3.1 STUDY AREA AND SELECTED SITES

The study was carried out during 2005-2008 covering 135 km stretch of the River Barak from Narain Dahr (24°43'32" N, 93°04'04" E), near Assam-Manipur border at upstream in its hill course to Tiganga (24°52'34" N, 92°29'21"E), the point of its bifurcation into two distributaries- the Surma and the Kushiyara at the Indo-Bangladesh border (Fig.2). As dolphins in the River Barak in dry months use to concentrate most in dahr (deep pool) areas, near mid-channel islands and pillars of bridges and Ferry Ghats, such locations were chosen for sampling of water and related studies. Altogether five riverine spots, as indicated below, were selected as sampling points:

Site No. I :: Dilkhush Dahr (24°46'52"N, 93°01'56"E), near Fulertal on Silchar-Imphal Road (NH-53).
:: A past residential dolphin spot near a mid-channel island (Samunoong) in the hill course of the Barak River.

Site No. II :: Lalmati Dahr (24°49'35" N, 92°51'45" E),
a present residential dolphin spot near Kashipur, about 9 km to the east on Silchar-Imphal Road (NH-53) from Silchar (24°50' N 92°51' E).
In the downstream from Site No. I and after meeting the two tributaries of the Barak - the Chiri and the Sonai.

Site No. III :: Gajambarer Dahr (24°51'19" N, 92°45'59" E), a past dolphin spot near Mazumder Bazar in Topkhana area, adjacent to Silchar-Kalain Road.

:: In the downstream from Site No. II, and after meeting the tributary - the Madhura River.

Site No. IV :: Siddheshwar Ghat (24°52'29" N, 92°34'30" E), a Ferry Ghat and a past dolphin spot near the mid-stream pillars of 100 year old Railway Bridge over the River Barak near Silchar-Karimganj Road at Badarpur Ghat.

:: In downstream from Site No. III and after meeting the three tributaries - the Jatinga, the Katakhal and the Dhaleswari rivers.

Site No. V :: Malua Dahr (24°52'53" N, 92°31' E), a riverine area with Malua on the left bank and Haritikor, a historical place, on the right bank.

:: a past dolphin spot near Ferry Ghat, at about 1 km upstream from the bifurcation point of the River Barak and in downstream from Site No. IV.
Fig. 2: Study area, sampling sites and rivers in Barak Valley
3.2 PHYSIOGRAPHY AND CLIMATIC CONDITION

The study area of the present investigation lies in the central part of Barak Valley in north-east India. Barak Valley (6962 km² area) is comprised of three districts of Assam state, viz., Cachar, Karimganj and Hailakandi, and is situated between longitude 92.15° East and 93.15° East and latitude 24.8° North and 25.8° North. It accounts for about 9% of the total geographical area of the state of Assam. Barak Valley is horse-shoe shaped with 85 km of east-west extension and 70 km north-south extension near Bangladesh border. It forms an important part of the Barak sub-basin of the Ganges-Brahmaputra-Meghna basin. The area of the Barak sub-basin within India is 41723 sq. km, nearly 1.38% of the total geographical area of the country and it spreads in the States of Meghalaya, Manipur, Mizoram, Assam, Tripura and Nagaland.

Barak Valley, also known as Barak plain or Cachar plain, is an undulating plain region with hills, small hillocks and rivers and shallow wetlands in between. There are numerous ox-bow lakes and swamps on either side of the extremely meandering course of the River Barak and some of its tributaries. Out of the total 6962 km² area of the valley, wetlands occupy a total area of 13747.5 ha, of which seasonally inundated floodplains occupy 10016 ha (72.9%). Most floodplains are low-lying areas and they get inundated during monsoon months.

