 km²), Malda (3,733 km²), Uttar Dinajpur (3,140 km²), Dakshin Dinajpur (2,219 km²), Alipurduar (3,383 km²) and Kalimpong (1,044 km²) are often referred to collectively as North Bengal. This area is divided into the Darjeeling Himalayan hill region, the *Terai* and *Duars* region and the North Bengal plains. The districts on the south of River Ganges Bankura (6,882 km²), Paschim Bardhaman (1,603.17 km²), Purba Bardhaman (5,432.69 km²), Birbhum (4,545 km²), Purulia

(6,259 km²), Murshidabad (5,324 km²), Nadia (3,927 km²), West Midnapore (9,345 km²), Jhargram (3,037.64 km²), East Midnapore (4,736 km²), Hooghly (3,149 km²), Howrah (1,467 km²), Kolkata (185 km²), North 24 Parganas (4,094 km²) and South 24 Parganas (9,960 km²) constitute a variety of geographical regions such as the Rarh region, the Western plateau and high lands, the coastal plains, the Sunderbans and the Gangetic Delta.

The climate is generally humid tropical monsoon. It varies from moist-tropical in the southeast to dry tropical in the southwest and from subtropical to temperate in the mountains of the north. The temperature ranges from 0°C to 45°C. The annual rainfall ranges from 900 mm in the southwest to 1,700 mm in the coastal region and 6,000 mm in the northern mountain areas.

The soil pattern of the state ranges from acidic in the entire north to Gangetic alluvial in the central districts; lateritic red soil to coastal saline soil in the southern delta region.

Total recorded forest of the state is 11,879 km² (Reserve Forest 7,054 km², Protected Forest 3,772 km², Unclassed State Forest 1,053 km²) or 13.38% of the geographical area. However, as per the digitized boundary of recorded forest area in the state, forest cover within and outside the recorded forest area covers 13,625 km² or 15.52% of the geographical area. As of 2015, this area is extended to 16,828 km² or 18.96% of the geographical area. Reserve Forest, Protected Forest and Unclassed State Forest constitute 59.4%, 31.8% and 8.9% of the geographical area respectively. Estuarine water bodies like rivers and creeks in mangrove forest and rivers flowing through the recorded forest land have been included while computing the forest cover. Similarly large portions of farm forestry plantation, raised outside forest land, having forest-like micro ecosystem, have been enumerated as forest cover. Thus, the vegetation cover of the state is raised to around 27% of the geographical area. The vegetation cover also includes village orchards or groves, tea gardens and horticultural plantations. All these areas are more or less used by the mammals.

These forest areas (tree cover) are divided into four classes:

- (1) Very Dense Forest (VDF) including mangrove cover with canopy density 70% and above (2.59%);
- (2) moderately Dense Forest (MDF) including mangrove cover with canopy density between 40% and 70% (4.26%);
- (3) Open Forest (OF) including mangrove cover with canopy density between 10% and 40% (7.14%); and
- (4) Scrub with canopy density less than 10% (0.08%).

However, the sum of VDF, MDF and OF is termed as 'FOREST COVER'. Tree Cover

includes all the land less than one hectare in area, especially those surrounding villages and woodlands. Such areas need Satellite and Manual Field Verification. The forest cover including the tree cover is 21.31% of the State's geographical area as per the India State of Forests Report, 2015 published by Forest Survey of India, Dehradun.

Broadly, the forest cover of the state belongs to 10 type groups. The hills in North Bengal are broadly divided into Lower Hill (up to 1,000 m), Middle Hill (1,001–1,950 m), Upper Hill (1,951–3,500 m) and Subalpine Forests (>3,500 m). Below 1,000 m, there are Moist Tropical Forests, whereas Montane Subtropical Forests start from 1,000 m and Montane Temperate Forests from 1,500 up to 3,000 m. Higher up, the forests are composed of evergreen conifers, mainly broadleaved trees with chief understorey of *Rhododendrons*, occasionally forming dense brakes.

Territorial Forest Divisions- Baikunthapur (228.82522 km²), Bankura (North 545.9387 km² & South 563.00475 km²), Birbhum (166.44542 km²), Burdwan (218.45461 km²), Coochbehar (66.5538 km²), Darjeeling (267.6687 km²), Durgapur (49.6327 km²), Howrah (including Hooghly) SF (3.37281 km²), Jalpaiguri (310.88 km²), Jhargram (594.9757 km²), Kalimpong (372.8766 km²), Kangsabati (North 271.0417 km² & South 285.593 km²), Kharagpur (325.4351 km²), Kurseong (163.5277 km²), Malda (17.02045 km²), Medinipur (513.5804 km²), Nadia-Murshidabad (12.3343 km²+ 7.7006 km²), Panchet (338.501 km²), Purba Medinipur (18.87472 km²), Purulia (676.8757 km²), Raiganj SF (6.02379 km²+ 8.27426 km²), Rupnarayan (291.3864 km²), 24-Parganas (North 0.9634 km² & South 1602.62 km²).

During British period, three game associations were created in north Bengal in 1926 to control hunting in their jurisdiction, namely:

- (a) the Darjeeling Shooting and Fishing Club,
- (b) the Tista-Torsa Game Association and
- (c) the Torsa-Sankosh Fishing and Shooting Association.

These associations employed guards to prevent local inhabitants from poaching in their protected areas. These were operative up to 1958 and the practice was banned from December 1962. They were given hunting and fishing lease outside the sanctuaries.

West Bengal inherited the larger share left by the British in the form of Protected Areas. The state got all the three Game Sanctuaries, i.e., Jaldapara (93.24 km²), Chapramari (7.77 km²) and Senchal (38.85 km²) constituted under the Indian Forest Act, 1927. These were later renotified under Wild Life (Protection) Act, 1972. During the post-independence days, many more have been added to the PA network totalling 22 at present.

In addition, four temporary Game Sanctuaries were also created during pre-independence period in Bengal. These were- Bhutri

(20.72 km²), Pana (12.95 km²) and Gaburbarra (38.85 km²) in Buxa, Alipurduar district during 4.9.1935 to 30.9.1938 and Mongpong (25.90 km²) in Kalimpong district during 1937-38 to 1945-46.

At present, Wildlife Conservation Areas in the state are spread over 4,691.8462 km² or 39.49% of recorded forest categorised into-

I. Protected Areas (PAs) 1502.8146 km²:

(a) National Park- (1) Singalila (78.60 km²) in Darjeeling district, (2) Neora Valley (159.8917 km²) in Kalimpong district, (3) Gorumara (79.45 km²) in Jalpaiguri district, (4) Jaldapara (216.34 km²) in Alipurduar district, (5) Buxa (117.10 km²) Alipurduar district, (6) Sundarban (1,330.10 km²) in South 24-Parganas district (World Heritage Site in 1987);

(b) Wildlife Sanctuaries- (1) Jorepokhri (0.04 km²) in Darjeeling district, (2) Senchal (38.88 km²) in Darjeeling district, (3) Mahananda (158.04 km²) in Darjeeling district, (4) Chapramari (9.60 km²) in Jalpaiguri district, (5) Buxa (314.52 km²) in Alipurduar district, (6) Pakhki Bitan (14.09 km²) in Jalpaiguri district, (7) Raiganj (1.30 km²) in Uttar Dinajpur district, (8) Chintamani Kar (0.07 km²) in South 24-Parganas district, (9) Bibhutibhusan (0.64 km²) in North 24-Parganas district, (10) Bethuadahari (0.6686 km²) in Nadia district, (11) Ballavpur (2.021 km²) in Birbhum district, (12) Ramnabagan (0.145 km²) in Purba Burdwan district, (13) West Sundarban (556.45 km²) in South 24-Parganas district, (14) Sajnekhali (362.40 km²) in South 24-Parganas district, (15) Halliday Islands (5.95 km²) in South 24-Parganas district, (16) Lothian Islands (38.00 km²) in South 24-Parganas district;

II. Tiger Reserves (TR) 3,345.7599 km² in Alipurduar district, [(1) Buxa (1983)[760.8699 km² overlapping with PAs=Critical 'tiger' habitats or Core 390.5813 km², Buffer/Peripheral 370.2886 km²]; (2) Sundarban (1973)[2,584.89 km² overlapping with PAs=Critical 'tiger' habitats or Core 1,699.62 km², Buffer/Peripheral 885.27 km² in North and South 24-Parganas districts];

III. Elephant Reserves [(1) Eastern Duars (overlapping with PAs and TR) in Alipurduar district: 977.51 km² (Core 484.00 km², Buffer 493.51 km², Zone of influence: Forest and tea gardens to the west and south: 1,800 km²) (2) Mayurjharna 414.00 km² in parts of Purulia, Paschim Medinipur and Bankura districts (Zone of influence 1,436 km² in parts of Purba Medinipur and Bankura districts)];

IV. Biosphere Reserve (Sundarban) 9,630 km² (overlapping with PAs and TR).

V. Conservation Reserves over a total area of 1,415.91 km² [1. Deul (10.50 km²), Paschim Bardhaman district, 2. Hijli (15.50 km²), Paschim Medinipur district, 3. Tekonia (5.87 km²), Cooch Behar district, 4. Mukutmonipur (43.70 km²), Bankura district and 5. Garpanchkot (1,340.34 km²), Purulia district] have been declared in 2017.

VI. Wetlands (5,050 km²), of which only EKW (125 km²) in North and South 24-Parganas districts is a Ramsar Site, are also habitats of some smaller mammals. These wetlands are distributed from the high altitude Darjeeling hills to the plains of southern part of Bengal. These wetlands are mainly lakes, floodplains, marshes, bogs and estuaries of Sunderbans.

VII. Sacred Groves (SGs): The community-protected forest fragments of various sizes or SGs (known as “Jaherasthan”), mostly found in south-

western Bengal (Purulia, Bankura, Birbhum, Jhargram, East and West Midnapore), function as important refugia for some small mammalian species (rabbit, porcupine, striped squirrels, rats, bats etc).

However, introduction of the protected area category ‘Community Reserves’ under the Wild Life (Protection) Amendment Act, 2002 has introduced legislation for providing government protection to such community-held lands, which could include SGs.

