

Comprehensive Management Action Plan for Conservation of Oussudu Sanctuary, Puducherry

Final Report
(November 2010 – March 2011)

Submitted to

The Department of Forests and Wildlife, Government of Puducherry



Submitted by



**Sálim Ali Centre for Ornithology and Natural History (SACON),
Moongilpallam, Anaikatti (PO),
Coimbatore – 641 108, Tamil Nadu**

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Acknowledgements

The information provided in this report is based on the primary information generated during the field surveys. It also has drawn information from several published and unpublished reports, articles and other documents, which are listed under the reference section. We profusely thank the authors of those reports and those who shared other valuable information with us. In case any document, from which information were drawn but inadvertently missed out to quote, we express our apologies. We express our gratitude to the persons, listed below in alphabetical order, for assistance, helps and suggestions that were very valuable in successful completion of the project.

Dr A. Anil Kumar, Deputy Conservator of Forests, Puducherry

Dr P. A. Azeez, Director, SACON, Coimbatore

Chief Secretary, Government of Puducherry

Dr Goldin Quadros, Sr. Scientist, SACON

Ms K P Kavitha, SACON

Mr K. Karuppaiah, Finance Officer, SACON

Dr H. N. Kumara, Scientist, SACON

Dr Manchi Shirish S., Scientist, SACON

Mr M. Manoharan, SACON

Mr L. Muthuaandavan, Pollution Control Board, Puducherry

Mr J. Paramanandham, SACON

Mr A. Srinivasan, Computer Assistant, SACON

Mr P. Subramanian, Field Assistant

Col. N. Sundarrajan, Civil Engineer, SACON

Secretary, Department of Agriculture, Government of Puducherry

Mr Sivakumar, Agriculture Officer, Puducherry

Tourism Department, Government of Puducherry

1. INTRODUCTION

Wetlands are the ecotones or transitional zones between permanently aquatic and dry terrestrial ecosystems. According to Ramsar Convention (1971) wetlands are *"areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"*. Wetlands as resources are responsible for the well-being of the humankind and are the vital elements of national and global ecosystems and economics (Hussain 2007). Wetlands supporting aquatic flora and fauna provide many economic benefits to mankind that include food, drinking water, irrigation for agriculture, ground water recharge, erosion control, water sports, ecotourism, cultural and heritage tourism and other recreational values. It also includes many ecological functions such as supporting biodiversity (including several endangered and threatened species), maintaining hydrological cycle and regime, bio-geochemical functioning and climate stability.

Wetlands form breeding and feeding grounds for numerous resident and migratory water birds and several other lesser-known species. Nearly 20% of the globally threatened bird species are found in wetlands of the Asian region. Thus, studying and understanding the quality of wetlands becomes important for the long-term conservation of flora and fauna. As a great productive life supporting system, wetlands have immense socio-economical, ecological, and aesthetical importance. The natural beauty and diversity of animals and plants make wetland aesthetically captivating (Tam and Wong 2000). In view of their environmental, ecological and conservation values, some of the wetlands in the world are protected as National Parks and World Heritage Sites, some even generate considerable returns from tourism providing recreational activities such as fishing, hunting, boating and as aesthetic retreats.

In India, wetlands are distributed in almost all bioclimatic regions. India, by virtue of its extensive geographical stretch, varied terrain and climate, supports a rich diversity of both inland and coastal wetlands. For the past two decades, wetlands are

facing serious threats due to anthropogenic activities and many of the wetlands are vanishing and being converted to other type of land use (Mitsch and Gosselink 2000, Prasad et al. 2002, Vijayan et al. 2004). Across the globe, their area is declining due to manifold reasons, including anthropogenic and natural processes. Burgeoning population, intensified human activity, unplanned development, absence of management structure, lack of proper legislation and lack of awareness about the vital role played by these ecosystems (functions, values, etc.) are the important causes that have contributed to their decline and subsequent disappearance (Mitsch and Gosselink 2000). In addition, wetlands are important feeding, breeding, and drinking areas for wildlife and provide a staging ground and refuge for waterfowl. As with any natural habitat, wetlands are important in supporting species diversity and have a complex and important food web. The rate of wetland loss has accelerated in recent years. While in urban areas these ecosystems are disappearing fast, in rural areas also the pace is catching up. Thus, the wetlands are one of the most threatened ecosystems of the world (Turner 1991). In places like Tamil Nadu and Puducherry, wetlands are being exploited due to growing demand for housing infrastructure, high foreign remittance, prevalent culture of nuclear families and flaming land prices (<http://www.kerenvs.nic.in/biodiversity/wetlands.pdf>). The Government of India has been implementing the National Wetlands Conservation Programme (NWCP) in close collaboration with the State/UT Governments since the year 1985-86. Under the programme, 115 wetlands have been identified until now (MoEF, 2009). In Puducherry, the Oussudu Lake is the only lake that has been declared as a wetland of national importance.

Puducherry, well known for wetlands, has 82 major and minor wetlands in and around the town; among them Oussudu and Bahour are the major ones. These wetlands provide livelihood for the residents around the regions in the form of agricultural produce, fish, fuel, fibre, fodder, and a host of other day-to-day necessities. Oussudu, the largest lake in Puducherry region, is home to hundreds of bird species including several migratory ones, which flock here in large numbers during migratory seasons. It was also one of the largest breeding sites for the Common Coot in South India (Chari and Abbasi 2003). The lake is also known for a

wide variety of fish, mussels and crabs. During 2008, Oussudu wetland was declared as a bird sanctuary by the Government of Puducherry.

1.1. ORIGIN OF THE STUDY

Wetlands in the urban areas are always exploited for several purposes leading to alteration of wetland characteristics and thus cause changes in species composition and density. The Oussudu Lake (*Oussudu Eri* in Tamil) is the most important fresh-water lake of Puducherry region. Located approximately 10 km west of Puducherry town, the lake is i) a major wintering ground for a large number of migratory birds, ii) rich in flora and fauna, and iii) known to provide several ecological and livelihood options to the local community. However, recently the lake and its surrounding are facing threats and pressures from several anthropogenic activities including rapid urbanizations and infrastructure developments in the immediate vicinity of the lake. Considering the importance of this wetland ecosystem, Government of Puducherry requested Sálim Ali Centre for Ornithology and Natural History (SACON) to prepare a Comprehensive Management Action Plan (CMAF) for Conservation of the Oussudu lake so that various conservation measures and management interventions can be taken up for long-term sustainability of this lake.

1.2. OBJECTIVES

The major objectives of the present study were to:

- Assess the state of environment in and around the Oussudu lake,
- Examine the probable threats to the lake and its ecological environs, and
- Develop a Comprehensive Management Action Plan (CMAF) for conservation of the lake and its surroundings.

2. OUSSUDU SANCTUARY

2.1. LOCATION

Oussudu sanctuary ($11^{\circ}56' - 11^{\circ}58' \text{ N}$ and $79^{\circ}44' - 79^{\circ}45' \text{ E}$) is a large shallow wetland situated along the western boundary of Puducherry (Figure 1). It is an inter-state lake with the water-spread area almost equally shared between the states of Puducherry and Tamil Nadu. The lake is situated at a distance of 10 km from Puducherry town in the western side on Puducherry-Villupuram-Valuthavur main road. Details on the environmental settings of this lake are listed in Table 1. The lake covers an area of about 800 ha (spread across both Tamil Nadu and Puducherry), of which 390 ha is in Puducherry and the rest in Tamil Nadu (Alexander and Pushparaj 2010). Much of the Oussudu bank along the Tamil Nadu side consists of rural settlements, the Pondicherry side of the lake is predominantly urban or suburban (Abbasi and Chari 2008), causing several stresses on the lake.



Figure 1. Location of Oussudu sanctuary, Puducherry

Table 1. Environmental setting of Oussudu sanctuary

Sl. No.	Particulars	Details
1	Latitude	11°56' - 11°58'
2	Longitude	79°44' - 79°45'
3	Elevation	~15 m above MSL
4	Name of the sub-taluk	Villianur
5	No. and name of the village	29- Oussudu
6	Survey field no.	08
7	Extent & capacity	390 ha – 00A-39Ca.
8	Boundaries	South: Oussudu and Koodappakkam villages West: Ramanathapuram and Thondamanatham villages; and North: Tuthipet and Karasur villages
9	Climatic conditions	Annual Mean Max Temp: 33.1°C Annual Mean Min Temp: 24.1 °C Annual Total Rainfall: 1338 mm
10	Major land use types around the lake	Agriculture, cash crop plantation, human habitation, scrub jungle and water body
11	Nearest highway	State Highway Pondicherry-Thirukkanur-Viluppuram (~35 km SW)
12	Nearest railway station	Puducherry RS (~ 13 km, NW)
13	Nearest airport	Lawspet, Pondicherry (12 ~ km, NW)
14	Nearest port	Chennai (165 ~ km, NE)
15	Nearest major habitation	Villianur (~ km, SW)
16	Nearest major town	Puducherry (10 km, SE)
17	Reserved forests	Nil
18	Historically important places	(Auroville, ~10 km), Pondicherry Museum and Library and Arikamedu (~8 km), Gokilambal Thirukameshwara Temple at Villianur (~ 4 km), Sri Aurobindo Ashram (~10 km), Promenade (~10 km), Lighthouse near the sea (~10 km)
19	Rivers/streams around the lake	Sankarabharani river (~ 2 km, South) and Pennaiyar (~7 km S)
20	Major dams and barrages	Suthukeni barrage (~ 6 km, NW) Vidur dam
21	Other major industries (with distance from the lake in parentheses)	ABC Engineers (~ 1 km) REIL Electricals (~ 1.5 km) Hindustan National Glass & Industries Ltd (~1 km) Sunbeam Generators Pvt Ltd (~0.5 km)
22	Survey of India Topo sheet covering the lake and surroundings	58 M/9
23	Seismic zone	Zone-III

2.2. GEOLOGY AND PHYSIOGRAPHY

Pondicherry is situated along the Coramandel coast and has a geographical area of 293 km². It is a flat monotonous plain, with an average elevation of about 15m above mean sea level. The three major physiographic units present in Pondicherry are i) coastal plain, ii) alluvial plain and iii) uplands (Source: State Ground Water Unit, Dept. Agriculture, Puducherry). The landscape of this area is a product of the Cretaceous, Paleocene, Eocene, Mio-Pliocene, of recent eras (Abbasi and Chari 2008). The geology comprises of charnockite overlain by a cover of sedimentary sequence. The thickness of this sub-horizontal sedimentary cover increases east to southerly up to 600 m near the coast (Krishnan and Srinivasan 1996). The landform of the area are marine, fluvial and fluvio-marine regimes each sustaining individual soil assemblages. Geologically, Oussudu and its surroundings comprise mostly of alluvium, Manaveli clay stone, and Vanur sand stone.

2.3. HYDROLOGY

According to the Tourism Department, the circumference of the lake is 7.275 km. The total catchment area of the lake is 15.54 km². It receives water mainly from Suthukeni check dam through Suthukeni canal and the run-off from the Lake basin. The Suthukeni check dam is constructed across the river Sankarabharani. The major water source for the Suthukeni dam is the excess water from Veedur dam, Viluppuram District of Tamil Nadu state. The hydraulic particulars of the lake as per the records of Public Works Department, Government of Puducherry are provided in Table 2.

The details of the volume of water inflow and outflow (mcft) and the level of water in Oussudu Lake (million m³) from 1999 until 2010 are presented in Appendix 1 and Figure 2, respectively. Figure 2 infers that prior to 2004, the Oussudu lake was a dynamic seasonal wetland that went almost completely dry during the months of June to September. However, the outflow was restricted from year 2004 onwards and the lake has never been dry ever since. This is likely to have affected the lake ecology and has contributed to the accumulation of pollutants including silt and other settled biological matter, and reduced the availability of submerged vegetation

and associated resource base for the migratory birds especially waders.

Table 2. Hydrology and structures associated with Oussudu lake

Sl. No.	Particulars	Details
1	Circumference of the lake	7.275 km
2	Ayacut	15.68 km ²
3	Free catchment area	10.36 km ²
4	Intercepted catchment	5.18 km ²
5	Combined catchment	15.54 km ²
6	Capacity of the lake	540 million cu. ft. (mcft)
7	Average yield	0.169 Mm ³ /km ²
8	Full tank level	+14.184 m
9	Maximum water level	+14.184 m
10	Top bund level	+16.504 m
11	Free board	2.02 m
12	Gross storage	15.29 Mm ³
13	Live storage	15.29 Mm ³
14	Dead storage	Nil
15	Type of bund	Earthen bund
16	Length of bund	727.5 m
17	Side slope (a) font	1.5 : 1
	(b) rear	2 : 1
18	Type of weir	Broad crested weir
19	Length of weir	24.50 m
20	Crest level of weir	+11.894 m
21	Maximum discharge capacity	92.99 cumecs
22	Length of the feeder channel (Suthukeni channel)	10.94 km
23	Discharge capacity of feeder channel	575 cumecs
24	Retention period	6 months 10 days
Source: Tourism Department records, Government of Puducherry; Abbasi and Chari (2008).		

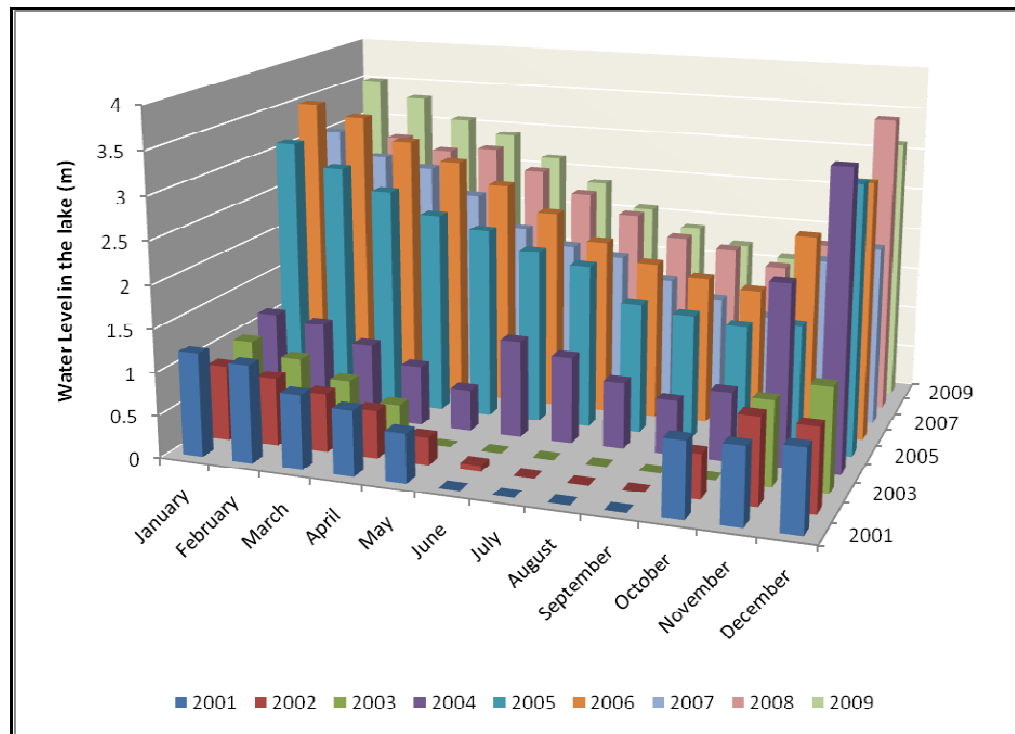


Figure 2. Monthly fluctuation in the water level of Oussudu lake (2001- 2009)

2.4. LAND USE AND LAND COVER

Vast stretches of agricultural fields were seen around the lake, as many of the villagers in the surrounding villages practice agriculture. An assessment on land use and land cover pattern of Puducherry region by Nobi et al. (2009) reveals that agriculture is the major land use followed by settlements and plantation (Figure 3 and Figure 4). Several tanks/ponds, satellite ponds were also seen in the catchment of Oussudu and the list is presented Table 3. Plantations in the catchment area are mainly *Casuarina* sp., and *Cocus nucifera*. The predominant settlements in the region are Villianur, Sedarapet and Katterikuppam, while the rest of the settlements fall under Koodapakkam, Agaram, Karasur and Poothurai. There are two prominent industrial belts near Oussudu lake: the one lying in the Northwestern part of the lake has a glass industry, a rubber industry and a coir industry; while the other located towards the road leading to Oussudu from Puducherry town includes a cosmetic industry, a brewery and a dairy. In toto, 25 industries are presently operating in Puducherry region (Source: Confederation of Indian Industries, Puducherry chapter).

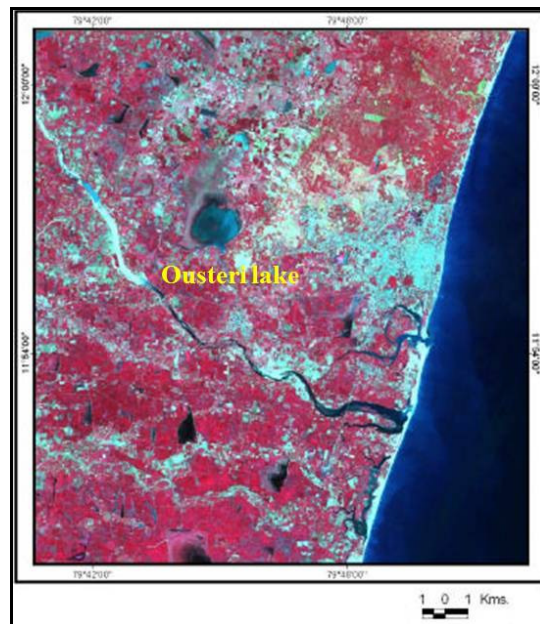


Figure 3. IRS IC LISS III satellite imagery of the study area (Source: Nobi et al. 2009)

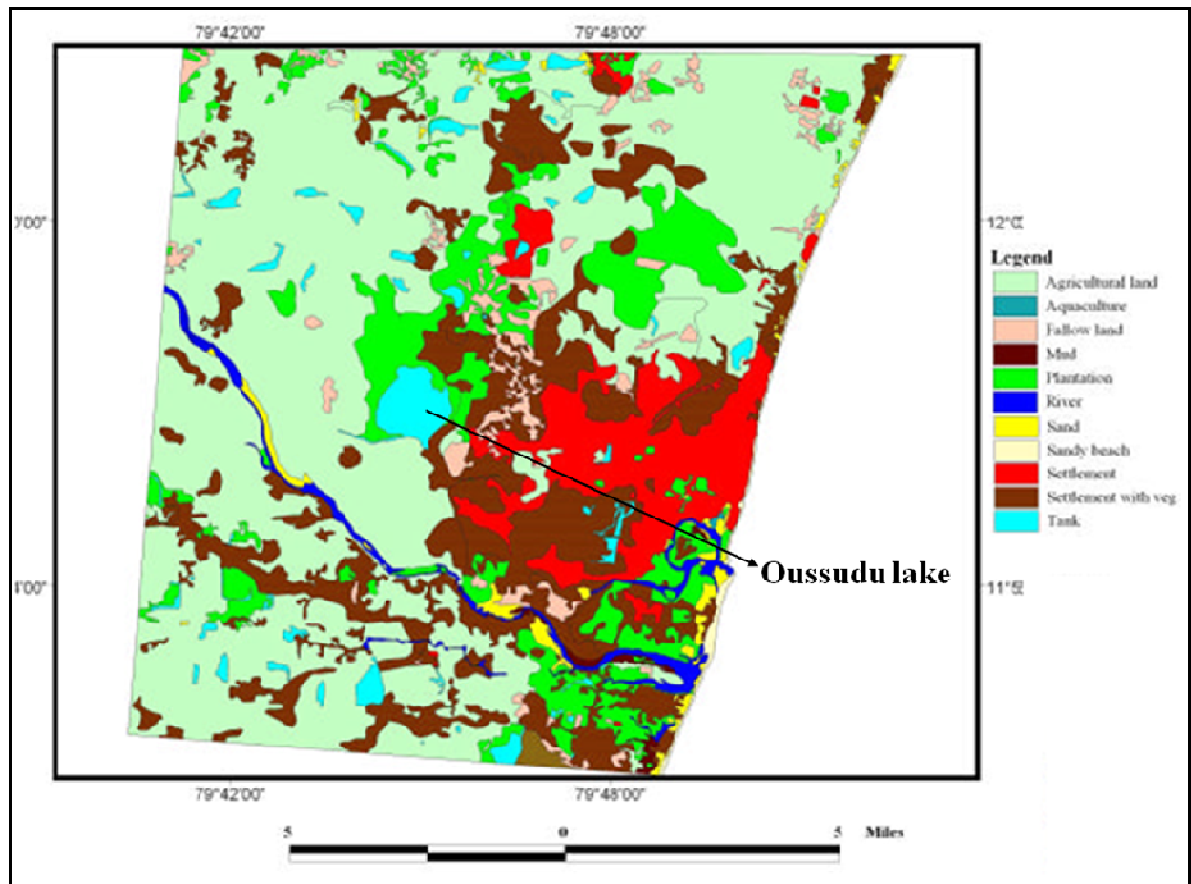


Figure 4. Classified Land use/Land cover map of the study area (Source: Nobi et al. 2009)

Table 3. Major tanks around the Oussudu lake

Sl. No.	Name of the Tank/Eri	Capacity Mm ³
1	Thondamanatham tank	0.34
2	Ariyur tank	0.04
3	Kadaperi eri	0.16
4	Karasur tank	0.34
5	Sedarapet Periya eri	0.42
6	Sedarapet Sitheri	0.13
7	Thuthipet tank	0.27
8	Katteriputhu Thangal	0.12
9	Kateripazham Thangal	0.17

2.5. CLIMATE

The climate of Oussudu watershed is humid. The average annual rainfall of Puducherry region is 1200 mm, of which around 63% occurs during the monsoon season, i.e. from June to September, while the remaining is scattered sporadically throughout the year. The climate is tropical dissymmetric with the bulk of the rainfall during northeast monsoon (October–December). Figure 5 presents the details about annual rainfall in Puducherry region for 14 years (1994-95 to 2007-08). The 14-year average rainfall for Puducherry is 1338 m. The mean number of annual rainy days is 55 and the mean monthly temperature ranges from 21.3°C to 30.2°C. 13-year record of several meteorological variables collected from the Public Works Department, Puducherry (Table 4) reveals that the annual mean temperature in Puducherry ranged between 23.6°C and 33.7°C.

2.6. LIVESTOCK AND ANIMAL HUSBANDRY

Historically the major occupation in villages situated in 5 km radius of Oussudu lake was animal husbandry and agriculture. During the last one decade, drastic change in the land use has resulted in a shift from these activities. Table 5 presents the details of livestock (as per 2007 census) in villages around Oussudu lake.

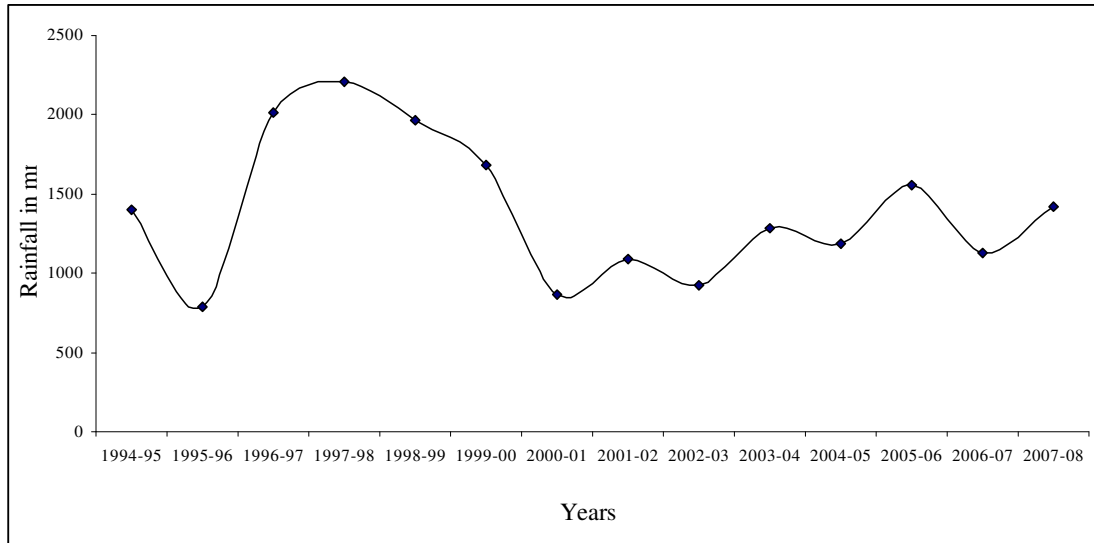


Figure 5. Annual rainfall pattern at Puducherry

Table 4. Annual profile for temperature and relative humidity at Puducherry

Year	Mean Maximum (°C)	Mean Minimum (°C)	Pooled mean (°C)	Relative Humidity	
				8.30 Hrs	17.30 Hrs
1995	33.2	24.6	28.9	77	76
1996	32.3	23.6	28	85	81
1997	32.8	24.0	28.4	84	80
1998	33.4	24.5	29	83	79
1999	33.1	23.8	28.5	84	78
2000	33.2	24.0	28.5	83	77
2001	33.4	24.2	28.8	83	77
2002	33.7	24.1	28.9	79	74
2003	33.6	24.2	28.5	79	72
2004	33.1	23.9	28.5	78	70
2005	33.3	24.4	28.9	79	72
2006	33.4	24.1	28.8	79	71
2007	33.1	24.1	28.6	79	72
Reference year: January to December;					
Source: India Meteorological Department, Chennai					

Table 5. Livestock population in villages within 5 km radius from Oussudu lake

Sl. No.	Village	Total livestock population census (2007)
1.	Sedarapet	473
2.	Karasur	365
3.	Thuthipet	122
4.	Thondamanatham	988
5.	Ramanathapuram	1077
6.	Pilliyarkuppam	882
7.	Koodapakkam	1443
8.	Ulaivakkal	336
9.	Oussudu	1107
10.	Kurumapet	332
11.	Gopalankadai	185
12.	Thavalapet	117
13.	Muthupillaipalayam	196
14.	G.N. Palayam	342
15.	Arasur	186
16.	Villianur	609
Source: 18 th Livestock census, Department of Animal Husbandry and Animal Welfare, Puducherry		

2.7. HUMAN, INDUSTRIAL AND OTHER DEVELOPMENTAL ACTIVITIES AROUND THE LAKE

- The Oussudu lake is surrounded by vast human settlements. The major settlements around the lake are Oussudu, Ramanathapuram, Thondamanatham, Koodappakkam, Thuthipet, Pathukannu, Poraiyur, Agaram, Villianur, Sedarapet and Katterikuppam, Kurambapet, Karasur and Poothurai.
- A medical college cum hospital named Lakshmi Narayana Hospital and Medical College is located in close vicinity of this lake.
- An amusement park called Pogo land is operational on the embankment of

the lake.

- The prominent industries found in the vicinity of Oussudu lake are 1) glass industry, 2) rubber industry, 3) coir industry, 4) cosmetic industry, 5) brewery, 6) dairy, and 7) plastic moulding factory.

2.8. VEGETATION OF THE AREA

The area supports diverse flora rich in rare and endemic elements. It is a monsoonal lake and the northeast monsoon flood the lake during the winter months and until recently goes partially dry during summer months. The vegetation of the area ranges from small herbs to very large trees including many aquatic plants. Large-scale cultivation of paddy was seen around the wetland. Coconut farms are also very common around the lake.

2.9. CURRENT STATUS

In recent times, the lake and its surroundings are exposed to enormous pressures due to the increasing human population, industrialization and urbanization. Oussudu lake has been facing serious threats from multiple fronts such as reclamation, agriculture, siltation, weed invasion and poaching. During the survey period, the lake was infested more towards the periphery by the aquatic weed *Eichornia crassipes* (Water hyacinth) in South-west corner. Earlier, 14% of the water spread area of the lake was covered by *Eichornia crassipes*. Encroachments in the form of rice paddies, land reclamation and plantations are on the rise. Runoff from agricultural fields can add substantial amounts of nitrates and phosphate to the lake waters that stimulates the growth of aquatic macrophytes and planktons, resulting in eutrophication. The ecologically sensitive zones such as roosting areas of birds are located in close proximity of humans. Illegal fishing and poaching of wild birds is frequent in the area. These trends if not checked can soon result in cultural (rapid) eutrophication, siltation, and ultimate death of the lake (Azeez et al. 2008, 2009).

Agricultural activities and urban land use pattern have brought about dramatic ecological changes affecting the quality of Oussudu watershed in terms of direct

destruction of natural habitat, increased nutrient input to the watercourses and the lake through increased erosion, agriculture run-off and waste disposal and increased natural resource utilization such as gravel extraction, firewood harvest and fisheries. Considering the area having adequate ecological, faunal, floral, geomorphological, natural and zoological significance, it was declared as a sanctuary vide GO Ms No. 17.Ag, dated 7th October, 2008 for the purpose of protecting, propagating and developing wildlife and its environment.

The Oussudu lake has been identified as a wetland of national importance under the National Wetland Conservation Programme (NWCP) of Ministry of Environment and Forests (MoEF), New Delhi; and an Important Bird Area (IBA) of India by the Bombay Natural History Society (BNHS), a member of Birdlife International. Over 20,000 birds belonging to nearly 40 species used to inhabit or winter at the lake (Balachandran and Alagarrajan 1995; Jhunjhunwala 1998). The Asian Wetland Bureau declared Oussudu lake as one of the 93 significant wetlands in Asia (Alexander and Pushparaj 2010). The lake has been identified as one of the heritage sites by IUCN (International Union for Conservation of Nature and Natural Resources) and ranked among the most important wetlands of Asia. It is one of the most important fresh water lakes in the Pondicherry region. The structure of the lake is very complex, consisting of water, wetland/marsh and mudflats.

3. METHODOLOGY

The survey and sampling was planned considering the bio-physical and socio-economic environments in and around the lake, and accordingly the management plan was proposed. We collected the secondary information from various line departments of Government of Puducherry and other published research articles and reports. To collect data and information on specific components of the ecological system and pertinent issues, widely used standard scientific methods were adopted. Frequent field surveys were undertaken in the study area during November 2010 to January 2011 for collecting relevant data on various aspects of the lake environment.

3.1. VEGETATION SAMPLING

Vegetation is universally recognized as an integral component of ecosystems that indicates the effects of changing environmental conditions in an obvious and easily measurable manner and is important in site evaluation and classification. Hence, careful analysis of vegetation is very important to know the distribution and types of floral components in an ecosystem. For phytosociological analysis, quadrat method was used in the present study since it is the most widely used technique for plant census.

In total, 25 quadrats of 10 x 10 m size, representing all the vegetation types, were laid to study the flora of the lake and its surrounding area in general, and to estimate the tree density in particular, quadrats. The Girth at Breast Height (GBH) of plants (trees) occurring in the 10 x 10 m plot were recorded. Species with GBH > 20cm were considered as trees. In the middle of each 10 x 10 m quadrat, a quadrat of 3 x 3 m was laid for shrub density estimation. Similarly, a quadrat of 1 x 1 m was laid within the 3 x 3 m quadrat to record the herbaceous species. All the herbaceous species within the 1 x 1 m quadrat were counted and recorded. Species encountered during the vegetation sampling and surveys were recorded. Previous floral studies were documented through literature survey. Taxonomic identification of the species encountered in the field was done referring to the flora of Hooker (1872-97), Gamble and Fischer (1915-1936) and Matthew (1996, 1999). Unidentified plant

specimens were persevered in 10% formaldehyde for identification by experts at the Botanical Survey of India, Coimbatore. Nomenclature used in this report is based on the Flora of Tamil Nadu Series 1 by Nair and Henry (1983), Henry et al. (1987), and Henry et al. (1989).

The vegetation data were analyzed to obtain the quantitative structure and composition of plant communities. For understanding the synthetic characters of the forest vegetation, the species richness and diversity of species in the stands were calculated. The vegetation data were tabulated for frequency, density, abundance, relative frequency, relative density, relative abundance, relative dominance, IVI and composition of plant communities, following Curtis and MC Intosh (1950), Philips (1959), Ludwig and Reynolds (1988) and Lande (1996). The Shannon-Wiener's index of diversity (H') was calculated using the software 'Species diversity and richness (version 2.65, Colwell, 1994-2004, Table 6).

Table 6. Calculating quantitative structure and composition of plant communities

Parameters	Formula adopted
Frequency (%)	(No. of quadrats in which a species occurred/ Total no. of quadrats studied) \times 100
Abundance	Total number of individuals of the species/ No. of quadrats in which the species occurred
Density	Total no. of individuals of a given species/ Total no. of quadrats examined
Relative density	No. of individuals/ No. of individuals of all species
Relative abundance	(Abundance of species \times 100) / Sum of all abundances
Relative frequency	Number of quadrats occurring/ Total no. of quadrats
Basal area	(GBH) ² / 4π
Relative Basal area	(Total basal area of Individuals/ Total basal area of all species) \times 100
Dominance	Total basal area/total area sampled
Relative dominance	Total basal area/ Total basal area of all species
IVI	Relative density + Relative dominance + Relative frequency

3.2. FAUNAL SAMPLING

Various groups of animals found in the study area were recorded by both direct and indirect methods during the present study period. Different sampling techniques were applied to record different faunal groups in the study area. Animals documented in the present study include butterflies, fishes, amphibians, reptiles, birds and mammals.