The Barail range in the north and the Duhalia, also called the Pratapgarh range in the south of the Barak Valley run east-west whereas the Bhuban range in the east, the Rengti range, the Tilain range and the Chhatachura range in the middle spread in north-south orientation. The Barail range is generally above 1600 m high and has many peaks above 2,000 m. It reaches its maximum height at Japvo (3048 m).
The Bhuban range on the eastern frontier covers a considerable area, and rises in places to over 915 m above the level of the sea. The Rengti and Tilain ranges are composed of hills of low heights. The Chhatachura range that starts from the southern border forms the whole length of border between Karimganj and Hailakandi districts. The summit of the range is called the Chhatachura peak and its height is 636 m above the sea-level. The hills gradually decline in height and in the middle section, which bears the name Sarashpur, is only 305m above mean sea-level. At the lowest level, where they are known as the Badarpur hills, the average height is about 150 m. The Chhatachura range is about 80 km from north to south and at some parts, 21 km in breadth. The Adamail or Patharia range marks the western border of the Barak Valley forming the international border with Bangladesh. Running from the south to the north, its length is about 45 km and breadth about 17 to 21 km. The highest point of the range is about 245 m above mean sea-level. The Duhalia range, also called the Pratapgarh range in Karimganj district is about 45 km with highest peak at 457 m above sea-level.

Almost the whole of the Barak valley, north and south of the river Barak is dotted with low-ranged isolated hills and hillocks called “tillahs” rising from the level of alluvial soil. They are mostly made of rocks of the Tipam (miocene) series. Most parts of banks of the Barak are lined with villages concealed in groves of slender areca palms, broad-leaved plantains and feathery bamboos, and in all seasons of the year, the country looks fresh and green. The hills on the southern part of the valley are covered with dense ever-green forest and bamboo jungle.

The soil of major area of Barak valley varies from alluvial to laterite soils having texture clay to clayey, pH 4.5 – 5.5 and is suitable for rice cultivation. Loam to sandy loam texture soils are found in the riverine tracts of the main river Barak and its tributaries. These soils are less acidic in reaction and the pH ranges 5.00 – 6.00. Laterite soils
(red and yellow) are generally found in the hill slopes and hillocks. Due to heavy rainfall these soils are acidic in reaction.

The climate of Barak Valley region and other general parts of Assam is sub-tropical and is characterised by high rainfall, hot and high humidity. Generally the daily temperature in the Barak Valley is about 15 °C in January. From April it rises and in July, the mean temperature ranges from 25 °C to 27.5 °C. During October, daily mean temperature is above 25 °C. From November, temperature gradually goes down and the lowest temperature dips down to 8 °C - 10 °C in the month of December. The winter is not as cold as that of Brahmaputra valley. The highest temperature is recorded in the month of June. The humidity is 80% and does not fall beyond 75% on an average. The mean annual rainfall (MAR) of Barak valley is 4103 mm and mean annual temperature (MAT) 24.9 °C, these are higher than those of the Brahmaputra valley. During rainy season, the air is surcharged with moisture and rainfall is extremely heavy. Distribution of rainfall is not uniform in the various months of the year. Most of the rainfall in the valley is, received under the influence of the south-west monsoon between June and October. However, rainfall starts from last part of March and continues up to October. About two-thirds of the total annual rainfall occurs in the months of June to August. Among the three districts of Barak Valley, Karimganj receives the highest rainfall. During monsoon months the riverine tracts of Barak valley are inundated by several waves of flood, the affected area being characterized as flood prone, chronically flood prone, occasionally flood prone etc.

Based on the climatic condition (Annexure V) and especially on the rainfall pattern (rainy days and rainfall amount) in the area, four seasons in a year have been identified for the present study and studies were carried out accordingly:
Pre-monsoon / summer : March-May
Monsoon / rainy season : June-August
Post-monsoon / autumn : September-November
Dry season / winter : December-February.

There is no sharp demarcation between any two adjacent seasons. The identification of the seasons has been mainly to facilitate the study and presentation of the results of monitoring of the dolphin and their habitat in the River Barak.

3.3 METHODOLOGY

3.3.1 IDENTIFICATION OF THE DOLPHIN SPECIES

In order to identify Foo Maach, the aquatic megafauna found in the River Barak, photographic copies of carcass and rolling ones upon water and also video footage of the animal recorded from Lalmati Dahr area of the river Barak were compared with images of dolphins and porpoises, in general and that of the species Gangetic River Dolphin *Platanista gangetica* Roxburgh 1801 and sub-species Ganges River dolphin *Platanista gangetica gangetica* in particular, available at various websites, books (Jerdan 1874, Prater 1971, Tikader 1983, Choudhury 1997) and journals and magazines (Gautam, 2000).