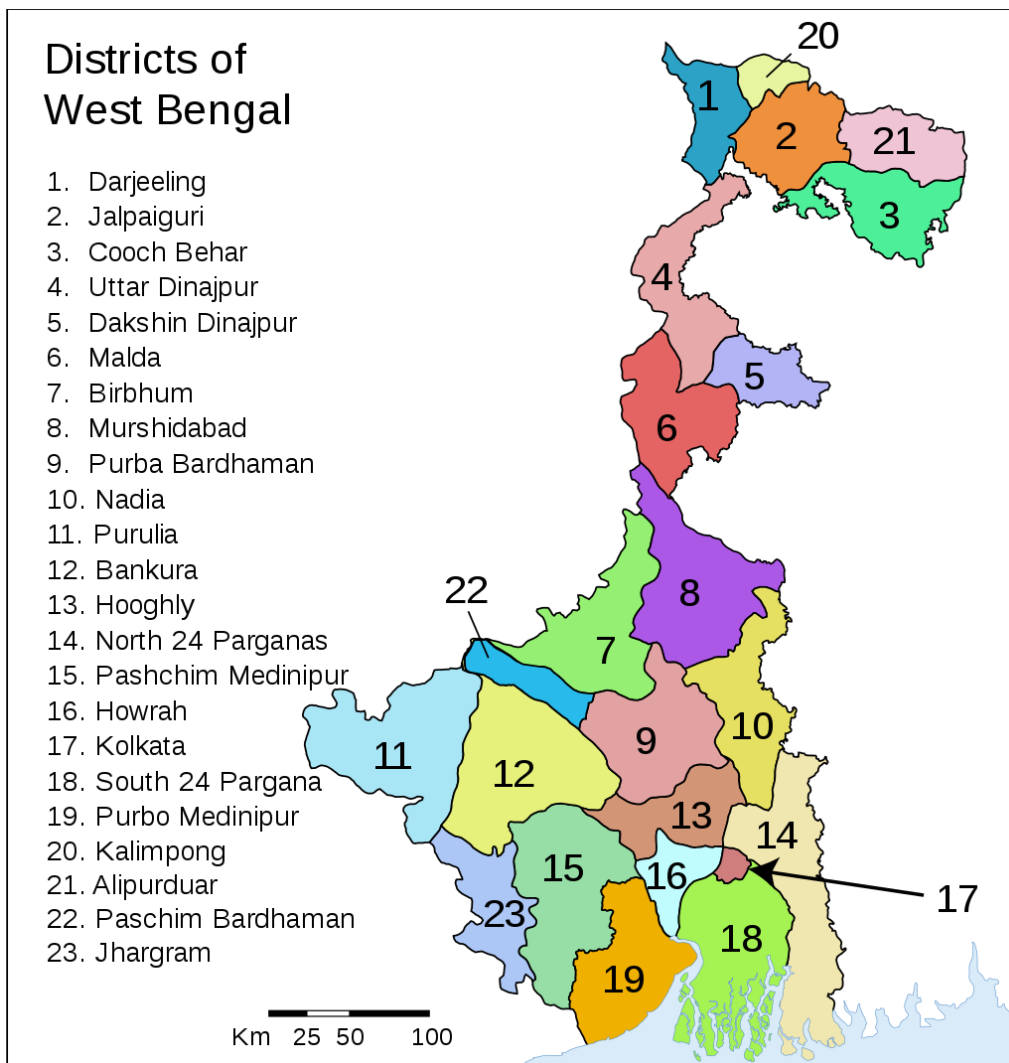


Fig 1. Map of study area.

Out of ten recognized biogeographic zones of India, based on altitude, moisture, topography, rainfall etc, four zones [(i) 2C Himalaya- Central Himalayas, (ii) 7B Gangetic Plain- Lower Gangetic plains, (iii) 8B Coasts- East Coast and (iv) 6B Decan peninsula- Chhotanagpur] are represented in the state.

The state is also classified into four zoogeographic regions, which resemble those of the bordering states and countries. The distribution of mammals in various parts of the state differs. For example, the fauna and flora of Darjeeling hills

resemble more to the fauna and flora of Sikkim Bhutan and Nepal than the other fauna of the State. Similarly, there is resemblance between north Bengal and Assam, whereas the biodiversity of south-west Bengal resembles those of Jharkhand and Odisha. The flora and fauna of Indian Sundarbans resembles those of contiguous Bangladesh counterpart. Past records show that a variety of animals representing vast tracts of all these Zoogeographic regions were found in this State. In course of time, some of them gave way to increasing human pressure. The status (past and

present), distribution and known habitats of all mammalian species in West Bengal are recorded in this updated inventory.

Data collection

Initially, secondary data were collected by reviewing the literature for mammal studies conducted in the study area, at nearby sites or in comparable habitats in the region. In addition, district gazetteers, museum records, field reports, record books of forest department, project reports, theses, working plans, management plans, annual reports and other lesser-known sources of information were also consulted. The data on Departmental radio-collaring (elephant and tiger), Noninvasive genetic assessment (tiger, rhino) and camera-trapping (Tiger, Leopard, Asiatic Golden Cat, Clouded leopard, Fishing cat, Leopard cat, Marbled cat, Jungle cat, Wild dog, Himalayan Palm Civet, Large Indian Civet, Small Indian Civet; Crab-eating Mongoose, Binturong, Himalayan Black Bear, Sloth Bear, Yellow-throated Marten, Wild boar, Cheetal, Barking deer, Hog deer, Sambar, Asian elephant, gaur, Assamese macaque, Rhesus macaque, Crestless Porcupine, Himalayan Serow, etc.) were also accessed for this purpose.

Secondly, interviews with local residents and concerned forest officials were conducted with the aim of collecting materials (sighting, hunting records/memories and trophies) on the pattern and conditions of mammal habitation in the past and at present. These materials made it possible to improve the efficiency of the baseline survey for identifying the species and their occupied locations.

The information obtained was used to compile a preliminary list of species that may be encountered at the study site. For identification of the species, 'Handbook of the Mammals of South Asia' (Bahuguna & Mallick 2010) was consulted.

For collection of primary data, all the protected areas (PAs) and other territorial forest and impact areas were visited in phases during different seasons and different hours of the day. The inventory was specifically prepared on the basis of direct observations as well as identification of signs, footprints, feces, etc. Based on the frequency of direct sighting and indirect evidences, the species-wise status is categorized into extinct (no further record since first known), very rare (2-3 records), rare (4-5 records), occasional (6-10 records), frequent (<15 records) and common (>15 records). In addition, some other status of the species like endemic, new record, introduced, doubtful and unknown, are mentioned. Habitat assessment was also done wherever possible.

RESULTS AND DISCUSSION

West Bengal is a mega-biodiversity state spread over four biogeographic zones and 10 forest type groups, covering Temperate and Sub-Alpine forests of Darjeeling to estuarian plains of Sundarbans,

representing a wide range of mammals including rare, threatened and endemic species.

Major groups of Forests type and assemblage of mammals of conservation significance

1. Sub-alpine forests 14C (3,000-3,660 m): 20 km² in Sandakphu, Sabarkum, Phalut in SNP:

Smaller mammals like voles, water shrews, pikas, long-eared bats, Barbastelle, mouse, rat, etc.

2. (i) East Himalayan Moist Temperate forests 12C (1,500-1,800 m): 150 km² in Rimbik in Darjeeling,

(ii) Northern Montane Wet Temperate Forests 11B (1,650-3,000 m): 150 km² in Selimbong, Kankibong, Little Rangit, Lopchu, Mahaldiram, Chattakpur, Dhobijhora, Upper Babukhola, Phuguri, Paglajhora and Lower Babukhola forest blocks in Darjeeling:

Tiger, leopard, clouded leopard, leopard cat, Himalayan black bear, red panda, yellow-throated marten, barking deer, goral, serow, tahr, flying squirrels, etc.

3. (i) Northern Tropical Wet Evergreen 1B (plains to 150 m): 167 km² in Bagdogra range of Kurseong division, Khutimari areas of Jalpaiguri division, Damanpur, Cheko, Gadadhar, Rajabhatkhawa, Rydak of BTR,

(ii) Northern Sub-tropical Semi-evergreen forests 2B (300-1,650 m): 25 km², in Sumbong and Peshok of Darjeeling division, Buxaduar of BTR,

(iii) Northern Sub-tropical Broad-leaved Wet Hill 8B: 800 km² in North Bengal hills (300-1,650 m): Sim, Upper Sumbong, Upper Reyong, Forests blocks of Majua, Lower Babukhola, Phuguri, Bunklong, Khairbani, Mana, Sittong Numbong, Setikhola, Shivakhola, Mirik, Paglajhora, Kuhi and Latpanchar in Darjeeling.

(iv) North India Moist Deciduous forests 3C: 1,757 km² in *duars* and *terai*.

Pygmy hog, scaly ant-eaters, tiger, leopard, wild dog, mongoose, bears, otters, civets, cats, fox, jackal, elephant, rhino, gaur, deer, wild boar, monkey, langur, squirrels, etc.

4. Littoral and Swamp Forests: Tropical Seasonal Swamps of Barringtonia 4D: 20 km²: Bats, mongoose, jungle cat, jackal, civet, etc. in Malda and Dinajpur districts.

5. Northern Tropical Dry Deciduous forests 5B: 4,527 km² in Bankura, Purulia, Jhargram, Midnapur, Birbhum, Burdwan:

Pangolin, tree shrew, wolf, fox, jackal, mongoose, leopard, deer, elephant, sloth bear, etc.

6. Littoral and Swamp Forests- The Mangroves 4B: 4,263 km² in Sundarbans:

Tiger, fishing cat, leopard cat, deer, wild pig, monkey, dolphins, otter, etc.

Key Habitats

Distribution of the mammals is governed by the basic biological needs like availability of food and water in association with shelter.

