CHAPTER –III: MATERIALS AND METHODS

3.0. Materials and Methods

3.1. Study Area

3.1.1. Physiography and Location

The Orang National Park (coordinates 92°15´- 92°27´ E and 26°29´-26°40´ N) is located on the North bank of the river Brahmaputra within the Udalguri district and Sonitpur district of Assam, India (Figure 3.1.1-3.1.6). It is located about 140 kilometers away from Guwahati and 32 kilometers from Tezpur and included under the jurisdiction of Mangaldoi wildlife division, Assam. It covers an area of 78.81 km$^2$ lies on the north bank of Brahmaputra river delimited between 26.483° N, 92.266° E and 26.666° N, 92.45° E within the district of Darrang and Sonitpur. The study area is bounded by Pachanoi river, Belsiri river and Dhansiri river and adjoining area of the Brahmaputra river.

![Map of Orang National Park](image)

**Fig 3.1.1: Map of Orang National Park (not in scale) (Source: Hazarika & Saikia, 2012).**

Thus, the park became alluvial flood plains of the river Brahmaputra and other river and wetland as well as alluvial terrace and become an integral part of the Indo-Burma bio diversity hot spot. Again the entire study area could be divided into two parts
i.e. lower and upper Orang. The lower Orang part is more recent in origin, whereas, the upper portion of the north side is separated by high bank traversing the park from east to west. The terrain is gently sloping from North to South. The altitude of the study area ranges between 45-75m msl. The total area of the park has been divided into Eastern Himalayan Moist deciduous forest (15.85 Km²), Eastern seasonal swamp forest (3.28 km²), Eastern wet alluvial grassland (8.3 Km²), Savannah grass land (18.17 km²), Degraded grassland (10.36 Km²), water body (6.13 km²), Moist sandy area (2.66 Km²), and Dry sandy area (4.02 Km²).

3.1.2: History

The name _Orang‘ owes its origin from the Assamese word _OOR‘ which mean _the end‘(Saikia, 2005). Historically, it was the end of Eastern boundary (demarcated by river Pachnoi) of former Kamrup district, whose capital was Rangiya (Gait, 1967; Choudhury, 1987) and the king _ARIMATTA or VAIDYADEVA‘ who ruled over after PAL Dynasty during 12th century A.D. According to some local people of that area the word _Orang‘ came from the ethnic group of _Tea Labour brought by British Tea planters from Orissa whose ancestors are still residing at the outskirts of the Orang National Park. Again, according to Talukdar and Sharma (1995), the entire study area was a human inhabitant area up to 19th century. Before declaration Orang as a Game Reserve in 1915, the whole study area was occupied by different ethnic groups. The old Siva temple in old Orang area and other 26 manmade ponds were the evidence of human habitation in the study area. Due to some water borne epidemic disease, the tribal people abandoned the study area (Talukdar and Sharma, 1995). As the entire area was abandoned by the villagers, the whole area was converted to an excellent habitat for different types of wildlife species. The river Brahmaputra along with the two tributaries namely Dhansiri and Pachnoi river including various wetlands, ponds and streams provide a large sources of water for various aquatic species and also for the entire study area.

3.1.3: Present status of the study area

The present area of the Orang National Park was first declared as a _Game Reserve‘ by British Government covering an area of 80.54 km² in the year 1915, 31 May(Talukder and Sharma, 1995). Then it became a part of Mazbat Forest Range under Darrang Forest Division. In 1972, the game reserve came under the control of the wildlife division of the State Forest Department and the area was included as an _Auxiliary
area’ of the Project Tiger. Later it was established as wildlife sanctuary in September 20, 1985, covering an area of 75.60 km$^2$. During the year 1991, an area of 3.21 km$^2$ was added to park by evicting encroachers from Government land and ultimately the total area became 78.81 km$^2$. But in 1992 the park was renamed as Rajiv Gandhi wildlife sanctuary. Finally the sanctuary was upgraded to a National Park in 1999, April, 8.

3.1.4: Climate

The climate of the study area is meso-thermal humid climate of Brahmaputra valley type. On the basis of the seasonal variation of temperature, rainfall and humidity, the climate could be divided into four district seasons viz., Pre-monsoon (March-May), Monsoon (June-September), Retreating Monsoon (October-November) and winter (December-February) (Borthakur, 1986)(Figure -3.1.2-3.1.4).