The following sampling techniques were used for the study of various fauna during the present study period are given in the Table 7.

Table 7. Sampling techniques used for the faunal study

Taxa	Sampling Methods
Butterflies	Random walk, opportunistic observations
Amphibians	Visual encounter survey (search)
Reptiles	Visual encounter survey (search)
Birds	Random walk, opportunistic observations
Mammals	Tracks and signs, and visual encounter survey

3.2.1. Butterflies

The butterflies in and around the wetland were documented by direct observations, random walk and opportunistic observations, during morning (06:00 to 10:00 hrs) and evening (17:00 to 19:00 hrs) hours, by using a pair of binoculars. Butterfly survey was carried out by looking at 5 m distance on either side of the transect. The identification of butterflies was done following Gunathilagaraj et al. (1998), Kunte (2000) and Kehimkar (2008). Larsen (1987a, b & c, 1988) was referred for correct scientific nomenclatures of butterflies. The quantification of butterflies were done by using line transect method by covering all sides of the lakes and its environs. The length and numbers of one kilometre transects were selected based on topography, vegetation physiognomy and the availability of the area.

3.2.2. Avifauna

The avifauna in and around the study site were documented by direct observations, random walk and opportunistic observations, during morning (06:00 to 10:00 hrs) and evening (17:00 to 19:00 hrs) hours by using a pair of binoculars. Avifaunal community was recorded and quantification was done using 1 km Line transect method (Bibby et al. 1992) covering all sides of the lakes and its environs. In total, 11 line transects were laid based on topography, vegetation physiognomy and the availability of the area. Based on the visibility, the search was done on both sides of the transect with the help of 10x50 mm field binoculars. Ali and Ripley (1987) and Grimmett et al. (1998, 2000, 2001) were referred for the identification of birds. Grimmett et al. (1998, 2000, 2001) were followed for nomenclature.

3.2.3. Herpetofauna

Visual Encounter Survey (VES, search) was followed to document herpetofauna (amphibians and reptiles) in the wetland and its environs. VES is a method one in which field personnel walks through an area or habitat for a prescribed time systematically looking for animals. During the survey leaf litter, fallen logs, trees (bark, buttress, root and holes), shrubs, boulders, rocks and rock crevices were examined. The identification of herpetofauna was done with the help of Boulenger (1890), Daniel and Sekar (1989), Daniel (1963, 1975, 1992 & 2002), Daniels (1997 a & b, 2005), Das (2003), Whitaker and Captain (2004).

3.2.4. Mammals

Both direct and indirect methods (tracks and signs, and visual encounter survey) were applied to get an overall view on mammals present in the area. Indirect evidences such as pugmarks, calls, signs and scats were identified by following Bang et al. (1972), Burnham et al. (1980) and Heyer et al. (1994). Nomenclature by Menon (2003) is followed in this report.

3.2.5. Ichthyofauna

Fish specimens were collected using monofilamentous gill nets, cast nets and drag nets wherever applicable. Fish species reaching the market from fish catchers of local fisher folk around the Oussudu Lake were also included in the list. Fishes caught were released after identification. Fish identification was based on Talwar and Jhingran (1991) and Jayaram (1999). The status of fish species was assigned based on IUCN categorization.

3.3. SOCIO-ECONOMIC SURVEY

A socio-economic survey was conducted in the villages located within the 5 km radial distance from the Oussudu lake to find out the people's opinions about its status and importance. Customized questionnaire was prepared (Appendix 2) to obtain information about the socio-economic standards of villagers around the lake and their perception and suggestion for improving the lake environment. Data on several socio-economic parameters were collected at household level using both open and close-ended questionnaire. This aided in obtaining information about villagers, their perception and attitude towards Oussudu lake, its surrounding, and their views for conserving the lake. Several issues such as alternate livelihood options to engage villagers in different activities, which would encourage them to stop poaching, hunting birds, and participate in conservation programme were discussed. This helped in preparing an environmental management plan where the immediate stakeholders - the villagers, can be engaged.

4. ECOLOGICAL OBSERVATIONS

4.1. BIODIVERSITY OF THE LAKE

4.1.1. Floral Analysis

In the study area, Oussudu lake and its environs, 480 plant species belonging to 317 genera and spreading over 92 families were documented (Appendix 3). Among the 480 species, herbaceous plants were dominant with 191 species (41%) followed by trees with 103 species (21%), shrubs 63 species (13%), stragglers were 20 species (4%), climbers 40 species (8%) and grasses 63 species (13%) excluding *Bambusa arundinacea*, which is included under trees due to its arborescent nature (Figure 6). Of the 92 plant families recorded from the study area, Poaceae is the dominant family and it is represented by 64 species followed by Fabaceae (30 species), Euphorbiaceae, Cyperaceae and Caesalpiniaceae with 28, 24 and 19 species each, respectively (Figure 7). Among the 317 genera recorded from the study area, *Cyperus* is the dominant genera with 12 species followed by *Cassia* (9 species), *Fimbristylis* (8 species), *Acacia* and *Phyllanthus* with 7 species each and *Justicia* (5 species, Figure 8).

The major trees recorded around the lake were *Acacia auriculiformis*, *Azadirachta indica*, *Bombax ceiba*, *Borassus flabellifer*, *Ceiba pentandra*, *Dalbergia paniculata*, *Ficus benghalensis*, *F. religiosa*, *Gmelina arborea*, *Khaya senegalensis*, *Lannea coromandelica*, *Morinda tinctoria*, *Peltophorum pterocarpum*, *Phoenix sylvestre*, *Pongamia pinnata*, *Prosopis juliflora*, *Samanea saman*, *Spathodea campanulata*, *Syzygium cumini*, *Tamarindus indicus*, *Terminalia arjuna* and *Thespesia populnea*. The palm, *Borassus flabellifer* was commonly seen in all sides of the lake.

The shrub such as *Abutilon hirtum*, *A. indicum*, *Barleria cristata*, *Calotropis gigantea*, *Cassia auriculata*, *Ficus hispida*, *Fluggea leucopyrus*, *Jatropha gossypifolia*, *J. tanjorensis*, *Lantana camara*, *Pavetta indica*, *Phoenix laurieri*, *Plumbago zeylanica*, *Randia malabarica*, *Rauvolfia tetraphylla* and *Ziziphus oenoplia* were commonly seen all around the lake.

Acalypha indica, *Alysicarpus monilifer*, *Achyranthes aspera*, *Borreria ocymoides*, *Clitoria ternatea*, *Commelina benghalensis*, *C. longifolia*, *Corchorus tridens*, *Cyperus rotundus*, *Desmodium triflorum*, *Euphorbia hirta*, *Justicia procumbens*, *Parthenium hysterophorus*, *Phyllanthus maderaspatensis*, *Pseudarthria viscid*, *Pupalia lappacea*, *Ruellia patula* and *Tridax procumbens* were the major herbaceous plants recorded in the study area.

The common climbers/stragglers recorded in and around the study area were *Cardiospermum halicacabum*, *Cissus trifolia*, *C. vitigena*, *Oxystelma esculentum*, *Passiflora foetida*, *Pergularia daemia*, *Tiliacora acuminata*, *Toddalia asiatica*, *Tragia involucrata*, *T. plukenetii*, *Tylophora benthamii* and *Wattakaka volubilis*.

The following grasses viz., *Andropogon pumilus*, *Apluda mutica*, *Arundo donax*, *Bothriochloa pertusa*, *Chloris barbata*, *Chrysopogon asper*, *Cynodon dactylon*, *Eleusine indica*, *Eragrostis amabilis*, *Oplismenus composites*, *Saccharum spontaneum* and *Setaria pumila* were commonly seen in the study area.

The major hydrophytes observed during the present study period were *Aponogeton natans*, *Ceratophyllum demersum*, *Ceratopteris thalictroides*, *Cyperus* spp., *Eichornia crassipes*, *Fimbristylis* spp., *Hydrilla verticillata*, *Ipomoea carnea*, *Lemna minor*, *Najas minor*, *Nelumbo nucifera*, *Nymphaea nouchalii*, *Ottelia alismoides*, *Polygonum glabrum*, *P. hydropiper*, *Pistia stratioides*, *Salvinia molesta*, *Typha angustata*, *Vallisneria spiralis*, *Vetiveria zizanioides*, and Among them, species such as *Ceratophyllum demersum*, *Hydrilla verticillata*, *Najas minor* and *Nelumbo nucifera* were the major aquatic weeds and were distributed throughout the lake and the rest were seen along the periphery of the lake only.

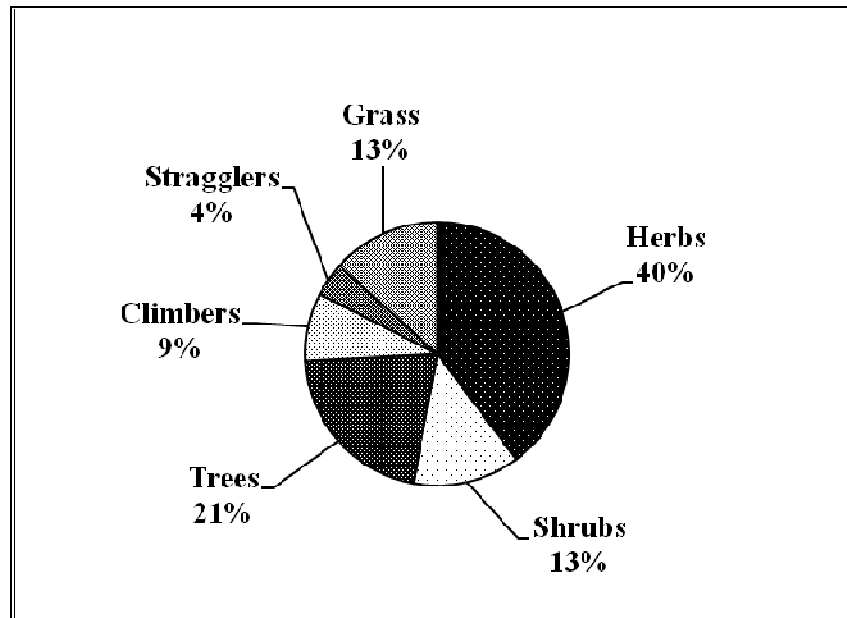


Figure 6. Habit wise representation of plants recorded in the study area

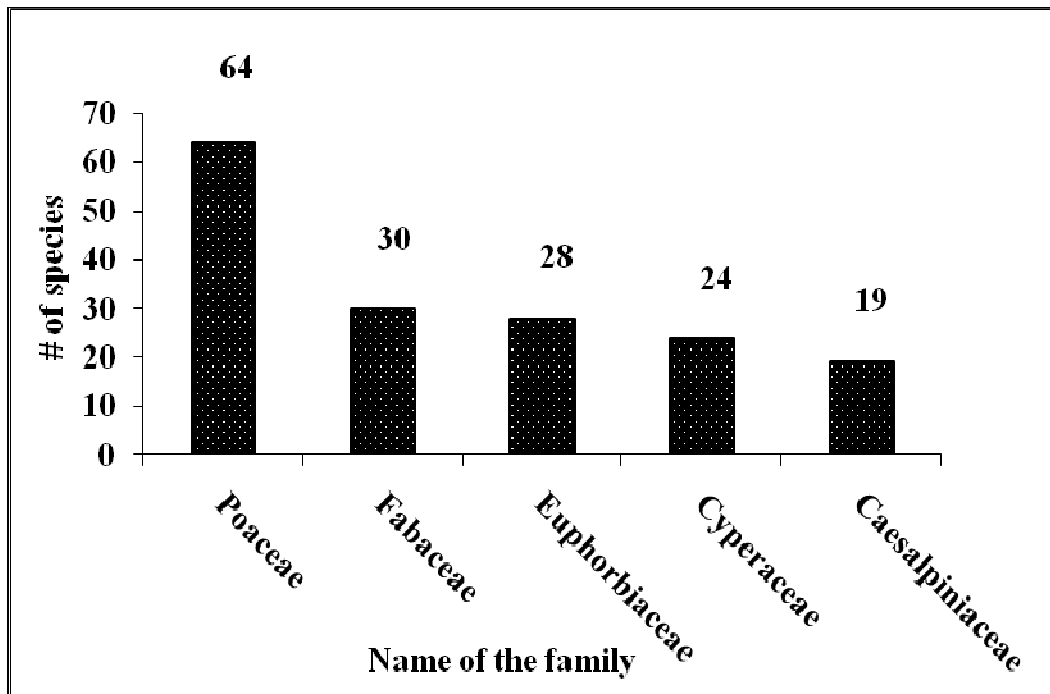


Figure 7. Dominant plant families observed in the study area

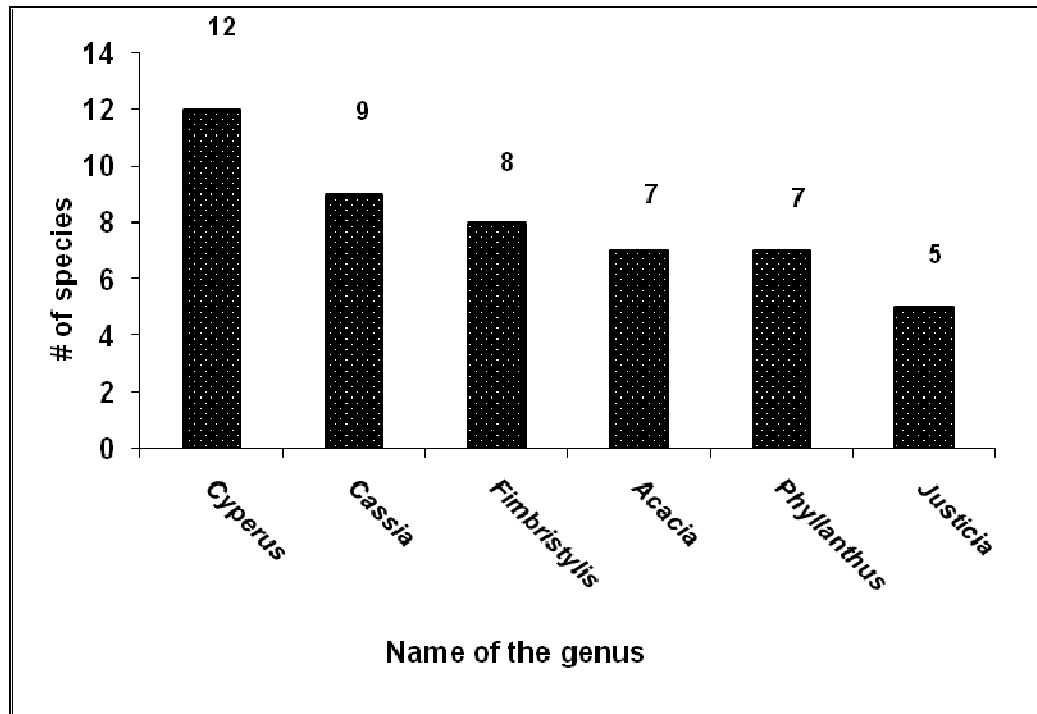


Figure 8. Dominant plant genera in the study area

Endemic plants

Of the 480 plant species recorded during the present survey, 11 species are endemic (*Andropogon pumilus*, *Asystasia dalzelliana*, *Barleria acuminata*, *Cynodon barberii*, *Drypetes roxburghii*, *Iseilema antheophoroides*, *Jatropha tanjorensis*, *Maba buxifolia*, *Phyllanthus rotundifolia*, *Sarcostemma brunonianum* and *S. intermedium*) and distributed only in the Indian subcontinent (Henry et al. 1978, Ahmedullah and Nayar 1987, Nayar 1996). Among them, only one species i.e. *Jatropha tanjorensis* has restricted distribution along the Coromandel coastal plains. *Phyllanthus rotundifolia* is distributed in the coastal regions of Tamil Nadu, Andhra Pradesh and Kerala.

Endangered/threatened IUCN red listed medicinal plants

Among the 480 plant species, 20 different species (*Acacia chundra*, *Achyranthes bidentata*, *Aegle marmelos*, *Aristolochia indica*, *Buchanania axillaris*, *Cadaba indica*, *Cassine glauca*, *Celastrus paniculatus*, *Crateva magna*, *Enicostemma littorale*, *Hemedesmus indicus*, *Hugonia mystax*, *Justicia gendarussa*, *Kedrostis foetidissima*, *Plumbago zeylanica*, *Pseudarthria viscida*, *Salacia chinensis*, *Santalum album*, *Semecarpus anacardium* and *Terminalia arjuna*) are categorized under

rare/endangered/threatened/vulnerable red listed medicinal plants category. Nevertheless, these are also not limited to the study area and have a wider distribution.

Phytosociology

Tree, shrub, herb community structure

In total, 150 trees belonging to 27 species, 24 genera spread over 16 families were recorded in the study area. The tree community parameters, computed from the data are presented in Table 8. *Borassus flabellifer* was represented by maximum number of individuals ($n = 44$) followed by *Azadirachta indica* ($n = 30$) and *Pongamia pinnata* ($n = 10$). Highest density was recorded for *Borassus flabellifer* (1.76/ha) followed by *Azadirachta indica* (1.2/ha) and *Samanea saman* (0.32/ha). In terms of relative density highest value was recorded for *Borassus flabellifer* (29.33) followed by *Azadirachta indica* (20.00) and *Pongamia pinnata* (6.67). The Shannon-Weiner diversity for tree community was 2.5202. The highest Important Value Index (IVI) was recorded for *Borassus flabellifer* (53.61) followed by *Azadirachta indica* (42.11) and *Pongamia pinnata* (18.30).

A total number of 615 individuals belonging to 50 shrub species, 47 genera and spread over 29 families were recorded in the study area. The shrub community parameters are given in Table 9. Among the 50 species, *Morinda tinctoria* was seen in highest number ($n = 103$) followed by *Ficus hispida* ($n = 67$) and *Rauvolfia tetraphylla* ($n = 45$). Highest density was recorded for *Morinda tinctoria* (4.12/ha) followed by *Ficus hispida* (2.68/ha) and *Rauvolfia tetraphylla* (1.80/ha). Likewise, the highest relative density was estimated for *Morinda tinctoria* (16.75) followed by *Ficus hispida* (10.89) and *Rauvolfia tetraphylla* (7.32). The Shannon-Weiner diversity for shrub community in total was 3.2607. Among the various shrubs recorded during the study period, the highest Important Value Index (IVI) was recorded for *Morinda tinctoria* (31.48) followed by *Ficus hispida* (21.42), *Rauvolfia tetraphylla* (16.01).

A total of 1430 individuals belonging to 54 herb species, 47 genera and spread over 20 families were recorded in and around the lake (Table 10), of which the grass *Cynodon dactylon* was represented by highest number of individuals ($n = 324$) followed by *Cyperus rotundus* ($n = 238$) and *Ruellia patula* ($n = 204$). The highest density was estimated for *Cynodon dactylon* (12.96/ha) followed by *Cyperus rotundus* (9.52/ha) and *Ruellia patula* (8.16/ha). The highest relative density value was recorded for *Cynodon dactylon* (22.66) followed by *Cyperus rotundus* (16.64) and *Ruellia patula* (14.27). The Shannon-Weiner diversity observed for herbaceous community in the area is 2.7103. The highest Important Value Index (IVI) value was recorded for *Cynodon dactylon* (40.96) followed by *Cyperus rotundus* (31.32) and *Ruellia patula* (28.15).

Table 8. Tree community parameters in the present study area

Plant Species	N	Qn	GBH	F	A	D	RF	RA	RD	BA	Do	RDo	IVI
<i>Acacia auriculiformis</i>	1	1	1.48	4	1.00	0.04	1.32	2.53	0.67	0.2	0.00	0	4.51
<i>Acacia nilotica</i>	1	1	0.6	4	1.00	0.04	1.32	2.53	0.67	0.0	0.00	0	4.51
<i>Aegle marmelos</i>	1	1	0.35	4	1.00	0.04	1.32	2.53	0.67	0.0	0.00	0	4.51
<i>Albizia lebbbeck</i>	1	1	0.95	4	1.00	0.04	1.32	2.53	0.67	0.1	0.00	0	4.51
<i>Azadirachta indica</i>	30	12	19.46	48	2.50	1.2	15.79	6.32	20.00	30.1	0.01	5	42.11
<i>Bombax ceiba</i>	1	1	1.52	4	1.00	0.04	1.32	2.53	0.67	0.2	0.00	0	4.51
<i>Borassus flabellifer</i>	44	10	38.17	40	4.40	1.76	13.16	11.12	29.33	115.9	0.05	19	53.61
<i>Cassia fistula</i>	2	2	0.74	8	1.00	0.08	2.63	2.53	1.33	0.0	0.00	0	6.49
<i>Ceiba pentandra</i>	6	4	30.74	16	1.50	0.24	5.26	3.79	4.00	75.2	0.03	12	13.05
<i>Delonix regia</i>	6	3	8.36	12	2.00	0.24	3.95	5.05	4.00	5.6	0.00	1	13.00
<i>Ficus benghalensis</i>	3	2	64.23	8	1.50	0.12	2.63	3.79	2.00	328.1	0.13	53	8.42
<i>Fiucs religiosa</i>	2	2	6.06	8	1.00	0.08	2.63	2.53	1.33	2.9	0.00	0	6.49
<i>Khaya senegalensis</i>	3	3	5.15	12	1.00	0.12	3.95	2.53	2.00	2.1	0.00	0	8.47
<i>Lannea coromandelica</i>	2	2	3.06	8	1.00	0.08	2.63	2.53	1.33	0.7	0.00	0	6.49
<i>Madhuca longifolia</i>	1	1	0.95	4	1.00	0.04	1.32	2.53	0.67	0.1	0.00	0	4.51
<i>Millingtonia hortensis</i>	1	1	0.91	4	1.00	0.04	1.32	2.53	0.67	0.1	0.00	0	4.51
<i>Morinda tinctoria</i>	4	2	0.93	8	2.00	0.16	2.63	5.05	2.67	0.1	0.00	0	10.35
<i>Peltophorum pterocarpum</i>	4	3	7.45	12	1.33	0.16	3.95	3.37	2.67	4.4	0.00	1	9.98
<i>Phoenix sylvestre</i>	1	1	0.7	4	1.00	0.04	1.32	2.53	0.67	0.0	0.00	0	4.51
<i>Pongamia pinnata</i>	10	5	11.94	20	2.00	0.4	6.58	5.05	6.67	11.3	0.00	2	18.30
<i>Samanea saman</i>	8	6	21.08	24	1.33	0.32	7.89	3.37	5.33	35.3	0.01	6	16.60
<i>Spathodea campanulata</i>	1	1	2.04	4	1.00	0.04	1.32	2.53	0.67	0.3	0.00	0	4.51
<i>Sterculia foetida</i>	3	2	2.66	8	1.50	0.12	2.63	3.79	2.00	0.6	0.00	0	8.42
<i>Syzygium cuminii</i>	2	2	1.89	8	1.00	0.08	2.63	2.53	1.33	0.3	0.00	0	6.49
<i>Tamarindus indicus</i>	3	2	7.92	8	1.50	0.12	2.63	3.79	2.00	5.0	0.00	1	8.42
<i>Tectona grandis</i>	6	2	6.38	8	3.00	0.24	2.63	7.58	4.00	3.2	0.00	1	14.21
<i>Thespesia populnea</i>	3	3	2.79	12	1.00	0.12	3.95	2.53	2.00	0.6	0.00	0	8.47

Where: N = Number of Individuals, Qn = Number of Quadrats where the species occur, GBH = Girth at Breast Height in meters, F = Frequency in percentage, A = Abundance, Den = Density, RF = Relative Frequency, RA = Relative Abundance, RD = Relative Density, BA = Basal Area, Do = Dominance, RDo = Relative Dominance, IVI = Importance Value Index.

Table 9. Shrub community structure in the study area

Name of the Species	N	Qn	F	A	D	RF	RA	RD	IVI
<i>Abutilon hirtum</i>	35	6	24	5.83	1.4	3.35	4.03	5.69	13.08
<i>Abutilon indicum</i>	44	6	24	7.33	1.76	3.35	5.07	7.15	15.58
<i>Arundo donax</i>	13	2	8	6.50	0.52	1.12	4.49	2.11	7.72
<i>Azadirachta indica</i>	30	12	48	2.50	1.2	6.70	1.73	4.88	13.31
<i>Barleria cristata</i>	14	1	4	14.00	0.56	0.56	9.68	2.28	12.51
<i>Bombax ceiba</i>	8	2	8	4.00	0.32	1.12	2.77	1.30	5.18
<i>Borassus flabellifer</i>	12	5	20	2.40	0.48	2.79	1.66	1.95	6.40
<i>Cadaba indica</i>	4	4	16	1.00	0.16	2.23	0.69	0.65	3.58
<i>Calotropis gigantea</i>	8	5	20	1.60	0.32	2.79	1.11	1.30	5.20
<i>Calotropis procera</i>	4	2	8	2.00	0.16	1.12	1.38	0.65	3.15
<i>Cardiospermum halicacabum</i>	3	1	4	3.00	0.12	0.56	2.07	0.49	3.12
<i>Cassia fistula</i>	1	1	4	1.00	0.04	0.56	0.69	0.16	1.41
<i>Coccinia grandis</i>	4	4	16	1.00	0.16	2.23	0.69	0.65	3.58
<i>Elatostema</i> sp.	5	2	8	2.50	0.2	1.12	1.73	0.81	3.66
<i>Feronia elephantum</i>	1	1	4	1.00	0.04	0.56	0.69	0.16	1.41
<i>Ficus hispida</i>	67	7	28	9.57	2.68	3.91	6.62	10.89	21.42
<i>Ficus religiosa</i>	4	1	4	4.00	0.16	0.56	2.77	0.65	3.97
<i>Fluggea leucopyros</i>	5	4	16	1.25	0.2	2.23	0.86	0.81	3.91
<i>Glycosmis pentaphylla</i>	2	2	8	1.00	0.08	1.12	0.69	0.33	2.13
<i>Gmelina arborea</i>	2	2	8	1.00	0.08	1.12	0.69	0.33	2.13
<i>Hyptis suaveolens</i>	4	2	8	2.00	0.16	1.12	1.38	0.65	3.15
<i>Jasminum rigidum</i>	1	1	4	1.00	0.04	0.56	0.69	0.16	1.41
<i>Jatropha gossypifolia</i>	7	2	8	3.50	0.28	1.12	2.42	1.14	4.68
<i>Lannea coromandelica</i>	1	1	4	1.00	0.04	0.56	0.69	0.16	1.41
<i>Lantana camara</i>	27	11	44	2.45	1.08	6.15	1.70	4.39	12.23
<i>Luffa aegyptiaca</i>	1	1	4	1.00	0.04	0.56	0.69	0.16	1.41
<i>Madhuca longifolia</i>	2	1	4	2.00	0.08	0.56	1.38	0.33	2.27
<i>Millingtonia hortensis</i>	2	1	4	2.00	0.08	0.56	1.38	0.33	2.27
<i>Mitragyna parvifolia</i>	2	1	4	2.00	0.08	0.56	1.38	0.33	2.27
<i>Morinda tinctoria</i>	103	20	80	5.15	4.12	11.17	3.56	16.75	31.48
<i>Mukia maderaspatana</i>	5	4	16	1.25	0.2	2.23	0.86	0.81	3.91
<i>Pavetta indica</i>	10	3	12	3.33	0.4	1.68	2.30	1.63	5.61
<i>Pentatropis microphylla</i>	1	1	4	1.00	0.04	0.56	0.69	0.16	1.41
<i>Pergularia daemea</i>	1	1	4	1.00	0.04	0.56	0.69	0.16	1.41
<i>Phoenix sylvestris</i>	9	4	16	2.25	0.36	2.23	1.56	1.46	5.25
<i>Phyllanthus reticulatus</i>	3	2	8	1.50	0.12	1.12	1.04	0.49	2.64
<i>Pithecellobium dulce</i>	6	4	16	1.50	0.24	2.23	1.04	0.98	4.25
<i>Plumbago zeylanica</i>	14	6	24	2.33	0.56	3.35	1.61	2.28	7.24
<i>Pongamia pinnata</i>	24	4	16	6.00	0.96	2.23	4.15	3.90	10.29
<i>Prosopis juliflora</i>	10	4	16	2.50	0.4	2.23	1.73	1.63	5.59
<i>Rauvolfia tetraphylla</i>	45	10	40	4.50	1.8	5.59	3.11	7.32	16.01
<i>Samanea saman</i>	5	3	12	1.67	0.2	1.68	1.15	0.81	3.64
<i>Solanum trilobatum</i>	17	5	20	3.40	0.68	2.79	2.35	2.76	7.91
<i>Spathodea campanulata</i>	2	1	4	2.00	0.08	0.56	1.38	0.33	2.27
<i>Tamarindus indicus</i>	6	2	8	3.00	0.24	1.12	2.07	0.98	4.17
<i>Tectona grandis</i>	2	1	4	2.00	0.08	0.56	1.38	0.33	2.27
<i>Tiliacora acuminata</i>	17	4	16	4.25	0.68	2.23	2.94	2.76	7.94
<i>Tragia plukenetii</i>	2	1	4	2.00	0.08	0.56	1.38	0.33	2.27
<i>Tylophora benthamii</i>	2	1	4	2.00	0.08	0.56	1.38	0.33	2.27

<i>Ziziphus oenoplia</i>	18	7	28	2.57	0.72	3.91	1.78	2.93	8.62
Where: N= Number of Individuals; Qn= Number of Quadrats where the species occur; F-Frequency in percentage; A-Abundance; D-Density; RF-Relative Frequency; RA-Relative Abundance; RD-Relative Density; IVI-Importance Value Index.									

Table 10. Herbaceous community parameters in the present study area

Name of the Species	N	Qn	F	A	D	RF	RA	RD	IVI
<i>Acalypha indica</i>	27	8	32	3.38	1.08	4.62	1.14	1.89	7.65
<i>Achyranthes aspera</i>	63	15	60	4.20	2.52	8.67	1.42	4.41	14.49
<i>Achyranthes bidentata</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99
<i>Alternanthera paronychioides</i>	21	1	4	21.00	0.84	0.58	7.09	1.47	9.14
<i>Alysicarpus monilifer</i>	3	2	8	1.50	0.12	1.16	0.51	0.21	1.87
<i>Boerhaavia diffusa</i>	2	1	4	2.00	0.08	0.58	0.68	0.14	1.39
<i>Borreria ocymoides</i>	2	2	8	1.00	0.08	1.16	0.34	0.14	1.63
<i>Bothriochloa pertusa</i>	14	2	8	7.00	0.56	1.16	2.36	0.98	4.50
<i>Brachiaria ramosa</i>	4	3	12	1.33	0.16	1.73	0.45	0.28	2.46
<i>Brachiaria remota</i>	110	4	16	27.50	4.4	2.31	9.29	7.69	19.29
<i>Chloris barbata</i>	29	6	24	4.83	1.16	3.47	1.63	2.03	7.13
<i>Cleome viscosa</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99
<i>Clitoria ternatea</i>	52	8	32	6.50	2.08	4.62	2.20	3.64	10.46
<i>Commelina benghalensis</i>	6	1	4	6.00	0.24	0.58	2.03	0.42	3.02
<i>Commelina longifolia</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99
<i>Corchorus tridens</i>	2	2	8	1.00	0.08	1.16	0.34	0.14	1.63
<i>Croton sparsiflorus</i>	16	7	28	2.29	0.64	4.05	0.77	1.12	5.94
<i>Cynodon dactylon</i>	324	8	32	40.50	12.96	4.62	13.68	22.66	40.96
<i>Cynotis axillaris</i>	2	1	4	2.00	0.08	0.58	0.68	0.14	1.39
<i>Cyperus rotundus</i>	238	8	32	29.75	9.52	4.62	10.05	16.64	31.32
<i>Dactyloctenium aegyptium</i>	75	5	20	15.00	3	2.89	5.07	5.24	13.20
<i>Desmodium triflorum</i>	26	2	8	13.00	1.04	1.16	4.39	1.82	7.36
<i>Digera muricata</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99
<i>Echinocolana colona</i>	6	4	16	1.50	0.24	2.31	0.51	0.42	3.24
<i>Eleusine indica</i>	3	1	4	3.00	0.12	0.58	1.01	0.21	1.80
<i>Eragrostis amabilis</i>	3	2	8	1.50	0.12	1.16	0.51	0.21	1.87
<i>Eragrostis viscosa</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99
<i>Euphorbia hirta</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99
<i>Evolvulus nummularius</i>	38	2	8	19.00	1.52	1.16	6.42	2.66	10.23
<i>Gomphrena decumbens</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99
<i>Hybanthus enneaspermus</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99
<i>Indigofera</i> sp.	4	2	8	2.00	0.16	1.16	0.68	0.28	2.11
<i>Ipomoea pescarpae</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99
<i>Justicia procumbens</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99
<i>Justicia simplex</i>	11	1	4	11.00	0.44	0.58	3.72	0.77	5.06
<i>Malvastrum coromandelianum</i>	4	1	4	4.00	0.16	0.58	1.35	0.28	2.21
<i>Oldenlandia umbellata</i>	2	1	4	2.00	0.08	0.58	0.68	0.14	1.39
<i>Oplismenus compositus</i>	7	2	8	3.50	0.28	1.16	1.18	0.49	2.83
<i>Panicum psilopodium</i>	2	1	4	2.00	0.08	0.58	0.68	0.14	1.39
<i>Parthenium hysteroporus</i>	4	2	8	2.00	0.16	1.16	0.68	0.28	2.11
<i>Paspalum scrobiculatum</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99
<i>Pavonia procumbens</i>	15	4	16	3.75	0.6	2.31	1.27	1.05	4.63
<i>Pentatropis microphylla</i>	1	1	4	1.00	0.04	0.58	0.34	0.07	0.99

<i>Phyllanthus amarus</i>	10	3	12	3.33	0.4	1.73	1.13	0.70	3.56
<i>Phyllanthus maderaspatensis</i>	9	3	12	3.00	0.36	1.73	1.01	0.63	3.38
<i>Polycarpon prostratum</i>	2	2	8	1.00	0.08	1.16	0.34	0.14	1.63
<i>Pseudarthria viscida</i>	23	6	24	3.83	0.92	3.47	1.29	1.61	6.37
<i>Pupalia lappacea</i>	9	3	12	3.00	0.36	1.73	1.01	0.63	3.38
<i>Rhyncosia minima</i>	7	2	8	3.50	0.28	1.16	1.18	0.49	2.83
<i>Rhyncosia minima</i>	5	2	8	2.50	0.2	1.16	0.84	0.35	2.35
<i>Ruellia patula</i>	204	17	68	12.00	8.16	9.83	4.05	14.27	28.15
<i>Setaria pumila</i>	2	1	4	2.00	0.08	0.58	0.68	0.14	1.39
<i>Sida acuta</i>	12	5	20	2.40	0.48	2.89	0.81	0.84	4.54
<i>Vernonia cinerea</i>	20	8	32	2.50	0.8	4.62	0.84	1.40	6.87

Where: N= Number of Individuals; Qn= Number of Quadrats where the species occur; F-Frequency in percentage; A-Abundance; D-Density; RF-Relative Frequency; RA-Relative Abundance; RD-Relative Density; IVI-Importance Value Index.