1. Riparian zone

This type of vegetation is mainly found in small strips along the rivers and streams and dominated by *Ficus racemosa*, *F. semicordata*, *Bischofia javanica*, *Bridelia retusa*, *Macaranga denticulata*, *Duabanga grandiflora*, *Dillenia pentagyna*, *Zyziphus* spp. in association with grasses like *Saccharum sponstaneum*, *S. narenga*, *Themeda arundinacea*, *Imperata* spp, *Phragmitis karka*, *Arundo donax*, etc. Leaves, fruits and twigs of this vegetation are palatable food for sambars, elephants and monkeys. Giant squirrels is also sighted in this zone. Spotted deer herds take shelter in these areas. Giant Squirrel occurs mostly in riparian zones, which retain the attribute of tall large crowned trees with continuous canopy, deep shade, characteristic vegetation diversity and presence of higher level of moisture. Hog deer, being an obligate species of grassland, is also found here.

2. Savannah areas with Khair-Sisoo and Simul-Sirish succession

Hispid hare, being the obligate species of grassland, takes shelter here. This type of vegetation offers best grazing ground for Cheetal, Sambar, Barking deer, Hog deer, Gaur and Elephants. The leaves, flowers and fruits of *Acacia catechu*, *Bombax ceiba*, *Dalbergia sissoo*, *Oroxylum indicum*, *Emblia officinalis*, *Bauhinia purpuria*, *Dillenia pentagyna*, etc. are liked by large herbivores as food.

3. Natural water bodies

Mammals, both herbivores and carnivores, drink water in these perennial sources, particularly during summer.

4. Broad leaved Hill Forests

In consequence to the variation of the altitudes, the type of vegetation varies considerably in these forests. The foothill portions generally bears dry mixed forests with some sal along the crest of the spurs and ridges. *Dendrocalamus hemiltonii*, *Acrocarpus frexinifolius*, *Phoebe lanceolata*, *Pterospermum acerifolium*, *Gynocardia odorata*, etc. occur as associates. Here, mammal concentration is higher, but sighting is rare.

5. Wet (Semi-evergreen) Mixed Forest

It has a complete canopy of considerable height and fully shaded forest floor covered with leaf litter. Grasses and other herbs are usually very little and the top storey formed by some deciduous species. Grazing and browsing of ungulates are very rare except some degraded places where the canopy is open. Food items available in this type are mainly underground corms and tubers of *Curcuma amada*, *Zingiber roseum*, *Dioscorea bulbifera*, *Asparagus racemosa*, *Colocasia esculenta*, *Costos speciosus* and others. The foliage of small trees and shrubs at low canopy level of *Macaranga denticulata*, *Leea asiatica*, *Mallotus philippinensis*, *Litsaea monopetala* and fleshy fruits of *Syzygium cumini*, *Sapium baccatum*, *Litsaea glutinosa*, *Cinnamomum glaucescens*, *Ficus benghalensis*, *Elaeocarpus lucidus*, etc. are also important for

sustenance. Since this type is rich in foliage trees and fleshy fruits, arboreal mammals like Rhesus monkeys and Squirrels are distributed very well here. Due to absence of grass, large herbivores are usually not found except wild pigs, which dig up and eat underground corms and tubers. Elephants are often found.

6. Dry Mixed Forests

This habitat comprises of very diverse type of vegetation. No particular vegetation occurs continuously. The mammals are distributed in pockets. Deciduous tree species of medium to good height are found here. They form an open canopy. In dry season, grasses are generally absent. Considerable quantity of grasses, shrubs and herbs are available during the monsoon. This type of vegetation provide better habitat to some mammals than wet mixed forest. Population of monkey, squirrel and other arboreal species are less due to lack of fleshy fruits and foliage. Ungulates like barking deer, sambar, gaur and elephants prefer such area. Rhinos are also found frequently in this forest type.

7. Moist Sal Forests

In this type Sal forms the top canopy with bahera, Sidha, Udal, Chilaune, Kawla, Bhadruse, Parrari as associates and the middle storey is composed of *Meliosma simplicifolia*, *Aphanomixis polistachae*, *Premna benghalensis*, *Bauhinia purpurea*, *Turpinia pomifera*, *Trewia nudiflora*, *Microstegium ciliatum*, *Dillenia pentagyna*, etc. This type of vegetation is not suitable for herbivores as food is not abundant but cover and water are available.

8. Mangroves

The habitat is classified into five categories:

(i) Water/Channels-1161.44 km², (ii) *Phoenix* dominated (*Phoenix paludosa*+*Excoecaria agallocha*)- 1033.76 km², (iii) *Ceriops* dominated-*Ceriops decandra*-333.48 km², (iv) Barren dry areas-145.6 km², (v) *Avicennia-Sonneratia* mixed habitats-126.56 km². The order of tiger's preference for habitat use is *Avicennia-Sonneratia* habitat > *Phoenix dominated habitat* > *Ceriops* dominated habitat > Barren areas > Water. Though *Avicennia-Sonneratia* was preferred, 58% of tiger locations were in the most common habitat type (*Phoenix* dominated areas) followed by 18% within *Ceriops* dominated habitats, which offer shelter from tidal inundations, since these habitats are on relatively higher ground and might, therefore, often be used as resting and cub rearing refuges. Water channels are used for shifting from one to another island or human habitations in the fringe area for shelter and food. River banks are preferred by the tiger for higher availability of prey species and easy hunting.

Mammalian Species diversity

About 6,495 species of mammal (96 recently extinct and 6,399 extant including 6,382 wild, genera 1,314, families 167, orders 27) have been reported from the globe (Burgin et al. 2018), of

which India accounts for 425 species placed under 48 families and 12 orders (Chakravaarty & Ramachandran 2019). As per the present study, the mammalian diversity of West Bengal is represented by 234 species (Extant 211, Extinct 23) and 215 subspecies, belonging to 137 genera, 39 families and 11 orders (Table 1). The chiropterans represent maximum number of species (75) followed by rodents (50), carnivores (48), Artiodactyls (29), Eulipotyphla (11), Primates (8), Lagomorpha (5), Perissodactyla (3), Pholidota (2) Scandentia (2) and Proboscidea (1). Relative to the 1992 version, the gain in number of species is 46 (+24.46%), that of subspecies 68 (46.89%), genera 31 (+29.24%) and families 7 (+21.87%). Order Insectivora is reassigned to the order Eulipotyphla including shrews, moles, etc. and order Cetacea to order Artiodactyla following the recent molecular evidences. There are a few recorded species, validity of which remains unresolved, doubtful or controversial. Besides, there are many changes in taxonomy and distribution.

A detailed species account is presented in Table 2. Here, each species entry includes the scientific name and recognized sub-species with known regional distribution. Comments have been provided at species level including habitat and status. The exact number of mammalian species is uncertain at a point of time due to new discoveries, intra-state and inter-state movement, taxonomic revisions and molecular phylogeny studies. Recent taxonomic updates and nomenclatural changes have been incorporated. The published and unpublished references dealing with the species occurrence in the state is also provided in the reference.

Human population density in different districts shows a negative correlation with the species richness. However, there is a positive correlation between total forest cover and faunal richness in the districts. It appears that north Bengal, particularly undivided Darjeeling district (including Kalimpong), represents maximum number of species. It is also seen that the mammal diversity in the state are positively correlated with the altitudinal variation, natural, dense and unfragmented forest cover, providing adequate shelter, food including source of perennial sweet water for both carnivores and herbivores, as well as low anthropological disturbances.

Endemicity

Two species (*Eptesicus tatei* and *Herpestes palustris*) are considered endemic to the state. Three specimens of the former were collected during 19th century only from the temperate forests of Darjeeling (exact locations not available). No further records of this species are available.

During 1964 and 1965, three specimens of *H. palustris* were collected from Acharya Jagadish Chandra Bose Indian Botanic Garden and outskirts in Howrah district, whereas, during the same

period, 28 specimens were collected from different sites of present EKW and outskirts of both South and North 24-Parganas. This species is now under threat of extinction due to anthropogenic pressure.

Extinction

23 species (four primates, six carnivores, two perissodactyla and 11 artiodactyla), earlier recorded from the state, are considered extinct. These are- *Hoolock hoolock*, *Nycticebus bengalensis*, *Trachypithecus geei*, *Pileatus pileatus*, *Acinonyx jubatus*, *Lynx lynx*, *Panthera leo*, *Panthera uncia*, *Helarctos malayanus*, *Arctogalidia trivirgata*, *Dicerorhinus sumatrensis*, *Rhinoceros sondaicus*, *Porcula salvania*, *Moschiola indica*, *Moschus chrysogaster*, *Rucervus duvauceli*, *Antelope cervicapra*, *Gazella bennettii*, *Bos frontalis*, *Bubalus arnee*, *Boselaphus tragocamelus*, *Tetracerus quadricornis* and *Pseudois nayaur*. The number may increase because some species are not sighted for many decades. Some species are also regionally extinct. For example, *Rhinoceros unicornis* is extinct from Sundarbans, but found in GNP and JNP of north Bengal.

Threatened species

Some of the threatened species of the state are- Binturong, Chinese and Indian Pangolin, clouded leopard, fishing cat, gaur, golden cat, Himalayan tahr, hispid hare, hog badger, honey badger, Indian elephant, Indian wolf, leopard, leopard cat, red panda, marbled cat, ratel, greater one-horned rhino, serow, clawless otter, sloth bear, Indian tiger, Ganges river dolphin, little Indian porpoise, Irawaddy dolphin, marsh mongoose, crab-eating mongoose, Asiatic black bear, Assamese macaque, common otter, Himalayan crestless porcupine, Sikkim bat, Sikkim rat, smooth-coated otter, wild dog, etc.

Conservation threats

Habitat fragmentation and disruption of the traditional migratory corridors, inter-state or intra-state, due to expansion of human settlements, population boom, conversion of forest land for agriculture, tea and other industries, national highways/motor roads, meter gauge to broad gauge railway track and many other non-forestry uses are major conservation threats impeding the frequent movement of wild animals within their home range. While the anthropogenic activities (e.g. illegal collection of fuel wood, fodder, grazing etc.) are destroying the habitats and disturbing the day-to-day activities of the animals, poaching of the mammals is causing high decimation of the extant species and their ultimate extinction.

Man-Mammal Conflict

Man-animal conflicts usually arise out of straying of wild animals into habitations. This results into killing of the animal or death/injury of human beings and loss of crop/cattle/huts. This is the most

serious problem in the state. It has become more acute due to shrinkage of habitats and increased activity in and around the forest. Tiger, leopard, elephant, gaur, rhino, deer and other smaller mammals are the worst sufferers of this conflict. Categorized compensation is paid to the victims-human beings and properties.