The river dolphin *Platanista gangetica* can be confused with several other small cetaceans. To confirm that the dolphin-like species found in the River Barak is Ganges River Dolphin and not a finless porpoise, Irrawaddy dolphin, bottlenose dolphin, or Indo-Pacific humpback dolphin, the distinguishing features - dorsal fin and beak, were observed. Finless porpoises completely lack dorsal fin. The dorsal fin of Ganges River dolphin is very low, almost ridge-like. Bottlenose
and humpback dolphins have prominent dorsal fins. Moreover, adult bottlenose and humpback dolphins are much larger than Ganges Dolphins. Ganges dolphin has long snout or beak; it is absent in Irrawaddy dolphins.

The two sub-species of *Platanista gangetica*, namely Ganges Dolphin *Platanista gangetica gangetica* and Indus Dolphin *Platanista gangetica minor* resemble closely. To ascertain which sub-species of Platanista gangetica is found in the River Barak, advantage of the fact that the Indus River dolphins do not enter the territories of Ganges River Dolphins and vice versa is taken into consideration. Moreover, the Indus River Dolphins are smaller than the Ganges River Dolphins. There is also a small difference between the maxillary crests (bony outgrowths on their skulls) of the two species. Throughout this manual, unless otherwise explicitly expressed Ganges River Dolphin, Ganges Dolphin or Susu will mean *Platanista gangetica gangetica*.

### 3.3.2 LOCATING DOLPHIN CONGREGATION SPOTS

To locate dolphin congregation and temporary migration spots in the River Barak, information of such possible sites was first collected from the people who row down pontoons of bamboos from upstream, boatman, fisherman, old-folks and riverside people. Then 1:50 000 toposheet maps of Survey of India and satellite images from internet were consulted to know the easy accessibility of those sites by roadways, waterways and footways so that regular monitoring might be done on those spots in the times to come.

After ascertaining (in 1999) that at least one dolphin congregation centre (Lalmati Dahr) was still left in the River Barak, an extensive and intensive search for dolphins and their preferred spots were carried out and a second congregation centre, Niyairgram Dahr (24°47'10'' N, 92°50' E ) was soon found. After that, prior to the
present format of study, there had been regular monitoring and periodic surveys of dolphins and their habitat in the River Barak. Some of those observations and data, especially those pertaining to dolphin population have been incorporated in the result and discussion section of the present study.

3.3.3 **MONITORING OF DOLPHIN POPULATION**

The numbers of dolphins were recorded in lean season following the method, as suggested by Smith & Reeves (2000), which is actually a modified line transact method. It involved three observers for locating the dolphin sightings. The observers sit in the extreme front of a boat in a high platform. Among the observers, the middle one acted as secondary observer as well as data recorder while the rest two other observers acted as primary observers.

Unlike the Brahmaputra and the Ganges, the Barak River, in winter, is a single channel stream and within easily visible (average bank-full and low-water widths around 300 and 150 metres respectively) and approachable banks. Advantage of this fact was taken during the monitoring of dolphin and dolphin habitat in the River Barak.

For dolphin search, a country-made boat was used. Motor boat emitting low sound and moving at slow speed within 9 km per hour was also often used for the purpose. Pair of binoculars (16 X 50), an SLR camera (Yashika FX 3) with fast films (400 ASA) and a digital camera COOLPIX L11 Nikon (6 Mega pixels, shutter speed 4 to 1/2000 s) were employed during the dolphin survey and monitoring of the dolphin habitat.

At each and every potential dolphin spot, about 15 minutes were spent to look for the presence of any dolphin there. At dolphin
congregation centre, more time were devoted and measures to minimise both upward and downward bias in dolphin counts were adopted. In this respect, size, colour, vicinity and distance, and periodicity of rolling of the dolphins were considered.