4.1.2. Faunal Analysis

Butterflies

63 butterfly species belonging to 46 genera and spread over 5 families were recorded during the present survey (Appendix 4). At family level, the family Nymphalidae is the dominant one with 21 species (34%) followed by Pieridae with 14 species (22%) and Lycaenidae 10 species (16%, Figure 9). Species such as Chocolate pansy, Common Jezebel, Plain Tiger, Danaid Eggfly, Common Crow, Lime Butterfly and Common Grass Yellow were commonly seen around the sanctuary. Of the 63 species, few butterflies fall under rare/threatened and endemic category. Crimson Rose, Danaid Eggfly and Common Pierrot are protected under schedule - I of Indian Wildlife Protection Act 1972 (WPA 1972). Common Gull is included under scheduled - II and Common Crow under schedule - IV of the Act. Double-banded crow, Blue Mormon, Crimson rose and Common-banded peacock are endemic species found occurring in and around the lake, the distributions of which are restricted to the Peninsular India (Kunte 2000).

Line transect survey resulted in the documentation and identification of 49 butterfly species spread over five families (Table 11). Of the 49 species, the Chocolate Pansy is the dominant one with 306 individuals followed by Common Jezebel (n=188), Small Grass Yellow, Common Grass Yellow with 169 individuals each.

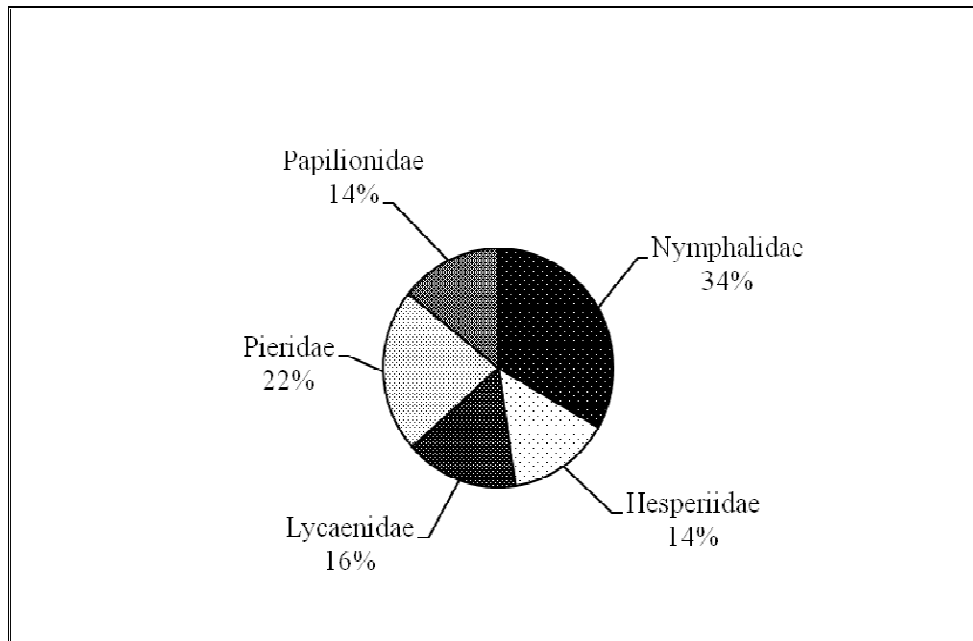


Figure 9. Dominant butterfly families observed in and around Oussudu lake

Table 11. Cumulative butterfly counts around Oussudu sanctuary during November - February 2011

Name of the Species	Number of Individuals
Common Jezebel	188
Chocolate Pansy	306
Angled Castor	10
Danaid Eggfly	83
Striped Tiger	62
Common Evening Brown	22
Blue Mormon	40
Plain Tiger	70
Small Grass Yellow	169
Common Castor	53
Crimson Rose	54
Lime Butterfly	52
Dark Blue Tiger	46
Common Crow	130
Common Rose	58

Name of the Species	Number of Individuals
Glassy Tiger	16
Lemon Pansy	41
Tawny Coster	53
Psyche	86
Common Pierrot	94
Common Gull	46
Common Sailer	118
Mottled Emigrant	83
Common Mormon	94
Common Emigrant	68
Common Leopard	32
Common Wanderer	150
Rice Swift	9
Common Grass Dart	59
Common Grass Yellow	169
Zebra Blue	15
Common Cerulean	10
Banded Blue Pierrot	3
Common Sergeant	7
Tiny Grass Blue	8
Crimson Tip	19
Common Jay	17
Common Bush Brown	34
Great Orange Tip	20
Yellow Orange Tip	31
Dark Cerulean	12
Plains Cupid	11
African Babul Blue	3
Southern Birdwing	6
Small Orange Tip	13
Chestnut Bob	14

Name of the Species	Number of Individuals
Peacock Pansy	3
Tailed Jay	2
Great Eggfly	4

Avifauna

166 species of birds belonging to 47 families around the Oussudu lake and its environs were documented during the present study (Appendix 5), which included 75 aquatic species. Of the 47 families, Muscicapidae is the dominant one with 16 species followed by Accipitridae (12 species), Ardeidae (11 species) and Anatidae (10 species). The present study resulted in the addition of 03 families, 12 genera and 27 species to the existing avifaunal list of Oussudu. Among the 166 bird species recorded, 75 species were aquatic and the rest terrestrial. About 120 species were resident breeding and rest migratory.

The comparison of earlier reports on birds from Oussudu lake (Chari & Abbasi 2003) with the present study resulted in the addition (27 species) of the following species: Great White Pelican, Greater Flamingo, Lesser Flamingo, Crested Serpent Eagle, White-bellied Sea Eagle, Osprey, Bronze-winged Jacana, Grey-headed Lapwing, Dunlin, Ruff, Chestnut-winged Cuckoo, Crested Tree-swift, Black-capped Kingfisher, Stork-billed Kingfisher, Black-rumped Flameback, Rufous-winged Bushlark, Barn Swallow, Bay-backed Shrike, Southern Grey Shrike, Black-headed Oriole, Rosy Starling, Common Iora, Jungle Babbler, Tawny-bellied Babbler, White-browed Fantail, Franklin's Prinia, Indian Silverbill.

Among the 166 species *Eurynorhynchus pygmeus* (Spoon-billed Sandpiper) is a "Critically endangered" and *Haliaeetus leucogaster* (White-bellied Sea Eagle) is listed as "Endangered". Species viz., *Phoenicopterus minor* (Lesser Flamingo), *Phoenicopterus ruber* (Greater Flamingo), *Anhinga melanogaster* (Darter), *Pelecanus philippensis* (Spot-billed Pelican), *Pelecanus onocrotalus* (Great white Pelican), *Threskiornis melanocephalus* (Black-headed Ibis), *Mycteria leucocephala* (Painted Stork), *Platalea leucorodia* (Eurasian Spoon Bill), *Sterna acuticauda* (Black-bellied Tern) and *Circus macrourus* (Pallid Harrier) are "Near Threatened" (IUCN 2007).

According to the Wildlife Protection Act (WPA 1972), the following birds viz., (*Pavo cristatus*) Indian Peafowl, *Platalea leucorodia* (Eurasian Spoonbill), *Accipiter virgatus* (Besra), *Accipiter badius* (Shikra), *Ictinaetus malayensis* (Black Eagle), *Spilornis cheela* (Crested Serpent Eagle), *Haliaeetus leucogaster* (White-bellied Sea Eagle), *Milvus migrans* (Black Kite), *Elanus caeruleus* (Black-shouldered Kite), *Haliastur indus* (Brahminy Kite), *Circus aeruginosus* (Eurasian Marsh Harrier), *Circus macrourus* (Pallid Harrier), *Circus melanoleucos* (Pied Harrier), *Pandion haliaetus* (Osprey) and *Falco tinnunculus* (Common Kestrel) are falling under Schedule-I (Balasubramanian and Vijayan 2004).

In the view of terrestrial birds Little Egret is the very common species in the study area and followed by Asian Palm Swift, White-headed Babbler, Common Myna, Jungle Crow, Black Drongo, House Crow, Red-vented Bulbul, White-browed bulbul and Blue-tailed Bee-eater. Bird species such as Asian Paradise Flycatcher, Besra, Indian Silverbill, Black-shouldered Kite, Black Headed Oriole and Crested-serpent Eagle are rare species in the study area and are rarely seen with 2-3 sightings during the entire study period. The following birds viz., White-browed Fantail Flycather, Rufous-winged Bushlark, Bay-backed Shrike and Southern Grey Shrike are rare species in the study area and seen only once in entire study period.

Among the aquatic birds, Little Egret, Cotton Pygmy Goose, Eurasian Wigeon, Little Cormorants were recorded in higher number during the present survey. Birds such as Spot-billed Pelican, Darter, Black Bittern, Purple Heron, Night Heron and Grey Heron could be seen throughout the study period. Even though birds such as Painted Stork, Northern Shoveler, Northern Pintail, Mallard, Common Teal, Gargany, Black-headed Ibis and Common Pochard were reportedly common, they were rarely seen during the study period. Birds such as Black Ibis and Eurasian Spoonbill were very rare species and seen only once during the entire study period. Bronze-winged Jacana, Great White Pelican, Greater Flamingo, Lesser Flamingo, and Woolly-necked Stork, the important wetland birds, were reported first time from the study area during the study period.

Among the terrestrial birds, Asian Palm Swift was commonly seen in and around the lake followed by White Headed Babbler, Common Myna, Jungle Crow, Black Drongo, House Crow, Red-vented Bulbul and Blue-tailed Beaeater. During the present study period, birds such as Asian Paradise Flycatcher, Jungle Grow, Black-shouldered Kite, Black Headed Oriole, Crested Serpent Eagle, Black-capped Kingfisher, Stork-billed Kingfisher were seen occasionally ($N < 10$). White-browed Fantail, Ruff, Dunlin, Grey-headed Lapwing, Rufous-winged Bushlark and Bay-backed Shrike were seen only once during the entire study period. Line transect survey resulted in the documentation of 135 avian species (Table 12), of which, Little Egret was the dominant one with 355 individuals followed by Common Myna ($n=338$), and Asian Palm Swift with 337 individuals.

Herpetofauna

The sanctuary and its surrounding area are rich in herpetofauna with 10 amphibians species and 29 reptilian species (Table 13 and Table 14). The snakes comprised of 16 species, which included few venomous species.

Table 12. Avifaunal community structure in the present study area

Name of the species	N	Habitat	Status
Rufous Treepie	54	T	R
Indian Pond Heron	245	A	R
Little Cormorant	234	A	R
House Crow	174	T	R
Black Drongo	111	T	R
Common Myna	338	T	R
Great Cormorant	28	A	R
Barn Swallow	101	A	R
White-throated Kingfisher	61	A	R
Little Egret	355	A	R
Broad-billed Sandpiper	24	A	M
Yellow Wagtail	13	A	M
Red-vented Bulbul	161	T	R
Marsh Sandpiper	7	A	M
Pacific Swallow	9	T	M
Asian Palm Swift	337	T	R
Rose-ringed Parakeet	82	T	R
Dunlin	3	A	M
Curlew Sandpiper	10	A	M
Spoon-billed Sandpiper	7	A	M

Name of the species	N	Habitat	Status
Ruff	7	A	M
Black-bellied Tern	13	A	M
Common Tern	4	T	M
Jungle crow	205	T	R
Black Kite	14	T	R
Small Green Beaeater	87	T	R
White-headed Babbler	282	T	M
Eurasian Wigeon	229	A	R
Great White Pelican	6	A	R
Asian Koel	63	T	R
Ashy Drongo	58	T	R
Rock Pigeon	19	T	R
Greater Coucal	14	T	R
Chestnut Headed beaeater	28	T	R
Red-wattled Lapwing	107	A	R
House Swift	51	T	R
Grey-headed Lapwing	2	A	M
Intermediate Cormorant	2	A	R
Indian Roller	14	T	R
Common Coot	51	A	R
Brahminy Kite	10	A	R
White-winged Tern	7	A	M
White-browed Bulbul	99	T	R
Pheasant-tailed Jacana	28	A	R
Purple Swamphen	11	A	R
Common Flameback	14	T	R
Loten's sunbird	97	T	R
Purple-rumped Sunbird	60	T	R
Spotted Dove	54	T	R
Baya Weaver	10	T	R
White-bellied Seaeagle	3	A	R
Common Snipe	1	A	M
Shikra	10	T	M
Black-headed Munia	97	T	R
White-bellied Drongo	27	T	R
Blue-faced Malkoha	10	T	R
Common Tailor Bird	33	T	R
Common Kingfisher	22	A	R
Red Collared Dove	16	T	R
Tawny-bellied Babbler	32	T	R
Common Hawk Cuckoo	24	T	R
Purple Sunbird	32	T	R
Blyth's Reed Warbler	14	T	M
Thick-billed Flowerpecker	2	T	R
Purple Heron	11	A	R
Paddyfield Pipit	23	T	R

Name of the species	N	Habitat	Status
Brahminy Starling	49	T	M
Ashy-crowned Sparrow Lark	4	T	R
Scaly-breasted Munia	40	T	R
Indian Silverbill	2	T	R
Greenish Warbler	5	T	M
Black-headed Cuckoo Shrike	3	T	R
Ashy Wood Swallow	3	T	R
Small Minivet	12	T	R
Grey Partridge	31	T	R
Grey Heron	2	A	R
Bay-backed Shrike	1	T	R
Pied-bushchat	4	T	R
Blue-tailed Beaeater	81	T	R
Indian Robin	21	T	R
Garganey Teal	31	A	M
Cotton Pygmy-goose	19	A	R
Asian Paradise Flycatcher	5	T	R
Cattle Egret	37	A	R
Pied Kingfisher	2	A	R
River Tern	16	A	R
Intermediate Egret	33	A	R
Great Egret	29	A	R
Darter	6	A	R
Little Grebe	5	A	R
Eurasian Marsh Harrior	13	A	M
Jungle Babbler	50	T	R
Stork-billed Kingfisher	3	A	R
Lesser Coucal	8	T	R
White-breasted Waterhen	19	A	R
Common Moorhen	12	A	R
Spot-billed Pelican	13	A	R
Black-headed Ibis	4	A	R
Black-crowned Night Heron	5	A	R
Northern Pintail	10	A	M
Black-capped Kingfisher	7	A	M
Coppersmith Barbet	25	T	R
Eurasian Golden Oriole	17	T	R
Common Iora	11	T	R
Ashy Prinia	4	T	R
Osprey	2	T	M
House Sparrow	1	T	R
Jungle Prinia	51	T	M
Tickell's Flowerpecker	55	T	R
Common Wood Shrike	3	T	R
Bronze-winged Jacana	33	A	R
Laughing Dove	23	T	R

Name of the species	N	Habitat	Status
White-browed Wagtail	4	A	M
Spot-billed Duck	3	A	R
Oriental Magpie Robin	3	T	R
Spotted Owlet	1	T	R
Drongo Cuckoo	7	T	R
Grey Wagtail	2	A	M
Black Eagle	3	T	R
White-cheeked Barbet	4	T	R
Raven	9	T	R
Indian Peafowl	2	T	R
Pied-crested Cuckoo	1	T	R
Indian Nightjar	1	T	R
Unidentified Duck	20	A	
Chestnut-winged Cuckoo	1	T	R
Common Hoopoe	2	T	R
Pallid Harrier	1	T	M
Plain Prinia	12	T	R
Crested Serpent Eagle	2	T	M
Franklin's Prinia	2	T	M
White-browed Fantail	2	T	R
Black-shouldered Kite	1	T	R
Southern Grey Shrike	1	T	R
Crested Tree Swift	1	T	R
A- Aquatic; T-Terrestrial; R-Resident; M-Migratory			

Table 13. Amphibian species recorded in and around Oussudu Lake

S.No	Family	Common Name	Scientific Name	Status
1	Bufonidae	Common Indian Toad	<i>Duttaphrynus melanostictus</i>	VU
2	Dicroglossidae	Water Skipper or Skipper Frog	<i>Euphlyctis cyanophlyctis</i>	LRnt
3	Dicroglossidae	Indian Pond or Green Frog	<i>Euphlyctis hexadactylus</i>	DD
4	Dicroglossidae	Cricket Frog	<i>Fejervarya mudduraja</i>	-
5	Dicroglossidae	Indian Bull Frog	<i>Hoplobatrachus tigerinus</i>	-
6	Dicroglossidae	Indian Burrowing Frog	<i>Sphaerotheca breviceps</i>	DD
7	Microhylidae	Ornate Narrow-mouthed Frog	<i>Microhyla ornata</i>	LRnt
8	Microhylidae	Narrow-mouthed Frog	<i>Ramanella</i> sp.	-
9	Microhylidae	Lesser or Marbled Balloon Frog	<i>Uperodon systoma</i>	LRnt/N
10	Rhacophoridae	Chunam or Common Tree Frog	<i>Polypedates maculatus</i>	LRic

Table 14. List of Reptile species recorded in and around Oussudu Lake

Sl. No	Common name	Scientific name	Conservation status
Turtles			
1	Indian Starred Tortoise	<i>Geochelone elegans</i>	VU
2	Indian Black Turtle*	<i>Melanochelys trijuga</i>	LR
3	Indian Flapshell Turtle*	<i>Lissemys punctata</i>	LR
Lizards			
1	Snake Skink	<i>Lygosoma punctatus</i>	LR
2	Common Supple Skink	<i>Eutropis macularius</i>	LR
3	Common Brahminy Skink	<i>Eutropis carinata</i>	LR
4	Termite Hill Gecko	<i>Hemidactylus triedrus</i>	LR
5	Southern House Gecko	<i>Hemidactylus frenatus</i>	LR
6	Bark Gecko	<i>Hemidactylus leschnaulti</i>	LR
7	Fan-throated Lizard	<i>Sitana ponticeriana</i>	LR
8	Common Garden Lizard	<i>Calotes versicolor</i>	LR
9	Indian Chameleon	<i>Chamaeleon zeylanicus</i>	VU
10	Indian Monitor Lizard	<i>Varanus bengalensis</i>	VU
Snakes			
1	Brahminy Worm Snake	<i>Ramphotyplops braminus</i>	LR
2	Common Sand Boa	<i>Gongylophis conicus</i>	LR
3	Red Sand Boa	<i>Eryx johnii</i>	LR
4	Indian Rock Python	<i>Python molurus molurus</i>	EN
5	Indian Bronze Back	<i>Dendrelaphis tristis</i>	LR
6	Common Vine snake	<i>Ahaetulla nasuta</i>	LR
7	Striped-keelback	<i>Amphiesma stolata</i>	LR
8	Checkered Keelback*	<i>Xenochrophis piscator</i>	LR
9	Common Cat Snake	<i>Boiga trigonota</i>	LR
10	Indian Wolf Snake	<i>Lycodon aulicus</i>	LR
11	Indian Kukri	<i>Oligodon arnensis</i>	LR
12	Indian Rat Snake	<i>Ptyas mucosa</i>	LR
13	Spectacled Cobra#	<i>Naja naja</i>	LR
14	Common Krait#	<i>Bungarus caeruleus</i>	LR
15	Russell's Viper#	<i>Daboia russelii</i>	LR
16	Saw -scaled Viper#	<i>Echis carinatus</i>	LR
# Venomous species, * aquatic			

Ichthyofauna

Table 15 lists a compilation of i) fish species observed during the study, ii) data gathered from irrigation department, Govt. of Puducherry, and iii) those recorded by earlier studies (Abbasi and Chari 2008). Fish species that reach the market through local fisherfolk were also included in the list. Fish identification was based on Talwar and Jhingran (1991) and Jayaram (1999). 25 fish species were recorded during the present study period, of which, two species namely *Pseudeutropius atherinoides* and *Etroplus maculatus* are endangered species (Table 15). Species such as *Catla Catla*, *Mystus vittatus*, *Heteropneustes fossilis*, *Channa orientalis*, *Clarias batrachus*, *Etroplus suratensis* and *Mystus gulio* are vulnerable species. Two species namely, *Channa striatus* and *Gambusia affinis* are falling under “Low Risk - least concern” category. Three species viz., *Oreochromis mossambica*, *Cyprinus carpio* and *Hypophthalmichthys molitrix* are exotic. Rest of the 10 species are included under “Low Risk-near threatened” category.

Table 15. List of ichthyofauna recorded from Oussudu lake

Sl. No.	Tamil Name	Common name	Scientific Name	IUCN status
1	Catla	*Catla	<i>Catla Catla</i>	VU
2	Jilabi Kendai	Tilapia	<i>Oreochromis mossambica</i>	Ex
3	Viraal	Striped Snakehead	<i>Channa striatus</i>	LRlc
4	Rogu Kendai	*Rohu	<i>Labeo rohita</i>	LRnt
5	Kalbasu	Kalbasu	<i>Labeocalbasu</i>	LRnt
6	Mirukula	*Mrigal	<i>Cirrhinus mrigala</i>	LRnt
7	Kezhuthi	Striped Dwarf Catfish	<i>Mystus vittatus</i>	VU
8	Theli	Stinging catfish	<i>Heteropneustes fossilis</i>	VU
9	Koravai	Asiatic snake head	<i>Channa orientalis</i>	VU
10	Kurali Koravai	Spotted Snake head	<i>Channa punctatus</i>	LRnt
11	Paambu Meen	Giant snake head	<i>Channa marulius</i>	LRnt
12	Vilaangu	Indian Shortfin eel	<i>Anguilla bicolor</i>	LRnt
13	Kulla Kendai	*Grass carp	<i>Ctenopharyngodon idella</i>	LRnt
14	Kendai	*Common carp	<i>Cyprinus carpio</i>	Ex
15	Potla Kendai	Indian Potassi	<i>Pseudeutropius atherinoides</i>	EN
16	Silver Kendai	*Silver carp	<i>Hypophthalmichthys molitrix</i>	Ex
17	Iraal	Prawn	<i>Fenneropenaeus indicus</i>	-
18	Aara	Striped spiny eel	<i>Macrogathus pancalus</i>	LRnt
19	Kosu Meen	Mosquito fish	<i>Gambusia affinis</i>	LRlc
20	Uzhavai	Sleepy goby	<i>Glossogobius giuris</i>	LRnt

Sl. No.	Tamil Name	Common name	Scientific Name	IUCN status
21	Senil	Magur	<i>Clarias batrachus</i>	VU
22	Sellakaachi	Orange chromide	<i>Etroplus maculatus</i>	EN
23	Sellavaachi	Green chromide	<i>Etroplus suratensis</i>	VU
24	Vella Kezhuthi	Gangetic mystus	<i>Mystus cavasius</i>	LRnt
25	Kondai Kezhuthi	Long-whiskered catfish	<i>Mystus gulio</i>	VU
<i>*Species introduced by the fisheries department, Govt. of Puducherry for rearing commercially important fishes in Oussudu lake</i> <i>VU-Vulnerable; LRlc-Low risk-least concern; LRnt-Low Risk-near threatened; EN-Endangered; Ex-Exotic species.</i>				

Mammals

In total, 14 species of mammals could be seen during the present study. Table 16 presented the list of species with their recent scientific name, endemic status, IUCN status and legal status.

Overall we observed that Oussudu lake harbours rich biodiversity and the overall details of the species richness of all the taxa surveyed are presented in Table 17.

Table 16. List of mammals recorded from Oussudu lake

Sl. No.	Common Name	Scientific Name	Endemic status	IUCN status	Legal Status
1	Spotted deer	<i>Axis axis</i>	-	LR\Lc	IV
2	Jackal	<i>Canis aureus</i>	-	LR\Lc	I
3	Jungle cat	<i>Felis chaus</i>	-	-	-
4	Common mongoose	<i>Herpestes edwardsii</i>	-	LR\Lc	-
5	Black naped hare	<i>Lepus nigricollis</i>	-	LR\Lc	-
6	Bonnet macaque	<i>Macaca radiata</i>	Southern India	-	II
7	Indian porcupine	<i>Hystrix indica</i>	-	LR\Nt	IV
8	Bandicoot rat	<i>Bandicota indica</i>	-	LR\Lc	V
9	Three-striped palm squirrel	<i>Funambulus palmarum</i>	-	LR\Lc	-
10	Indian pangolin	<i>Manis crassicaudata</i>	-	LR\Lc	-
11	Asian Palm Civet	<i>Paradoxurus hermaphroditus</i>	-	LR\Lc	II
12	Mice	<i>Mus sp.</i>	-	-	-
13	Short-nosed Fruit Bat	<i>Cynopterus brachyotis</i>	-	-	-
14	Flying fox	<i>Pteropus giganteus</i>	-	-	-
Legal status as per Indian Wildlife Protection Act, 1972					

Table 17. Overall species richness of all the taxa surveyed

Name of the organisms			Total number of species
Plants	Herbs		191
	Shrubs		63
	Trees		103
	Stragglerss		20
	Climbers		40
	Grasses		63
Butterflies			63
Ichthyofauna			25
Herpetofauna	Reptiles	Turtles	3
		Lizards	10
		Snakes	16
	Amphibians		10
Avian fauna			166
Mammals			14

4.2. DEPTH PROFILE OF THE LAKE

Bathymetric measurements are helpful in preparing a depth profile of the lake. Such data aids in preparing environmental management plan. The depth profile of Oussudu lake was measured manually using a bamboo pole. Three transects were laid criss-crossing the lake. Two transects were of 2.5 km long and the third one was of 2.0 km long. The maximum depth and the average depth of the lake were 3.5 m and 3.0 m, respectively. Details of transects, their locations and corresponding depth in meters is presented in Appendix 6. The lake is deeper in the southern part all along the bank starting from Suthukeni channel inlet point until boathouse. Details of water availability in Oussudu lake since 1998 until 2010 are presented in Appendix 1. Further, an analysis of the water level in the lake in the month of January, considering January as the peak migratory season, revealed that the annual average water availability in the lake has been gradually increasing consistently since the year 2003 with a fall in 2007 (Figure 10).

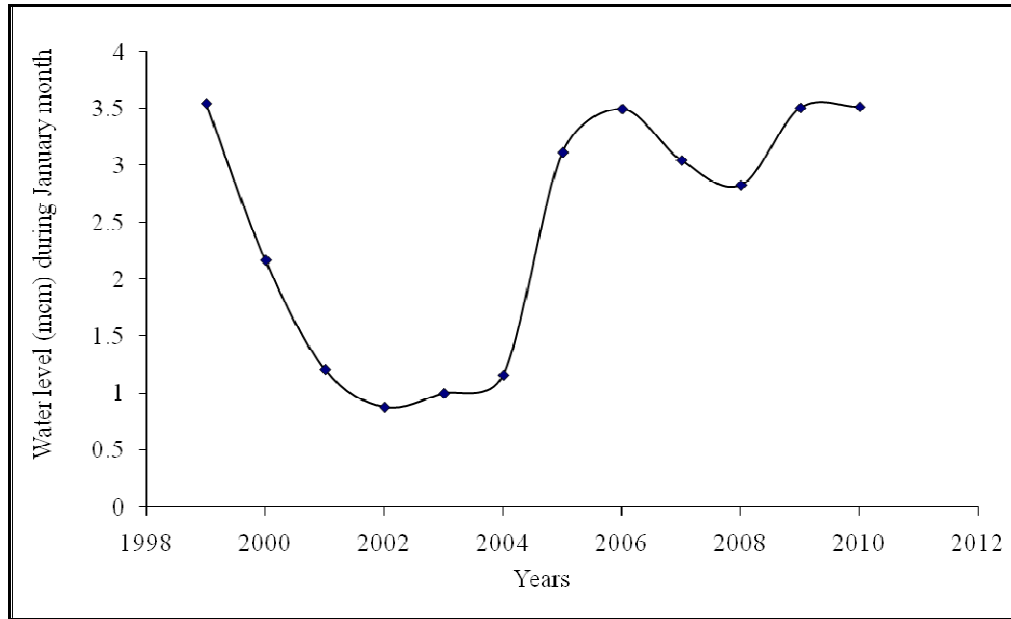


Figure 10. Water level in Oussudu lake (million m³) every January month

4.3. SOCIO-ECONOMIC STATUS

The household survey, undertaken to understand the socio-economic status, peoples' activity and their dependency pattern on Oussudu lake, revealed the following:

- In total 53 households in eight villages from two taluks (Vanoor and Villianur) were surveyed. This resulted in interviewing 272 persons in all.
- Of these, around nine percent of the households were from Vanoor taluk and the rest from Villianur taluk.
- Earlier 18 villages were dependent on Oussudu directly for irrigation (Chari & Abbasi, 2007). People from villages such as Oussudu, Koodappakkam, Agaram, Poraiyur, Sendhanatham and Olavaizkal use the lake water for agricultural purposes. In addition, bore wells are commonly noticed in these areas. Apart from this, the villagers of Ramanathapuram and Katterikuppam also use the Suthukeni canal (the only water source for Oussudu lake) for irrigation and other basic needs.
- The major crop around the lake is a monoculture of Paddy and Sugarcane. Casuarina and Coconut plantations are also a common around the lake. Polyculture practice is rare around the lake.

- The chemical and pesticide usage for agricultural practices around the Oussudu lake watershed have direct implications/impacts with the lake. Now-a-days, chemical fertilizers are in use in order to boost up the yield of the crop in lesser time. According to the present survey, only 33% of farmers practice organic farming in and around the lake. However, conventionally 60% farmers use to follow organic farming by making use of dried cow dung, compost, azolla, phosphobacteria and azospirillum (Chari and Abbasi, 2007).
- Fishing provides additional income and dietary supplement to many of the deprived people. While the lake is a bird sanctuary, fishing activities were noticed several times during the survey.
- Based on people's opinion inhabiting around the Oussudu lake, the factors such as untamed fishing, illegal hunting, dumping of industrial solid waste and domestic garbage (by the industries in the vicinity and by the human settlements), tourists and other settlers around the lake, discharge of industrial effluent to the lake, practice of open defecation around the lake have major impacts on Oussudu lake. These activities are likely to affect various migratory and residential birds, and other biological environments. Of these factors, 41% of the respondents felt fishing to be a major threat followed by illegal hunting of birds (28% respondents, Figure 11).
- Notably, during the survey all the respondents opined about the potential for promoting eco-tourism activities in the wetlands, and expressed their willingness to be part of any sort of initiative been undertaken by the Government of Puducherry.
- To expedite the efforts for conserving the lake, declaration of the lake as a sanctuary was a very timely step. In the event of stopping peoples direct interference and dependence on lake, as per public opinion three major alternative livelihood options does exist, viz. livestock rearing, employment and self employment or entrepreneurship (Figure 12). Entrepreneurship includes starting their own units of handloom and/or handicrafts, workshop and/or small engineering units for which vocational training is essential. This also includes avenues such as poultry farming, piggery and aquaculture.
- The results presented here are for the villages where more than 50% of the

respondents could spellout their preferred alternate livelihood options.

- Overall, livestock and including cattle rearing seem to be the major livelihood options for most of the villagers around the Oussudu lake. A major proportion of respondents were open to any sort of alternate option likely to be initiated/implemented by the Puducherry Government, viz., Agaram (38%), Koodappakkam (25%) and Oussudu (33%).