Tiger

In Sunderbans, there are records of the ‘man-eating’ tigers and tiger-straying in the north-western fringe villages since the 18th century. Between 1881 and 1912 more than 2,400 full-grown tigers were killed by the hunters in Sunderbans under official patronage, *i.e.* rewards. Montgomery (2008) mentioned that about the end of the nineteenth century 4,218 people were killed by tigers.

The man-eating tigers in the Sundarban are divided, according to their behaviour pattern, into three broad categories-

Category I: This includes two sub-categories, of which one is inherent and designed maneater (25%). This sub-category is again subdivided into two micro-groups: one is aggressive maneater (80%) and the other lusty and adventurous (20%).

Category II: Undesignated man-eater (15%), and Category III: Circumstantial man-eater (60%).

Mallick (2007) categorized the problem of human-tiger conflict in Sunderbans into two types:

(i) Conflict outside the forest area: This is caused when the tiger stray out of the forests and enter the villages on the opposite side by crossing the channels. In the past, these fringe villages were established on the reclaimed forestland, where the interface is mostly demarcated by a small creek, *e.g.* Kalitala and Samsernagar on the boundary of Arbesi-1.

(ii) Conflict within the forest areas: This is caused due to intrusion (with or without legal permits) of people in the tiger habitat. Mostly the honey collectors and fishermen fall prey to the tigers inside the forest.

Most human kills took place in the forests of north-eastern part. Most of the victims (59%) were residents of Gosaba block followed by Hingalganj (14.96%), Basanti (9.99%), Hasnabad (3.8%), Canning II (2.54%), Pathar Pratima (2.54%), Kultali (2.03%) and others (5.14%). In case of the fishermen and crab collectors, the incidents mainly occur in the small creeks deep inside the forest and very close to the tiger habitat. The tiger victim data during the last three decades reveal that Jhila followed by Pirkhali, Chandkhali and Arbesi were the four most vulnerable forest blocks because, except Chandkhali, border the fringe villages of Gosaba and Hingalganj CD blocks, from where a large number of people regularly enter the forests for their livelihood. On the contrary, the intensity of tiger attacks in the distant and remote core area is much low.

The saline water, muddy terrain, recurrent high tide, dense vegetation etc coupled with difficulty in preying upon animals bring about a psychological change in the tiger behaviour. This type leads to be cyclic and chronic, giving the tiger predatory proficiency.

The straying of tiger is a common phenomenon in Sunderbans (Mukherjee & Tanti 2001), in which the tiger swims across the rivers to reach the fringe villages in darkness for many reasons. The spurt in this aberrant behaviour has been marked since 2002. Whereas up to 2001, there were 140 cases of tiger straying, the figure up to March 2010 rose to 148. During 2008-2011, the tigers came out of the forests for 58 times and entered the villages in most of the cases. In 2010-2011, there were 28 cases of tiger straying in STR and 11 in South 24-Parganas Forest Division and the corresponding figures in 2011-12 (up to August) were 5 and 3 respectively. The tiger straying incidents take place throughout the year, but most of them occurred during 3 months (Dec–Feb) of the winter season (42%) followed by 3 months (July–Sept) of the monsoon season (31%). 84.22% of cases have been reported from 21 villages of five affected blocks of Sundarban (Das, 2011). In most cases, the tigers resorted to cattle lifting or poultry feeding. Only in 8.9% of the cases human beings were attacked or killed. Majority of the straying tigers (68.46%) were male. In most cases (78.9%) strayed tigers were aged and 22% of these were partly injured. 96.05% straying occurs during the night.

Depending on tiger-density, STR has a higher intensity of conflict whereas South 24-Parganas Division has a lower intensity of conflict. The villages where the straying tigers (single male or female and often a pair) had so far strayed are Adibasipara, Amlamati, Anpur-Rajatjubilee, Bali, Bhuruliapara, Dayapur, Deulbari, Dulki, Emlibari, Glasskhali, Gosaba, Hemnagar, Hentalbari, Jamespur, Jharkhali, Kalidaspur, Kalitala, Kishorimohanpur, Kultali, Kumirmari, Lahiripur-Chargheri, Lakhimpur, Mathurakhanda, Mitrabari, Mollakhali, Pakhiralaya, Petkulchand, Purba Sripatinagar, Samsernagar, Satjelia, Satyanarayanpur, Sonagaon, Sudhangsupur, Tridibnagar, etc. They strayed from seven forest blocks- Arbesi (crossing the River Raimangal, Kapura or Kalitala *khal*), Chandkhali, Gosaba, Harinbhanga, Jhilla (Korankhali *khal*, Rangabelia), Pirkhali (River Pitchkhali, Gomdi *khal*, Dattar Passur *khal*) and Panchamukhani (Bidya). The civil blocks of Gosaba, Hingalganj and Kultali are most vulnerable to the tiger straying. In Hingalganj, such villages are Samsernagar, Kalitala, Hemnagar and Pargumti, whereas in Gosaba, these are Rajatjubilee, Jamespur, Dayapur, Kumirmari and Lahiripur and Kultali include Kultali, Sunkijan, Deulbari, Bhasa, Maipeet East Gurguria, Nagenabad and Katamari. Sitarampur, Daspur, K. plot, Kishorimohanpur in Patharpratima block and

Jharkhali in Basanti block are also some other affected villages. Although in the last few years, tiger straying incidents are few in Basanti block, such incidents have increased in Kultali block since 2007.

During the late twentieth century, the problem of tiger-straying was not so acute except for a few years. In 2009–2010, the incidences were on the rise, probably as an impact of the 'Aila' and ultimately in 2010–2011, the tiger straying cases showed an all time record. According to the present study, the adjoining areas of the Rivers Melmel and Gomor under Gosaba CD Block are more dangerous than other parts of human settlement in Sundarban because it is just opposite to the buffer zone of STR. Although many tigers strayed, the villagers help the forest staff to rescue them safely with the people's cooperation in Sundarbans. Retaliatory killing of tiger is rare now.

The measures like driving (including bursting firecrackers at night) the tiger back to the forest, trapping with a live bait (generally a culprit returns to the trap laid after a cycle of 9-15 days), sedating, radio collaring, ear tagging (chips) and monitoring the released tigers (majority of whom were released in different blocks like Chamta, Gosaba, Panchamukhani, Chandkhali, Matla, Harinbhanga, Bagmara, Netidhopani, Pirkhali, Khatuajhuri, Ajmalmari, Herobhanga, etc.) are the most cost-effective means to reduce the human-tiger conflict. There was a strong case of such aberrant behaviour of the tiger (Bahuguna & Mallick 2010):

An old tiger was trapped in July 2008 on the fringe of Sundarbans. It was released in the forest. Although apparently it was healthy, it had only one canine intact. It was again captured in October at the same place. This time it was released deep inside the forest. In November, it again appeared in same area from where it was captured. This time it was released at the southernmost tip of Sundarbans. But, this time also it came back to the same place, covering a distance of about 100 km by crossing many rivers, one of which is 4-5 km wide. Finally, it was trapped in December and handed over to the Kolkata Zoo.

The probable reasons of tiger straying in the Sundarbans are-

- (i) Scarcity of Prey Animals,
- (ii) Difficulty in Hunting,
- (iii) Proximity of Reclaimed Human Settlement to the Tiger Habitat,
- (iv) Tigers do not Stray in the Village just to Kill Easy Prey like Human,
- (v) Embankment Protection Mangrove Strips of the Villages are Confused by the Tigers as their Own Habitat,
- (vi) Littering Female Strays in the Paddy Field to Protect her Cubs,
- (vii) Paddy Fields Confused with *Porteresia coarctata*,
- (viii) Generally Old Tigers Stray for Easy Prey of domestic animals,

- (ix) Straying Due to Washing Out of Pheromone by Tidal Waves,
- (x) Male Tiger Losing Domain to the Aggressive Male Tiger may Stray,
- (xi) Fog during winter misdirect the tiger,
- (xii) Adventure attitude of the youngs, and
- (xiii) Impact of Environmental Change.

Elephant

North Bengal

In northern West Bengal, the habitat of the endangered Indian elephant lies in Darjeeling (*terai*), Jalpaiguri and Alipurduar (*duars*) districts spread over 1,828.35 km² of forests (Elephant Census, 2010) and divided by major rivers into three zones: 1) Terai (Mehi-Teesta) - 339.96 km²; 2) Western duars (Teesta-Torsa) - 482.54 km²; and 3) Eastern duars (Torsa-Sankosh) - 1,005.85 km².

The east-west ecological range of the *terai* elephant population extends from the Teesta char (Baikunthapur Division) through MWLS and southern forests of Kurseong Division, up to Bahundangi Village Development Council, Jhapa district, Nepal, on the western border. In recent years, this landscape, interspersed with human habitations, has become an extensive human-elephant conflict (HEC) zone in terms of human mortality, crop depredations and loss of properties.

The recent elephant population in North Bengal is reported to be average 514 (range 460-564) individuals spread across an area of 2,000 km² as a result of protection, creation of PAs and cessation of capture (*Mela Shikar, Kheda operation*). The human population has also increased in the past few decades due to large-scale immigration.

During 19th century, the entire stretch of forests along the foothills of North Bengal from the Indo-Nepal border with Mechi river in the west to the Sankosh river in the east bordering Assam is believed to be a historically contiguous elephant range. But, large tracts of forests in the prime elephant habitats were converted to agricultural lands, tea gardens, labour lines, army camps, road and rail tracks, resorts and townships. Just about 34% of the century-old elephant habitat in North Bengal constitutes forests now.

This has led to a steady rise in Human-Elephant Conflict (HEC) with majority of such incidents occurring outside PAs. The average annual number of human deaths and injuries to elephant attacks between 2006 and 2016 was estimated to be 212. Hotspots of human-elephant conflicts were identified in an east-west direction primarily around PAs, tea plantations and along major riverine corridors. Local community members used to chase and harass elephants from agriculture fields or human settlements under the influence of alcohol and thus were primary victims of fatal interactions.