(a) **Pre-monsoon (March-May):** Pre-monsoon is a transitional period between relatively dry winter and hot summer and is characterized by a rapid rise and fall of temperature. The minimum and maximum temperature during this season was ranged between 16$^\circ$ and 32$^\circ$C. The average relative humidity was 59%–78% and the average rainfall was 150 mm during the study period.

(b) **Monsoon (June-September):** Monsoon season is the characteristic type of rainy season of the year with an average rainfall of 1160mm. The minimum and maximum temperature ranged between 25$^\circ$ and 36$^\circ$C. The average relative humidity was 81% during this season.

(c) **Retreating monsoon (October-November):** In Retreating Monsoon season, the temperature gradually falls and moving mist and fog appears. The minimum and maximum temperature ranged between 17$^\circ$ and 34$^\circ$ C. Rainfall slightly lowered in this season and attained up to 150 mm and average relative humidity was 78% during the study period.

(d) **Winter (December-February):** Whereas, the winter season is characterized by cool weather and fogs. Average minimum and maximum temperature dropped down to 10$^\circ$ and 27$^\circ$C respectively. The average relative humidity ranged between 77% and 65%. The average rainfall was 21 mm only, during the study period.
Fig. 3.1.2: Maximum and minimum temperature of the study area during the period of 2010-2012.

Fig. 3.1.3: Maximum and minimum rainfall of the study area during the period of 2010-2012.
3.1.5: Vegetation

The vegetation of the study area is basically composed of four different types (Champion and Seth, 1968) such as (i) Eastern Himalaya's Moist-deciduous forests, (ii) Eastern seasonal swamp-forest, (iii) Khair-Sisso forests and (iv) Eastern Wet-Alluvial grasslands. Apart from that, the vegetation composition of the study area is unique within North Bank, which comprises short and tall grasslands dotted with natural and planted woodland habitat and water bodies.

(a) Grassland Habitat

On the basis of the height of the grasses, the grasslands may be divided into (i) Tall grassland (ii) Short grassland and (iii) Marshy grassland.

(i) Tall Grassland: The tall grassland consists of *Saccharum ravennae*, *Arundo donax*, *Phragmites karka*, *Themeda arundinacea*, *Saccharum spontaneum*, *Saccharum elephantinum*, *Andropogon squarrosum*, *Pollinia ciliate*, *Cencharus ciliaris* etc.
(ii) **Short Grassland**: the short grasslands consist of *Imperata cylindrica*, *Cynodon dactylon*, *Hemerthria compressa*, *Chrysopogon aciculatus*, *Vetivaria ziganoides*, *Leersia hexandra*, *Brachiarea ramosa*, *Hymenachene pseudoimperata* etc.

(iii) **Marshyland**: The marshylands mostly covered with *Enhydra fluctuans*, *Ipomoea raptans*, *Ipomoea aquatica*, *Vallisnaria sp*, *Hydrilla verticillata*, *Eichhornia crassipes*, *Trapa bispinosa*, *Trapa natans*, *Lemma perpusilla*, *Nymphaea rubra*, *Nelumbo nucifera*, *Tinospora cordifolia*, *Brachiaria pseudoimperata*, *Alpinia alohas*, *Pistia stratiotes*, *Lemma puncistroata* etc. Grasses like *Leersia hexandra*, *Hymenachene pseudoimpeartata*, *Hygroryza aristata* etc. are available in these areas.

(b) **Woodland habitat**: The Woodlands are mainly found in northern part of the park, which consists of indigenous trees, found in the form of both man-made and natural conditions. Many softwood trees and exotic trees are also found in the man-made forest patches. The woodlands may be divided into (i) Plantation forests (ii) Natural forest

(i) **Natural forest**: The trees of the natural forest represented by *Bombax ceiba*, *Acacia catechu*, *Albizia procera*, *Sterculia villosa*, *Ziziphus mauriciana*, *Trewia nudiflora*, *Syzygium fruticosum*, *S. cumini*, *Bauhinia purpurea*, *Tamarix dioca*, *Lagerstroemia speciosa*, *Ficus bengamina*, *Ficus religiosa*, *Biscofia javanica*, *Alstonia scholaris* etc.