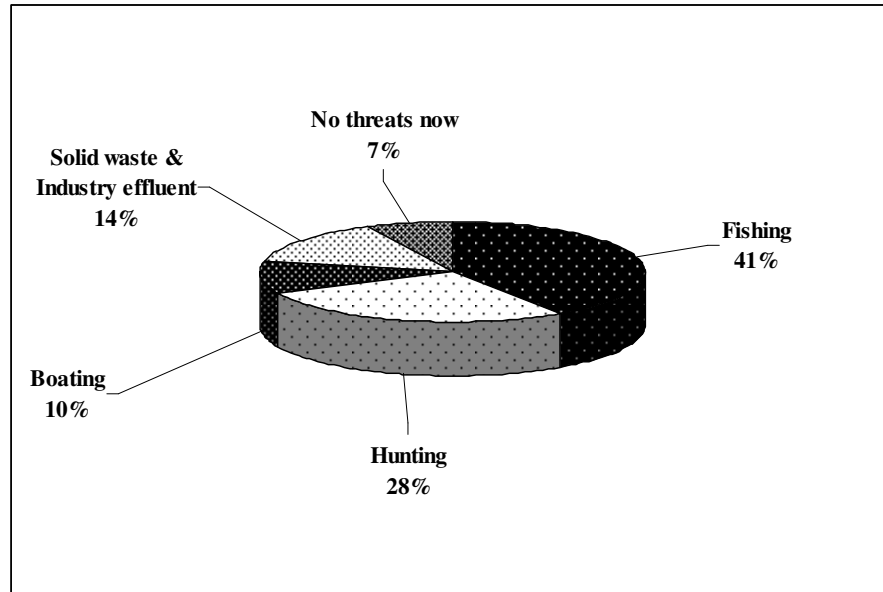


Figure 11. Major threats to the Oussudu sanctuary as per public opinion

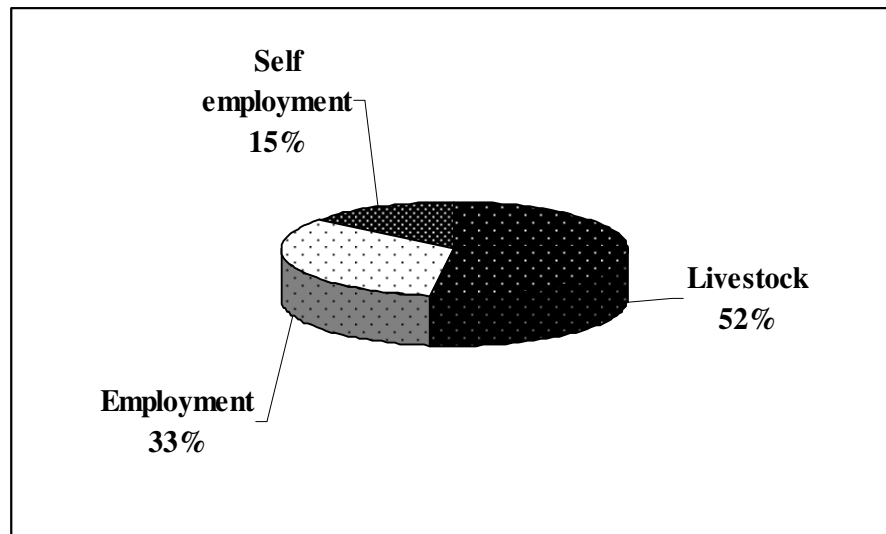


Figure 12. Alternative livelihood options (as per public opinion) for local community

4.3.1. Public perception on Oussudu sanctuary

Oussudu sanctuary is important for people living around the lake as it provides several direct and indirect livelihood resources and ecosystem services. The lake is put to use in several ways (Figure 13):

- Water for irrigation, drinking, bathing, washing of clothes.
- Plays a major role in maintaining and recharging the ground water level. When the lake had dried up, there was significant ground water depletion observed in the nearby villages.
- Periodic fish harvest.
- Source of fodder and grass: the shallow banks and lake embankments of the Oussudu lake support in the luxuriant growth of various grasses including reeds and herbaceous species. The local people graze their cattle on these grasses throughout the year. Apart from this, the reeds and grasses growing in and around the lake are used for thatching the huts. *Ipomoea*, which grows profusely in the lake used for fencing around the houses and agricultural fields.
- Aesthetic and recreational spot.
- Additionally, many of the respondents do realize the importance of Oussudu sanctuary as an eco-tourism spot and suggest promoting eco-tourism in a comprehensive manner. The same can also be a source of employment.

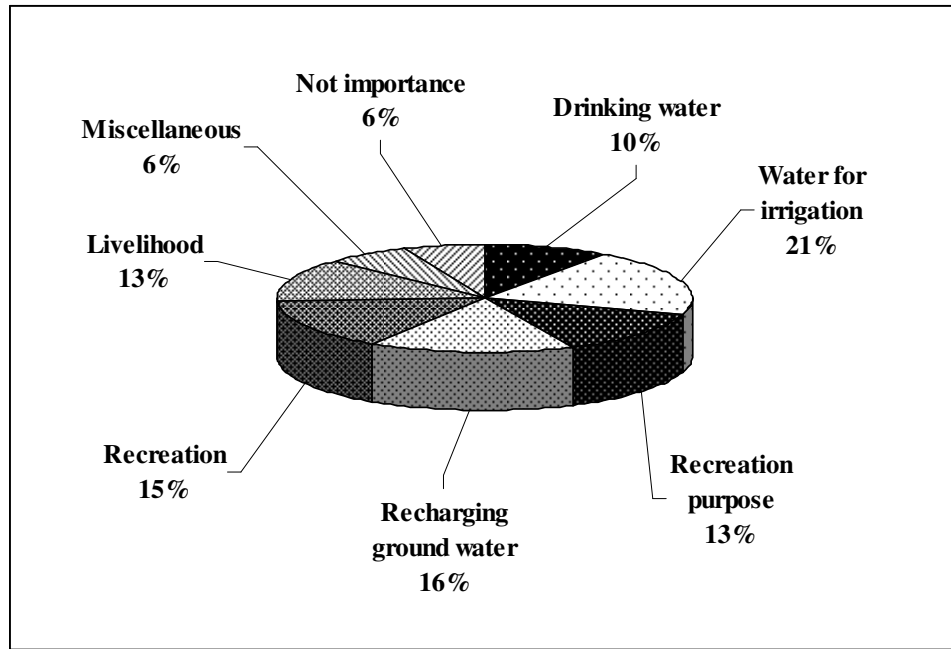


Figure 13. Public opinion on importance of Oussudu sanctuary

4.4. ECOLOGICAL SIGNIFICANCE AND ECOSYSTEM SERVICES

Wetland ecosystems are known to assume significance from several dimensions. Oussudu lake is no exception to this. The present survey highlights the importance of the lake from both ecological and socio-economical perspective. The rich assemblage of different species of flora and fauna make it additionally important for its upgraded status as “**wetland of national importance**”. A large array of aquatic vegetation and ichthyofauna attract many bird species both resident and migratory. This necessitates a holistic management approach, which is discussed in detail in subsequent sections that would be helpful in maintaining the ecological integrity of this wetland ecosystem. The availability of several species of aquatic macrophytes such as *Hydrilla verticillata*, *Lemna minor* and *Najas minor* comprise major food plants for several avian species and hence can attract thousands of birds to the lake. Overall, it is observed that Oussudu lake harbours rich biodiversity (

Table 17).

Wetland ecosystems provide several ecosystem services, which supports biodiversity and helps in well-being of humankind. During our survey of the lake and its surrounding areas, socio-economic survey of households in the villages, interaction with officials of government and non-government organizations, and literature survey on Oussudu, it is found that people recognize several of the ecosystem services as listed below:

- **Provisioning services:** Food, fresh water, fibre, fuel and genetic materials.
- **Regulating services:** climate regulation, water regulation (hydrological flows), water purification and waste treatment, erosion regulation, natural hazard regulation, pollination (habitat for pollinators).
- **Cultural services:** Recreational, aesthetic and educational.
- **Supporting services:** Soil formation and nutrient cycling.

5. ECOLOGICAL ISSUES

Oussudu lake is under serious anthropogenic pressures at various levels and magnitudes, as is in the case of other wetlands located in urban and agricultural landscapes. The people residing around the lake have exploited its resources for their routine activities since decades. It is also expected that Oussudu would lose its ecological integrity, if proper coordinated efforts are not taken by management authorities and non-government organizations including public to save this fragile wetland ecosystem. The action of Government of Puducherry declaring about 390 ha of Oussudu lake as a sanctuary is timely, which is appreciated by all. Intensive environmental management programme for comprehensive eco-restoration of the wetland is also envisaged. However, it is apt that steps should be taken up to bring the adjoining parts of the lake under protection. In this regard, discussion with Government of Tamil Nadu is essential. Mechanisms to manage the area jointly by both the governments, and people of Tamil Nadu and Puducherry needs to be developed.

The following are the issues to be addressed at the earliest for the conservation of Oussudu lake and its environment for its ecological sustenance.

5.1. POACHING OF BIRDS

Poaching of birds in and around the Oussudu sanctuary is one of the most important issues that need to be addressed for conservation of birds in the area. During the present survey, we found that several families of Narikkurava (a group of tribe) community are engaged in hunting of birds, and indeed that has become their chief source of livelihood. There is an encroachment by a hamlet of around 15 families, of Narikurava on Villianur-Pathukanu junction road. This settlement was found to hunt several species of aquatic birds both resident and migratory. The birds such as Asian koel (state bird of Puducherry), Great bittern, Common moorhen, White-breasted water hen, Common myna, Common coot, Egrets, Cormorants were commonly hunted and sold @ Rs. 150 – 200 per kg. The need of the hour is to provide them with appropriate source of livelihood and employment to stop further hunting of birds.

5.2. UNSUSTAINABLE FISHING

Fishing activity is a major threat to the biodiversity of the Oussudu lake, as untamed fishing is a regular practice followed around the lake. The diversity of fish species in the lake attracts people for fishing. Even though the fishing in Oussudu lake has been banned by the Government of Puducherry, several illegal fishing was observed in the lake. Unbridled fishing activity using fishing nets has lead to the killing of water snakes and several aquatic birds (pelicans, coots, darters). A study by Alexander (2010) states that while the snake remains entangled in the fishing nets, the fisherman simply cuts the snake to extricate the fishing nets. Akin to these, fishing cause direct disturbance to birds due to reduced availability of fish species, for which several avian species visit the lake. 36 piscivorous species (especially 21 heronry species) were observed visiting the lake for foraging due to the availability of diversified fish species. These birds especially the heronry species visit the lake for foraging and breeding, and several of them would be threatened if fishing activities were not controlled/regulated. Aquatic plants such as *Hydrilla verticillata*, *Najas minor* are food for many birds of Oussudu. During fishing, these aquatic macrophytes get entangled in the fishing net by causing disturbance and imbalance in the biodiversity composition of the lake.

5.3. WEED INFESTATION

Infestation of wetlands by weed species is a serious threat mainly to the ecological quality, species composition and environmental goods and services rendered by the wetlands. Weed species such as *Eichornia crassipes*, *Salvinia molesta*, *Pistia stratiotes* and *Ipomoea carnea* were seen invading the wetland area of Oussudu. Thus, infestation of weeds in the lake is likely to be a serious issue in near future that would directly affect the biodiversity of the lake and water quality. Apart from aquatic weeds, *Prosopis juliflora* was also observed along the roadside. Thus, removal of this species is of utmost importance as it is reported to invade the other wetlands at much higher rates (Chandra et al. 2009). It is suggested that these weeds must be removed manually.

5.4. DUMPING OF SOLID WASTES ON THE LAKE EMBANKMENTS

Modern society generates large quantum of solid wastes thereby, creating problems related to their disposal. In a country like India, it is a common practice to deem wetlands or marshes as wastelands and use them as dump yards for untreated raw sewage and solid wastes. This practice of solid waste dumping in wetlands leads to fall in ecological / conservation value, species richness or species distribution of the system / area. Apart from swallowing / shrinking of the wetland, dumping municipal wastes can seriously affect the water bodies by releasing noxious chemicals during decomposition. The heavy organic contents in municipal wastes degrade slowly and release acidic and toxic leachates for many years. The Oussudu wetland is not much an exception to this, as we could see large quantities of solid wastes in and around the lake embankment during the present survey. Solid waste dumped in different parts of the wetland by the industries in the vicinity and human settlement, is a major environmental, public health threat, and a management issue.

5.5. VEHICULAR MOVEMENT, NOISE AND OTHER POLLUTION

A network of roads connecting Pathukannu junction to different places in Puducherry region surrounds the Oussudu lake. A number of both light and heavy motor vehicles ply on these roads. Additionally, establishment of several educational institutions and an amusement park near the lake also add to the vehicular density. These are likely to produce loud, stark and intense noise that is deterrent to birds. Especially use of air horns by the moving vehicles are major source of disturbance to birds. Boating has always been a source of threat to any wetland, where mechanized boats are involved for income generation through tourism. These boats are a source of gaseous and particulate hydrocarbon pollution in Oussudu lake apart from the noise pollution. They can thus, lead to situations like stress and panic to the water birds, and those on the banks and nearby trees. Once the tourist activities are in peak, the noise level is expected to rise up, leading to disturbance to the birds, particularly the shy ones abandoning their nest.



Plate 1. Fishermen with their day's catch



Plate 2. Nets with fine mesh size used for illegal fishing in Oussudu sanctuary



Plate 3. Littering around lake: an impact of tourism that needs strict management



Plate 4. Dumping of solid waste by tourists on the lake periphery



Plate 5. Dumping of solid waste by industries along Suthukeni canal



Plate 6. Amusement park near lake: water intensive developmental activities

5.6. WASTE WATER DISCHARGE

The Suthukeni canal is the only major canal that brings water to Oussudu lake. This canal is essentially the only means of water movement / discharge of sewage and storm water to the lake. It is currently a channel, into which considerable quantity of

municipal and non-point source effluents flow in. Several industries such as rubber and glass industries and the agricultural lands located around the Oussudu lake, release runoff water with various chemicals into the Oussudu lake. Several colleges, hospitals, housing, residential projects and commercial, business centres are also coming up in the vicinity of Oussudu. This will further deteriorate the quality of water reaching the lake. As mentioned by the officials at boathouse of Oussudu, it is a common practice that industries located around the Oussudu lake keep their effluent in large tanks / containers for long period and during the rainy season, they release the effluent with flood/runoff that reaches the lake. Several tanning and leather industries are surrounding the lake; disposal of effluent from these industries would directly affect its ecological set up. Further, cleaning of hospital clothes on lake banks could also be a source of pathogens, vectors and a heaven for vermin, and a threat to the public health.

5.7. AGROCHEMICALS

During the survey, we observed intensive agricultural practice was followed in the land adjoining the Oussudu lake. Agriculture being the predominant land use category in Oussudu catchment and considering the elevation contours of 40 m and 20 m above mean sea level towards North and Northeast (Abbasi and Chari 2008), there is a potential risk of run off – rich in nutrients, pesticides and sediments - contaminating the lake. The presence of agricultural fields around the lake contributes significant amounts of N, P, K and pesticides through run-off. The wetland is presumed to receive loads of agricultural pesticides from paddy crops cultivated in its border villages. Heavy metals and several pesticides, as an outcome of application of agrochemicals in nearby agriculture fields, can get accumulated through the trophic levels (macrophytes, fish etc.) in the wetland ecosystem and may ultimately affect the apex of the food chain, i.e. birds. Wetlands located in agricultural landscapes are particularly affected by agrochemicals (Azeez et al. 2007 and Prusty et al. 2007).

5.8. SOIL EROSION AND SILTATION

Rapid urbanization involves land clearing, levelling and construction activities. Thus, the disturbed and loosened surface soil is easily washed off in rain and carried away along with the runoff. The silt and sediments reaching the wetland make the water turbid. Their subsequent settling in low-lying areas reduce the depth and extent of lake, which leads to reduction of optimum growth and productivity of macrophytes; water and sediment quality; and subsequently the habitat quality (Prusty et al. 2007; Abbasi and Chari 2008). In the present case, the booming real estate business leading to massive land modification and uprooting of native vegetation causes large-scale soil erosion. A considerable portion of the low-lying area on the sides of lake becomes drier due to settled soil and silt posing serious threats to Oussudu lake.

5.9. TOURISM ACTIVITIES

Presently, Oussudu lake is one of the locations in the Puducherry region that draws considerable number of tourists both nature lovers and commercial tourists. One of the major impacts of tourism is generation of solid waste near the lake banks and littering of the area. During the survey, dumping and loitering of food packets, polythene bags, etc. were noticed.

6. ENVIRONMENTAL MANAGEMENT PLAN

In view of the present scenario with threats to its existence and functioning, Oussudu sanctuary needs active conservation and management interventions. This may include activities such as protection, prevention of encroachment and control of polluting activities, eco-restoration and initiating habitat improvement programs. Thus, an attempt is made to discuss and propose management of certain issues for Oussudu lake that require timely and appropriate management strategy. Owing to our observations and literature survey of the lake and its surroundings, we have listed out and discussed the major ecological issues related to the management of this wetland system in the preceding chapter. Thus, possible management plans and measures are suggested and discussed here below.

The EMP proposed focuses only on the Puducherry part of the Oussudu lake. however, similar management actions by Tamil Nadu government for the part of the lake in their jurisdiction would be very crucial for effective and meaningful long-term management of this lake.

6.1. WATER MANAGEMENT

The three factors vital to the management of water in a wetland are: i) time of flooding, ii) water level, and iii) the duration of the dry period. Variations in these factors affect the annual cycle of events and stabilization of the wetland ecosystem. In the case of Oussudu, water is released into the lake every year during monsoon through Suthukeni channel. The quantum of water and the duration of water inflow vary with the monsoon rain experienced in the catchment area. In the present case, the issues that assume significance are the water level and duration of dry period. Water level inside the lake depends on the quantum of input, which again depends on the rainfall in the catchment. Maintenance of different depth regimes is necessary for providing habitat to a variety of organisms especially bird species. Furthermore, maintenance of a particular water level or supply of a definite quantum of water annually would help stabilizing the system.

The duration of dry period is another important factor that influences the ecological functioning of wetlands. An analysis of the data on water level in the lake from January 1999 to August 2010 (Appendix 1) reveals that traditionally some areas inside the lake use to go dry during the summer months leaving behind only pools in the deeper areas prior to 2004. However, subsequent to 2004, the water in the lake has been maintained at a higher level even during summer months resulting in permanent flooding of potential bird habitats during the migratory season. Higher water levels would attract only certain species of migratory water birds. Hence, the sustained high level of water in the lake is likely to have resulted in reduction in the number and diversity of migratory birds, especially waders. There should be a controlled water regime for the sanctuary, wherein the inflow and outflow levels are maintained in such a way that, by controlled release of water during the lean seasons (around April - July) the water level reaches near zero level before the monsoon sets in. This should be repeated every year.

The dry spell and the pools present during the dry period are biologically significant. This would help in restoring the natural ecological dynamics that prevailed in the wetland earlier and attract migratory birds. It would also result in the reduction of aquatic weeds in the lake, improvement of lake water quality and water availability and ground water conditions in the downstream areas as well. Flushing out water from the lake is also important for flushing out the organic load (agro-chemical residues) from the system. Wetlands being a dynamic system, unlike the terrestrial ones, require periodic management interventions. Periodic letting out/release of water during high flood condition is being practiced in some national parks such as Keoladeo National Park (KNP) in Bharatpur, Rajasthan (Vijayan 1991). The KNP wetland ecosystem has benefitted largely due to annual dry spell of 2-3 months. Earlier studies in KNP (Vijayan 1991, Azeez et al. 2007, Prusty et al. 2007, Azeez et al. 2009) reveal that the availability of large number of fish and other food items in such pools attract large number of birds. These birds begin to breed within a month, which shows that the food abundance in the pools acts as the ultimate factor for breeding. Additionally, summer flocking is known to facilitate mate selection in certain species of birds (Vijayan 1991).

The dry period helps in faster decomposition of plant litter in the ensuing monsoon. The drying up of plant litter during summer is one of the key factors in keeping the system in a dynamic condition. Dry condition would also help in germination and regeneration of submerged aquatic plants such as *Hydrilla*, *Najas*, which are main food plants of migratory waterfowl wintering in India. Therefore, any attempt to keep the water level high during summer months should be discouraged.

6.2. FISHING

Regular monitoring of the fishing activity is suggested. Although controlled small-scale sustenance fishing activities by local communities using traditional methods of fishing may be allowed, the Department of Forest and Wildlife, in consultation with the fishery experts, should develop a sustainable and participatory harvesting regime for the fishing activities in the lake. The fishing regime would include *inter alia* suggesting fishing nets with appropriate mesh sizes, and avoiding specific breeding sites and seasons, if any. The Department of Forest and Wildlife may in consultation with fishery department plan out strategies for sustainable harvesting of fish from the lake while ensuring the benefit sharing with the communities around the lake. Once a controlled water regime is maintained in the lake, i.e. maintaining a dry period of 2-3 months, controlled harvesting of fish should be allowed under the supervision of authorities of Forest and Wildlife during May-June. Formation of Eco-development committee (EDC) involving stakeholders will be a step in sustainable management of fishery resources of the lake. The harvest regime (time, quantity, fees, if any) may be fixed for the reserve to be used or harvested including fishes. EDCs are legally recognized entities and are operational in many wildlife sanctuaries in India.

As several local people around the Oussudu lake are dependent on the lake for their daily livelihood needs, the government may also arrange for and promote development of alternate livelihood options such as cattle farming and self-employment facilities. Enquiry with locals revealed that Fishery department is releasing fish seeds (fingerlings) during monsoon, which includes exotic species such as *Tilapia* sp. This species is known to dominate over other native species.

Examination of fish catch revealed large quantum of *Oreochromis mossambica* as well. Hence, it is suggested that department should consider releasing only local species in the lake. Raids and other monetary fines must be imposed if any, for illegal fishing.

6.3. VEHICULAR MOVEMENT AND BOATING

- As mentioned in the section 5.5, to reduce the disturbance caused to birds due to vehicular movements and use of air horns, appropriate measure should be taken to stop use of air horns. Further, efforts should also be made to divert vehicles moving towards Pathukannu junction through a crossroad connecting Pathukannu-Villianur road and thereafter to Pathukannu junction (Figure 14).
- Rampant use of motor boats in the Oussudu lake for ferrying tourists was seen during the study duration. We observed that boats carry tourists crisscrossing the lake, and specified areas needs to be investigated for regulating this activity. Both conservation of biota and tourist interest must be taken care of. It is suggested that the boating route in the lake should be parallel to the road leading to Pathukannu junction.
- Replacement of motor boats with paddled boats (having capacity of four or six persons) and coracles, which would help reduce disturbance to birds is herein proposed. It is suggested that the forest department in collaboration with the tourism department should procure two Fibre glass boats (4-6 seated capacity), four Inflatable rubber boats (4 seated capacity) and three Canoes for routine tourism.
- Peak activity of birds and many other organisms is during morning (0500 - 0900 hrs) and evening (1700 - 1900 hrs) hours. Hence, the number of motor boats should be regulated during dawn and dusk hours in order to have minimal disturbance to the birds.
- **No horn zone** may be declared near the road along the lakeside. Further, plantation of tree species that would help trapping the sounds should be promoted and opted.

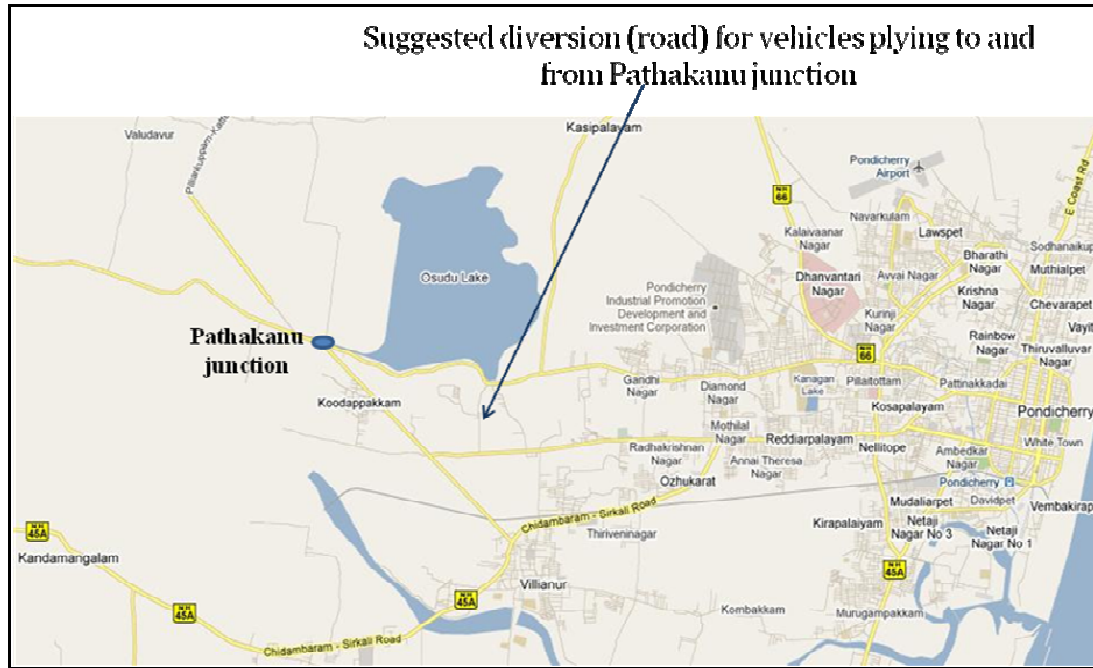


Figure 14. Suggested alternate road for vehicles near Oussudu sancturay

6.4. BOUNDARY DEMARCATION AND PREVENTION OF ENCROACHMENT

- Development of real estate leading to the encroachment of wetlands is a very common practice. The parts of Oussudu lake, which have already been encroached, should be identified and their protection and restoration measures should be immediately undertaken. In the case of Oussudu wetland, it is proposed to mark the Protected Area boundary in order to prevent further encroachment, and help conservation activities.
- Demarcation of boundary need to be done both in landward side and inside the lake. Demarcation/fencing on landward side should be done from Pathukannu junction to ahead of boat house (on eastern side) and until the end of Puducherry boundary along the lake bank on western side, with a total distance of around seven km.
- Demarcation inside the lake should be done in such a way that it does not disturb the natural flow of water. The lake boundary between Puducherry and Tamil Nadu should be demarcated by making mounds (03 no.) along the boundary line (Plate 7). This would solve dual purpose: as a boundary demarcation and as well as habtat improvement.

6.5. MOUNDS WITHIN THE LAKE

Presently birds are seen resting and using the trees on the lake bank and some on the island within the lake for roosting and other activities. Thus, nearly five mounds (including three along the boundary line) should be constructed wherein bird-attracting trees need to be planted to facilitate nesting of water birds. *Acacia nilotica* and *Tamarindus indica* are the preferred trees. Heronry species such as Pelicans, Spoonbills, Egrets, Cormorants, Herons, Asian Openbill are the likely ones to use these trees for nesting. Moreover, the suggested mounds are likely to be used by ducks, rails, lapwings, etc. The ideal size of mounds should be with a radius of 2.5 meters approximately, which can be constructed during the dry period (April - June) by dredging the lake bed in the nearby areas and accordingly the locations suggested for mounds are in shallow areas as evidenced from wetland depth profile survey. Plate 8 presents the few suggested locations of mounds. However, all mounds should be constructed in due consultation with experts. The undergrowth of the mounds should be cleaned periodically which would help in increased use of by birds and visibility for tourists.

6.6. BRIDGE AND WATCH TOWER

While attempting to improve the banks for attracting tourists, it may also be noted that to avoid increased vehicular movements, a walkway bridge (hanging) may be constructed to allow tourists and/or naturalists to cross over the canal and reach the western bank of the lake. The bridge construction should not result in ecological disturbance in the site. The typical design of the suggested hanging bridge is presented in Figure 15. One watchtower may also be constructed near the northern end of the suggested bridge, where facilities such as spotting scope may be made available to the tourists for watching the birds. The typical design of the suggested watch towers are presented in Figure 16. The watchtower need to be equidistant from the suggested location for constructing mounds. Plate 8. presents the details of the suggested location of watchtower etc. The bridge may be connected to the watchtower through a walkway on the western bank of the lake. Efforts should also be taken to renovate the existing watchtowers near boathouse and increasing their

height. Naturalists may be appointed and posted near the watchtower for regulating the tourists and provide information on the natural resources of the area.

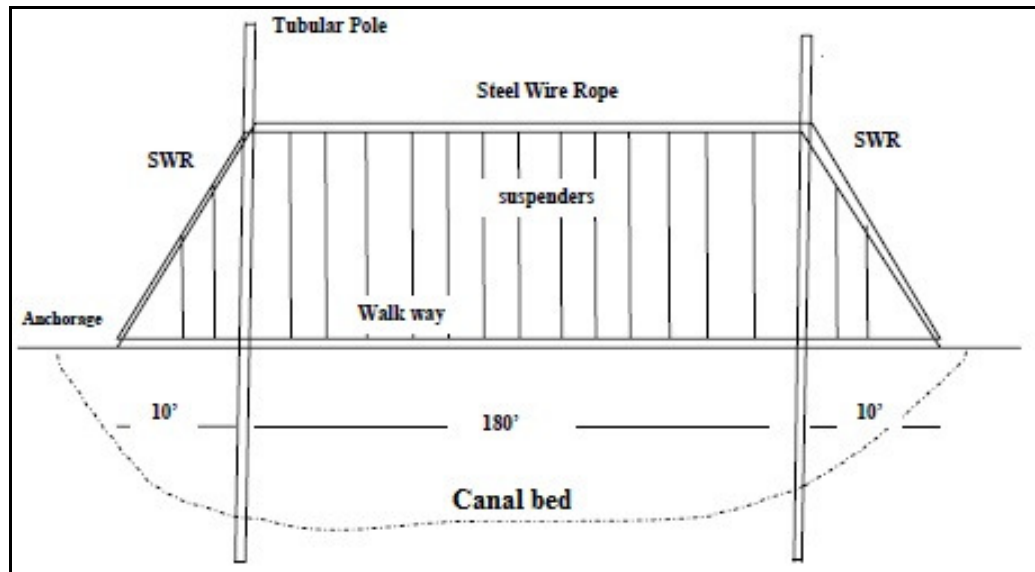


Figure 15. Typical design of a foot suspension bridge for Oussudu sanctuary

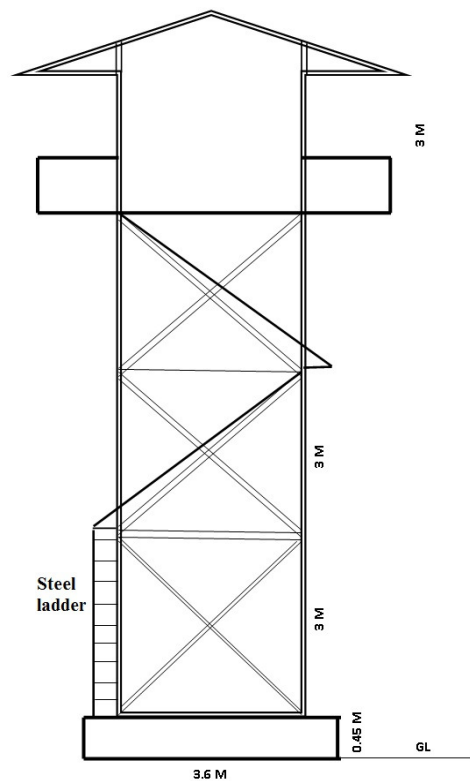


Figure 16. Typical design of a watchtower along the bank of Oussudu sanctuary

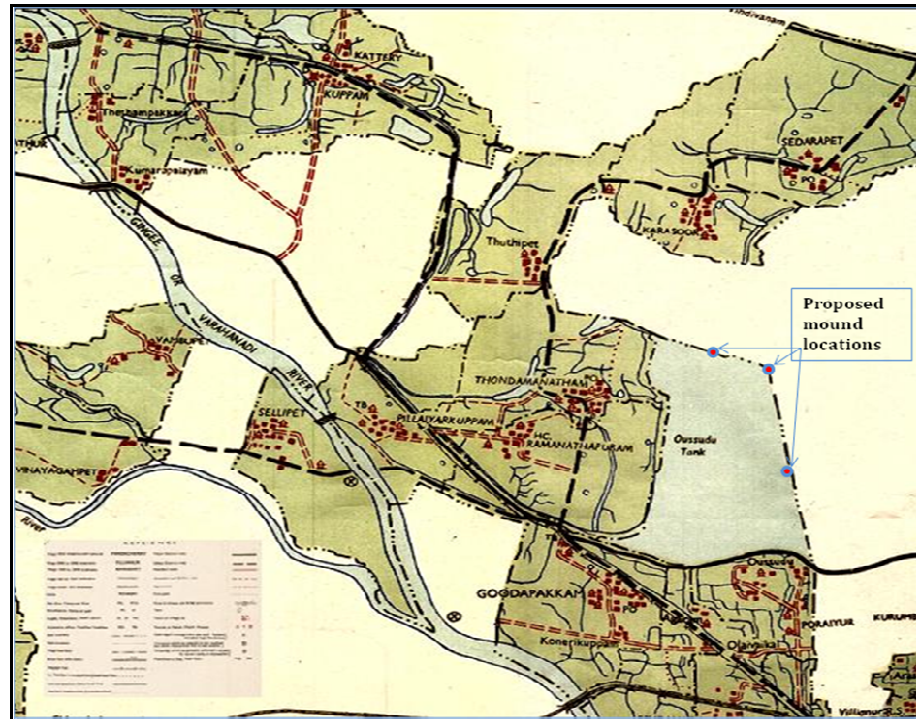


Plate 7. Suggested mound locations for boundary demarcation inside the lake

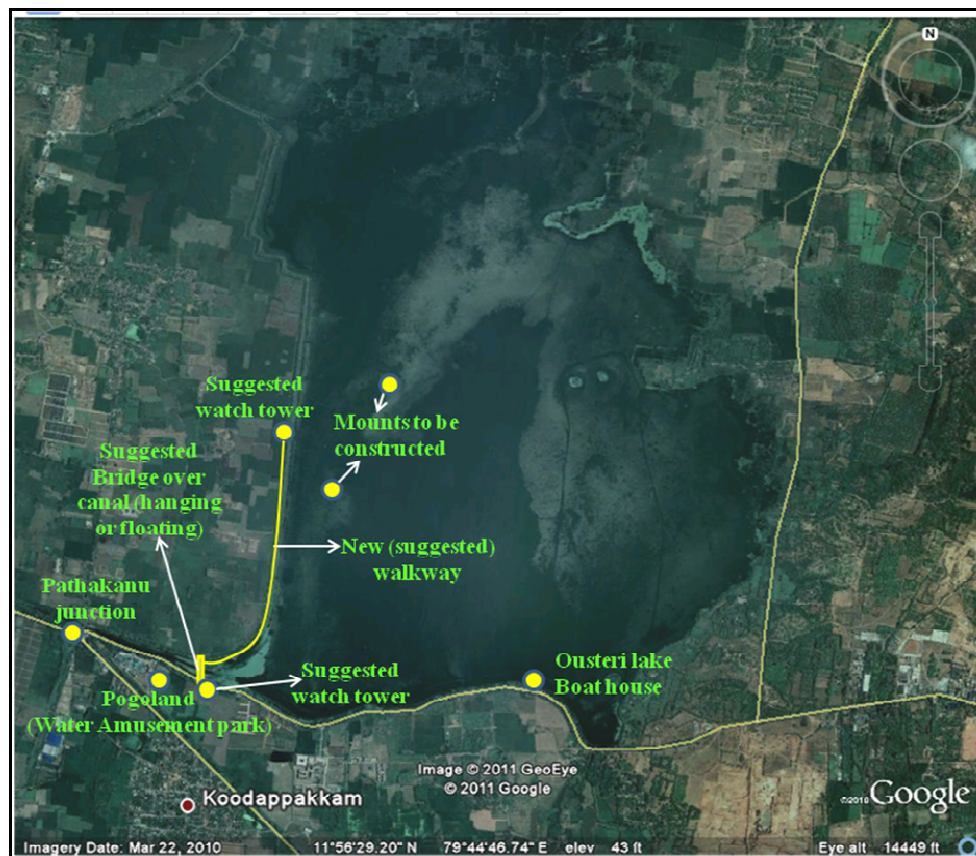


Plate 8. Suggested locations for habitat improvement program around Oussudu sanctuary

6.7. WALK-WAY IMPROVEMENT

A foot trail (existing) along the canal up to Pathukannu junction should be improved by paving the walkway with bricks and this nature trail may be used for nature awareness programme and bird watching. The walkway of around 1.2 m width (brick on edge interlocking) need to be laid all along the Puducherry boundary (07 km) for the ease of patrolling (Figure 17). Additionally, this walkway may be fenced on the sides exposed towards the main road leading to Pathukannu junction with gates opening in two to three places for entry by visitors and other citizens to use the walkway during morning and evening hours. Similarly, the paved walkway found near the existing boathouse should be improved for effective use by tourists and bird watchers without removing the trees found nearby.