HEC may be divided into two classes:

- A. Direct conflict

1. Conflict in search of food
 2. Poaching
- B. Indirect conflict**
1. Collision with trains
 2. Transboundary conflict in Nepal
 3. Electrocutation
 4. Stuck or falls down into Ditch/ Deep Excavation/ Well.
 5. Shot as rogue

According to Naha et al. (2019), out of a total of 2,122 incidents, 476 persons died whereas the rest (n=1646) sustained injuries due to elephant attacks between 2006–2016. The annual mean number of humans killed and injured by elephant attacks in North Bengal was estimated to be 47 (SE 8) and 164 (SE 97) respectively. The highest number of attacks was recorded in 2010–11 (360 injuries and 56 deaths). There was a sudden peak in number of such incidents between 2008 and 2012 which gradually declined. Between 2006–2016, annual crop damage by elephant depredation was estimated to be 2,078 ha. Based on complaints registered, the state forest department officials paid an annual sum of INR 47,01,309 for compensating human deaths and injuries, whereas for crop damage it was estimated to be INR 54,17,390 per year. The annual compensation due to property damage based on forest department records were estimated to be or INR 30,08,012. Thus the annual *ex gratia* / compensation amount paid by the forest department regarding human death, injury, crop depredation and household damage combined was INR 131 lacs.

54% of elephant attacks occurred between May-July (30%) and August-October (24%) followed by 32% between November to January and rest 14% during February to April. Fifty percent of these attacks were recorded between 1800h and 0000h (23% between 1800h and 2100h and 27% between 2100h and 0000h) whereas 14% between 0000h and 0300h and 13% between 0030h and 0600 h respectively. Majority of the elephant attacks occurred in flat areas with an average elevation of 103 m.

Majority of the elephant attack victims were middle aged adults, with 20% in the 20–30 years category followed by 20% in the 30–40 years, 23% in the 40–50 years and 16% in the 50–60 years category respectively. 74% of the elephant-attacked victims were males. 30% of the victims were farmers, 19% daily labours and 17% tea estate workers by profession. 36% of the victims were drunk and were chasing elephants in agriculture fields and near households, 20% were returning home after dark from work, 7% had gone collecting fuelwood from the forests, 8% were defecating in the open at night and 8% were sleeping inside houses when attacks occurred. Most of the victims were in a group comprising of < 3 people with an average of 4 households present in the vicinity of the site, and 25% of the attacks occurred in patches

dominated by miscellaneous tree species, 21% near betel nut plantations, 13% within tea estates and 12% in agricultural fields).

South Bengal

Prior to 1900, South Bengal had dense Sal forests that housed elephant herds. However, rapid deforestation in the early 20th century depleted the vast Sal reservoir, thereby causing the elephants to leave the region for several decades. In 1976, there was a single elephant sighting—a herd of 42 elephants migrated from the Dalma Sanctuary in Jharkhand to Sindri in Purulia district. They roamed around for 20 days, destroyed paddy crops and killed 2 people.

Elephant herds from Dalma began migrating to south West Bengal regularly from 1987 onwards. Approximately 20 to 50 elephants would arrive in September and return after winter. Over the last two decades, damages to cropland and villages by visiting herds has been increased, escalating to a menace the villagers are still facing today.

Das Chatterjee (2016) wrote:

“Incidentally, the elephants’ migration was aided by the success of forestry projects in West Bengal, under which large patches of degraded forest were turned into regenerated forest. These forest patches provide corridors for movement and convenient shelter to elephants.” A change detection study based on satellite data from 1988 to 1991 for Midnapore, Bankura and Purulia districts confirmed an increase of 315 km² in forest cover. Initially, the herd from the Dalma would come up to Jhargram in West Midnapore, their movement restricted up to the western bank of river Kangsabati. Later, the herds started crossing the Kangsabati and spending most of the time in the eastern part of the river as this area is fertile with food and water in abundance.

With each passing year, as the migratory herds kept expanding their numbers, they began pushing deeper into south Bengal, even crossing over to Burdwan district. A herd also marched to Hooghly district during the last century. There are an estimated 140-150 elephants in south Bengal of which about one-third return to their home in the Dalma hills. But the majority stay back due to the easy availability of food and water. In the 1990s, small elephant herds from Dalma visited these southern districts for a very short period of time but now, not only they are four times stronger in number but are also staying throughout the year in south-west Bengal.

Initially, only the Dalma herd invaded the southern Bengal area, but a forest department report states that another herd, which migrated from Odisha through the Mayurjharna Elephant Reserve area have not been able to go back to its original habitat due to the construction of elephant-proof trenches (EPT) along the Odisha-Bengal boundary. This herd is identified by its physical appearance—shorter in stature and a lighter colour compared to the Dalma elephants.

Their depredation is more harmful than that of the Dalma herd.

Over the years, measures adopted to address the issue—using physical barriers, crop guarding and scaring or driving them away by throwing stones or bursting crackers— have proven futile.

Some of the mitigation measures currently underway include –

1. The forest department is working towards maintaining official documentation that helps identify each elephant based on types (herds or solitary bulls) and keeps track of their movement and numbers
2. Impart training to Forest staff in tranquilizing, immobilizing and capturing wild animals
3. Raising fodder and bamboo plantation on the route
4. Digging earthen dams and EPTs
5. Alternative crop patterns
6. Electric fencing
7. Launching awareness campaigns in affected areas to sensitize people.

Leopard

The leopards are widely distributed in the forests, fringe tea gardens and fringe villages of North Bengal. The problem of human-leopard conflicts has recently increased in North Bengal due to changes in the land use pattern.

During the period 2000 to 2013, a total of 101 humans were attacked by leopards, of which 10 persons died and 91 individuals suffered injuries. Higher conflicts have been observed in the tea gardens (77%) than in the forest areas and its fringes (23%). Leopard-attacked victims comprise 73% male and 27% female.

In addition, during the period 2002-03 to 2012-13, a total of 1,649 livestock have been killed by leopards in tea gardens and forest fringe villages and a total compensation of Rs. 1.03 million has been paid.

During the same period 245 leopard deaths were recorded, of which 185 were recorded as natural deaths and 60 leopard deaths as unnatural for the reasons of road accidents, retaliatory killings, poaching and elimination as rogues.

25 leopards were captured during the period 2010 to 2013. During the same period, a total of 8 leopards were immobilized when they strayed to human settlements. After medical treatment, all these captured leopards are released back into the nearest PA.

Human-leopard conflict is a result of diminished prey base, fragmentation of habitat and increase in disturbances due to biotic interferences in leopard habitats.

Gaur

Due to deforestation, inadequate fodder availability in the forest and encroachment, Gaurs stray into human habitat mainly during November to April to graze in the fringe area crop fields. When they are

surrounded by people and stoned or driven, the animals violently attack the people, kill and injure in many such incidents. Forest staff have also been seriously affected in several capture operations. In most cases, the animals become so excited and exhausted due to continuous disturbance by people that they are prone to cardio-respiratory failure soon after immobilization. During crossing railways line gaurs are often hit by train and killed.

Rhino

Tendency of the rhinos to stray out of the PAs due to increased biotic and abiotic pressure was observed more during the fall and winter than other seasons. In most of the cases, bulls were involved and the majority strayed from JNP. Traditionally, these animals are retrieved back to the respective PA with the help of manpower and *kunkis* (trained captive elephants). But driving through the fragmented thickly populated disturbed areas is very difficult and risky too. Besides, such efforts consume lot of resources as well as time. When such an effort fails, chemical restraining and translocation of the disoriented animal becomes the only viable option left to save the life of the individual.

Bear

Two species of bears found in the state - Asiatic Black Bear and Sloth Bear are killed for illegal trade. The latter are also hunted during annual tribal festival in Purulia and Jhargram. Human-Asiatic Black Bear conflict in Wildlife Divisions I (SWLS), II (NVNP) and Kalimpong are also reported. They cause major damage through livestock and crop (mainly maize) depredation, and may also attack humans. These reports are on the increase in recent years.

Fishing cat

Fishing cat has become another worst victim of human-wildlife conflict in the wetland zones outside PAs, particularly rapidly developing urbanized areas near Kolkata and its suburbs in the Howrah and Hooghly districts as well as Medinipur and Nadia districts. Baseless panic and mistaken identification also leads to killing of the fishing cat. Poisoning, trapping, snaring and clubbing seem to be common methods to kill Fishing Cats in the human-dominated landscape. In a few cases, death due to train or road-traffic accidents was also reported. Its poaching cases most often go unnoticed or are ignored unless some interested people and non-governmental organisations pursue the case until the perpetrators are convicted (Adhya 2015). In the Sundarbans, local people from Sagar Island admitted to having exterminated the cat from their island (Mukherjee et al. 2012). In 2010-2011 (18 months), at least 27 fishing cat killings were reported from areas like Shyampur, Bagnan, Amta, Bally, Domjur and Dankuni — all in conflict with the locals in Howrah and Hooghly districts. From

August 2016 till date, only seven fishing cat killings, including two road kills, were reported in Howrah (Adhya 2017). Consequently, it is now under significant threat of local extinction.

Civet

For the past few years, the Wildlife Wing of Forest Department, West Bengal, has experienced a rise in the number of calls and mails regarding civet-depredation. It is reported that at least 20 civets, which have strayed into people's homes, are being brought to the rescue centre every month. These are again released back into the wilderness. But the centre is also running out of space.

Civets are hunted for meat (some tribes shoot, snare and trap with help of hunting dogs), fur or body parts, which are sometimes used in folk medicine. Last November (2017) it was reported that one of the two culprits, who killed and ate a civet and proudly posted the photographs on Facebook, was arrested during a joint operation conducted by the Forest Department, SOG, CID and Titagarh P.S. Many civets have also been exterminated as pests for depredation of poultry and orchards.

The nocturnal civets have to cross the road frequently in search of food, water and mates. But they are slow-movers, hence killed by speeding vehicles. Even if they are injured and handicapped, survival in the wild becomes difficult and they die a painful death.

Gangetic dolphin

A few cases of poaching are recorded. Entanglement of Ganges River dolphins in fishing nets causes significant damage to the local population. The primary cause is believed to be entanglement in fishing gear such as nylon gillnets because their preferred habitat is often in the same location as primary fishing grounds. On few occasions accidental killing due to collisions with vessels has also been observed.