(ii) **Plantation forest**

The plantation forests of Orang National Park consists of *Anthocephalus cadamba*, *Dalbergia sisoo*, *Acacia catechu*, *Albizia procera*, *A. lebek*, *Samania saman*, *Tectona grandis*, *Tona ciliata*, *Trewia nudiflora*, *Michelia champaka*, *Bombax ceiba*, *Alstonia scholaris*, *Biscofia javanica*, *Lagerstremia speciosa* etc. (Hazarika, 2008; Hazarika & Saikia, 2012).
3.1.6: Important wildlife

The study area harbours several mammalian species. One horned Rhinoceros (*Rhinoceros unicornis*) (68 at the last count) which is the dominant species of the national park. Other key species are Royal Bengal Tiger (*Panthera tigris tigris*), Asiatic
Elephant (*Elephas maximus*), Hog Deer (*Axis porcinus*), Wild Boar (*Sus scrofa*), different species of Civet cats, Leopard (*Panther pardus*), Porcupines (*Erethizon dorsatum*), Chinese Pangolin (*Manis pentadactyla*), Common Otter (*Lutra lutra*). The park is a habitat of different types of birds such as migratory birds, water birds, predators, scavengers and game birds, some of them are Spotbilled Pelican, Great White Pelican, Blacknecked Stork, Greater Adjutant Stork, Lesser Adjutant Stork, Gadwall, Brahminy Duck, Pintail, Hornbills, Pallas’s Fish Eagle, Kingfishers and Woodpeckers etc. It is also an important habitat for endangered Bengal Florican (*Houbaropsis bengalensis*) and Endemic Swamp Francolin (*Francolinus gularis*) species. About 50 species of Fishes have been recorded in the Brahmaputra suti and all other wetlands. Among reptiles, various snakes, lizards and Turtles and tortoises are the important species.

Plate 3.1.6.A: Main entrance of Orang National Park
Plate 3.1.6.B: A view of Brahmaputra Suti in Marsalii area.

3.2 Methods of Study

Field survey was carried out in Orang National Park from January 2010 to December 2014 to determine the diversity, distribution, abundance and habitat use types. The methods of Jaeger (1978), Pough et al. (1987), Cramps and Pounds (1989), Lloyd et al. (1968), Scott (1976), Inger (1980) and Lieberman (1986) was used for the survey and data collection. Data recording techniques were such as VES (visual encounter survey) Direct sighting and Active searching. These methods were used as per Jaeger (1978). Pough et al. (1987) and Cramps and Pounds (1989). Quadrate sampling (Lloyd et al., 1968a; Scott, 1976; Inger, 1980; Lieberman, 1986) method was also used to collect the data and specimens in the study area. For vegetation Sampling Quadrate (size: 20×20 m²) sampling method was used mainly in grassland habitat in the study area (Heatwole & Sexton, 1966; Barbault, 1967; Lloyd et al., 1968a; Toft, 1980; Scott, 1989; Lieberman, 1986; Fauth et al., 1989).
3.2.1: Study design

Major habitat types of Chelonian species were selected based on the species existence and divided it into five zones. In this regards, all relevant terrestrial and aquatic habitats were covered in the study area for data collection.

The survey was conducted thrice in a month for twelve month of period in each year to determine the species availability in various months. The survey time periods were also differentiated based on season such as Pre-monsoon (March-May) Monsoon (June-August), Re-treating Monsoon (September-November) and winter (December-February).

To investigate the population sizes and basking behaviour of the aquatic chelonian species, the multiple transects were laid in Barkhai, Gaspara and Jaoni area in the river side of the Brahmaputra (Size: length, 10 meters and width 5 metres). Direct sighting method was used in Dighali beel, Katahali beel, Ramkong beel, Malamari beel, Chyla beel, Sat simalu down old Orang pukhuri, Padum pukhuri, Segun pukhuri and Rowmari beel for the collection of aquatic species. For studying aquatic vegetation like floating, sub merged, emergent, direct sighting method was used and accordingly collected the samples for identification.