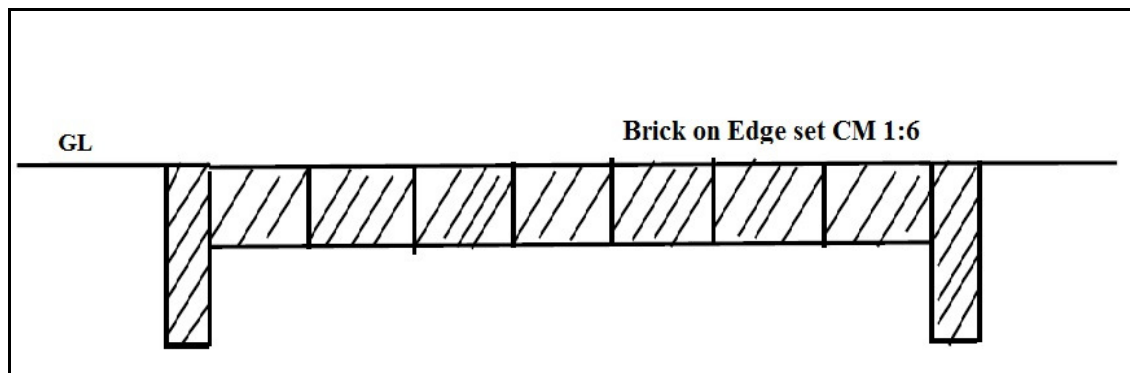


Figure 17. Typical design of a brick walk way of 1.2 m wide

6.8. DUMPING OF SOLID WASTES ON THE LAKE EMBANKMENTS

- Garbage and other municipal and domestic solid waste were found dumped near the lake. This waste should be segregated into compostable and non-compostable components. The compostable component may include food wastes, paper, and vegetation that can be composted on site, which can be used later as fertilizer. The non-compostable fraction, which includes plastic, paper, metal parts and batteries, should be collected and stored on site until transferred to the government hazardous waste disposal site.
- During our survey, it was noted that several birds do visit the garbage

dumping yard managed by M/s Puducherry Municipal Services Private Ltd., at Kurumbapet, due to its location in the close vicinity of the sanctuary. Hence, It is suggested that the Forest Department discuss with the Municipal authorities to explore possibilities of better methods of scientifically managing municipal solid wastes, such as sanitary land filling.

- Industrial solid waste should be collected from the nearby locations of lakes and transported to Treatment Storage and Disposal Facility (TSD), Gummudipundi, Chennai as notified by Tamil Nadu Pollution Control Board. Further, on a model basis, the Puducherry forest department should explore resources for funding towards the transportation of around five truck load (container) of industrial solid waste every month for a year. Later, the local naturalist groups and forest department should co-ordinate with the environment and CSR wing of industries in order to continue the process from their own sources.
- It is proposed to train / educate the local public about the repercussions of open dumping practices related to solid waste, manning the surroundings and warnings and punishments / penalties. Awareness programmes related to importance of wetlands and their conservation in terms of open dumping needs to be conducted. It is also urged to implement proper waste management and treatment programs in and around the lake.
- Ban on use of plastics and discharge of solid and liquid effluents into the wetlands must be strictly implemented.
- The Forest Department in collaboration with the Confederation of Indian Industries (CII), Puducherry chapter may initiate an orientation program in sensitizing all the industries located in the vicinity to refrain from dumping of solid wastes around the lake.

6.9. DISPOSAL OF SEWAGE

The untreated effluent reaching Oussudu waters is likely to lead to deterioration of water quality in the lake. Sewage and other contaminants reaching Suthukeni canal is a source of pollutants to the lake. The forest department, Puducherry proposes

renovation of this canal, which would go a long way towards improving the quality of the wetland. During the renovation, attention needs to be given to the following:

- Clearing the canal all along its course for silt and solid wastes
- Reinforcing its sides and closing all unauthorized discharges to it
- Preventing any sewers joining the canal and enforcing appropriate treatment of discharges to the canal
- Regular monitoring of water quality of the canal
- Erecting grids at the entry point of the canal to wetlands in order to prevent the entry of any floating solids
- Regular cleaning of the installed grids.
- Making compulsory preliminary treatment practices for all the industrial and commercial complexes, and hospitals.
- Monitoring the discharge of hazardous chemicals and biomedical wastes.
- Erecting sign-posts and guide-posts that instruct the pedestrians and other travellers not to litter in the channel
- Control discharge of obnoxious chemicals let out from various unauthorised point / fugitive sources and washouts from fuel outlets
- Leaching of metals from tanning and leather industries near the lake should be monitored on a regular basis.
- It is suggested that the Forest Department in collaboration with the CII should work out a mechanism of installing a common effluent treatment plant (CETP). Forest department may take initiative in organizing the meeting with all the industries in this regard and make necessary follow-ups in pursuing the matter with them.
- The Forest Department may initiate an orientation program in sensitizing all the industries located in the vicinity to refrain them from discharge of effluents or drawl of water from the lake for industrial use; and the importance of the Oussudu sanctuary in providing several ecosystem services.

6.10. WEED INFESTATION

- The alarming growth of weed species such as *Eichhornia crassipes*, *Pistia stratioides*, *Salvinia molesta*, *Polygonum galbrum*, *P. hydropiper* and *Typha angustifolia* in the lake needs to be managed scientifically. Regular removal of these weeds will help sustain the canal, its habitat quality and species diversity, vegetation structure, water quality, salinity, etc. Initially physical removal of weeds may be necessary in the wetlands, its surroundings and the channel. Apart from the above-mentioned weeds, other weed species growing along with aquatic vegetation also needs to be removed.
- The best way of eradicating weed infestation is to prevent the seeds and remnants of weeds from germinating and colonizing again in water rich with dissolved nutrients. Thus, regular monitoring of these aquatic weeds near the study area and routine clean up strategy should be strictly followed, to have a check on weed colonization.
- With respect to *Prosopis juliflora*, it is suggested to manually remove every possible saplings of this species found in the area. The species is known to remain in viable form for more than 09 months in cattle's stomach / rumen. Thus, measures like quarantine should be taken especially with respect to this species. Photographs with small description about the weeds may be circulated in the form of pamphlets to the local people to keep them informed about the invading potential and concurrent loss to biodiversity, and as to how to eradicate these weeds.

6.11. AUTOMOBILE EXHAUST AND POLLUTION

The noise created by vehicles would disturb the birds. Thus, measures such as facilitating a smooth flow of traffic by avoiding junctions / signals and steep speed-breakers may help reduce the pollutant levels. Further, it is suggested to construct a bridge over the canal in order to restrict vehicular movement at the roads adjoining Oussudu embankments. Caution / signboards should be placed at appropriate places for the visitors. Speed limit for vehicles must be strictly monitored as per these caution boards.

6.12. CONSTRUCTION DEBRIS AND OTHER DISTURBANCES

The establishment of watchtowers involves movement of materials and people to the area and intensive activities during the construction. This is likely to alter the local biological environment. It would be preferable to use prefabricated materials for construction of the watchtower to minimize disturbance. Construction debris and the associated waste will spoil the lake in several ways and therefore appropriate measures to handle such wastes need to be identified. Further, signs and hoardings should be put up in order to draw attention of the tourists about waste problems. A parking lot should be identified with appropriate facilities and strategy to manage wastes and other pollutants arising from the parking lot should be conceived.

6.13. SOIL EROSION AND SILTATION

Soil erosion and siltation is a major threat to the very survival of any wetland. To overcome this problem it is suggested to plant trees at edges of Oussudu lake and Suthukeni canal, and install silt traps along the channels that drain storm water to the canal. Further, systematic dredging can be followed during lean months in order to avoid sedimentation and siltation after consultation with experts. Regular monitoring of water depth could also be a good method of keeping track about siltation and availability of the water spread area. In addition, the outlets of the lake (several of them exist now) should be opened during high flood month to flush out the sedimentary materials (silt) and other agrochemicals.

6.14. MAINTAINING CLEANLINESS NEAR LAKE

- Tourists should be advised not to carry food items while visiting lake banks for bird watching in order to avoid throwing up of food materials and other solid waste such as packing materials and polythene bags into the water. Moreover, the existing waste materials dumped near the boathouse and along the banks of the lake, as observed during our survey, should also be cleaned.
- While efforts should be made to improve the ecotourism activities in and

around the lake, efforts also must be taken to ensure that the walkway and nearby areas are not littered by tourists. Necessary instructions may be given in the entry point for all concerned. Hence, the whole stretch should be declared as “**Litter free zone**”.

- Restaurants produce huge quantum of both biodegradable and non-biodegradable waste, and sludge rich in organic load. Thus, appropriate ways to handle these wastes and subsequent discharges in an ecologically and environmentally benign manner need to be adopted.
- It is expected that on an average more than half a kilogram of solid waste including biodegradable as well as non-biodegradable components will be generated per person per day in a premium tourist location. Thus, tourism department should adopt special strategy for handling different types of wastes based on the expected number of tourists each day.
- Toilet and other such public conveniences also need to be provided with treatment facilities so that human excrements do not get into the environment.

6.15. WATER AND LAND USE PLANNING

- There should be continuous monitoring of the water supply and sewage water generated by the human settlements and industries around the lake. Based on the approvals granted to the existing and new industrial units, and other institutions by the town planning department regular assessment of solid and liquid waste generated within the catchment areas of the drains and water tanks need to be carried out.
- There should be a periodic assessment of boundaries of the lake and their water harvesting area. Boundary pillars and fencing should be provided wherever necessary. The revenue department of the state government should initiate proper land use plan and policy within the catchment areas of the lake and on the either side of the drains. A buffer belt of 5 to 10 meters should be maintained around the lake. Regulating the existing settlements in and around the lake, including encroachments and unauthorized constructions / hutments need to be regularized and planned.

6.16. ECOFRIENDLY/ORGANIC AGRICULTURE

It is anticipated that there would be leaching of agrochemicals (residues of chemical fertilizers and pesticides) applied in the adjoining paddy field of Oussudu lake, affecting the species diversity in the lake. Large influxes of phosphorous generated primarily from agricultural activities and detergents remain a critical management concern. The primary productivity when compared with other lakes of India is tending towards hyper-eutrophy. Thus, it is strongly recommended to stop chemical farming in the villages that are along the banks of Oussudu lake. Thus, organic farming should be promoted initially and be obligatory later on. Incentive programme for developing organic farming must be planned. Publicity material with respect to organic farming in the area will be useful in maintaining healthy environment.

6.17. NATURE EDUCATION AND INTERPRETATION CENTRE

Owing to the rich flora and fauna the lake harbours, necessary arrangements need to be made available for displaying important species of birds, butterflies, aquatic vegetation, etc. Signage and display boards, depicting the picture and brief information about different species, may be placed along the walkways for better understanding and appreciation by the visitors / tourists. These displays need to be designed in appropriate sizes and placed non-obtrusively. Regular staffs should be appointed for nature education and outreach activities and space need to be identified for establishing an interpretation centre. The staff designated for outreach should include a nature education officer / fellows and assistants. During drier months, due to reduced availability of birds in the lake, this centre would become a tourist attraction wherein, the tourists will get information about the lake and better orientation about the importance of wetlands and its associated biodiversity.

6.18. TRAINING AND AWARENESS PROGRAMMES

- There is a need to create awareness among the officials as well as public regarding environmental aspects of the Oussudu lake. Appropriate training

programmes for the officials, public as well as the members of local non-government organizations have to be formulated and should be carried out on a regular basis.

- It is suggested that regular awareness and nature education programmes be conducted through various eco-clubs in schools and colleges.
- Short film shows or slide shows may be conducted on floral and faunal wealth and their conservation implications in the region. The printed handbooks, posters and brochures may be circulated to the tourists visiting the area to propagate the message of conservation to the public at large and student community particularly.
- During the socio-economic survey several local people had shown interest to learn about biodiversity of the area especially avifauna. Thus, training on nature and environment should be given to them so that they can serve as tourist guide / bird watchers and improve their livelihood. Further, this can also be one of the alternate livelihood options.

6.19. INFORMATION MANAGEMENT SYSTEM

A detailed Information Management System (IMS) needs to be put on board by covering all the information regarding the environment of the lake. The information collected, stored and analyzed should include meteorological data, short details about biodiversity, land use and settlement details, industrial details located around lake, water use, sewage flows, tank water levels, ground water data, lake depth details and water quality.

6.20. PUBLIC PARTICIPATION

The people residing around the Oussudu lake should be involved for management purposes, which can be done by forming a committee for the lake similar to that of EDC. The committee should monitor the status of the lake and protect it against encroachment by public and dumping of solid wastes into the water bodies. These committees can also generate funds for the maintenance of parks, walkways, fountains and lighting.

6.21. PLANTATION FOR HABITAT IMPROVEMENT

Naturally occurring species should be selected for plantation along the lake embankments. Tree species that are likely to attract birds for nesting and the herbs that attract butterflies and birds may also be planted. These species should be commonly seen in and around the lake, fast growing and drought resistant. Seedlings / saplings of these species can be easily procured from local nurseries. A well-managed green belt of these trees all along the sides of the lake may improve the local environment by reducing the noise and dust pollution. A thick layer of green belt near the vehicle parking lot is also advised that will help reduce the sound. Appropriate parking space has to be provided buffered around by a green belt of thick bushes and trees with thick and low canopy. 25 tree species that can be considered for planting are listed in Table 18. The selection of plant species depends on various factors such as climate, elevation and soil. The plants exhibiting the following characteristics should be selected for plantation:

- The species should be fast growing and providing optimum penetrability.
- The species should be wind-resistant and deep-rooted.
- The species should form a dense canopy.
- As far as possible, the species should be indigenous and locally available.
Species tolerance to air pollutants like suspended particulate matter, sulphur dioxide and oxides of nitrogen should be preferred.
- The species should be permeable to help create air turbulence and mixing within the belt.
- There should be no large gaps for the air to spill through.
- Trees with high foliage density, leaves with larger leaf area and hairy on both the Surfaces.
- Ability to withstand conditions like inundation and drought.
- Soil improving plants, such as nitrogen fixing plants, rapidly decomposable leaf litter.
- Having attractive flowers and fruit bearing.
- Bird and insect attracting tree species.
- Sustainable green cover with minimal maintenance

Species that can trap / sequester more carbon can also be a criterion for selection.

6.22. BUTTERFLY PARK

Rich assemblage of butterflies is present in the area. A butterfly park may be developed as an added tourist attraction, preferably sans-enclosure, depending on land and resource availability. Several of these attractive butterflies can be attracted to a selected area through developing a properly planned and managed butterfly park with required nectar resources and larval food plant for the butterflies. The butterfly park has to be a simulation of butterflies' natural habitat having nectar and host plants suiting the needs of various species of butterflies. A suggestive list of plant species for attracting more butterflies to the park is given in Table 19. Visitors can also learn about the lifecycle and other aspects of butterflies. Similar open butterfly park is also developed at Thenmala, Kollam district of Kerala by the Tourism Department of Govt. of Kerala.

6.23. SUSTAINABLE LAKE MANAGEMENT THROUGH COMMUNITY PARTICIPATION

- After desilting and eviction of encroachments, it is necessary to keep the lakes clean and green, which cannot be done only by the department of Forest and Wildlife, and thus responsible community participation is proposed.
- Responsible NGO's, Self Help Group (SHG), welfare associative entrepreneurs under the coordination of concerned departments can jointly manage the maintenance of the lakes. During the initial period, awareness creation, education and capacity building of the core groups and public is most essential. Hence, series of continuous programme have to be proposed under this section. Additionally, engaging local people in the development and conservation initiatives will keep them engaged in activities for lake restoration and in turn, activities such as poaching and hunting may be minimized.
- Each village may be given Rs. 5.00 lakh for forming SHG or wetland protection committee for maintaining the suitable alternate livelihood in consultation with the corresponding stakeholders.

- People from communities like Narikurava may be employed in development concerning the lake such as cleanliness works around the lake, and as watch and/or security guards for watchtower and other facilities as suggested. This would reduce their activities of hunting birds for their subsistence.

Table 18. List of tree species suggested for planting in and around the Oussudu sanctuary

S. No.	Scientific Name	Family	Common Name
1	<i>Albizia lebbbeck</i>	Caesalpiniaceae	Vaagai
2	<i>Azadirachta indica</i>	Meliaceae	Veppamaram
3	<i>Bauhinia raceamosa</i>	Caesalpiniaceae	Aathi
4	<i>Bombax malabaricum</i>	Bombacaceae	Mul Ilavu
5	<i>Borassus flabellifer</i>	Arecaceae	Panai
6	<i>Butea monosperma</i>	Fabaceae	Porusamaram
7	<i>Calophyllum inophyllum</i>	Clusiaceae	Punnai
8	<i>Cassine clauca</i>	Celastraceae	Keeri maram
9	<i>Ceiba pentandra</i>	Bombacaceae	Ilava maram
10	<i>Diospyros montana</i>	Ebenaceae	Vakkanathi
11	<i>Erythrina stricta</i>	Fabaceae	Kalyana murungai
12	<i>Ficus benghalensis</i>	Moraceae	Aala maram
13	<i>Ficus religiosa</i>	Moraceae	Arasamaram
14	<i>Gmelina arborea</i>	Verbenaceae	Kumizham
15	<i>Mangifera indica</i>	Anacardiaceae	Mamaram
16	<i>Madhuca longifolia</i>	Sapotaceae	Iluppai
17	<i>Mimusops elengi</i>	Sapotaceae	Makizham
18	<i>Pongamia pinnata</i>	Fabaceae	Pungam
19	<i>Syzygium cumini</i>	Myrtaceae	Naaval
20	<i>Tamarindus indicus</i>	Caesalpiniaceae	Puliya maram
21	<i>Tectona grandis</i>	Verbenaceae	Thekku
22	<i>Terminalia arjuna</i>	Myrtaceae	Vellai Maruthu: Neermathi
23	<i>Thespesia populnea</i>	Malvaceae	Poovarasu
24	<i>Vitex altissima</i>	Verbenaceae	Mayiladi
25	<i>Ziziphus mauritiana</i>	Rhamnaceae	Ilanthai

6.24. FORMATION OF ANTI POACHING CAMPS AND REHABILITATION OF NARIKKURAVA COMMUNITY

One of the most important issues to be dealt with for conserving the birds in and around Oussudu sanctuary is hunting. Since poaching of birds for livelihood is very common practice around the lake especially by the members of Narikurava community, engaging them as anti-poaching watchers is important. The local people can be engaged to assist in organizing special camps in the remote area and for regular patrolling of the area to prevent poaching activities. A few members from Narikurava community may be included as anti-poaching watchers, as most of them are willing to give up hunting, if appropriate employment opportunities are provided. Since, most of the Narikkurava community members are illiterates or school dropouts; they prefer to have their profession as conservancy workers in the municipal and/or town panchayat area, or as security guard in different establishments/offices. The forests department should decide upon the livelihood options (preferably poultry, piggery and livestock) for this community in co-ordination with village level committees and SHGs. Thus, the Government of Puducherry may consider in employing them in appropriate positions in the many options mentioned in this chapter. Nevertheless, they need to be employed for different works as suggested after providing them with proper training about the importance of wildlife and biodiversity in general, and the role of the lake in providing sustainable livelihood for local populace and its ecological significance particularly.

Table 19. List of plants suggested for planting in Butterfly Park

Sr No	Common Name	Scientific Name	Habit
1	Wild Cotton	<i>Calotropis gigantea</i>	Shrub
2	Lantana	<i>Lantana camara</i>	Shrub
3	Shoe flower (Gudhal)	<i>Hibiscus rosa-sinensis</i>	Shrub
4	Pedilanthus variegated	<i>Pedilanthus tithymalodes</i>	Shrub
5	Wadelia	<i>Wadelia triolobata</i>	Ground cover
6	Menya	<i>Menya erecta</i>	Shrub

Sr No	Common Name	Scientific Name	Habit
7	Lemon	<i>Citrus limon</i>	Tree
8	Singapori Ixora	<i>Ixora singaporensis</i>	Shrub
9	Allamanda	<i>Allamanda cathartica</i>	Shrub
10	Gardenia	<i>Gardenia lucida</i>	Shrub
11	Plumbago	<i>Plumbago capensis</i>	Shrub
12	Tagar (Chandani)	<i>Tabernaemontana divaricata</i>	Shrub
13	Kachnar- Blue	<i>Bauhinia purpurea</i>	Tree
14	Kachnar- yellow	<i>Bauhinia tomentosa</i>	Tree
15	Golden bamboo	<i>Bambusa goldeana</i>	Shrub
16	Kaner	<i>Nerium oleander</i> var. <i>roseum</i>	Shrub
17	Tapioca	<i>Manihot esculenta</i>	Shrub
18	Justicia	<i>Justicia aurea</i> var. <i>variegata</i>	Shrub
19	Gardenia variegated	<i>Gardenia lucida</i> var. <i>variegata</i>	Shrub
20	Russelia	<i>Russelia juncia</i>	Shrub
21	Chinese Ixora	<i>Ixora chinensis</i>	Shrub
22	False Heather	<i>Cuphea hyssopifolia</i>	Ground cover
23	Periwinkle	<i>Vinca rosea</i>	Ground cover
24	Lantana	<i>Lantana sellowiana</i>	Ground cover
25	Kaner	<i>Nerium divaricatum</i>	Shrub
26	Cassia	<i>Cassia bicapsularis</i>	Tree
27	Kadipatta	<i>Murraya koenigi</i>	Shrub

6.25. DATABASE ON BIODIVERSITY

- A database on plant species, insect, butterflies fish, herpetofauna, birds and mammals should be maintained by the department of Forest and Wildlife.
- The database on the available population size and the distribution of native fauna should be prepared through extensive survey.

6.26. ECO-FRIENDLY APPROACH

Tourism and construction activities can be in a more eco-friendly way. A few suggestions in this regard are given below:

- Benches, chairs, etc. are suggested to be made of local rocks, bamboo or such items for people visiting the area.
- Native plant species for plantation purposes should be preferred than the exotic ones.
- Striking colours may be avoided for the buildings and other structures.
- Striking, bright and attractive lights may deter birds hence, the same should be avoided.
- Lights at banks of the wetland near roadside may be fixed at low heights focussing towards the paths and bright lights directed upwards should be avoided. Compact fluorescent lamps may be used to meet light requirements, in order to save energy.
- In eateries and interpretation centres, sky windows and strategically placed windows may reduce lighting requirements.
- The watchtowers should be sufficiently camouflaged so that visitors would not affect the nesting birds.
- A portion of earnings from tourism should be earmarked for improvement of the local livelihood; environment and biodiversity that would directly help conserve the biodiversity in and around the lake.
- Special stalls for selling / promoting local eco-friendly products produced by self-help groups and others should be installed.
- Nature education camps may be arranged for students/ teachers, in collaboration with educational and research institutes, and schools.

6.27. ENVIRONMENTAL MONITORING AND MANAGEMENT CELL

The purpose of Environmental Monitoring is to evaluate the effectiveness of implementation of Comprehensive Management Action Plan (CMAP) by periodically monitoring the important environmental parameters in and around the lake area.

Several monitoring and executing groups can be constituted and the same in hierarchical order are as below:

- The Forest department in collaboration with Tourism department may develop a Local Environmental Monitoring Group (LEMG) that will monitor all the activities related to the lake, closely safeguard the environment in general and avifauna in particular. The monitoring group mainly manned by in-house officials may also include experts in the field along with officials responsible for wildlife protection.
- An Environmental Monitoring Cell (EMC) operated by officials supervised by an '**Environmental Monitoring Panel**' may also be constituted. The panel may involve members from agencies such as the Puducherry Forest Department, Pollution Control Board and Academic / Research institutions. The broad mandate of this panel should be to oversee the EMC and LEMG, and advise them on management of lake and its surrounding environment as and when required.
- The EMC should directly over see and ensure that the measures to be taken under the EMP is implemented properly and to ensure that the pollution parameters in lake are within the prescribed limits. The EMC in consultation with the local environmental group and environmental panel may also suggest appropriate changes in CMAP and its execution, if found necessary in due course of time. Some of the responsibilities of the EM are to:
 - i. conduct environmental awareness program for the workers, supervisory staff engaged in lake conservation.
 - ii. regularly monitor the environmental parameters and recommend necessary measures to improve the environmental conditions.
 - iii. advise on any negligence or derelictions on the part of concerned staff or workers in implementing CMAP and to advice on the necessary steps to be adopted.
 - iv. implement the CMAP.
 - v. assure regulatory compliance with all relevant rules and regulations.
 - vi. minimize environmental impacts of operations by strict adherence to the EMP.
 - vii. initiate environmental monitoring as per approved schedule.

- viii. review and interpret the monitored results, and suggest corrective measures in case the results are above the specified limit as applicable in local case scenario.
- ix. coordinate with regulatory agencies, external consultants, monitoring agencies.

6.28. INTER-STATE ENVIRONMENTAL PANEL

- There is a need for constituting an interstate panel including members from both Puducherry and Tamil Nadu, for coordinating conservation and management efforts for long-term sustainability of the lake.
- Representatives of the villages surrounding the lake may be identified to form Local Environmental Conservation Committee. This committee would act as bridge between local communities and administration and discuss all issues pertaining to environmental problem and solutions. A committee comprising of representatives of officials and people of both the states (Puducherry and Tamil Nadu) should be formed to look at issues pertaining to interest of people and environmental conservation on a broader scale.

6.29. BUDGET PROVISIONS

The budget requirements for implementing the Environment Management Plan for the Puducherry portion of the lake are given below. The budget is estimated for the first five-year period. Further justification for each of the major heads is also provided.

6.29.1. Abstract estimate

The abstract estimate given below summarises total estimate for duration of five years (Table 20) for the environment management and eco-restoration of the Oussudu sanctuary. The estimated amount is Rs. 546.33 lakhs for the first five-year period with annual break-ups. The major portion of the projected budget is envisaged to meet the expenditure towards project.

6.29.2. Detailed estimate

The detailed estimate given below (Table 21) provides detailed break-ups of the estimate under different heads mentioned above in Table 20.

Table 20. Summary of the budget estimate (in Rupees) for the EMP of Oussudu sanctuary

	Heads	1 Year	2 Year	3 Year	4 Year	5 Year	Total (Rs.)
1	Survey and demarcation	705000.00	---	---	---	---	705000.00
2	Catchment Area Treatment	3658610.00	5203775.00	875000.00	875000.00	625000.00	11237385.00
3	Protection Measures	7212000.00	4582000.00	1000000.00	1000000.00	1000000.00	14794000.00
4	Community Participation: Supplementary/Alternate livelihood	---	---	---	---	---	---
5	Biodiversity Conservation	155000.00	236795.00	125000.00	95000.00	95000.00	706795.00
6	Environmental Education and Awareness	8580000.00	740000.00	540000.00	540000.00	540000.00	10940000.00
7	Water management// Pollution Mitigation Measures	640000.00	600000.00	600000.00	580000.00	580000.00	3000000.00
8	Sustainable Resource Development	2250000.00	1750000.00	1750000.00	1750000.00	1750000.00	9250000.00
9	Impact Assessment through Concurrent and Terminal Evaluation	600000.00	600000.00	600000.00	600000.00	1600000.00	4000000.00
	Total	23800610.00	13712570.00	5490000.00	5440000.00	6190000.00	54633180.00
	ROUNDED OFF TO						54633000.00

Table 21. Details of the aspects covered under each head of the Budget estimate (in lakhs) for the EMP

No.	Head/ Category	1 Year	2 Year	3 Year	4 Year	5 Year	Total (Rs.)
1.	Survey and demarcation						
i.	Survey, mapping and demarcation of wetland based on revenue records, ground truthing	75000.00	---	---	---	---	75000.00
	Remote sensing imageries and maps	350000.00	---	---	---	---	350000.00
	Demarcation of lake boundary	280000.00	---	---	---	---	280000.00
	Total						705000.00
2.	Catchment Area Treatment						
i.	Vegetative contour bunding	---	4328775.00	---	---	---	4328775.00
ii.	Gully plugging	---	---	---	---	---	---
iii.	Check dams	---	---	---	---	---	---
iv.	Other water harvesting structures	---	---	---	---	---	---
v.	Desiltation and dredging	1208610.00	---	---	---	---	1208610.00
vi.	Periphery bunding	---	---	---	---	---	---
vii.	Stream bank erosion control	2200000.00	---	---	---	---	2200000.00
viii.	Raising of nurseries*	250000.00	250000.00	250000.00	250000.00	---	1000000.00
ix.	Plantation*	---	625000.00	625000.00	625000.00	625000.00	2500000.00
x.	Others	---	---	---	---	---	---
	Total						11237385.00
3.	Protection and Monitoring						
i.	Patrolling & surveillance*	3162000.00	2982000.00	---	---	---	6144000.00
ii.	Construction of watch towers*	600000.00	600000.00	---	---	---	1200000.00
iii.	Purchase of boats and canoes	3450000.00	---	---	---	---	3450000.00
iv.	Formation of village level protection committees	---	1000000.00	1000000.00	1000000.00	1000000.00	4000000.00
	Total						14794000.00
4.	Community Participation: Supplementary/Alternate livelihood						
i.	Training for various activities like piggery, animal husbandry, duckery,	---	---	---	---	---	---

No.	Head/ Category	1 Year	2 Year	3 Year	4 Year	5 Year	Total (Rs.)
	small cottage industry, mushroom cultivation, tailoring, carpet weaving, etc. <i>The cost to be managed as per the provision in item no. 3.iv.</i>						
ii.	others	---	---	---	---	---	---
	Total						NIL
5.	Biodiversity Conservation						
i.	Conservation of sensitive species through in-situ and ex-situ methods						
	Mounds	---	81795.00	---	---	---	81795.00
	Habitat manipulation: weed removal	130000.00	130000.00	100000.00	70000.00	70000.00	500000.00
	Animal Rescue Centre	25000.00	25000.00	25000.00	25000.00	25000.00	125000.00
ii.	Others	---	---	---	---	---	---
	Total						706795.00
6.	Environmental Education and Awareness						
i.	Launching various environmental awareness campaigns	100000.00	100000.00	100000.00	100000.00	100000.00	500000.00
ii.	Health camp and nature education camp	---	---	---	---	---	---
iii.	Way side exhibits/ display boards/ hoardings	550000.00	---	---	---	---	550000.00
iv.	Interpretation centre	7290000.00	---	---	---	---	7290000.00
v.	Nature trail	---	---	---	---	---	---
vi.	Group meetings	---	---	---	---	---	---
vii.	Street plays/ puppet show	---	---	---	---	---	---
viii.	Awareness among school children	80000.00	80000.00	80000.00	80000.00	80000.00	400000.00
ix.	Constitution of SHG/CBO	---	---	---	---	---	---
x.	Seminars/workshops	---	---	---	---	---	---
xi.	Use of media	200000.00	200000.00	---	---	---	400000.00
xii.	Others:	360000.00	360000.00	360000.00	360000.00	360000.00	1800000.00

No.	Head/ Category	1 Year	2 Year	3 Year	4 Year	5 Year	Total (Rs.)
	Technical Personnel for Interpretation Centre						
	Total						10940000.00
7.	Water Management/ Pollution Mitigation Measures						
i.	Sluice gates maintenance: Spindle operation (clock and anti-clockwise), and guide rails Total Sluice gates: 5 nos., Maintenance: Twice in 5 year period (1 st yr & 3 rd yr)	20000.00	---	20000.00	---	---	40000.00
ii.	Point and non-point source of pollution:						
	Organic farming for 2 model villages each year	400000.00	400000.00	400000.00	400000.00	400000.00	2000000.00
	Collection and transportation of industrial solid waste	180000.00	180000.00	180000.00	180000.00	180000.00	900000.00
	Coordination meeting CETP	40000.00	20000.00	---	---	---	60000.00
	Total						3000000.00
8.	Sustainable Resource Development						
i.	Economic valuation – to be performed by a group of experts (one time)	500000.00	---	---	---	---	500000.00
ii.	Sustainable agriculture and appropriate livelihood options	1000000.00	1000000.00	1000000.00	1000000.00	1000000.00	5000000.00
iii.	Sanctuary protection by engaging Narikkurava tribals	750000.00	750000.00	750000.00	750000.00	750000.00	3750000.00
	Total						9250000.00
9.	Impact Assessment through Concurrent and Terminal Evaluation						
i.	Quantitative and qualitative assessment	---	---	---	---	1000000.00	1000000.00
ii.	Monitoring and evaluation						
	Interstate Environmental Panel Meeting	200000.00	200000.00	200000.00	200000.00	200000.00	1000000.00
	Steering Committee Meeting	200000.00	200000.00	200000.00	200000.00	200000.00	1000000.00
	Advisory Committee Meeting	200000.00	200000.00	200000.00	200000.00	200000.00	1000000.00

No.	Head/ Category	1 Year	2 Year	3 Year	4 Year	5 Year	Total (Rs.)
	<i>Total</i>						4000000.00
	GRAND TOTAL						54633180.00
	ROUNDED OFF TO						54633000.00
	<i>In words: Rupees five hundred fourty six lakhs thirty three thousands only</i>						

6.29.3. Justifications for the budget provisions with specifications

Detailed justification along with required quantity and specifications are presented in the Table 22.