Wild boar

Wild boar, a prolific breeder, occur in almost all protected lands with wide elevational distribution, ranging from plains to 3,500 m and are attracted to agricultural crops, that are often richer in protein, carbohydrates, and mineral nutrients than wild plants and animals. Large foraging groups, for their opportunistic crop-raids at night, tendency to trample the crop and preference for forest edges, make wild boars particularly problematic in fragmented landscapes comprised of small farms. When the crop is young, the wild pigs from the forested neighbourhood come and destroy the crops by tilling the soil using its teeth in search of food. When the crop is ready for harvest, these animals destroy the crop by eating the grains and also by random movement across the fields. As a primary crop raider, it is viewed as one of the most destructive pest that causes great damages to crops

(particularly potato, maize, paddy), for example at Latpanchar area of MWLS, Rampuria and Lalung in SWLS, Samanden bordering SNP.

Yellow-throated marten

Consequent upon extensive forest reclamation, over-exploitation of vegetative resources, habitat loss-degradation-fragmentation, hunting and diminishing prey, the human-marten conflict, i.e. nocturnal raids causing large-scale depredation on the poultry and pets, is often reported from the enclave and fringe villages. Sunar et al. (2012) recorded that about 50% of the wildlife depredation on the village livestock in and around SWLS was caused by the Yellow-throated Marten alone. The affected areas were mostly enclave forest villages (Rambi Forest Village, Rangiroom Forest Village, Rishop Forest Village, Rampuria Forest Village, Chattakpur, etc), one khasmahal or leasehold land (Lhabda) and two fringe villages (Raja Hatta and Upper Johnson Hatta). In Samanden Forest Village (Rammam), the kills of Yellow-throated marten [n= 8 (61.5%) involved chicken and n= 2 (100% kitten) was reported during the period April 2011–May 2012.

Others

In addition, human conflicts with primates, jackal, deer, mongoose, rodents, etc. are also prominent in and around the reserve forests in the state, particularly human-dominated non-forest landscape. Mitigation of these conflicts. i.e. curbing depredation is a challenging task of the PA managers.

Transboundary Conservation Landscape for migratory species

The transboundary landscape in the state with Nepal, Bhutan and Bangladesh provides habitat to many umbrella and charismatic species including tiger (*Panthera tigris*), elephant (*Elephas maximus*) and red panda (*Ailurus fulgens*). The thrust areas for collaborative conservation of these species are SNP, NVNP, BTR and STR.

1. Linkage of SNP with Reserve Forests of Sikkim's Barsey Rhododendron Sanctuary and Kangchendzonga National Park and Nepal's Kanchenjunga Conservation Area (around 5,000 km²) on the north-west. SNP is bordered on the west by an unmetalled road. Williams (2004) in his study along the Indo-Nepal border recorded three sightings of red panda - one at 2,857 m, when it first ran into the Nepalese side of the ridge and then scampered across the border road into SNP. The second sighting occurred at approximately 2,442 m, 0.5 km below Gairibas on the Jamuna-Gairibas road, when a red panda shifted from a *Lindera pulcherrima* into a *Rhododendron arboreum* and scampered away over a large boulder. The third sighting took place at 2,685 m, directly below Kaiyakatta, 200 m southwest of Kaiyakatta creek. The red panda jumped down from its resting spot

on the stump of a twisted *Rhododendron grande* and sped into the mist.

2. Elephant herds also migrate into Nepal, during the crop harvesting seasons through the Panighata (Kurseong Division) corridor via Mahananda-Lamagumpha-Bamanpokhri. The results from radio-collaring of elephants during 2005-2006 have indicated that parts of Jhapa district were included in the home range of certain elephant herds from south-western Darjeeling district (Mahananda population). Hence, this landscape is an integrated habitat for elephants.

3. In the past, Teesta Valley (54.14 km², 27°03'36.00"N, 88°25'48.00"E) under Darjeeling Forest Division was a habitat occupied by the tiger, which used to migrate in between the valley in Darjeeling and Sikkim by conveniently crossing the intervening rivers.

4. In Kalimpong district, NVNP is linked with Sikkim's Pangolakha Wildlife Sanctuary (128km², 27°32'N-27°35'N, 88°76'E-88°79'E) and Bhutan's Torsa Strict Nature Reserve (around 2,000 km²) on the north. Tigers in Sikkim are seasonal migrators from the upper reaches of NVNP.

5. Recently, trans-boundary dispersal and exchange of genes of tiger between Phibsoo WLS (268.93km², 26°42'N-26°51'N, 89°56'E-90°12'E) of southern Bhutan (having biological corridor linking Royal Manas) and contiguous northern BTR is also mentioned in the Tiger Action Plans of 13 Tiger Range Countries (2011) by Global Tiger Forum and National Tiger Survey of Bhutan (2014-2015). The forests of Ripu and Chirang are contiguous not only with those of BTR but also Phibsoo WLS of Bhutan. Promoting trans-boundary collaboration for conservation of tigers involving the concerned PA Managers of Assam, Sikkim and West Bengal in India and Bhutan should be ensured. During the present study, it was observed that Kalikhola and Khurul sources through Kumargram Forest Block and Newlands Forest Block are two important sites along Indo-Bhutan boundary. On the eastern side, the corridor is narrow because of location of Kumargram and Sankosh forest villages and at present a two-way movement of elephants is taking place through this corridor.

6. STR with contiguous forests of Bangladesh Sundarbans on the south-east: A tiger had entered into Malmelia village in North 24-Parganas and was eventually trapped in the Arbeshi forest on 21 May 2010. It was tranquillized and radio-collared before being released in the Khatuajhuri forest of STR on 22 May. This Khatuajhuri male was a blind tiger on the right eye, perhaps indicating signs of territorial fights. There is enough prey in the Katuajhuri jungle and the forest guards, who examined the terrain, found carcasses of prey animals devoured by the tiger. The radio collar signals revealed that on the first two days, it was on the hunt and traveled only 6-7 km. But on the third day, the tiger traveled more than double that distance. The signals showed that it crossed the

River Harinbhanga and left its command area and moved into a new territory at will, even if there is enough prey. So, it was surprising when the tiger suddenly started moving from south to east, towards Bangladesh. It was not known whether it had originally strayed into the Indian territories from Bangladesh or now it strayed across the border. This hints that a tiger can migrate due to reasons other than the lack of prey base, probably in fight. Signals were being received from the collar and had located it somewhere in the middle of Talpatty Island (only two kilometres from the mouth of River Harinbhanga). In recent times, a tiger and a tigress, which had entered into Shamsernagar village bordering STR, were also found to have entered the Indian territories from Bangladesh. It was reported that in 2008, when the supercyclone 'Sidr' caused severe damage to the mangroves forests of Bangladesh Sundarbans, the tigers crossed the bordering river and took refuge in the Indian Sundarbans.

CONSERVATION INITIATIVES

The most important aspects of the biodiversity (including mammals) conservation in the state are as follows:

Protection of Wildlife and their Habitats, control of poaching through regular patrolling on foot, elephant back, vehicle and speed boats, improvement of communication network (Long distance RT network), supply of improved weapons to the wildlife guards, wildlife squads, Intelligence gathering including strengthening of information network, installation of watchtower at strategic points etc, regular coordination between various enforcement agencies like BSF, Railway Police, Customs, Director of Revenue Intelligence, Police etc. are the measures taken to control poaching and illegal trade of wildlife products.

Habitat Improvement Programme like canopy opening in monoculture teak plantations, followed by natural or artificial regeneration of grasses and under planting with bamboo and tree fodder species, Development of water holes and wetland development through soil moisture conservation works have been implemented on top priority basis. Regular maintenance of fire lines are given priority to control ground fire. Grassland Management is one of the major activities in the terai and duars Forests. Indigenous grasses are being regularly planted to increase the fodder base of herbivores.

Reduction of Man-Animal Conflict: Long term and short term strategies are being applied to reduce the magnitude of this conflict. Habitat Improvement Programme in the elephant range is being done regularly. Maintenance and development of corridors of large mammals like elephants has been a key activity. Further, conflict

is being reduced through erection of Power fencing, judicious use of tranquilization techniques, driving of wild elephants from human habitation with the help of anti-depredation squads and voluntary squads with the help of local people. Programme of Awareness Generation on wildlife conservation in the forest fringe areas is being taken up to seek cooperation of local people in combating animal depredation.

Eco-development activities in and around PAs: Around 103 eco-development committees and 127 forest protection committees have been formed in the fringe villages of PAs with around 62,030 members, who are protecting more than 1,82,406.24 ha of forests.

Ex-situ conservation: Padmaja Naidu Himalayan Zoological Park, Darjeeling and Alipore Zoological Garden, Kolkata are involved in conservation breeding. Captive breeding programmes have also been undertaken by the forest department at Sajnakhali, Sukna, Murti, Kalimpong, Adina (Malda), S. Khairbari, Rajabhatkhawa, Garchamuk (Uluberia, Howrah), Jhargram, Kumari Kangsabati, Bankura, Ramnabagan, Rasikbeel (Cooch Behar), Kunjanagar (Jalpaiguri), Surulia (Purulia), etc. Around nine hundred Cheetals have been translocated from the excess population in the PAs of South Bengal to STR and other PAs in North Bengal. During early 21st century, captive-bred Red Pandas were translocated from Padmaja Naidu Himalayan Zoological Park to SNP, but they did not survive for long.

Research and Monitoring: Regular census of wild animals is conducted in various PAs as well as in the reserve forests (first conducted in the state in JNP in 1964). A formal census regime of tiger population in Project Tiger reserves is conducted every two years, and in the rest of the areas every four years. Surveillance and monitoring of wildlife in protected areas across the state is now a regular practice. Periodic monitoring of forests of the state is done with application of remote sensing and GIS technology for mapping and assessment of bio-resources. Monitoring changes in biodiversity in different ecosystems is recorded regularly and accordingly management actions are implemented to correct the negative impacts. A priority list of research programme has been prepared for each PA and different scientific institutions, universities and NGOs are involved to conduct research. Research has been conducted on various aspects of eco-biological studies on different species, habitat requirement and socio-economic pattern of fringe villages. The scientific survey reports and baseline

data on different aspects are included in the management plan which also is updated from time to time based on scientific findings.