Determination of sex of the dolphin, at the time of their surfacing from water for a fraction of a second to barely a few seconds, being extremely difficult, only categorisation of the animals in terms of their age groups i.e., infant, adult and juvenile, was done following Biswas and Boruah (2000). Accordingly, a specimen dark black in colour, small in size and length of about 0.7 m or less was considered as infant, a specimen slaty grey in colour and large in size having a length of about 1.2 m or above was considered as adult and a specimen of intermediate colour, size and length between 0.7 m to 1.2 m was considered as juvenile.

Dolphin surveys covering the whole part (135 km) of the study area were accomplished during the dry months, when dolphins were expected to remain in the main river. Areas where dolphins congregate most (14 km stretch from Niyairgram Dahr to Lalmati Dahr) were more frequently surveyed. The linear density (number of dolphins per km) within congregation area, outside congregation area and overall River Barak were calculated dividing the number of dolphins encountered in these areas by 14, 121 and 135, the respective length of the river of these areas.

3.3.4 MOVEMENT, MIGRATION, MORTALITY AND BEHAVIOUR

The dolphin congregation centres were visited frequently, at least once in a month and observations were made on the presence or absence, movement, calving, schooling, feeding and other related matters of the dolphin.
Confluences of tributaries, meandering parts, mid-channel islands in the River Barak were visited regularly and specially after the onset of pre-monsoon rains, during rainy season and also at the close of the rainy season. Lightning visits at some of the spots were also made on receiving specific information from the local people regarding the presence of dolphin in their areas. Surface observations were used to follow movement and migration of dolphin in the river.

During the study period, no past record of mortalities of dolphins in the River Barak was available in the local offices of Forest as well as Fishery Department. During visits to the various spots, fishermen, anglers, men at ferryghats and other villagers were interviewed, talked to and information of sighting of small and black (infant), large and brownish (adult) and medium sized (juvenile) dolphins, their behaviour, birth, entanglement in fishing gears, mortality and other related matters were collected. In order to authenticate information on mortality of dolphin, gathered from individuals, the sincerity and body-language of the person concerned, his or her background etc. were taken into consideration. Furthermore, cross-checking of the particular information from more than one source was carried out. In order to extract reliable information from individuals, they were first made convinced that nothing harm would cause to them in any way in the future because of supplying any information.

3.3.5 STUDY OF HABITAT ECOLOGY

3.3.5.1 GEOMORPHOLOGY, HYDROLOGY AND OTHER RIPARIAN FEATURES

Information on geomorphologic and other riparian features especially channels form and vegetation were collected from satellite images, posted by some websites in the internet. The satellite images
were cross checked during dolphin surveys and by visits to the concerned areas.

River channel depth, width and velocity of flow were measured during the dry season, in the months of December and January because of its more relevance to the congregation period of dolphin in the River Barak.

Width, depth and flow characteristics of the river at the various sampling sites were determined following Trivedy et al., 1987. Width and depth of the river were determined first by a series of measurements of the stream. The cross-section of the stream was found out multiplying the width by the average depth. Surface velocity of the stream along the measured width was determined at various equidistant points by finding the time required for a weighted float to travel a fixed distance along the stream. Average velocity of water column at each point was found out dividing the surface velocity by 1.2 (correction factor). Average velocity of the cross-section was then calculated out from the average velocities of water columns. This average velocity multiplied by the area of cross-section gave the discharge of the river at the particular site.

3.3.5.2 Physico-chemical characteristics of water

Studies on seasonal variation of altogether ten physico-chemical parameters of water of the river Barak at the five selected sites including one dolphin congregation spot within the study area were carried out following standard methods (Trivedy et al., 1987, APHA, 1980) :-

i) Temperature of water: The temperature of surface water was measured using a mercury thermometer of 0.01 °C markings and graduated from -10 °C to +110 °C.
ii) **Transparency:** Transparency or light penetration in water was determined using a 20 cm diameter Secchi Disc following Trivedy et al. (1987).

iii) **pH:** A digital pH meter (pHep® Pocket-sized pH Meter, Resolution 0.1 pH: make – HANNA, Italy, and ISO 9001 Certified Company) was used for determination of pH of water samples. The instrument was regularly checked and calibrated using buffer solution of known pH.