Table 22. Details of the justification (quantity and specifications) for the budget estimate

Sl. No.	Particulars	Unit cost (Rs.)	Total cost (Rs)
1.	Survey and demarcation: Survey, mapping and demarcation of wetland based on revenue records, ground truthing		
	Hiring of manpower and vehicle, coordinating with various departments – 3 months		
	Vehicle hires: 30 days	1500/- per day	45000.00
	Research fellow / Surveyor – 60 man days	500/- per day	30000.00
	Remote sensing imageries and maps – Land sat images 5 scenes	50000/- per scene	250000.00
	Image analysis (outsourcing)		100000.00
	Demarcation/fencing on land side from Pathukannu to ahead of boat house (on eastern side) and till the end of Puducherry boundary along the lake on western side – concrete pillars and chain link mesh for protection from stray cattle and garbage dumping: Total pillars: 280 no. Total distance to be covered : 7.0 km	1000 / pillar	280000.00
	Total cost		705000.00
2.	Catchment Area Treatment		
	Vegetative contour bunding		



Sl. No.	Particulars	Unit cost (Rs.)	Total cost (Rs)
	Canal – Length 6 km x 2 banks = 12000 m; Bund width 1.5 m x 2 sides = 3 m; Total Area = 36000 m ² ; Average height = 0.90 m Total Volume of earth filling = 13500 m ³ Grass planting over the earthen bund (only outer side): 10,800 m ²	272.65 / m ³ 60 / m ²	3680775.00 648000.00
	De siltation and dredging in the canal Removal of grass and vegetation and dispersal Total bed area = 6 km x 3 mt width = 18000 m ² Dredging (manual) by excavation: Ave depth – 0.50 m Total volume = 9000 m ³	247/ 100 m ² 129.35 / m ³	44460.00 1164150.00
	Stream bank erosion control: Stone patching in select places along the feeder canal Average thickness = 0.30 m with random rubble stones in CM 1:6. Extent to be covered : 2000 m ²	1100 / m ²	2200000.00
	Raising of nurseries: Raising of around 10,000 saplings 1 st yr – 2500 saplings, 2 nd yr – 2500 saplings, 3 rd yr – 2500 saplings, 4 th yr – 2500 saplings	100/ sapling	1000000.00
	Plantation: Annually around 2500 saplings to be continued for 4 years 1 st yr – nil (only raising of saplings), 2 nd yr – 2500 saplings, 3 rd yr – 2500 saplings, 4 th yr – 2500 saplings, 5 th yr – 2500 saplings: Total – 10000 nos. [Price is inclusive for pitting(3'x3'x3') transportation, planting]	250/ plant	2500000.00
	Total cost		11237385.00
3.	Protection and Monitoring		
	1) Patrolling and surveillance Patrolling path: 7.00 km length, 1.2 m width (brick on edge interlocking) = (7000 x 1.2) m ² = 8400 m ² @ Rs. 710 per m ²	5964000.00	
	Walky Talky – 10 nos. @ Rs. 15000 per unit (for 5 km range) Walky Talky control station – Rs. 30000.00	150000.00 30000.00	6144000.00
	2) Watch tower: 2 nos.	600000.00	1200000.00

Sl. No.	Particulars	Unit cost (Rs.)	Total cost (Rs)
	3) Boats and canoes Fibre glass boat – 2nos. @ Rs. 800000.00 per boat (4-6 seated) Inflatable rubber boats – 4 nos. @ Rs. 400000.00 per boat (4 seated) Canoes – 3 nos. @ Rs. 150000.00 per unit	1600000.00 1600000.00 450000.00	3450000.00
	4) Village level committee: 8 villages Each village can be given Rs. 5.00 lakh for forming SHG or wetland protection committee for maintaining the suitable alternate livelihood in consultation with the corresponding stakeholders. For details please see item no. 4. as below.	500000.00	4000000.00
	Total cost		14794000.00
4.	Community Participation: Supplementary/Alternate livelihood		
	Promotion of different livelihood options in the dependent (surrounding) villages The activities include: Horticulture, floriculture, poultry, piggery, vegetable growing, Orchards, fishery etc. The required budgetary estimate is mentioned in item no. 3.4 (previous item): The village level committee need to decide the option based on their skills, and resource availability and accessibility. Detailed options and budgetary provisions are mentioned in item no. 8 (iii).	---	---
	Total cost		---
5.	Biodiversity Conservation		
	1) Mounds: total 5 no.s Radius of each mound: 2.5 m; Area of each mound: 20 m ² ; Mound height (depth inside water: 2m, height above water: 1m): 3m Total Volume: 300 m ³	272.65 / m ³	81795.00
	2) Habitat manipulation: i. Manual removal of <i>Eichornia</i> , <i>Pistia</i> , <i>Prosopis</i> for 5 years 1 st yr – 1300 m ² , 2 nd yr – 1300 m ² , 3 rd yr – 1000 m ² , 4 th yr – 700 m ² , 5 th yr – 700 m ² : (Total – 5000 m ²)	100/ m ²	500000.00



Sl. No.	Particulars	Unit cost (Rs.)	Total cost (Rs)
	ii. <i>In-situ</i> methods are already presented in the previous section (item no. 5.1.)		
	iii. For preservation and protection of injured birds and animals: Animal Rescue Centre <i>The expenses would be towards land, enclosure, feed, medicine, care and maintenance</i>	25000/ year	125000.00
	Total cost		706795.00
6.	Environmental Education and Awareness		
	Environmental awareness campaigns (through various eco-clubs in schools and colleges). The eco-clubs need to be sponsored for various environmental education and outreach activities – around 20 eco-clubs for five year period @ 4 eco clubs/year	25000.00 / eco-club	500000.00
	Pictorial Brochures on Art paper: On Oussudu sanctuary, types of wetlands, ecological importance, important flora and faunal species [Bilingual in English & Tamil] for distribution among visitors, school students, eco clubs for 5 years. Approx. 10,000 nos.	25/ brochure	250000.00
	High quality illuminated Signage boards (Way side exhibits/ display boards/ hoardings): to be installed all along the periphery of the lake displaying various species and other resources of the wetland - @ 30 nos. for 3 km stretch (on land side) (cost is inclusive of the platform, and display)	10000.00 / board	300000.00
	Use of media: Documentary(4 nos) & short films(2 nos.) in different languages for publicity and awareness	50000/ documentary 100000/ short film	200000.00 200000.00
	Capacity building programmes: quarterly once = 4 programme x 5 years = 20 programme (various target groups: School, college, NGO, govt. officials, other stakeholders, villagers)	20000.00 / programme	400000.00
	Interpretation centre lay out (preferably within the premises of the Forest department, Puducherry Building (double storey): total 3200 ft ² @ Rs. 1500 per ft ² = Rs. 48.00 lakhs Facilities: Displays materials including furniture and office peripherals = Rs. 10.00 lakhs Air conditioning only for the conference hall – 2.00 lakhs	4800000.00 1000000.00 200000.00	4800000.00 1000000.00 200000.00
	Public Address System (Audio-visuals and peripherals): LCD screen, computer, projector	500000.00	500000.00

Sl. No.	Particulars	Unit cost (Rs.)	Total cost (Rs)
	for the seminar hall in the interpretation centre		
	Other details : Posters about wetlands, IUCN, Ramsar convention, important species, biodiversity of the area to be displayed in the interpretation centre)	50000.00	50000.00
	Binoculars – around 20 nos. (8 X 40x magnification) for staff as well as eco-tourists, and other visitors: schools children, etc.)	7000.00 / binocular	140000.00
	Telescope – 3 nos.	200000.00 / telescope	600000.00
	Technical Personnel for Interpretation Centre: One Ornithologist @ consolidated pay of Rs. 15000/month for five years One Botanists @ consolidated pay of Rs. 15000/month for five years	900000.00 900000.00	1800000.00
	Total cost		10940000.00
7.	Water Management/ Pollution Mitigation Measures		
	Sluice gates maintenance: Spindle operation (clock and anti-clockwise), and guide rails Total Sluice gates: 5 nos., Maintenance: 1 st yr & 3 rd yr only	4000.00 / gate	40000.00
	Point and non-point source of pollution:		
	i. Organic farming trials basis for 2 model villages @ Rs. 2.00 lakhs (to be given to SHG through EDC for promoting organic farming) - organic manure/ vermicomposting (discouraging people from chemical based farming system). 2 villages each year will be supported to adopt new methods.	200000/village	2000000.00
	ii. Collection of industrial solid waste and transportation to Treatment Storage and Disposal Facility (TSDF), Chennai [5 trucks for 12 months]	15000.00 / container	900000.00
	iii. Funding the coordination meeting for common effluent treatment plant (CETP) [3 meetings for finalizing the same]: 1 st year – 2 meetings, 2 nd year – 1 meeting	20000.00 / meeting	60000.00
	Total cost		3000000.00



Sl. No.	Particulars	Unit cost (Rs.)	Total cost (Rs)
8.	Sustainable Resource Development		
	i. Economic valuation – to be performed by a group of experts (one time)	500000.00	500000.00
	ii. Sustainable agriculture: for promoting organic farming, the forest Department may sponsor their agro-inputs cost, as well as monetary grants to continue with organic farming practices.	1000000 / per village / 5 closest model villages	5000000.00
	iii. Appropriate livelihood options: Forest department to decide the same after the formation of village level committees and SHGs, and fund the same (preferably one village may be selected for a particular activity: Horticulture, floriculture, poultry, piggery, vegetable growing, orchards (cash crops and fruits), fishery.		
	iv. Sanctuary protection works by engaging Narikkurava tribals (5 individuals x 2 shifts @ 250/day for 25 days/month for 5 years)	750000/year	3750000.00
	Total cost		9250000.00
9.	Impact Assessment through Concurrent and Terminal Evaluation		
	i. Quantitative and qualitative assessment after 05 years: post implementation scenario	1000000.00	1000000.00
	ii. Monitoring and evaluation – 3 tier system (meeting expenses): for five years		
	a. Interstate Environmental Panel – Annually (2.00 lakhs / meeting)		
	b. Steering Committee – Annually	200000.00 / meeting	1000000.00
	c. Advisory Committee – Annually	200000.00 / meeting	1000000.00
		200000.00 / meeting	1000000.00
	Total cost		4000000.00
	*GRAND TOTAL		54758180.00
	ROUNDED OFF TO		54633000.00
	In words: Rupees five hundred forty six lakhs thirty three thousands only		

*** Notes:**

- Rough cost for various units and works are only for guidance.
- Approximate estimate based on the site condition shall be prepared by the executing agency.



6.29.4. Post Implementation Scenario

In view of the management interventions and proposed habitat management programme as suggested in this chapter, it is envisaged that there would be considerable improvement from various dimensions to the ecosystem of Oussudu sanctuary, some of which (not to list all) are as below:

- Increased public awareness about the importance of Oussudu sanctuary and improved understanding on its ecosystem services and values.
- Annual dry cycle inducing growth of aquatic vegetation, i.e. more species diversity, and thereby, more number of migratory birds visiting the lake.
- Gradual increase in involvement of members of Narikurava community in protection of lake and other associated activities, thereby reducing the cases of hunting and poaching of birds in the area.
- Regulated harvesting of fish would also result in both maintaining a desired fish stock in the lake, which would attract more piscivorous birds, and sustainable benefit sharing among the fisherman community.
- Butterfly Park with required host plants would attract more butterflies, there by adding to the biodiversity of the lake environs.
- Overall forest cover and greenery in the area would be enhanced.
- Operationalisation of Nature Interpretation Centre would ensure more inflow of school and college students for bird and butterfly watching.
- Increased stakeholder participation and involvement in the lake ecosystem management and conservation of biodiversity in the area.
- Akin to all these issues, the improved situation in and around the sanctuary environs would attract more academicians and researchers to study additional issues regarding the lake ecosystem.

These may be considered as *success/progress indicators* of CMAP implementation, and thus, can be the deciding variables during the post implementation environmental monitoring.

7. EXECUTIVE SUMMARY

- The Government of India has been implementing the National Wetlands Conservation Programme (NWCP) in close collaboration with the State/UT Governments since the year 1985-86. Under the programme, 115 wetlands have been identified until now (MoEF, 2009). In Puducherry, the Oussudu Lake is the only lake that has been declared as a wetland of national importance. During 2008, the lake was declared as a bird sanctuary by the Government of Puducherry.
- Recently the lake and its surrounding are facing threats and pressures from several anthropogenic activities (encroachment, poaching and pollution) including rapid urbanizations and infrastructure developments in the immediate vicinity of the lake. Considering the importance of this wetland ecosystem, Government of Puducherry requested Sálím Ali Centre for Ornithology and Natural History (SACON) to prepare a Comprehensive Management Action Plan (CMAP) for Conservation of the Oussudu lake so that various conservation measures and management interventions can be taken up for long-term sustainability of this lake. SACON undertook the study during November 2010 to March 2011. However, expanding the scope, the surrounding villages were also surveyed.
- In all, 480 plant species, 166 bird species, 63 butterfly species, 29 reptilian species, 25 fish species, 14 mammalian species, 10 amphibians species, were recorded.
- As part of the Environmental Management Plan 23 issues were identified for management intervention in order to maintain the ecological integrity of the Oussudu sanctuary. However, a few important ones which should be implemented on priority basis are: 1) Boundary Demarcation, 2) Renovation of the feeder canal, 3) Infrastructure and logistics for patrolling, 4) Habitat Restoration, 5) Water Management, 7) Sustainable Resource Management, 8) Pollution control and Waste management, 9) Alternate livelihood for Narikkurava community, 10) Nature Education, extension and outreach programmes, 11) Interpretation 12) Database and Information Management, and 13) Inter-state environmental panel.

- Oussudu, being an Inter-state lake, requires constitution of a joint Inter-state environmental panel, in order to look after the environmental issues of the lake on both Puducherry and Tamil Nadu, and co-ordinate periodic environmental monitoring.
- Attempts also may be made to protect neighbouring wetlands such as Bahour lake as it offers supplementary habitats for many wetland species.
- Regular environmental monitoring and documentation of flora and fauna in and around the Oussudu lake should be under taken since the floral and faunal changes can be considered among the best and easily assessable indicators of environmental sustainability.
- The household questionnaire survey revealed diversified resource utilisation by the villagers and their dependency on Oussudu lake. Notably, during the survey all respondents opined upon the potential for promoting eco-tourism activities in the lake, and also expressed their willingness to be part of any sort of initiative been taken by the Government of Puducherry in near future.
- Looking at the need for maintaining the ecological integrity of wetlands and ecosystem goods and services, implementation of the suggested management plan in association with all the potential stakeholders would help in furthering the process of sustainable ecosystem management of Oussudu lake.

8. LITERATURE CITED

- Abbasi SA and Chari KB (2008). Environmental management of urban lakes: with special reference to Oussudu. Discovery Publishing House, New Delhi. 269 pp.
- Ahmedullah M and Nayar MP (1987). Endemic Plants of the Indian Region. Vol. 1. Botanical Survey of India, Howrah.
- Alexandar R (2010). Conservation of Ousteri Lake, Puducherry. Current Science. 98(4): 467.
- Alexandar R and Pushparaj P (2010). Resettlement of weaver birds (*Ploceus philippinus*) in Oussudu Lake. Current Science. 99(1): 10.
- Ali S and Ripley SD (1987). Compact handbook of the birds of India and Pakistan together with those of Bangladesh, Nepal, Bhutan and Sri Lanka. Oxford University Press, Delhi.
- Azeez PA, Bhupathy S, Ranjini J, Dhanya R and Nikhil Raj PP (2008). Management Plan for the Eco-restoration of Pallikaranai Reserve Forest. Report submitted to SACON, pp. 1-62.
- Azeez PA, Bhupathy S, Nikhil Raj PP and Chandra R (2009). Conservation of Kottuli Wetlands, Calicut, Kerala. Report submitted to Tourist Resorts (Kerala) Limited. pp. 1-66.
- Azeez PA, Nadarajan NR and Prusty BAK (2007). Macrophyte decomposition and its impact on the water quality. Edited Book on "Environmental Degradation and Protection" Volume – II, MD Publications, New Delhi, pp. 115-156.
- Azeez PA, Prusty BAK and Jagadeesh EP (2009). Select alkali and alkaline earth metals in decomposing macrophytes in a wetland system. Acta Ecologica Sinica. 29 (1): 13-19 (June 2009).
- Balachandran S and Alagarrajan R (1995). An ecological survey of the wetlands of Pondicherry with special reference to Oussudu lake. Institute of Restoration of Natural Environment. Nagercoil. Pp. 40.
- Balasubramanian, P and Vijayan L (2004). Conservation Strategies and Action Plans for the Avifauna of Tamil Nadu: in Tamil Nadu Biodiversity Strategy and Action Plan-Cordate Diversity (Edr. R. Annamalai). 76-99.
- Bang P, Dhalstrom P and Vevers G (1972). Collins guide to animal tracks and signs. Collins, London. 100pp.

- Bibby CJ, Burgess ND and Hill DA (1992). Bird Census Techniques. Academic Press publishers, 257p.
- Boulenger GA (1890). The fauna of British India, including Ceylon and Burma, Reptilia and Batrachia. Taylor and Francis xviii + 541 p.
- Burnham KP, Anderson DR and Laake JL (1980). Estimation of density from line transect sampling of biological populations. Wildlife Monographs 72.pp 202.
- Chandra R, Prusty BAK and Azeez PA (2009). Impact of *Prosopis juliflora* on Herbaceous Diversity in Keoladeo National Park, Bharatpur. Pp. 09-13. In: "Proceedings of the National Symposium on *Prosopis*: Ecological, Economic Significance and Management Challenges" (Eds. Thivakaran GA, Kumar A, Prusty BAK and Sunderraj SFW), Gujarat Institute of Desert Ecology, Bhuj, India. 115 pp.
- Chari KB and Abbasi SA (2003). Ecology, habitat and bird community structure at Oussudu lake: towards a strategy for conservation and management. Aquatic Conservation: Marine Freshwater Ecosystem. 13: 373-86.
- Chari KB and Abbasi SA (2007). Socio-economic implications of the Oussudu lake (Pondicherry, India). Hydrology Journal. 30 (3-4): 77-90.
- Colwell RK (1994-2004). EstimateS: Statistical estimation of species richness and shared species from samples. Version 7. Persistent URL <purl.oclc.org/estimates>.
- Curtis JT and Mc Intosh RP (1950). The interrelations of certain analytic and synthetic phytosociological characters. Ecology 31: 434-455.
- Daniel JC (1963). Field guide to the amphibians of Western India. Part 1. Journal of Bombay Natural History Society. 60 (2): 415-438; Part 2. 60(3): 690-702.
- Daniel JC (1975) Field guide to the amphibians of Western India. Part III. Journal of Bombay Natural History Society. 72(2):506-522.
- Daniel JC (1992). The book of Indian Reptiles, Bombay Natural History Society, Bombay. 136 pp.
- Daniel JC and Sekar AG (1989). Field guide to the amphibians of Western India. Part IV. Journal of Bombay Natural History Society. 86 (2):194-202.
- Daniel JC (2002). The book of Indian reptiles and amphibians. Oxford University Press, Oxford House, Mumbai. 238pp.

- Daniels RJR (1997a). A Field Guide to the Frogs and Toads of the Western Ghats, India: Part I., Cobra, 27:1-25.
- Daniels RJR (1997b). A Field Guide to the Frogs and Toads of the Western Ghats, India: Part III., Cobra, 29:1-24.
- Daniels RJR (2005). Amphibians of peninsular India. Universities press. Hyderabad, 268pp.
- Das I (2003). Growth of knowledge on the reptiles of India, with an introduction to systematics, taxonomy and nomenclature. J. Bombay Nat. Hist. Soc. 100 (2 & 3): 446-501.
- Gamble JS and Fischer CEC (1915-1936). The Flora of the Presidency of Madras. Part 1-11. (Part 1-7 by Gamble and 8-11 by Fischer). Adlard & Sons Ltd., London. (repr. ed. Vols. 1-3. 1957).
- Grimmett R, Inskipp C and Inskipp T (1998). Birds of the Indian Subcontinent. Christopher Helm Publishers Ltd. London. p. 888.
- Grimmett R, Inskipp C and Inskipp T (2000). Pocket guide to the birds of the Indian subcontinent. Oxford University Press., New York, 384pp.
- Grimmett R, Inskipp C and Inskipp T (2001). Pocket Guide to the Birds of the Indian Subcontinent. Oxford University Press, New Delhi. p. 1-384.
- Gunathilagaraj K, Perumal TNA, Jayaram K and Ganesh KM (1998). Some South Indian Butterflies: field guide. Published under Project Lifescape, Indian Academy of Science, Bangalore. pp: 274.
- Henry AN, K. Vivekananthan and N.C. Nair (1978). Rare and threatened flowering plants of South India. J. Bomb. Nat. Hist. Soc. 75:695-696.
- Henry AN, Kumari GR and Chitra V (1987). Flora of Tamil Nadu, India. Ser. 1: Analysis. Vol. 2. Botanical Survey of India, Coimbatore.
- Henry AN, V. Chitra and N.P. Balakrishnan (1989). Flora of Tamil Nadu, India. Ser. 1: Analysis. Vol. 3. Botanical Survey of India, Coimbatore.
- Heyer WR, Donnelly M, Mc Diarmid RW, Hayek LC and Foster MS (1994). Measuring and Monitoring Biological Diversity. Standard Methods for Amphibians. Smithsonian Institution Press, Washington, 364p.
- Hooker JD (1872-97). The Flora of British India. Vols. 1-7. Reeve & Co., London.
- <http://www.kerenvis.nic.in/biodiversity/Wetlands.pdf>.

- Hussain SA (2007). Integrated management of wetlands: A case study on Asan Conservation Reserve, Uttarakhand, India. *Indian Forester*. 133(10): 1305-1311.
- IUCN (2007). www.iucnredlist.org/info/gallery2004.
- Jayaram KC (1999). The freshwater fishes of the Indian region. Narendra Publishing House, Delhi. 551 pp.
- Jhunjhunwala S (1998) The Ornithological importance of Oussudu lake and Bahour lake: A study of the habitat preferences of their waterfowl and waders. M.Sc. Dissertation. Salim Ali School of Ecology and Environmental Sciences, Pondicherry University.
- Kehimkar I (2008). The book of Indian Butterflies. Sponsored by Tata Social Welfare Trust. BNHS, Oxford University Press, Bombay, India, 497 pp.
- Krishnan V and Srinivasan R (1996). Geo-Environmental Impact studies along the Tamilnadu coast between Ramanathapuram and Kollencode and Madras and Pulicate lake. In Project: Environmental Geological Studies (OP: Tamil Nadu and Pondicherry), Records of Geological survey of India, vol. 130. Pt-5.
- Kunte K (2000). India-a landscape butterflies of Penninsular India. Ed. Madhav Gadgil. Foreward Professor. E O, Wilson. Indian Academy of Sciences. University Press (India) Limited. 254 pp.
- Lande R (1996). Statistics and Partitioning of Species Diversity, and Similarity among Multiple Communities. *Oikos*. 76(1): 5-13.
- Larsen TB (1987a). The Butterflies of Nilgiri mountains of Southern India (Lepidoptera: Rhopalocera). *J. Bomb. Nat. Hist. Soci.* 84: 26- 54.
- Larsen TB (1987b). The Butterflies of Nilgiri mountains of Southern India (Lepidoptera: Rhopalocera). *J. Bomb. Nat. Hist. Soci.* 84: 291- 316.
- Larsen TB (1987c). The Butterflies of Nilgiri mountains of Southern India (Lepidoptera: Rhopalocera). *J. Bomb. Nat. Hist. Soci.* 84: 560- 584. .
- Larsen TB (1988) The Butterflies of Nilgiri mountains of Southern India (Lepidoptera: Rhopalocera). *J. Bomb. Nat. Hist. Soci.* 85: 26- 43.
- Ludwig JA and Reynolds JF (1988). Statistical ecology: a primer of methods and computing. Wiley Press, New York, New York. 337 pp.
- Matthew KM (1996). Illustrations on the Flora of the Palni Hills, South India. The Rapinat Herbarium, St. Joseph's College, Tiruchirappalli.

- Matthew KM (1999). The Flora of the Palni Hills, South India. The Rapinat Herbarium, St. Joseph's College, Tiruchirappalli.
- Menon V (2003). A field guide to Indian Mammals. Dorling Kindersley (India) Pvt. Limited. 200 pp.
- Mitsch WJ and Gosselink JG (2000). Wetlands (Third Edition). John Wiley & Sons, New York.
- MoEF (2009). National Wetland Conservation Programme Guidelines for Conservation and Management of Wetlands in India. Ministry of Environment, Govt. of India, New Delhi.
- Nair NC and Henry AN (1983). Flora of Tamil Nadu, India, Ser. 1: Analysis Vol. 1. Botanical Survey of India, Coimbatore.
- Nayar MP (1996). Hotspots of Endemic plants of India, Nepal and Bhutan. Tropical Botanic Garden and Research Institute, Thiruvananthapuram. New Delhi.
- Nobi EP, Umamaheswari R, Stella C and Thangaradjou T (2009). Land use and Land cover assessment along Pondicherry and its surroundings using Indian Remote Sensing Satellite and GIS. American-Euresian Journal of Scientific Research. 4 (2): 54-58.
- Philips EA (1959). Methods of vegetation study. Henry Holt & Co., New York.
- Prasad SN, Ramachandra TV, Ahalya N, Sengupta T, Kumar A, Tiwari AK, Vijayan VS and Vijayan L (2002). Conservation of wetlands of India – a review. Tropical Ecology. 43 (1): 173-186.
- Prusty BAK, Azeez PA and Jagadeesh EP (2007). Alkali and transition metals in macrophytes of a wetland system. Bulletin of Environmental Contamination and Toxicology. 78 (5): 405-410 (May 2007).
- Talwar PK and Jhingran AG (1991). Inland fishes of India and adjacent countries. Oxford and IBH publishing Co., New Delhi.
- Tam NFY and Wong WS (2000). Spatial variation of heavy metals in surface sediments of Hong Kong mangrove swamps. Environmental Pollution. 1: 195-205.
- Turner RK (1991). Economics and Wetland Management. Ambio. 20.
- Vijayan VS (1991). Keoladeo National Park Ecology Study (1980-1990), Final Report, Bombay Natural History Society, Bombay. 337 pp.

- Vijayan VS, Prasad SN, Vijayan L and Muralidharan S (2004). Inland Wetlands of India – Conservation Priorities. Sálim Ali Centre for Ornithology & Natural History, Coimbatore. pp. xxiv + 532.
- Whitaker R and Captain A (2004). Snakes of India-the field guide, Draco Books, Chennai. pp. 479.
- WPA (1972). Wildlife Protection Act. In: The Wildlife (Protection) Act, 1972. Professional Book Publishers, Wildlife Protection Society of India.