The new techniques for monitoring include:

- (a) Radio-collar/GPS collar;
- (b) Remote photography (camera trapping);
- (c) Genotyping of scats and hair; and
- (d) Tracing of pugmark and other indirect signs like scrapes, scent marks, rake marks on trunks, vocalization (roaring).

The National Tiger Conservation Authority (NTCA) has laid down an improved counting system using the latest technology like satellite tracking and camera trapping of tigers. The outcome of the 2006 census through a new methodology "Monitoring of tigers, co-predators, prey and habitat" was not published. The study by Wildlife Institute of India was completed in 2010. Data were available since 2007. Tiger occupancy in Sundarban was reported to be 1,586 km² (Jhala et al. 2008). The survey, based on direct sighting and indirect evidences along the river/creek banks, bank-side mangroves and at the watchtower locations, revealed that the tigers were present throughout the landscape with varying abundance (Mallick, 2011). In all, the tiger was sighted 417 times (mean 13 in September and maximum 56 in January) in fourteen forest blocks in 2010. Four cubs were also sighted, two each at Pirkhali and Chhotohardi in November. However, the cub-sighting ratio is very low in the study area. In all only five cubs were found in three out of fifteen blocks (20%).

The present study has revealed some interesting results. The most important outcome is that maximum tigers were sighted in Pirkhali block, but the frequency was highest here during the four months from January to April and then the sightings started reducing from May onwards recovering only in December. This may indicate a periodical fluctuation of population in this block. Another remarkable feature is that Netidhopani is the second important sighting area in the region, but here also the sighting records were not uniform throughout the year, but fluctuates during the rainy and winter months. Arbesi block is the third important sighting area. Here, most sightings were recorded in December. On the contrary, the sighting record in the adjacent Panchamukhani block is low throughout the year. Matla block may be termed as very low in terms of sighting, where from August to December no sighting record was available. Experience is almost similar in Chamta, Chhotohardi, Chandkhali and Gosaba blocks. But in the southern blocks of Gona, and Bagmara, sighting was almost negligible and in Mayadwip it was nil. Jhilla, Khatuajhuri and Harinbhanga blocks

were not much important in terms of sighting. So, the presence of tigers was mostly felt in the northern belt of forest blocks, whereas only one block in the central zone, i.e. Netidhopani, holds most of its residents throughout the year.

However, since 2007, according to the national prescription for the tiger monitoring, a range of techniques including camera traps, DNA sampling, pug mark surveys and the assessment of tiger claw marks on trees have been followed in the Indian Sundarban to get a reliable estimate of tiger numbers. The estimate showed that the Indian Sundarbans has >50 (but <100) adult tigers. A density of 4.3 tigers/100 km² (taking into account about 1,600 km² land area) was found with the range being 64–90 tigers. However, that was not a total count but only a tidal channel search and the inner mangrove forests were excluded due to lack of proper animal trails and fear of tiger attacks.

On the basis of field surveys in Indian Sundarbans, carried out from October 1998 to February 1999, Karanth & Nichols (2000) reported the tiger density of 0.84 tigers/100km². The photographs of six different tigers obtained by camera traps showed differences in stripe patterns that permit unambiguous identification of the individuals. But no estimates of prey abundance were provided. The small data set of captures (SBT 101–106= 6 inclusive of a cub less than one year of age [SBT 105]).

Again, during the year 2010-2011, an attempt was made to estimate the tiger population and density by using camera (Moultrie Digital) traps in a mark re-capture framework with closed population estimators at Netidhopani and the area covered was 220 km². Since the Sundarban is a unique habitat with six hourly tidal effects, it was extremely difficult to locate regularly used game trails for setting the camera traps. Therefore, it was decided to use lures and baits to attract the tigers to camera traps. Due to this limitation the cameras could not be set systematically across the study area but were sparsely spaced near attractants of fresh water ponds. In all, 102 photos were taken using camera traps recording presence of 12 different tigers (10 adult and two cubs). But, due to limited sampling, a reliable estimate of mean maximum distance moved could not be made for density estimation. Nor the camera configuration provided a robust design for using the modern approaches of spatially explicit likelihood and Bayesian approaches to density estimation.

In South 24-Parganas Forest Division, a camera trap exercise was initiated jointly by WWF-India and the state forest department in January 2012.

Initially, the new technology for enumeration like radio collars on tigers and cameras trapping in Sundarbans became useless when exposed to the salt water of Sundarbans. In a few cases, the radio-collars were detached or stopped functioning much earlier than their longevity and none of the collars

fitted were found functional more than four months. The terrain of Sundarbans, where tigers alternate between land and saline water, may be one of the reasons for the radio collar getting defunct. Moreover, it can easily come off a tiger's neck as the big cats have to negotiate through dense mangrove forest. A few camera traps were also damaged by the saline high tides (reportedly stolen in BTR). However, this technique is now successfully used in Sunderbans and other PAs in the state.

7. Extension of Nature Education and Awareness Generation.

8. Rescue and Rehabilitation:

Every year hundreds of wild mammals are rescued and rehabilitated in different parts of the state. For example, during 2012-13, the following species (number indicated in parenthesis) were rescued and rehabilitated by the Wildlife Squads- Langur (218), Monkey (72), Civet (285), Jungle Cat (38), Fishing Cat (10), Sambar (6), Mongoose (6), Jackal (25), Fox (1), Dolphin (3), Spotted Deer (8), Tiger (2), Hog Deer (2), Barking Deer (12), Pangolin (3), Hyaena (1), Leopard (19), Elephant (8), Gaur (15), Leopard Cat (1), Wild Boar (1), Porcupine (3), Squirrel (4), Nilgai (1) and Chinese Ferret Badger (2).

Lessons learnt on *in situ* and *ex situ* conservation initiatives in the state

Both *in situ* and *ex situ* conservation are essential and complementary to each other, aiming at long-term survival of the flagship species along with harmonious co-existence of other indigenous species in the natural ecological background. The climate change adaption and mitigation, management of problem animals and many other emerging challenges have to be confronted. It is most crucial for the management to balance between maintaining viable populations of the key as well as associated species by regulating their density and distribution, safeguarding the human welfare, property as well as satisfying the needs of stakeholders in a cost-effective manner. Proactive education and public awareness programmes are the keys to achieving that balance. Protection and conservation of the wetlands lying in the non-forest areas should be another priority area. Besides, the organizational set up should be revamped at the grass root level and efficiency ensured. "What's necessary" includes creation of a New Conservation Movement dedicated to gaining ground in pursuit of ecological sustainability.

Table 1: Tabular summary of checklist (Figures in parenthesis recorded in Agrawal et al. 1992)

SL NO	ORDERS	NO OF FAMILIES	NO OF GENERA	NO OF SPECIES	NO OF SUB - SPECIES
1	EULIPOTYPHILA (INSECTIVORA)	2(2)	7(6)	11(13)	13(11)
2	SCANDENTIA	1(1)	2(2)	2(2)	2(2)
3	CHIROPTERA	7(7)	32(29)	75(60)	60(44)
4	PRIMATES	3(1)	5(2)	8(3)	6(3)
5	CARNIVORA	8(8)	32(23)	48(37)	48(30)
6	PROBOSCIDEA	1(1)	1(1)	1(1)	1(1)
7	PERISSODACTYLA	1(1)	2(1)	3(1)	2(0)
8	ARTIODACTYLA(*)	9(3+3=6)	27(10+6=16)	29(13+6=19)	18(11)
9	PHOLIDOTA	1(1)	1(1)	2(1)	1(0)
10	RODENTIA	4(3)	25(23)	50(48)	60(41)
11	LAGOMORPHA	2(1)	3(2)	5(3)	4(2)
Total	11(12)	39(32)	137(106)	234(188)	215(145)

*Cetaceans included in Artiodactyla (separately dealt with in Agrawal et al. 1992).

Table 2: Checklist of extant and extinct mammalian species in West Bengal.

ORDER EULIPOTYPHILA FAMILY SORICIDAE SUB-FAMILY CROCIDURINAE TRIBE CROCIDURINI			COMMENTS
GENUS	SPECIES	SUB-SPECIES	
1. Grey or Himalayan White-toothed Shrew			
<i>Crocidura</i>	<i>attenuata</i>	<i>rubricosa</i>	Frequent. Restricted to North Bengal. Specimens at ZSI from Mungpo (Mongpu), Gopaldhara, Pashok, Takdah in Darjeeling and Hasimara in Alipurduar (Agrawal et al. 1992; Khajuria & Ghose 1970). Habitat: Lowland and montane tropical and subtropical moist forest, bamboo forest, herbaceous vegetation, scrubland, foothills of <i>Terai</i> and <i>Bhabar</i> regions. JNP (Maheswaran & Kumar 2003). Anderson (1877) described <i>C. kingiana</i> from Mungpo in Darjeeling on the basis of lateral glands being absent. Later (1881) he could find lateral glands in the type series and synonymised it with <i>C. rubricosa</i> . Ellerman & Morrison-Scot (1951) treated both the <i>rubricosa</i> and <i>kingiana</i> as separate subspecies of the <i>C. attenuata</i> without assigning any definite reason.
2. Etruscan Pygmy Shrew			
<i>Suncus</i>	<i>etruscus</i>	<i>nitidofulvus</i>	Very rare. Probably, extinct. Holotype from Kolkata, also found in Howrah (Agrawal et al. 1992). Sterndale (1982) mentions its presence in Kolkata as <i>Sorex melanodon</i> . Habitat: Warm and damp habitats covered with shrubs, grasslands.
		<i>pygmaeoides</i>	Occasional in north Bengal (Anderson 1881, Wroughton 1917). Specimens from Darjeeling (Pashok) and Alipurduar (Hasimara and Bhamabari). Found in different types of habitats in plains and hills up to an altitude of 3,000m. Found under litter in forests (Pratihari & Chakraborty 1996). GNP, RBWLS, BTR.
3. House Shrew			
<i>Suncus</i>	<i>murinus</i>	<i>griffithi</i>	Occasional. Restricted to higher altitudes of Darjeeling. Specimens collected from Ghoom and Tonglu. SNP.
		<i>soccatus</i>	Common. Found in Darjeeling, Kalimpong and Alipurduar districts.
		<i>caerulescens</i>	Common. All districts, in forests or near human