iv) **Conductivity:** It was measured using a digital conductivity meter equipped with temperature compensation (DiST 3: HI 98303: make – HANNA, Italy, an ISO 9001 Certified Company).

v) **Dissolved oxygen:** It was measured by modified Winkler’s Method.

vi) **Dissolved free carbon dioxide:** Free carbon dioxide was determined by titrating water sample using a standard alkali and phenolphthalein indicator.

vii) **Alkalinity:** It was measured by titration. An acid of known strength (the titrant) was added to a volume of a treated sample of water. The volume of acid required to bring the sample to a specific pH level reflected the alkalinity of the sample. The pH at the end point was indicated by a colour change.

viii) **Total dissolved solids:** Total dissolved solid was determined as the residue left after evaporation of filtered sample of water.

ix) **Total solids:** It was determined as the residue left after evaporation of unfiltered sample of water.

x) **Total suspended solids:** It was determined as the difference between total solids and total dissolved solids.
3.3.5.3 **FISH ABUNDANCE AND FISHING INTENSITY**

River dolphin being mainly a piscivorous animal, assessments of the availability of fish within the study area and its immediate vicinity were made. Vicinity areas considered were the freely connected water bodies like the river plains, nulas (streams), beels and anuvas, lying within a distance of about 1km from the main channel of the River Barak. Connected water-bodies were included because dolphins quite often ventured and foraged into those areas and because there was a constant exchange as well as to and fro movement of the fishes between the main river and those water bodies. Available fish species within the congregation area of the dolphin (Lalmati Dahr-Niyairgram Dahr) were also separately assessed.

Fish samples were collected using cast nets, fixed nets and drag nets. A good number of samples were also gathered from fish landing spots at Fulertal, Banskandi Puran Bazar, Sonabari Ghat, Berenga, Kashipur, Madhuramukh, Mazumder Bazar, Jatingamukh, Katakhal, Panchgram, Katigorah, Badarpurghat, Padrighat, Srigauri and Haritikor, all along the bank of the River Barak.

Depending on the frequency of catching and/or trapping and also on the availability in fish markets, an estimate of the relative abundance of the sampled fish species were made categorising them as common, occasional and rare. Detailed photographs of fresh fish samples were taken to facilitate in identification. Samples were also preserved in 10% formalin and brought to the laboratory for the same purpose. Identification and classification of the samples were made taking the help of Jayaram (1981) and Talwar and Jhingran (1991). To get an idea of foods consumed by the dolphin, there was a look out for observing gut content of dolphin corpse and for collecting the necessary information in an indirect way from the fishermen and villagers who in the past had got the chance to cut river dolphins and see their stomach contents.
To assess the overall abundance of fish, the catch per unit effort (c.p.u.e.) at the various sampling stations were found out following the method described by Biswas (1993). The c.p.u.e. is the average hourly fish-catch due to the effort of a single person. It has direct bearing with the density and abundance of fish of a locality. For estimating the c.p.u.e, one of the most common fishing methods practised in the River Barak was considered. In this method, two fishermen mounting on a country boat use a drag net for catching fish.

3.3.6 THREAT AND CONSERVATION ASPECTS

Incidental / intentional mortality of dolphin, fishing pressure in dolphin inhabited areas, issues of water development projects, and attitude of the local people towards dolphin of the Barak were investigated. A semi quantitative and qualitative questionnaire was prepared and people were interviewed. As many of the concerned ones were illiterate and as interactions with them were mainly carried out on river banks, sand bars, boats and fields, voice recorder (Panasonic, RQ-L11) was used more often.

In regard to conservation of the animal, its conservation status, concerns and ground realities in the Barak, available options and prospects of anuwas or ox-bow-lakes as dolphins’ semi-natural reserve were first explored and then keeping in view of the threats on the dolphin and its habitat condition, strategies for the conservation of dolphin in the River Barak were developed. Accordingly, concerned authorities were approached to initiate conservation steps. Side by side, awareness campaigns were organised. To begin with attempts were made to record the initiatives taken so far and to project an overview on the conservation of dolphin vis-à-vis other wildlife in the Barak Valley, Assam.