Appendix 1. Quantum of water received by Oussudu lake during January 1999 to
August 2010

Year	Month	Tank Water Reading (million m ³)	Inflow (Mcft)	Outflow (Mcft)	Tank Capacity (Mcft)
1999	January	3.55	Nil	Nil	522.89
	February	3.37	Nil	39.56	483.33
	March	3.12	Nil	59.97	423.36
	April	2.76	Nil	77.62	345.74
	May	2.42	Nil	70.46	275.28
	June	2.11	Nil	60.43	214.86
	July	1.81	Nil	60.43	154.42
	August	1.45	Nil	51.40	103.02
	September	1.47	28224	Nil	105.84
	October	1.36	Nil	13.41	92.43
	November	1.18	Nil	23.75	68.68
	December	1.63	603360	Nil	129.02
2000	January	2.17	96.77	Nil	225.79
	February	2.00	Nil	48.69	177.11
	March	1.91	Nil	12.35	164.76
	April	1.61	Nil	39.16	125.60
	May	1.40	Nil	28.93	96.67
	June	1.17	Nil	29.43	67.24
	July	0.95	Nil	27.72	39.51
	August	0.60	Nil	22.58	16.94
	September	0.33	Nil	3.66	13.27
	October	0.28	Nil	0.75	12.52
	November	0.77	12.17	Nil	24.70
	December	1.00	21.87	Nil	46.57
2001	January	1.21	29.29	Nil	75.86
	February	1.14	Nil	12.98	62.88
	March	0.87	Nil	31.13	31.75
	April	0.76	Nil	7.76	23.99
	May	0.57	Nil	8.11	15.88
	June	Nil	Nil	15.88	Nil
	July	Nil	Nil	Nil	Nil
	August	Nil	Nil	Nil	Nil
	September	Nil	Nil	Nil	Nil
	October	0.87	31.75	Nil	31.75
	November	0.88	0.71	Nil	32.46
	December	0.94	5.64	Nil	38.10

Year	Month	Tank Water Reading (million m ³)	Inflow (Mcft)	Outflow (Mcft)	Tank Capacity (Mcft)
2002	January	0.88	Nil	Nil	32.46
	February	0.80	Nil	16.23	26.81
	March	0.69	Nil	10.23	20.11
	April	0.56	Nil	6.39	15.53
	May	0.32	Nil	13.72	13.23
	June	0.07	Nil	Nil	9.70
	July	Nil	Nil	Nil	Nil
	August	Nil	Nil	Nil	Nil
	September	Nil	Nil	Nil	Nil
	October	0.51	14.08	Nil	14.08
	November	1.00	32.49	Nil	46.57
	December	0.96	Nil	5.64	40.92
2003	January	1.00	5.64	Nil	46.57
	February	0.85	Nil	16.23	30.34
	March	0.65	Nil	10.23	20.11
	April	0.43	Nil	6.39	13.72
	May	Nil	Nil	13.72	Nil
	June	Nil	Nil	Nil	Nil
	July	Nil	Nil	Nil	Nil
	August	Nil	Nil	Nil	Nil
	September	Nil	Nil	Nil	Nil
	October	Nil	Nil	Nil	Nil
	November	0.98	43.75	Nil	43.75
	December	1.20	27.84	Nil	71.59
2004	January	1.16	Nil	4.80	66.78
	February	1.10	Nil	8.92	57.86
	March	0.91	Nil	23.28	34.57
	April	0.71	Nil	13.77	20.81
	May	0.49	Nil	6.82	13.99
	June	1.14	48.89	Nil	62.88
	July	1.01	Nil	14.90	47.98
	August	0.78	Nil	22.58	25.40
	September	0.64	Nil	7.06	18.34
	October	0.81	9.17	Nil	27.52
	November	2.11	187.34	Nil	214.86
	December	3.43	281.18	Nil	496.04
2005	January	3.12	Nil	72.68	423.36
	February	2.86	Nil	58.56	364.80

Year	Month	Tank Water Reading (million m ³)	Inflow (Mcft)	Outflow (Mcft)	Tank Capacity (Mcft)
	March	2.62	54.14	50.80	313.99
	April	2.38	Nil	Nil	368.13
	May	2.25	Nil	127.87	240.26
	June	2.05	Nil	48.69	191.57
	July	1.93	Nil	24.34	167.23
	August	1.53	Nil	52.92	114.31
	September	1.46	Nil	9.88	104.43
	October	1.39	Nil	8.82	95.61
	November	1.46	8.80	Nil	104.43
	December	3.12	318.93	Nil	423.36
2006	January	3.50	87.49	Nil	510.85
	February	3.37	Nil	27.53	483.33
	March	3.11	Nil	62.79	420.54
	April	2.90	Nil	47.28	373.26
	May	2.66	Nil	49.39	323.87
	June	2.37	Nil	57.51	266.36
	July	2.07	Nil	67.03	199.33
	August	1.86	Nil	39.87	159.47
	September	1.74	Nil	10.72	148.74
	October	1.65	Nil	15.70	133.04
	November	2.34	128.03	Nil	261.07
	December	3.01	132.30	Nil	393.37
2007	January	3.05	10.23	Nil	403.60
	February	2.77	Nil	56.10	347.51
	March	2.67	Nil	21.17	326.34
	April	2.37	Nil	59.98	266.36
	May	2.00	Nil	89.26	177.11
	June	1.83	Nil	20.82	156.29
	July	1.74	Nil	7.55	148.74
	August	1.51	Nil	37.26	111.48
	September	1.33	Nil	22.23	89.26
	October	1.17	Nil	22.03	67.23
	November	1.91	97.53	Nil	164.76
	December	2.11	50.10	Nil	214.86
2008	January	2.83	135.59	Nil	350.44
	February	2.90	22.82	Nil	373.26
	March	2.78	Nil	23.99	349.27
	April	2.84	11.29	Nil	360.76

Year	Month	Tank Water Reading (million m ³)	Inflow (Mcft)	Outflow (Mcft)	Tank Capacity (Mcft)
	May	2.60	Nil	50.80	309.76
	June	2.35	Nil	43.92	262.84
	July	2.13	Nil	42.69	220.15
	August	1.89	Nil	57.51	162.64
	September	1.80	Nil	9.03	153.61
	October	1.63	Nil	24.59	129.02
	November	1.95	41.03	Nil	170.05
	December	3.51	345.04	Nil	515.09
2009	January	3.51	Nil	Nil	515.09
	February	3.32	Nil	42.34	472.75
	March	3.07	Nil	63.50	409.25
	April	2.91	Nil	33.87	375.38
	May	2.65	Nil	53.98	321.40
	June	2.37	Nil	55.04	266.36
	July	2.08	Nil	63.15	203.31
	August	1.88	Nil	41.63	161.58
	September	1.71	Nil	16.47	145.11
	October	1.59	Nil	22.33	122.77
	November	1.50	Nil	12.70	110.07
	December	3.11	310.48	Nil	420.56
2010	January	3.52	94.53	Nil	FTL
	February	3.38	Nil	29.64	485.45
	March	3.15	Nil	54.68	430.77
	April	2.86	Nil	65.97	364.80
	May	2.62	Nil	50.80	313.99
	June	2.40	Nil	42.34	271.66
	July	2.37	Nil	5.29	266.36
	August	2.18	Nil	39.16	227.20
Source: Irrigation Division, Public Works Department, Government of Puducherry					

Appendix 2. Questionnaire used for household survey during the present study

**Comprehensive Management Action Plan for Conservation of Oussudu Lake
Socio-Economic Survey in Puducherry, Household Level Questionnaire**

Name of the Surveyor:

Date:

General

1. Name of the Respondent:
2. Village:
3. Taluk:
4. Type of Family: Nuclear/Joint
5. Family members:

Name	Age	Sex	Educational qualification	Occupation		Annual expenditure	
				Main	Other	Food	Other

6. Type of House: a. Kuchcha: b. Pakka: c. Semi
pakka:

7. Owned/ Rented
8. Electricity: Yes/No
9. Sanitation: Yes/No

Agriculture

10. Landholdings: Agriculture/Housing Plot/Other

11. Type of Land (ha):

- Irrigated land
- Non- irrigated
- Wasteland
- Other, Pls. specify

12. Type of Irrigation:

1. Groundwater:

Source:

Duration:

2. Surface water:

Source:

Duration:

13. Cropping Pattern:

a. Monoculture

b. Polyculture

Season	Name of the crop	Cropping area (ha)	Product (Yield kg/ha)

Livestock

14. Do you have any livestock? Yes/No

Live-stock	Male	Female	Total	Income from livestock
Sheep				
Goat				
Cow				
Buffalo				
Bull				
Poultry				
Others (Specify)				

15. Annual Income:

Agriculture	Expenditure	Income
1. Monsoon		
2. Winter		
3. Summer		
4. Milk & Milk products		
5. Daily wages		
6. Others (Specify)		

16. Any health related problems: Yes/No

If Yes, then

17. Energy resource:

Energy source	Amount	Source	Expenditure (yearly)
Firewood			
Charcoal			
Cow dung cake			
Gobar gas			
LPG gas			
Solar store			

Electric Heater			
Others Plz(specify)			

18. Any improvements in resources accessibility and/or availability in recent past?

Yes/No

If yes, then pls. Specify the type of improvement/benefit and source...

a. Income increased b. Transportation facility c. Electricity d. Others (specify)...

19. What are the problems you are facing in recent years?

1. Diseases.....
2. Problem in agriculture land.....
3. Reduction in quality of crops.....
4. Others (specify).....

19. Problem from Wildlife: Yes/No

If yes then

Animal	Nature of Damage	Annual Loss (Rs.)

20. What do you suggest for improving the environment quality in your village?

.....

21. What are the lakes around your village?

.....

22. How much you are dependent on lake for your needs: Partially/Fully

Partially...

Fully.....

23. Distance between your home and lake:

24. Location you go for fishing-Lake/Dam:

25. Area you cover while fishing - (Near bank/ middle of lake)

Location-1:

Location-2:

Location-3:

26. How frequently you go for fishing: Daily/Weekly/Monthly/ Seasonally

a. Time of fishing: Morning/Noon/Evening/ Night/

b. Which season: Summer/Winter/Monsoon/All season

c. Quantum of fish catch:.....

27. What are the Fish species you have collected so far?

.....



.....

Species from Oussudu lake:

.....

.....

28. Other species you have observed in and around your village:

Birds:.....

.....

Mammals:.....

.....

Turtles:.....

.....

30. Your opinion about tourism potential of Oussudu lake:

.....

.....

31: Interest of village folk towards of wildlife:

.....

.....

Appendix 3. List of plant species in and around Oussudu sanctuary

Sl. No.	Name of the plant species	Family	Habitat
1	<i>Andrographis alata</i>	Acanthaceae	Herb
2	<i>Asystasia dalzeliiana</i>	Acanthaceae	Herb
3	<i>Asystasia gangetica</i>	Acanthaceae	Herb
4	<i>Barleria acuminata</i>	Acanthaceae	Shrub
5	<i>Barleria buxifolia</i>	Acanthaceae	Herb
6	<i>Barleria cristata</i>	Acanthaceae	Shrub
7	<i>Barleria prionotis</i>	Acanthaceae	Shrub
8	<i>Blepharis molluginifolia</i>	Acanthaceae	Herb
9	<i>Blepharis tetraphylla</i>	Acanthaceae	Herb
10	<i>Crossandra infundibuliformis</i>	Acanthaceae	Herb
11	<i>Ecbolium viride</i>	Acanthaceae	Herb
12	<i>Indoneesiella echioides</i>	Acanthaceae	Herb
13	<i>Justicia betonica</i>	Acanthaceae	Shrub
14	<i>Justicia gendarussa</i>	Acanthaceae	Shrub
15	<i>Justicia procumbens</i>	Acanthaceae	Herb
16	<i>Justicia simplex</i>	Acanthaceae	Herb
17	<i>Justicia tranquebariensis</i>	Acanthaceae	Herb
18	<i>Ruellia patula</i>	Acanthaceae	Herb
19	<i>Ruellia tuberosa</i>	Acanthaceae	Herb
20	<i>Strobilanthus consanguinea</i>	Acanthaceae	Shrub
21	<i>Agave americana</i>	Agavaceae	Shrub
22	<i>Mollugo cerviana</i>	Aizoaceae	Herb
23	<i>Mollugo nudicaulis</i>	Aizoaceae	Herb
24	<i>Mollugo pentaphylla</i>	Aizoaceae	Herb
25	<i>Trianthema decandra</i>	Aizoaceae	Herb
26	<i>Caldesia parnassifolia</i>	Alismataceae	Herb
27	<i>Limnophytum obtusifolium</i>	Alismataceae	Herb
28	<i>Aloe vera</i>	Aloeaceae	Herb
29	<i>Achyranthes aspera</i>	Amaranthaceae	Herb
30	<i>Achyranthes bidentata</i>	Amaranthaceae	Herb
31	<i>Aerva lanata</i>	Amaranthaceae	Herb
32	<i>Aerva persica</i>	Amaranthaceae	Herb
33	<i>Alternanthera paronychioides</i>	Amaranthaceae	Herb
34	<i>Alternanthera pungens</i>	Amaranthaceae	Herb
35	<i>Alternanthera sessilis</i>	Amaranthaceae	Herb
36	<i>Alternanthera tenella</i>	Amaranthaceae	Herb
37	<i>Amaranthus spinosus</i>	Amaranthaceae	Herb
38	<i>Amaranthus viridis</i>	Amaranthaceae	Herb
39	<i>Celosia polygonoides</i>	Amaranthaceae	Herb
40	<i>Digera muricata</i>	Amaranthaceae	Herb
41	<i>Gomphrena decumbens</i>	Amaranthaceae	Herb
42	<i>Nothosaerva brachiata</i>	Amaranthaceae	Herb
43	<i>Psilotrichum elliotii</i>	Amaranthaceae	Herb
44	<i>Pupalia lappacea</i>	Amaranthaceae	Herb
45	<i>Trichurus monsoniae</i>	Amaranthaceae	Herb

Sl. No.	Name of the plant species	Family	Habitat
46	<i>Crinum asiaticum</i>	Amaryllidaceae	Shrub
47	<i>Pancratium triflorum</i>	Amaryllidaceae	Herb
48	<i>Buchanania axillaris</i>	Anacardiaceae	Tree
49	<i>Mangifera indica</i>	Anacardiaceae	Tree
50	<i>Semecarpus anacardium</i>	Anacardiaceae	Tree
51	<i>Artabotrys odoratissimus</i>	Annonaceae	Straggler
52	<i>Polyalthia longifolia</i>	Annonaceae	Tree
53	<i>Polyalthia suberosa</i>	Annonaceae	Tree
54	<i>Centella asiatica</i>	Apiaceae	Herb
55	<i>Carissa carandas</i>	Apocynaceae	Shrub
56	<i>Carissa spinarum</i>	Apocynaceae	Shrub
57	<i>Rauvolfia tetraphylla</i>	Apocynaceae	Shrub
58	<i>Thevetia peruviana</i>	Apocynaceae	Tree
59	<i>Wrightia tinctoria</i>	Apocynaceae	Tree
60	<i>Aponogeton natans</i>	Aponogetanaceae	Herb
61	<i>Colocasia esculenta</i>	Araceae	Shrub
62	<i>Cryptocoryne retrospiralis</i>	Araceae	Herb
63	<i>Cryptocoryne spiralis</i>	Araceae	Herb
64	<i>Pistia stratiotes</i>	Araceae	Herb
65	<i>Borassus flabellifer</i>	Arecaceae	Tree
66	<i>Cocos nucifera</i>	Arecaceae	Tree
67	<i>Corypha umbraculifera</i>	Arecaceae	Tree
68	<i>Phoenix loureirii</i>	Arecaceae	Shrub
69	<i>Phoenix sylvestris</i>	Arecaceae	Tree
70	<i>Aristolochia bracteolata</i>	Aristolochiaceae	Climber
71	<i>Aristolochia indica</i>	Aristolochiaceae	Climber
72	<i>Asclepias curassavica</i>	Asclepiadaceae	Herb
73	<i>Calotropis gigantea</i>	Asclepiadaceae	Shrub
74	<i>Calotropis procera</i>	Asclepiadaceae	Shrub
75	<i>Gymnema montanum</i>	Asclepiadaceae	Climber
76	<i>Hemidesmus indicus</i>	Asclepiadaceae	Climber
77	<i>Ichnocarpus frutescens</i>	Asclepiadaceae	Climber
78	<i>Leptadania reticulata</i>	Asclepiadaceae	Climber
79	<i>Oxystelma esculentum</i>	Asclepiadaceae	Climber
80	<i>Pentstemonis microphylla</i>	Asclepiadaceae	Climber
81	<i>Pergularia daemia</i>	Asclepiadaceae	Climber
82	<i>Sarcostemma brunonianum</i>	Asclepiadaceae	Climber
83	<i>Sarcostemma intermedium</i>	Asclepiadaceae	Climber
84	<i>Tylophora benthamii</i>	Asclepiadaceae	Climber
85	<i>Tylophora indica</i>	Asclepiadaceae	Climber
86	<i>Wattakaka volubilis</i>	Asclepiadaceae	Climber
87	<i>Acanthospermum hispidum</i>	Asteraceae	Herb
88	<i>Ageratum conyzoides</i>	Asteraceae	Herb
89	<i>Chromolaena odorata</i>	Asteraceae	Shrub
90	<i>Eclipta alba</i>	Asteraceae	Herb
91	<i>Parthenium hysterophorus</i>	Asteraceae	Herb
92	<i>Synedrella nodiflora</i>	Asteraceae	Herb

Sl. No.	Name of the plant species	Family	Habitat
93	<i>Wedelia urticifolia</i>	Asteraceae	Herb
94	<i>Millingtonia hortensis</i>	Bignoniaceae	Tree
95	<i>Spathodea campanulata</i>	Bignoniaceae	Tree
96	<i>Tecoma stans</i>	Bignoniaceae	Tree
97	<i>Bombax ceiba</i>	Bombacaceae	Tree
98	<i>Ceiba pentandra</i>	Bombacaceae	Tree
99	<i>Carmona retusa</i>	Boraginaceae	Shrub
100	<i>Coldenia procumbens</i>	Boraginaceae	Herb
101	<i>Cordia obliqua</i>	Boraginaceae	Tree
102	<i>Cordia sebastiana</i>	Boraginaceae	Tree
103	<i>Ehretia pubescens</i>	Boraginaceae	Shrub
104	<i>Glinus lotoides</i>	Boraginaceae	Herb
105	<i>Glinus oppositifolius</i>	Boraginaceae	Herb
106	<i>Heliotropium indicum</i>	Boraginaceae	Herb
107	<i>Lepidagathis cristata</i>	Boraginaceae	Herb
108	<i>Commiphora berryi</i>	Burseraceae	Tree
109	<i>Lannaea coromandelica</i>	Burseraceae	Tree
110	<i>Opuntia stricta</i>	Cactaceae	Shrub
111	<i>Albizia amara</i>	Caesalpiniaceae	Tree
112	<i>Albizia lebbeck</i>	Caesalpiniaceae	Tree
113	<i>Bauhinia racemosa</i>	Caesalpiniaceae	Tree
114	<i>Caesalpinia bonduc</i>	Caesalpiniaceae	Straggler
115	<i>Cassia alata</i>	Caesalpiniaceae	Shrub
116	<i>Cassia auriculata</i>	Caesalpiniaceae	Shrub
117	<i>Cassia fistula</i>	Caesalpiniaceae	Tree
118	<i>Cassia javanica</i>	Caesalpiniaceae	Tree
119	<i>Cassia montana</i>	Caesalpiniaceae	Tree
120	<i>Cassia obtusa</i>	Caesalpiniaceae	Herb
121	<i>Cassia occidentalis</i>	Caesalpiniaceae	Herb
122	<i>Cassia siamea</i>	Caesalpiniaceae	Tree
123	<i>Cassia tora</i>	Caesalpiniaceae	Shrub
124	<i>Delonix elata</i>	Caesalpiniaceae	Tree
125	<i>Delonix regia</i>	Caesalpiniaceae	Tree
126	<i>Peltophorum pterocarpum</i>	Caesalpiniaceae	Tree
127	<i>Pithecellobium dulce</i>	Caesalpiniaceae	Tree
128	<i>Samanea saman</i>	Caesalpiniaceae	Tree
129	<i>Tamarindus indica</i>	Caesalpiniaceae	Tree
130	<i>Cadaba indica</i>	Capparidaceae	Straggler
131	<i>Capparis aphylla</i>	Capparidaceae	Tree
132	<i>Capparis grandis</i>	Capparidaceae	Tree
133	<i>Capparis sepiaria</i>	Capparidaceae	Straggler
134	<i>Capparis zeylanica</i>	Capparidaceae	Straggler
135	<i>Cleome aspera</i>	Capparidaceae	Herb
136	<i>Cleome monophylla</i>	Capparidaceae	Herb
137	<i>Cleome viscosa</i>	Capparidaceae	Herb
138	<i>Crateva adansonii</i>	Capparidaceae	Tree
139	<i>Crateva magna</i>	Capparidaceae	Tree

Sl. No.	Name of the plant species	Family	Habitat
140	<i>Gynondropsis pentaphylla</i>	Capparidaceae	Herb
141	<i>Maerua oblongifolia</i>	Capparidaceae	Straggler
142	<i>Polycarpaea corymbosa</i>	Caryophyllaceae	Herb
143	<i>Polycarpon prostratum</i>	Caryophyllaceae	Herb
144	<i>Cassine glauca</i>	Celastraceae	Tree
145	<i>Celastrus paniculatus</i>	Celastraceae	Straggler
146	<i>Maytanus emarginata</i>	Celastraceae	Shrub
147	<i>Ceratophyllum demersum</i>	Ceratophyllaceae	Herb
148	<i>Ceratopteris thalictroides</i>	Ceratopteridaceae	Herb
149	<i>Calophyllum inophyllum</i>	Clusiaceae	Tree
150	<i>Combretum ovalifolium</i>	Combretaceae	Straggler
151	<i>Terminalia arjuna</i>	Combretaceae	Tree
152	<i>Terminalia bellirica</i>	Combretaceae	Tree
153	<i>Terminalia catappa</i>	Combretaceae	Tree
154	<i>Commelina benghalensis</i>	Commelinaceae	Herb
155	<i>Commelina clavata</i>	Commelinaceae	Herb
156	<i>Commelina longifolia</i>	Commelinaceae	Herb
157	<i>Cynotis tuberosa</i>	Commelinaceae	Herb
158	<i>Cuscuta reflexa</i>	Convolvulaceae	Climber
159	<i>Evolvulus alsinoides</i>	Convolvulaceae	Herb
160	<i>Evolvulus nummularius</i>	Convolvulaceae	Herb
161	<i>Ipomoea cornea</i>	Convolvulaceae	Shrub
162	<i>Ipomoea hederifolia</i>	Convolvulaceae	Climber
163	<i>Ipomoea pescarpae</i>	Convolvulaceae	Climber
164	<i>Ipomoea pestigiridis</i>	Convolvulaceae	Climber
165	<i>Merremia emarginata</i>	Convolvulaceae	Herb
166	<i>Merremia tridentata</i>	Convolvulaceae	Herb
167	<i>Coccinia grandis</i>	Cucurbitaceae	Climber
168	<i>Cucumis</i> sp.	Cucurbitaceae	Climber
169	<i>Diplocyclos palmatus</i>	Cucurbitaceae	Climber
170	<i>Kedrotsis foetidissima</i>	Cucurbitaceae	Climber
171	<i>Luffa aegyptiaca</i>	Cucurbitaceae	Climber
172	<i>Mukia maderaspatana</i>	Cucurbitaceae	Climber
173	<i>Bulbostylis barbata</i>	Cyperaceae	Herb
174	<i>Cyperus articulatus</i>	Cyperaceae	Herb
175	<i>Cyperus corymbosus</i>	Cyperaceae	Herb
176	<i>Cyperus difformis</i>	Cyperaceae	Herb
177	<i>Cyperus digitatus</i>	Cyperaceae	Herb
178	<i>Cyperus distans</i>	Cyperaceae	Herb
179	<i>Cyperus exaltatus</i>	Cyperaceae	Herb
180	<i>Cyperus iria</i>	Cyperaceae	Herb
181	<i>Cyperus nutuns</i>	Cyperaceae	Herb
182	<i>Cyperus pangorei</i>	Cyperaceae	Herb
183	<i>Cyperus pilosus</i>	Cyperaceae	Herb
184	<i>Cyperus procerus</i>	Cyperaceae	Herb
185	<i>Cyperus rotundus</i>	Cyperaceae	Herb
186	<i>Fimbristylis argentea</i>	Cyperaceae	Herb

Sl. No.	Name of the plant species	Family	Habitat
187	<i>Fimbristylis bisumbellata</i>	Cyperaceae	Herb
188	<i>Fimbristylis cinnamometorum</i>	Cyperaceae	Herb
189	<i>Fimbristylis complanata</i>	Cyperaceae	Herb
190	<i>Fimbristylis cymosa</i>	Cyperaceae	Herb
191	<i>Fimbristylis dichotoma</i>	Cyperaceae	Herb
192	<i>Fimbristylis miliaceae</i>	Cyperaceae	Herb
193	<i>Fimbristylis ovata</i>	Cyperaceae	Herb
194	<i>Kyllinga nemoralis</i>	Cyperaceae	Herb
195	<i>Mariscus paniceus</i>	Cyperaceae	Herb
196	<i>Scirpus littoralis</i>	Cyperaceae	Herb
197	<i>Diospyros montana</i>	Ebenaceae	Tree
198	<i>Maba buxifolia</i>	Ebenaceae	Shrub
199	<i>Bergia ammanioides</i>	Elatinaceae	Herb
200	<i>Acalypha indica</i>	Euphorbiaceae	Herb
201	<i>Acalypha fruticosa</i>	Euphorbiaceae	Shrub
202	<i>Breynia vitis-idaea</i>	Euphorbiaceae	Shrub
203	<i>Croton sparsiflorus</i>	Euphorbiaceae	Herb
204	<i>Drypetes roxburghii</i>	Euphorbiaceae	Tree
205	<i>Drypetes sepiaria</i>	Euphorbiaceae	Tree
206	<i>Euphorbia hirta</i>	Euphorbiaceae	Herb
207	<i>Euphorbia microphylla</i>	Euphorbiaceae	Herb
208	<i>Euphorbia rosea</i>	Euphorbiaceae	Herb
209	<i>Fluggea leucopyros</i>	Euphorbiaceae	Shrub
210	<i>Fluggea virosa</i>	Euphorbiaceae	Shrub
211	<i>Jatropha curcus</i>	Euphorbiaceae	Shrub
212	<i>Jatropha glandulifera</i>	Euphorbiaceae	Shrub
213	<i>Jatropha gossypifolia</i>	Euphorbiaceae	Shrub
214	<i>Jatropha tanjorensis</i>	Euphorbiaceae	Shrub
215	<i>Mallotus philippensis</i>	Euphorbiaceae	Tree
216	<i>Micrococca mercurialis</i>	Euphorbiaceae	Herb
217	<i>Phyllanthus emblica</i>	Euphorbiaceae	Tree
218	<i>Phyllanthus gardenerii</i>	Euphorbiaceae	Herb
219	<i>Phyllanthus maderaspatensis</i>	Euphorbiaceae	Herb
220	<i>Phyllanthus polyphyllus</i>	Euphorbiaceae	Shrub
221	<i>Phyllanthus reticulatus</i>	Euphorbiaceae	Shrub
222	<i>Phyllanthus uliginosa</i>	Euphorbiaceae	Herb
223	<i>Phyllanthus wightianus</i>	Euphorbiaceae	Herb
224	<i>Ricinus communis</i>	Euphorbiaceae	Tree
225	<i>Sebastiania chamaelea</i>	Euphorbiaceae	Herb
226	<i>Tragia involucrata</i>	Euphorbiaceae	Climber
227	<i>Tragia plukenetii</i>	Euphorbiaceae	Climber
228	<i>Abrus precatorius</i>	Fabaceae	Straggler
229	<i>Aeschynomene aspera</i>	Fabaceae	Herb
230	<i>Alysicarpus monilifer</i>	Fabaceae	Herb
231	<i>Alysicarpus rugosus</i>	Fabaceae	Herb
232	<i>Alysicarpus vaginalis</i>	Fabaceae	Herb
233	<i>Butea monosperma</i>	Fabaceae	Tree

Sl. No.	Name of the plant species	Family	Habitat
234	<i>Canavalia gladiata</i>	Fabaceae	Climber
235	<i>Clitoria ternatea</i>	Fabaceae	Climber
236	<i>Crotalaria evolvuloides</i>	Fabaceae	Herb
237	<i>Crotalaria juncea</i>	Fabaceae	Herb
238	<i>Crotalaria mysorensis</i>	Fabaceae	Herb
239	<i>Crotalaria verrucosa</i>	Fabaceae	Shrub
240	<i>Dalbergia paniculata</i>	Fabaceae	Tree
241	<i>Derris scandens</i>	Fabaceae	Straggler
242	<i>Desmodium gangeticum</i>	Fabaceae	Herb
243	<i>Glychirrhiza glabra</i>	Fabaceae	Straggler
244	<i>Indigofera linnaei</i>	Fabaceae	Herb
245	<i>Indigofera tinctoria</i>	Fabaceae	Shrub
246	<i>Indigofera trifoliata</i>	Fabaceae	Herb
247	<i>Indigofera trita</i>	Fabaceae	Herb
248	<i>Pongamia pinnata</i>	Fabaceae	Tree
249	<i>Pseudarthria viscida</i>	Fabaceae	Herb
250	<i>Rhynchosia minima</i>	Fabaceae	Herb
251	<i>Rothia indica</i>	Fabaceae	Herb
252	<i>Sesbania procumbens</i>	Fabaceae	Herb
253	<i>Stylosanthes fruticosus</i>	Fabaceae	Herb
254	<i>Tephrosia purpurea</i>	Fabaceae	Herb
255	<i>Tephrosia villosa</i>	Fabaceae	Herb
256	<i>Vigna trilobata</i>	Fabaceae	Herb
257	<i>Zornia gibbosa</i>	Fabaceae	Herb
258	<i>Flacourtia indica</i>	Flacourtiaceae	Tree
259	<i>Flacourtia</i> sp.	Flacourtiaceae	Tree
260	<i>Enicostemma littorale</i>	Gentianaceae	Herb
261	<i>Salacia chinensis</i>	Hippocrateaceae	Straggler
262	<i>Loseneeriella obtusifolia</i>	Hippocratiaceae	Straggler
263	<i>Hydrilla verticillata</i>	Hydrocharitaceae	Herb
264	<i>Ottelia alismoides</i>	Hydrocharitaceae	Herb
265	<i>Anisomeles indica</i>	Lamiaceae	Herb
266	<i>Anisomeles malabarica</i>	Lamiaceae	Shrub
267	<i>Hyptis suaveolens</i>	Lamiaceae	Herb
268	<i>Leanotis nepetifolia</i>	Lamiaceae	Herb
269	<i>Ocimum sanctum</i>	Lamiaceae	Herb
270	<i>Orthosiphon pallidus</i>	Lamiaceae	Herb
271	<i>Cassytha filiformis</i>	Lauraceae	Climber
272	<i>Barringtonia acutangula</i>	Lecythidaceae	Tree
273	<i>Lemna minor</i>	Lemnaceae	Herb
274	<i>Gloriosa superba</i>	Liliaceae	Herb
275	<i>Sansevieria roxburghiana</i>	Liliaceae	Herb
276	<i>Hugonia mystax</i>	Linaceae	Straggler
277	<i>Strychnos nux-vomica</i>	Loganiaceae	Tree
278	<i>Dendrophthoea falcata</i>	Loranthaceae	Shrub
279	<i>Ammania baccifera</i>	Lythraceae	Herb
280	<i>Abutilon hirtum</i>	Malvaceae	Shrub

Sl. No.	Name of the plant species	Family	Habitat
281	<i>Abutilon indicum</i>	Malvaceae	Shrub
282	<i>Hibiscus micranthus</i>	Malvaceae	Herb
283	<i>Hibiscus vitifolius</i>	Malvaceae	Shrub
284	<i>Pavonia procumbens</i>	Malvaceae	Herb
285	<i>Pavonia zeylanica</i>	Malvaceae	Herb
286	<i>Sida acuta</i>	Malvaceae	Herb
287	<i>Sida cordata</i>	Malvaceae	Herb
288	<i>Sida cordifolia</i>	Malvaceae	Herb
289	<i>Sida rhomboidea</i>	Malvaceae	Herb
290	<i>Thespesia populnea</i>	Malvaceae	Tree
291	<i>Urena lobata</i>	Malvaceae	Shrub
292	<i>Memecylon edule</i>	Melastomataceae	Shrub
293	<i>Memecylon umbellatum</i>	Melastomataceae	Shrub
294	<i>Azadirachta indica</i>	Meliaceae	Tree
295	<i>Khaya senegalensis</i>	Meliaceae	Tree
296	<i>Melia azaderach</i>	Meliaceae	Tree
297	<i>Swietenia macrophylla</i>	Meliaceae	Tree
298	<i>Cissampelos pereira</i>	Menispermaceae	Climber
299	<i>Cocculus hirsutus</i>	Menispermaceae	Climber
300	<i>Pachygone ovata</i>	Menispermaceae	Climber
301	<i>Tiliacora acuminata</i>	Menispermaceae	Straggler
302	<i>Tinospora cordifolia</i>	Menispermaceae	Climber
303	<i>Acacia auriculiformis</i>	Mimosaceae	Tree
304	<i>Acacia caesia</i>	Mimosaceae	Straggler
305	<i>Acacia chundra</i>	Mimosaceae	Tree
306	<i>Acacia leucophloea</i>	Mimosaceae	Tree
307	<i>Acacia mangium</i>	Mimosaceae	Tree
308	<i>Acacia nilotica</i>	Mimosaceae	Tree
309	<i>Acacia torta</i>	Mimosaceae	Straggler
310	<i>Adenanthera pavoniana</i>	Mimosaceae	Tree
311	<i>Dicrostachys cinerea</i>	Mimosaceae	Shrub
312	<i>Prosopis juliflora</i>	Mimosaceae	Tree
313	<i>Ficus benghalensis</i>	Moraceae	Tree
314	<i>Ficus hispida</i>	Moraceae	Tree
315	<i>Ficus racemosa</i>	Moraceae	Tree
316	<i>Ficus religiosa</i>	Moraceae	Tree
317	<i>Streblus asper</i>	Moraceae	Tree
318	<i>Syzygium cuminii</i>	Myrtaceae	Tree
319	<i>Najas indica</i>	Najadaceae	Herb
320	<i>Najas minor</i>	Najadaceae	Herb
321	<i>Boerhavia diffusa</i>	Nyctaginaceae	Herb
322	<i>Boerhavia erecta</i>	Nyctaginaceae	Herb
323	<i>Nelumbo nucifera</i>	Nymphaeaceae	Herb
324	<i>Nymphaea nouchalii</i>	Nymphaeaceae	Herb
325	<i>Ochna ontusata</i>	Ochnaceae	Shrub
326	<i>Jasminum rigidum</i>	Oleaceae	Straggler
327	<i>Biophytum sensitivum</i>	Oxalidaceae	Herb

Sl. No.	Name of the plant species	Family	Habitat
328	<i>Pandanus odoratissimus</i>	Pandanaceae	Tree
329	<i>Passiflora foetida</i>	Passifloraceae	Climber
330	<i>Martynia annua</i>	Pedaliaceae	Herb
331	<i>Pedaliium murex</i>	Pedaliaceae	Herb
332	<i>Plumbago zeylanica</i>	Plumbaginaceae	Shrub
333	<i>Alloteropsis cimicina</i>	Poaceae	Grass
334	<i>Andropogon pumilus</i>	Poaceae	Grass
335	<i>Apluda mutica</i>	Poaceae	Grass
336	<i>Aristida adscensionis</i>	Poaceae	Grass
337	<i>Aristida funiculata</i>	Poaceae	Grass
338	<i>Aristida hystrix</i>	Poaceae	Grass
339	<i>Arundo donax</i>	Poaceae	Grass
340	<i>Axonophus compressus</i>	Poaceae	Grass
341	<i>Bambusa arundinacea</i>	Poaceae	Tree
342	<i>Bothriochloa pertusa</i>	Poaceae	Grass
343	<i>Brachiaria ramosa</i>	Poaceae	Grass
344	<i>Brachiaria remota</i>	Poaceae	Grass
345	<i>Cenchrus ciliaris</i>	Poaceae	Grass
346	<i>Centotheca lappacea</i>	Poaceae	Grass
347	<i>Chloris barbata</i>	Poaceae	Grass
348	<i>Chloris dolichostachya</i>	Poaceae	Grass
349	<i>Chrysopogon aciculatus</i>	Poaceae	Grass
350	<i>Chrysopogon asper</i>	Poaceae	Grass
351	<i>Coelachyrum lagopoides</i>	Poaceae	Grass
352	<i>Cymbopogon citratus</i>	Poaceae	Grass
353	<i>Cymbopogon flexuosus</i>	Poaceae	Grass
354	<i>Cymbopogon martinii</i>	Poaceae	Grass
355	<i>Cynodon barberi</i>	Poaceae	Grass
356	<i>Cynodon dactylon</i>	Poaceae	Grass
357	<i>Dactyloctenium aegyptium</i>	Poaceae	Grass
358	<i>Dactyloctenium aristatum</i>	Poaceae	Grass
359	<i>Echinochloa colona</i>	Poaceae	Grass
360	<i>Eleusine indica</i>	Poaceae	Grass
361	<i>Eragrostis amabilis</i>	Poaceae	Grass
362	<i>Eragrostis plumosa</i>	Poaceae	Grass
363	<i>Eragrostis unioides</i>	Poaceae	Grass
364	<i>Eragrostis viscosa</i>	Poaceae	Grass
365	<i>Iseilema antheoporoides</i>	Poaceae	Grass
366	<i>Iseilema laxum</i>	Poaceae	Grass
367	<i>Leptochloa chinensis</i>	Poaceae	Grass
368	<i>Manisurus myoros</i>	Poaceae	Grass
369	<i>Mnesithea laevis</i>	Poaceae	Grass
370	<i>Ophiuros exaltatus</i>	Poaceae	Grass
371	<i>Oplismenus compositus</i>	Poaceae	Grass
372	<i>Oropetium thomaeum</i>	Poaceae	Grass
373	<i>Oryza sativa</i>	Poaceae	Grass
374	<i>Panicum notatum</i>	Poaceae	Grass