			types, visited by the radio-collared elephants during early 21 st century, which are: dense evergreen forest (56 km ²), semi-evergreen forest (92 km ²), deciduous forest (87 km ²), degraded forest (141 km ²), dry thorn forest (28 km ²), flood plains (50 km ²), and plantations and mixed forest (221 km ²) in addition to area under tea, cereal cultivation and settlement.
ORDER PERISSODACTYLA SUB-ORDER CERATOMORPHA FAMILY RHINOCEROTIDAE			
SUB-FAMILY RHINOCEROTINAE TRIBE RHINOCEROTINI			
146. Sumatran or Asiatic Two-horned Rhinoceros			
<i>Dicerorhinus</i>	<i>sumatrensis</i>	<i>lasiotis</i>	Extinct. One shot ca.1915 in Dalgaon forest of Jalpaiguri (Inglis et al. 2019). Another one shot near the Sankosh river of present BTR (<i>ibid</i>).
147. Javan or Smaller One-horned Rhinoceros			
<i>Rhinoceros</i>	<i>sondaicus</i>	<i>inermis</i>	Extinct from both north Bengal (a young female specimen shot by JA Mollar from Denmark in Moraghat forests in Jalpaiguri on 24 February 1881 and kept in the Copenhagen Museum) and South Bengal. EO Shebbeare reported one killed by JWA Grieve in Buxa. However, Grieve last recorded its sighting in Chilapata (JNP) forests. Type locality of <i>inermis</i> collected from Sundarbans in 1876. It was recorded from Sagar (Saugor) Island, Pealee river bank (Baruipur), Raimangal river bank. During early 18 th century, the grassland was spread up to the River Piyali, where the greater and smaller one-horned rhinos were found to roam about, but the forest reclamation was started there since 1775 and both the grassland and the depending fauna were wiped out during the next hundred years. The sub-recent remains of <i>Rhinoceros unicornis</i> have been discovered in this region (Ghosh <i>et al.</i> , 1992). There is hardly any grassland or large herbivores within the mangrove forest now.
148. Great Indian One-horned Rhinoceros			
<i>Rhinoceros</i>	<i>unicornis</i>	-	Restricted. Common in JNP and GNP. Extinct from Sundarbans (Bakkhali, Mollakhali in Gosaba), Malda, Murshidabad, Koch Behar, Darjeeling, Jalpaiguri, BTR. Inhabits two types of forests, viz. (i) dense moist forest and low hill slopes of terai and <i>duars</i> (ii) tall grass land and mixed forest. Habitat use pattern JNP The rhinos appear to be confined to the moist habitats supporting the semi-evergreen to evergreen forests, almost always in association with the alluvial plains and tall grassland. This largest tract of tropical grasslands (savannah) in the state consists of <i>Saccharum spontaneum</i> , <i>S. arundinaceum</i> , <i>Phragmites karka</i> , <i>Arundo donax</i> , <i>Narenga porphyrocoma</i> , <i>Themada villosa</i> , etc, dotted with associations of Khair-Sissoo (<i>Acacia catechu-Dalbergia sissoo</i>) and Simul-Siris (<i>Bombax ceiba-Albizia procera</i>) woodlands. GNP It appears that the rhinos usually prefer the savannah and natural grasslands for grazing than the plantations and riverine forests.

			<p>Forest typewise undisturbed habitats used by the rhinos as dung midden are-</p> <p>JNP</p> <ol style="list-style-type: none"> 1. Savannah forest – 59.31% 2. Natural grassland- 23.64% 3. Plantation- 13.87% 4. Riverine forest- 3.18% 5. Tropical moist deciduous forest- Nil <p>GNP</p> <ol style="list-style-type: none"> 1. Savannah forest –14.08% 2. Natural grassland- 26.77% 3. Plantation- 23.95% 4. Riverine forest- 14.08% 5. Tropical moist deciduous forest- 21.12%. <p>During the present study in JNP, 96.04 km² (45% of the total area) were found to be most suitable habitat of the rhinos, of which the pure grasslands cover 30.55 km² (14.11%), grasslands with <i>Acacia-Dalbergia</i> succession 42.90 km² (19.81%) and grassland with <i>Bombax-Albizia</i> succession 22.59 km² (10.3%), whereas the secondary habitat was estimated to be about 50 km² and the seasonal (monsoon) upland habitat to be approximately 10 km². The rhinos are not presently known to visit Titi (39.19 km²), Jaigaon (17.56 km²) and Dalsingpara (14.78 km²) blocks, north of National Highway 31A as well as Salkumar (5.02 km²) in between the two legs. In GNP too, the resident rhinos do not use the whole park area. In fact, the core habitat used by them is only 8 km² (10.06%). There are two distinct ecotones for the rhinos- Riverain Rolling Flood Land Forests (RFF), Riverine Riparian Forests (RRF). This habitat offers the best grazing ground for the rhinos. During the present study, the rhinos were found to graze mostly in the riverine grasslands of Dhupjhora and Jaldhaka blocks (6.86 km²). The rhinos usually avoided the wet mixed forests, but, in the dry season (summer), when there is threat of fire in the grassland, the rhinos frequently used this type of forests at Barahati 1, 3; Central 1; Medlajhora 1; Dhupjhora 1b, 2 and Kakurjhora 2 as resting place and browsed on the lower canopy. The rhinos were mostly seen in the wallow pools and saltlicks.</p> <p>Temporary or seasonal local migration for food and shelter is a common phenomenon among the adult rhinos, particularly the males. In the past, the rhinos confined to the grassland habitat between the Rivers Sankosh and Rydak moved freely between Assam and West Bengal. Similarly, the rhinos of Jaldapara and Chilapata travelled to the neighbouring Bhutri forests on the east and also to Cooch Behar on the south. The Patlakhawa subpopulation also ranged further up to Pundibari near Cooch Behar. The rhinos were distributed across the forest of upper Tondu, lower Tondu and in the floodplains of the Rivers Diana and Jaldhaka on the north-east or Hiljhora forest on the north-west of Gorumara. They further moved up to Indo-Bhutan border on the</p>
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			north and Mynaguri (now non-forest civil area) on the south. In March 1989, one female rhino strayed up to the Bangladesh border and was later brought back. In 1992, another female strayed out to Mahananda Sanctuary by crossing the River Tista and died due to exertion of such longest journey. Whereas there are contiguous reserve forests in the eastern side of Jaldapara, some older or subordinate male rhinos, after being chased out of the prime habitat by the dominant male, used to move towards the secondary habitat at their range-edge and settle in Bania-Mendabari-Chilapata or southern Patlakhawa forests of Cooch Behar..
ORDER ARTIODACTYLA INFRA-ORDER CETACEA SUB-ORDER MYSTICETI			
FAMILY BALAENOPTERIDAE SUB-FAMILY BALAENOPTERINAE			
149. Bryde Whale or Smaller Indian Fin Whale			
<i>Balaenoptera</i>	<i>edeni</i>	-	Rare. The skeleton of a 42-foot male, which was stranded on Digha coast since December 2012, is now preserved by noted Odisha taxidermist Siba Prasad Parida.
150. Fin Whale or Common Rorqual			
	<i>physalus</i>	-	Rare. Stranding recorded by Yennawar (2009).
Unidentified sp.	-	-	Jambudwip in Sundarbans (Jones 1953).
SUB-ORDER CETARTIODACTYLA FAMILY DELPHINIDAE SUB-FAMILY GLOBICEPHALINAE			
151. Pilot or Ca'ing Whale			
<i>Globicephala</i>	<i>macrorhynchus</i>	-	Rare. Recorded in July, 1852 in Salt Lake near Kolkata and another killed in the river Hooghly near Serampur. No further record.
SUB-FAMILY ORCAELLINAE			
152. Irrawaddy or Snubfin Dolphin			
<i>Orcaella</i>	<i>brevirostris</i>	<i>brevirostris</i>	Occasional. Specimen collected from circular canal in Kolkata during late 19 th century. Also recorded from the Hooghly river near Srirampur and Budge Budge. Now restricted to STR (Rivers Raimangal, Jhilla, Amlamati), and East Midnapore (Digha).
SUB-FAMILY CEPHALORHYNCHINAE			
153. Indo-pacific Hump-backed or Plumbeous Dolphin			
<i>Sousa</i>	<i>chinensis</i>	<i>plumbea</i>	Rare. First photographic record of three individuals (male, female and baby) swimming in Gommor river of Sundarbans (Sajnakhali) by Saha and Palchowdhury (2008) and Mukherjee (2017).
SUB-FAMILY DELPHININAE			
154. Pantropical Spotted Dolphin			
<i>Stenella</i>	<i>attenuata</i>	<i>attenuata</i>	Rare. Restricted to Sundarbans. Earlier recorded as <i>S. malayana</i> .
155. Bottlenose Dolphin			
<i>Tursiops</i>	<i>truncatus</i>	-	Rare. Recorded by Kar (1996).
FAMILY PHOCOENIDAE SUB-FAMILY PHOCOENINAE			
156. Little Black Finless Porpoise			
<i>Neophocaena</i>	<i>phocaenoides</i>	-	Rare. 19 th century record from Hooghly river near Kolkata during high tide. Also recorded from Sundarbans. No recent sighting.



Fig. 4. Mammals in different habitats (Jungle cat, Indian elephant (loner tusk), Indian rhino, Binturong drinking water from a *pokhri*)

CONCLUSION

Regular monitoring and research on abundance /distribution/status of mammalian species involving the local communities and all stakeholders in the conservation works is considered most important in securing long-term sustenance of mammalian fauna in the state. Future action plans should include shifting and rehabilitation of the in-forest settlements, eviction of unauthorized occupants, developing institutional conservation capacity, ensuring effective patrolling force with modern arms and ammunitions to prevent illegal activities like poaching or exploitation of natural resources, regular evaluation of occupancy, connectivity and population size, reduction of unsustainable use of forest resources, implementation of prioritized conservation activities.

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