For terrestrial habitat survey, altogether 15 randomly selected line transacts were established with a fixed length and breadth of 50 ×20 meters (Wilson et al., 1981; Flanowski et al., 1990; Burnham et al., 1981). As cheloniens are active in morning to midday day (06:00-11:00 hrs. and 15:00 hrs. to 16:00 hrs.), the survey has been done depending on the temperatures during pre-monsoon, monsoon, retreating monsoon and winter. One hour was spent in each sample quadrate. During Monsoon and Retreating monsoon early morning was preferred. But during winter, midday survey was preferred. 25 quadrates quadrates were also established (Size-25×25 m²) and then systematically sampled by walking in parallel paths across the plot or by walking a zigzag pattern between numbered stakes (Archinger, 1987; Donnelly, 1989; Nishikawa, 1990) and all the data of collected specimens were noted down in data sheet. Data sheet appendix–I was used to collect relevant information such as date, time, specific locality, latitude, longitude, habitat type, habitat description, temperature, relative humidity etc.

We categorized the habitat (grassland) based on different vegetation structure and landscape characters. Quadrates were plotted in the (a) Grassland habitat of Nislamari
Gorabhanga & new Gorabhanga region. (b) Satsimalu, Naorasisa Charali, Singveti region. (c) Tall grass land area under Ramkong Block. (d) Tincona Bantapu area and (d) Hajarbigha, Katahali area. We designed and used a habitat data sheet (Appendix-I) to collect relevant information about the vegetation of turtle habitat and photographs were taken for different types of habitat. To find out the threats factor management burning area were visited during the time of burning (Feb-April) to collect the information and data of burnt turtles. Interviews were conducted among local people and forest guard to obtain the information about the status and threats of turtle. Market survey was conducted in the nearest market of the study area and questioning the fringe villagers traders, local fisherman to collect the information about threats factor. Survey was conducted in basking habitat for monitoring the basking behaviour regularly.

For survey and data collections following sites and routes were selected, those were such as-Nislamari was the starting point of data collection and for the survey purposes transects were plotted in the bank of Malamari beel, Solmaribeel, Silani beel, Tongshi no. 1 and Tongshi no.2. This area was the breeding sites of Chelonian species, so, survey was done during breeding period. The area covered, data and sample collection sites were such as-Gorabhanga old to Gorabhanga new, Ramkong Tower to beel including river side of Brahmaputra, Amulya Camp was covered within Futa Simalu, Chyla beel Tower to Kanchanbagan, Bantapu (beel) to Tinkona, Satsimalu Tower to down, Kheoratali Pukhuri, Gondamari beel (old Orang pukhuri) to Naorasisa chariali, Barkhai to Gaspara (gelabeel, baghmari, pavamari), Hati Camp, Hajarbigha area to Katahali (beel), Jaoni area including Kat ghar, Magurmari, Golduba Brahmaputra Site, Lalduba, Rangagara Pukhuri to Miraduba, Rahmanpur area, Rowmari beel, Solmari Lalpani, Belsiri to Ramdas and Marisali area - Lachit camp etc.

3.2.2: Data Collection

The surveys were made on foot as well as using motor boats. Surveys were conducted from the early morning and continued till after noon. For VES (Visual encounter survey), Active search technique, and Direct sighting methods, minimum equipments were used such as Data sheets, pencil, marker pen, Digital Slide callipers and Spring balance (weighting up to 15 KG) and paper flags were used. All accessible habitats were sampled as much area as possible. All chelonian species were detected visually by active searching in wooden logs, leaf litter, and underground
in forest and the potential breeding sites in sand bank of river Brahmaputra, Pachnoi river and other wetlands. Aquatic habitats were sampled only to a certain depth depending on water clarity. Nesting sites were also detected and monitoring of lots of eggs laying in the sand and hatching from the egg. Ecological Parameters has been taken such as water temperature, ph of water, turbidity etc.

Collected specimens were measured using Mitutoyo Digital Vernier Slide callipers and the species were released after identification, taking of photographs and also recording the entire morphological measurements viz. carapace length (CL) carapace Breadth (CB), weight of the specimens and number of individuals sighted as per Das (1990). Weights were measured using portable spring balance in the field. However, the weight measurement data were not mentioned in the results text because both juvenile observed and adults observed were taken for measurements. All data were noted down in field notebook for further analysis.
3.2.3: Identification of Species

All the specimens were systematically identified using diagnostic keys as per Smith (1935, 1945), Field guide of Das et al. (1995) and as well as photographic guide of Ahmed et al. (2009).

3.2.4: Data Analysis

Data was analysed using standard statistical method. MS Excel was used to construction radar Diagram of habitat wise distribution of Chelonian species in the study area. Data were also represented in tabular form for all the parameters taken. The mean body parts viz. carapace length and breadth, plastron length, weight of the specimen etc. were done and descriptive statistics were calculated using MS excel. Data were represented in tabular form in all parameters. Diversity was estimated in terms of species richness and evenness, as well as using the Shannon-Wiener index, which combines richness and abundance into a single measure (Magurran, 1988). Bootstrap method was used to calculate 95% confidence intervals for Shannon-Wiener’s indices. The diversity of species was estimated in terms of species evenness (or equitability), using Margalef’s D index and bootstrap method was used to calculate 95% confidence intervals (Hurlbert, 1971; Magurran, 1988). Evenness or equitability refers to the pattern of distribution of the individuals between the species. In order to test the differences in diversity between habitats, pair-wise randomization tests were carried out based on 10,000 re-samples of species abundance data following Solow (1993). Species richness was estimated using rarefaction (Heck et al., 1975).

For each Chelonian species, the proportional abundance of each species in each habitat was computed using software (formulae used for computations: for **BR**: (BR)/(BR+PR+BEEL+MH+SH+ML+GL); for **PR**: (PR)/(PR+BR+BEEL+MH+SH+ML+GL); for **BEEL**: (BEEL)/(BEEL+BR+PR+MH+SH+ML+GL); for **MH**: (MH+BR+PR+BEEL+MH+SH+ML+GL) for **SH**: (SH)/(SH+BEEL+BR+PR+MH+ML+GL); for **ML**: (ML)/(ML+MH+BR+PR+BEEL+SH+GL); for **GL**: (GL)/(GL+SH+BEEL+BR+PR+MH+ML). For statistical analysis of data, Spearman rank correlations were used as per Hamer et al. (2003). All data computations and statistical analyses were done using SPSS, statistical software, version 17.0.1 (Dytham, 1999). Diversity was analyzed using species diversity and richness software version 3.0 (Pisces conservation Ltd., UK) as per Magurran (1988) and Solow (1993). Diversity ordering was done using Renyi Diversity ordering (Rényi, 1961).
Table 3.2.1 Establishment of line transects with a fixed breadth of 5 meter in different study zones of the Orang National Park.

<table>
<thead>
<tr>
<th>Study Zone</th>
<th>Transects No.</th>
<th>Length (in meter)</th>
<th>Transect Size</th>
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<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>50</td>
<td>Nislamari Camp-Malamaribeel, Solmaribeel, Sitanibeel, Tongshi no. 1 and Tongshi no.2</td>
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<td></td>
<td>2</td>
<td>50</td>
<td>Pachnoi much to Pachnoi river, Gorabhangaold-Gorabhanga new.</td>
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<td></td>
<td>3</td>
<td>50</td>
<td>Ramkong Tower to beel-riverside of Brahmaputra</td>
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<td></td>
<td>4</td>
<td>50</td>
<td>Amulya Camp-Futasimalu-Chylabeel Tower-Kanchanbagan</td>
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<tr>
<td>2</td>
<td>5</td>
<td>50</td>
<td>Bantapu Camp to beel-Tincona</td>
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<td></td>
<td>6</td>
<td>50</td>
<td>Barkhai to Gaspara (Gela beel), Baghmari, Pavamai)-Hati Camp</td>
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<td></td>
<td>7</td>
<td>50</td>
<td>Hajarbigha area to Katawalibeel.</td>
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<td></td>
<td>8</td>
<td>50</td>
<td>Jaoni-Kataghara, Magurmari, Golduba, Brahmaputra sut.</td>
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<td></td>
<td>9</td>
<td>50</td>
<td>Old Orang Pukhuri-Gondamariibeel-Naorasisa Charali, Kawamari, Chandanpur.</td>
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<td>3</td>
<td>10</td>
<td>50</td>
<td>Rangapara Pukhuri-Miraduba</td>
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<td></td>
<td>11</td>
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<td>Rahmanpur-Rahmanpurpukhuri</td>
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<td>4</td>
<td>12</td>
<td>50</td>
<td>Rowmaribeel to Solamari-Lalpani</td>
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<td></td>
<td>13</td>
<td>50</td>
<td>Satsimalu tower to down-Seoratalipukhuri-Singvetyi, Magurmari</td>
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<td>14</td>
<td>50</td>
<td>Belsiri to Ram Das</td>
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<td></td>
<td>15</td>
<td>50</td>
<td>Marisali area to Lachit Camp</td>
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