Sl. No.	Name of the plant species	Family	Habitat
375	<i>Panicum psilopodium</i>	Poaceae	Grass
376	<i>Panicum trypheron</i>	Poaceae	Grass
377	<i>Paspalidium flavidum</i>	Poaceae	Grass
378	<i>Paspalidium geminatum</i>	Poaceae	Grass
379	<i>Paspalidium punctatum</i>	Poaceae	Grass
380	<i>Paspalum longifolium</i>	Poaceae	Grass
381	<i>Paspalum scrobiculatum</i>	Poaceae	Grass
382	<i>Paspalum vaginatum</i>	Poaceae	Grass
383	<i>Perotis indica</i>	Poaceae	Grass
384	<i>Phragmites karka</i>	Poaceae	Shrub
385	<i>Saccarum spontaneum</i>	Poaceae	Grass
386	<i>Sacciolepis indica</i>	Poaceae	Grass
387	<i>Sehima nervosa</i>	Poaceae	Grass
388	<i>Setaria verticillata</i>	Poaceae	Grass
389	<i>Setaria pumila</i>	Poaceae	Grass
390	<i>Sporobolus coromandelianus</i>	Poaceae	Grass
391	<i>Sporobolus indicus</i>	Poaceae	Grass
392	<i>Sporobolus maderaspatanus</i>	Poaceae	Grass
393	<i>Sporobolus spicatus</i>	Poaceae	Grass
394	<i>Typha angustata</i>	Poaceae	Shrub
395	<i>Vetiveria zizanioides</i>	Poaceae	Grass
396	<i>Zoysia matrella</i>	Poaceae	Grass
397	<i>Antigonon leptopus</i>	Polygonaceae	Climber
398	<i>Polygonum glabrum</i>	Polygonaceae	Herb
399	<i>Polygonum hydropiper</i>	Polygonaceae	Herb
400	<i>Monochoria vaginalis</i>	Pontederiaceae	Herb
401	<i>Potamogeton nodosus</i>	Potamogetonaceae	Herb
402	<i>Ziziphus mauritiana</i>	Rhamnaceae	Tree
403	<i>Ziziphus oenoplia</i>	Rhamnaceae	Straggler
404	<i>Ziziphus trinervia</i>	Rhamnaceae	Tree
405	<i>Ziziphus xylopyrus</i>	Rhamnaceae	Tree
406	<i>Borreria hispida</i>	Rubiaceae	Herb
407	<i>Borreria ocymoides</i>	Rubiaceae	Herb
408	<i>Borreria pusilla</i>	Rubiaceae	Herb
409	<i>Ixora arborea</i>	Rubiaceae	Tree
410	<i>Mitragyna parvifolia</i>	Rubiaceae	Tree
411	<i>Morinda tinctoria</i>	Rubiaceae	Tree
412	<i>Oldenlandia biflora</i>	Rubiaceae	Herb
413	<i>Oldenlandia umbellata</i>	Rubiaceae	Herb
414	<i>Pavetta indica</i>	Rubiaceae	Shrub
415	<i>Randia brandisii</i>	Rubiaceae	Tree
416	<i>Randia dumetorum</i>	Rubiaceae	Tree
417	<i>Randia malabarica</i>	Rubiaceae	Shrub
418	<i>Tarenna asiatica</i>	Rubiaceae	Shrub
419	<i>Aegle marmelos</i>	Rutaceae	Tree
420	<i>Atalantia monophylla</i>	Rutaceae	Tree
421	<i>Atalantia racemosa</i>	Rutaceae	Tree

Sl. No.	Name of the plant species	Family	Habitat
422	<i>Chloroxylon swietenia</i>	Rutaceae	Tree
423	<i>Clausena dentata</i>	Rutaceae	Shrub
424	<i>Glycosmis mauritiana</i>	Rutaceae	Shrub
425	<i>Glycosmis pentaphylla</i>	Rutaceae	Shrub
426	<i>Toddalia asiatica</i>	Rutaceae	Straggler
427	<i>Azima tetracantha</i>	Salvadoraceae	Shrub
428	<i>Salvadora persica</i>	Salvadoraceae	Tree
429	<i>Salvinia molesta</i>	Salviniaceae	Herb
430	<i>Santalum album</i>	Santalaceae	Tree
431	<i>Allophyllus serratus</i>	Sapindaceae	Tree
432	<i>Cardiospermum halicacabum</i>	Sapindaceae	Climber
433	<i>Dodonaea viscosa</i>	Sapindaceae	Shrub
434	<i>Lepisanthes tetraphylla</i>	Sapindaceae	Tree
435	<i>Sapindus emarginata</i>	Sapindaceae	Tree
436	<i>Madhuca longifolia</i>	Sapotaceae	Tree
437	<i>Mimusops elengi</i>	Sapotaceae	Tree
438	<i>Bacopa monnieri</i>	Scrophulariaceae	Herb
439	<i>Lindernia antipoda</i>	Scrophulariaceae	Herb
440	<i>Scoparia dulcis</i>	Scrophulariaceae	Herb
441	<i>Stemodia viscosa</i>	Scrophulariaceae	Herb
442	<i>Striga asiatica</i>	Scrophulariaceae	Herb
443	<i>Datura innoxia</i>	Solanaceae	Shrub
444	<i>Datura metel</i>	Solanaceae	Shrub
445	<i>Physalis minima</i>	Solanaceae	Herb
446	<i>Solanum surrattense</i>	Solanaceae	Herb
447	<i>Solanum torvum</i>	Solanaceae	Shrub
448	<i>Solanum trilobatum</i>	Solanaceae	Tree
449	<i>Melochia corchorifolia</i>	Sterculiaceae	Herb
450	<i>Sterculia foetida</i>	Sterculiaceae	Tree
451	<i>Waltheria indica</i>	Sterculiaceae	Herb
452	<i>Corchorus aestuans</i>	Tiliaceae	Herb
453	<i>Corchorus capsularis</i>	Tiliaceae	Herb
454	<i>Corchorus olitorius</i>	Tiliaceae	Herb
455	<i>Corchorus tridens</i>	Tiliaceae	Herb
456	<i>Grewia hirsuta</i>	Tiliaceae	Shrub
457	<i>Grewia tenax</i>	Tiliaceae	Shrub
458	<i>Muntingia calabura</i>	Tiliaceae	Tree
459	<i>Triumfetta rhomboidea</i>	Tiliaceae	Herb
460	<i>Triumfetta rotundifolia</i>	Tiliaceae	Herb
461	<i>Elastostemma</i> sp.	Urticaceae	Herb
462	<i>Vallisneria spiralis</i>	Vallisneriaceae	Herb
463	<i>Gmelina arborea</i>	Verbenaceae	Tree
464	<i>Gmelina asiatica</i>	Verbenaceae	Shrub
465	<i>Lantana camara</i>	Verbenaceae	Shrub
466	<i>Phyla nodiflora</i>	Verbenaceae	Herb
467	<i>Stachytarpheta jamaicensis</i>	Verbenaceae	Herb
468	<i>Tectona grandis</i>	Verbenaceae	Tree

Sl. No.	Name of the plant species	Family	Habitat
469	<i>Vitex altissima</i>	Verbenaceae	Tree
470	<i>Vitex leucoxylon</i>	Verbenaceae	Tree
471	<i>Vitex negundo</i>	Verbenaceae	Tree
472	<i>Vitex trifolia</i>	Verbenaceae	Tree
473	<i>Hybanthus ennaespermus</i>	Violaceae	Herb
474	<i>Viscum articulatum</i>	Viscaceae	Herb
475	<i>Viscum ramosissimum</i>	Viscaceae	Herb
476	<i>Cayratia pedata</i>	Vitaceae	Climber
477	<i>Cissus quadrangularis</i>	Vitaceae	Climber
478	<i>Cissus trifolia</i>	Vitaceae	Climber
479	<i>Cissus vitigenea</i>	Vitaceae	Climber
480	<i>Tribulus terrestris</i>	Zygophyllaceae	Herb

Appendix 4. List of butterflies in and around the study area

Sl. No.	Common name	Scientific name	Family	Status
Family I. Papilionidae				
1	Blue Mormon	<i>Papilio polymnestor</i>	Papilionidae	Endemic
2	Common Banded Peacock	<i>Papilio crino</i>	Papilionidae	Endemic
3	Common Jay	<i>Graphium doson</i>	Papilionidae	
4	Common Mormon	<i>Papilio polytes</i>	Papilionidae	
5	Common Rose	<i>Pachliopta aristolochiae</i>	Papilionidae	
6	Crimson Rose	<i>Pachliopta hector</i>	Papilionidae	Schedule I & Endemic
7	Lime Butterfly	<i>Papilio demoleus</i>	Papilionidae	
8	Southern Birdwing	<i>Troides minos</i>	Papilionidae	Endemic
9	Tailed Jay	<i>Graphium agamemnon</i>	Papilionidae	
Family II. Pieridae				
10	Common Emigrant	<i>Catopsilia pomona</i>	Pieridae	
11	Common Jezebel	<i>Delias eucharis</i>	Pieridae	
12	Common Grass yellow	<i>Eurema hecabe</i>	Pieridae	
13	Common Gull	<i>Cepora nerissa</i>	Pieridae	Schedule II
14	Common Wanderer	<i>Pareronia valeria</i>	Pieridae	
15	Crimson Tip	<i>Colotis danae</i>	Pieridae	
16	Great Orange Tip	<i>Hebomoia glaucippe</i>	Pieridae	
17	Mottled Emigrant	<i>Catopsilia pyranthe</i>	Pieridae	
18	Psyche	<i>Leptosia nina</i>	Pieridae	
19	Small Grass Yellow	<i>Eurema brigitta</i>	Pieridae	
20	Small Orange Tip	<i>Colotis etrida</i>	Pieridae	
21	Spotless Grass Yellow	<i>Eurema laeta</i>	Pieridae	
22	White Orange Tip	<i>Ixias marianne</i>	Pieridae	
23	Yellow Orange Tip	<i>Ixias pyrene</i>	Pieridae	
Family III. Nymphalidae				
24	Angled Castor	<i>Ariadne ariadne</i>	Nymphalidae	
25	Baronet	<i>Euthalia nais</i>	Nymphalidae	
26	Chocolate Pansy	<i>Precis iphita</i>	Nymphalidae	
27	Common Bush Brown	<i>Mycalesis perseus</i>	Nymphalidae	
28	Common Castor	<i>Ariadne merione</i>	Nymphalidae	
29	Common Crow	<i>Euploea core</i>	Nymphalidae	Schedule IV
30	Common Evening Brown	<i>Melanitis leda</i>	Nymphalidae	
31	Common Leopard	<i>Phalanta phalantha</i>	Nymphalidae	
32	Common Sailer	<i>Neptis hylas</i>	Nymphalidae	
33	Common Sergeant	<i>Athyma perius</i>	Nymphalidae	
34	Danaid Eggfly	<i>Hypolimnas misippus</i>	Nymphalidae	Schedule II
35	Dark Blue Tiger	<i>Tirumala septentrionis</i>	Nymphalidae	
36	Double-branded Crow	<i>Euploea sylvester</i>	Nymphalidae	Endemic

Sl. No.	Common name	Scientific name	Family	Status
37	Glassy Tiger	<i>Parantica aglea</i>	Nymphalidae	
38	Great Eggfly	<i>Hypolimnas bolina</i>	Nymphalidae	
39	Lemon Pansy	<i>Junonia lemonias</i>	Nymphalidae	
40	Peacock Pansy	<i>Junonia almana</i>	Nymphalidae	
41	Plain Tiger	<i>Danaus chrysippus</i>	Nymphalidae	
42	Striped Tiger	<i>Danaus genutia</i>	Nymphalidae	
43	Tawny Coster	<i>Acraea violae</i>	Nymphalidae	
44	Yellow Pansy	<i>Junonia hierta</i>	Nymphalidae	
Family IV. Lycaenidae				
45	African Babul blue	<i>Azanus jesous</i>	Lycaenidae	
46	Banded Blue Pierrot	<i>Discolampa ethion</i>	Lycaenidae	
47	Common Cerulean	<i>Jamides celeno</i>	Lycaenidae	
48	Common Pierrot	<i>Castalius rosimon</i>	Lycaenidae	Schedule I
49	Common Silverline	<i>Spindasis vulcanus</i>	Lycaenidae	
50	Dark Cerulean	<i>Jamides bochus</i>	Lycaenidae	
51	Plains Cupid	<i>Chilades pandava</i>	Lycaenidae	
52	Slate Flash	<i>Rapala manea</i>	Lycaenidae	
53	Tiny Grass Blue	<i>Zizula hylax</i>	Lycaenidae	
54	Zebra Blue	<i>Lepotes plinius</i>	Lycaenidae	
Family V. Hesperidae				
55	Brown Awl	<i>Badamia exclamatoris</i>	Hesperidae	
56	Bush Hopper	<i>Ampittia dioscorides</i>	Hesperidae	
57	Chestnut Bob	<i>Iambrix salsala</i>	Hesperidae	
58	Common Banded Owl	<i>Hasora chromus</i>	Hesperidae	
59	Common Grass Dart	<i>Taractrocera maevius</i>	Hesperidae	
60	Dark Palm Dart	<i>Telicota ancilla</i>	Hesperidae	
61	Indian Palm Bob	<i>Suastus gremius</i>	Hesperidae	
62	Indian Skipper	<i>Spialia galba</i>	Hesperidae	
63	Rice Swift	<i>Borbo cinnara</i>	Hesperidae	
*Schedule of Wildlife Protection Act 1972				

Appendix 5. List of bird species observed in and around Oussudu Lake

Sl. No.	Family	Common name	Scientific name	Habitat	Status	IUCN status	Legal Status
1.	Podicipedidae	Little Grebe	<i>Tachybaptus ruficollis</i>	A	R	-	S-IV
2.	Pelicanidae	*Great White Pelican	<i>Pelecanus onocrotalus</i>	A	M	NT	S-IV
3.		Spot-billed Pelican	<i>Pelecanus philippensis</i>	A	R	NT	S-IV
4.	Phalacrocoracidae	Little Cormorant	<i>Phalacrocorax niger</i>	A	R	-	S-IV
5.		Indian Cormorant	<i>Phalacrocorax fuscicollis</i>	A	R	-	S-IV
6.		Great Cormorant	<i>Phalacrocorax carbo</i>	A	R	-	S-IV
7.		Darter	<i>Anhinga melanogaster</i>	A	R	NT	S-IV
8.	Ardeidae	Grey Heron	<i>Ardea cinerea</i>	A	R	-	S-IV
9.		Indian Pond Heron	<i>Ardeola grayii</i>	A	R	-	S-IV
10.		Little Heron	<i>Butorides striata</i>	A	R	-	S-IV
11.		Purple Heron	<i>Ardea purpurea</i>	A	R	-	S-IV
12.		Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	A	R	-	S-IV
13.		Greater Egret	<i>Casmerodius albus</i>	A	R	-	S-IV
14.		Intermediate Egret	<i>Mesophoyx intermedia</i>	A	R	-	S-IV
15.		Little Egret	<i>Egretta garzetta</i>	A	R	-	S-IV
16.		Cattle Egret	<i>Bubulcus ibis</i>	A	R	-	S-IV
17.		Great Bittern	<i>Botaurus stellaris</i>	A	M	-	S-IV
18.		Black Bittern	<i>Dupetor flavicollis</i>	A	R	-	S-IV
19.	Ciconiidae	Painted Stork	<i>Mycteria leucocephala</i>	A	R	-	S-IV
20.		Asian Openbill	<i>Anastomus oscitans</i>	A	R	-	S-IV
21.		Woolly-necked Stork	<i>Ciconia episcopus</i>	A	R	-	S-IV
22.	Threskiornithidae	Black Headed Ibis	<i>Threskiornis melanocephalus</i>	A	R	NT	S-IV
23.		Black Ibis	<i>Pseudibis papillosa</i>	A	R	-	S-IV
24.		Eurasian Spoonbill	<i>Platalea leucorodia</i>	A	R	NT	S-I
25.	Phoenicopteridae	*Greater Flamingo	<i>Phoenicopus ruber</i>	A	M	NT	S-IV
26.		*Lesser Flamingo	<i>Phoenicopus minor</i>	A	M	NT	S-IV
27.	Anatidae	Common Poachard	<i>Aythya ferina</i>	A	M	-	S-IV
28.		Cotton Pygmy-Goose	<i>Nettapus coromandelianus</i>	A	R	-	S-IV



Sl. No.	Family	Common name	Scientific name	Habitat	Status	IUCN status	Legal Status
29.		Eurasian Wigeon	<i>Anas penelope</i>	A	M	-	S-IV
30.		Common Teal	<i>Anas crecca</i>	A	M	-	S-IV
31.		Gargany Teal	<i>Anas querquedula</i>	A	M	-	S-IV
32.		Mallard	<i>Anas platyrhynchos</i>	A	M	-	S-IV
33.		Northern Pintail	<i>Anas acuta</i>	A	M	-	S-IV
34.		Northern Shoveler	<i>Anas clypeata</i>	A	M	-	S-IV
35.		Spot-billed Duck	<i>Anas poecilorhyncha</i>	A	R	-	S-IV
36.		Unidentified Duck	<i>Anas sp.</i>	A	M	-	-
37.	Accipitridae	Besra	<i>Accipiter virgatus</i>	T	M	-	S-I
38.		Shikra	<i>Accipiter badius</i>	T	M	-	S-I
39.		Black Eagle	<i>Ictinaetus malayensis</i>	T	R	-	S-I
40.		*Crested Serpent Eagle	<i>Spilornis cheela</i>	T	R	-	S-I
41.		*White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>	A	R	EN	S-I
42.		Black Kite	<i>Milvus migrans</i>	T	R	NT	S-I
43.		Black-shouldered Kite	<i>Elanus caeruleus</i>	T	R	-	S-I
44.		Brahminy Kite	<i>Haliastur indus</i>	T	R	-	S-I
45.		Eurasian Marsh Harrier	<i>Circus aeruginosus</i>	A	M	-	S-I
46.		Pallid Harrier	<i>Circus macrourus</i>	T	M	NT	S-I
47.		Pied Harrier	<i>Circus melanoleucos</i>	T	M	-	S-I
48.		*Osprey	<i>Pandion haliaetus</i>	T	M	-	S-I
49.	Falconidae	Common Kestrel	<i>Falco tinnunculus</i>	T	R	-	S-IV
50.	Phasianidae	Grey Francolin	<i>Francolinus pondicerianus</i>	T	R	-	S-IV
51.		Indian Peafowl	<i>Pavo cristatus</i>	T	R	-	S-I
52.	Rallidae	Common Coot	<i>Fulica atra</i>	A	R	-	S-IV
53.		Common Moorhen	<i>Gallinula chloropus</i>	A	R	-	S-IV
54.		Purple Swamphen	<i>Porphyrio porphyrio</i>	A	R	-	S-IV
55.		White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	A	R	-	S-IV
56.	Jacanidae	*Bronze-winged Jacana	<i>Metopidius indicus</i>	A	R	-	S-IV
57.		Pheasant Tailed Jacana	<i>Hydrophasianus chirurgus</i>	A	R	-	S-IV
58.	Charadriidae	*Grey-headed Lapwing	<i>Vanellus cinereus</i>	A	M	-	S-IV
59.		Red-wattled Lapwing	<i>Vanellus indicus</i>	A	R	-	S-IV

Sl. No.	Family	Common name	Scientific name	Habitat	Status	IUCN status	Legal Status
60.		Yellow-wattled Lapwing	<i>Vanellus malabaricus</i>	A	R	-	S-IV
61.		Grey Plover	<i>Pluvialis squatarola</i>	A	M	-	S-IV
62.		Little Ringed Plover	<i>Charadrius dubius</i>	A	M	-	S-IV
63.		Common Redshank	<i>Tringa totanus</i>	A	M	-	S-IV
64.		Marsh Sandpiper	<i>Actitis hypoleucos</i>	A	M	-	S-IV
65.		Green Sandpiper	<i>Tringa ochropus</i>	A	M	-	S-IV
66.		Wood Sandpiper	<i>Tringa glorioles</i>	A	M	-	S-IV
67.	Regurvirostridae	Black-winged Stilt	<i>Himantopus himantopus</i>	A	R	-	S-IV
68.	Laridae	Black-bellied Tern	<i>Sterna acuticauda</i>	A	M	NT	S-IV
69.		Black-naped Tern	<i>Sterna sumatrana</i>	A	M	-	S-IV
70.		Common Tern	<i>Sterna hirundo</i>	A	M	-	S-IV
71.		River Tern	<i>Sterna aurantia</i>	A	R	-	S-IV
72.		Whiskered Tern	<i>Chlidonias hybridus</i>	A	M	-	S-IV
73.		White-winged Tern	<i>Chlidonias niger</i>	A	M	-	S-IV
74.	Pteroclididae	*Dunlin	<i>Calidris alpina</i>	A	M	-	S-IV
75.		Broad Billed Sandpiper	<i>Limicola falcinellus</i>	A	M	-	S-IV
76.		Curlew Sandpiper	<i>Calidris ferruginea</i>	A	M	-	S-IV
77.		Spoon Billed Sandpiper	<i>Eurynorhynchus pygmeus</i>	A	M	CE	S-IV
78.		*Ruff	<i>Philomachus pugnax</i>	A	M	-	S-IV
79.		Little Stint	<i>Calidris minuta</i>	A	M	-	S-IV
80.		Common Snipe	<i>Gallinago gallinago</i>	A	M	-	S-IV
81.	Columbidae	Rock Pigeon	<i>Columba livia</i>	T	R	-	S-IV
82.		Laughing Dove	<i>Streptopelia senegalensis</i>	T	R	-	S-IV
83.		Red Collared Dove	<i>Streptopelia tranquebarica</i>	T	R	-	S-IV
84.		Spotted Dove	<i>Streptopelia chinensis</i>	T	R	-	S-IV
85.	Psittacidae	Rose-ringed Parakeet	<i>Psittacula krameri</i>	T	R	-	S-IV
86.	Cuculidae	*Chestnut-winged Cuckoo	<i>Clamator coromandus</i>	T	M	-	S-IV
87.		Common Hawk Cuckoo	<i>Hierococcyx varius</i>	T	R	-	S-IV
88.		Drongo Cuckoo	<i>Surniculus lugubris</i>	T	R	-	S-IV
89.		Pied-crested Cuckoo	<i>Clamator jacobinus</i>	T	R	-	S-IV
90.		Asian Koel	<i>Eudynamis scolopacea</i>	T	R	-	S-IV

Sl. No.	Family	Common name	Scientific name	Habitat	Status	IUCN status	Legal Status
91.		Blue-faced Malkoha	<i>Phaenicophaeus viridirostris</i>	T	R	-	S-IV
92.		Greater Coucal	<i>Centropus sinensis</i>	T	R	-	S-IV
93.		Lesser Coucal	<i>Centropus bengalensis</i>	T	R	-	S-IV
94.	Strigidae	Barn Owl	<i>Tyto alba</i>	T	R	-	S-IV
95.		Spotted Owlet	<i>Athene brama</i>	T	R	-	S-IV
96.	Caprimulgidae	Indian Nightjar	<i>Caprimulgus asiaticus</i>	T	R	-	S-IV
97.	Apodidae	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	T	R	-	-
98.		*Crested Tree-swift	<i>Hemiprocne coronata</i>	T	R	-	-
99.		House Swift	<i>Apus affinis</i>	T	R	-	-
100.	Alcedinidae	Black-capped Kingfisher	<i>Halcyon pileata</i>	A	R	-	
101.		Common Kingfisher	<i>Alcedo atthis</i>	A	R	-	S-IV
102.		Pied Kingfisher	<i>Ceryle rudis</i>	A	R	-	S-IV
103.		*Stork-billed Kingfisher	<i>Halcyon capensis</i>	A	R	-	S-IV
104.		White-breasted Kingfisher	<i>Halcyon smyrnensis</i>	A	R	-	S-IV
105.	Meropidae	Blue-tailed Bee-eater	<i>Merops philippinus</i>	T	R	-	-
106.		Chestnut-headed Bee-eater	<i>Merops leschenaulti</i>	T	R	-	-
107.		Green Bee-eater	<i>Merops orientalis</i>	T	R	-	-
108.	Coraciidae	Indian Roller	<i>Coracias benghalensis</i>	T	R	-	S-IV
109.	Upupidae	Common Hoopoe	<i>Upupa epops</i>	T	R	-	S-IV
110.	Capitonidae	Coppersmith Barbet	<i>Megalaima haemacephala</i>	T	R	-	S-IV
111.		White-cheeked Barbet	<i>Megalaima viridis</i>	T	R	-	S-IV
112.	Picidae	*Black-rumped Flameback	<i>Dinopium benghalense</i>	T	R	-	S-IV
113.		Common Flameback	<i>Dinopium javanense</i>	T	R	-	S-IV
114.	Pittidae	Indian Pitta	<i>Pitta brachyura</i>	T	R	-	S-IV
115.	Alaudidae	Ashy-crowned Sparrow Lark	<i>Eremopterix griseus</i>	T	R	-	S-IV
116.		*Rufous-winged Bushlark	<i>Mirafrassa assamica</i>	T	R	-	S-IV
117.	Hirundinidae	*Barn Swallow	<i>Hirundo rustica</i>	T	M	-	-
118.		Pacific Swallow	<i>Hirundo tahitica</i>	T	R	-	-
119.		Red-rumped Swallow	<i>Hirundo daurica</i>	T	R	-	-
120.	Laniidae	*Bay-backed Shrike	<i>Lanius vittatus</i>	T	R	-	-
121.		*Southern Grey Shrike	<i>Lanius meidionalis</i>	T	R	-	-

Sl. No.	Family	Common name	Scientific name	Habitat	Status	IUCN status	Legal Status
122.	Oriolidae	*Black-headed Oriole	<i>Oriolus xanthornus</i>	T	R	-	S-IV
123.		Eurasian Golden Oriole	<i>Oriolus oriolus</i>	T	R	-	S-IV
124.	Dicruridae	Ashy Drongo	<i>Dicrurus leucophaeus</i>	T	M	-	S-IV
125.		Black Drongo	<i>Dicrurus macrocercus</i>	T	R	-	S-IV
126.		White-bellied Drongo	<i>Dicrurus caerulescens</i>	T	R	-	S-IV
127.	Artamidae	Ashy Wood Swallow	<i>Artamus fuscus</i>	T	R	-	-
128.	Sturnidae	Brahminy Starling	<i>Sturnus pagodarum</i>	T	R	-	S-IV
129.		Common Myna	<i>Acridotheres tristis</i>	T	R	-	S-IV
130.		*Rosy Starling	<i>Sturnus roseus</i>	T	M	-	S-IV
131.	Corvidae	House Crow	<i>Corvus splendens</i>	T	R	-	S-IV
132.		Jungle Crow	<i>Corvus macrorhynchos</i>	T	R	-	S-IV
133.		Rufous Treepie	<i>Dendrocitta vagabunda</i>	T	R	-	S-IV
134.	Campephagidae	Common Wood Shrike	<i>Tephrodornis pondicerianus</i>	T	R	-	S-IV
135.	Irenidae	*Common Iora	<i>Aegithina tiphia</i>	T	R	-	S-IV
136.	Pycnonotidae	Red-vented Bulbul	<i>Pycnonotus cafer</i>	T	R	-	S-IV
137.		White-browed Bulbul	<i>Pycnonotus luteolus</i>	T	R	-	S-IV
138.	Muscicapidae	*Jungle Babbler	<i>Turdoides striatus</i>	T	R	-	S-IV
139.		White-headed Babbler	<i>Turdoides affinis</i>	T	R	-	S-IV
140.		*Tawny-bellied Babbler	<i>Dumetia hyperythra</i>	T	R	-	S-IV
141.		Paradise flycatcher	<i>Terpsiphone paradisi</i>	T	R	-	S-IV
142.		*White-browed Fantail	<i>Rhipidura aureola</i>	T	R	-	S-IV
143.		Blyth's Reed Warbler	<i>Acrocephalus dumetorum</i>	T	M	-	S-IV
144.		Greenish Warbler	<i>Phylloscopus trochiloides</i>	T	M	-	S-IV
145.		Common Tailorbird	<i>Orthotomus atrogularis</i>	T	R	-	S-IV
146.		Pied Buschat	<i>Saxicola caprata</i>	T	R	-	S-IV
147.		Indian Robin	<i>Saxicoloides fulicata</i>	T	R	-	S-IV
148.		Oriental Magpie Robin	<i>Copsychus saularis</i>	T	R	-	S-IV
149.		Paddyfield Pipit	<i>Anthus rufulus</i>	T	R	-	S-IV
150.		Ashy Prinia	<i>Prinia socialis</i>	T	R	-	S-IV
151.		*Franklin's Prinia	<i>Prinia hodgsonii</i>	T	M	-	S-IV
152.		Jungle Prinia	<i>Prinia sylvatica</i>	T	R	-	S-IV

Sl. No.	Family	Common name	Scientific name	Habitat	Status	IUCN status	Legal Status
153.		Plain Prinia	<i>Prinia inornata</i>	T	R	-	S-IV
154.	Motacillidae	Grey Wagtail	<i>Motacilla cinerea</i>	A	M	-	S-IV
155.		White-browed Wagtail	<i>Motacilla maderaspatensis</i>	A	R	-	S-IV
156.		Yellow Wagtail	<i>Motacilla flava</i>	A	M	-	S-IV
157.		Dicaeidae	Thick-billed Flowerpecker	<i>Dicaeum agile</i>	T	R	-
158.	Tickell's Flowerpecker		<i>Dicaeum erythrorhynchus</i>	T	R	-	S-IV
159.	Nectariniidae	Loten's Sunbird	<i>Nectarinia lotenia</i>	T	R	-	S-IV
160.		Purple Sunbird	<i>Nectarinia asiatica</i>	T	R	-	S-IV
161.		Purple-rumped Sunbird	<i>Nectarinia zeylonica</i>	T	R	-	S-IV
162.	Ploceidae	House Sparrow	<i>Passer domesticus</i>	T	R	-	S-IV
163.		Baya Weaver	<i>Ploceus philippinus</i>	T	R	-	S-IV
164.	Estrildinae	Black-headed Munia	<i>Lonchura malacca</i>	T	R	-	S-IV
165.		Scaly-breasted Munia	<i>Lonchura punctulata</i>	T	R	-	S-IV
166.		*Indian Silverbill	<i>Lonchura malabarica</i>	T	R	-	S-IV
* - New Addition; A-Aquatic; T-Terrestrial; M-Migratory; R-Resident; CE-Critically Endangered; EN-Endangered; NT-Near Threatened; S-I-Schedule I; S-IV- Schedule IV.							

Appendix 6. Water depth profile of Oussudu lake (January 2011)

Transect -Sampling point No.		Longitude	Latitude	Water depth (m)
Transect No. 1: from boat house to western bank of lake	1	11° 56′ 29.6″	79° 44′ 46.4″	0.0
	2	11° 56′ 30.0″	79° 44′ 48.6″	3.6
	3	11° 56′ 34.1″	79° 44′ 48.8″	3.0
	4	11° 56′ 36.0″	79° 44′ 48.3″	4.0
	5	11° 56′ 39.6″	79° 44′ 47.1″	3.0
	6	11° 56′ 42.8″	79° 44′ 46.0″	3.0
	7	11° 56′ 45.7″	79° 44′ 44.4″	3.0
	8	11° 56′ 48.6″	79° 44′ 43.4″	3.1
	9	11° 56′ 51.9″	79° 44′ 42.0″	3.2
	10	11° 56′ 55.0″	79° 44′ 41.1″	3.2
	11	11° 56′ 58.1″	79° 44′ 40.7″	3.2
	12	11° 56′ 01.5″	79° 44′ 39.9″	3.1
	13	11° 57′ 04.6″	79° 44′ 39.2″	3.1
	14	11° 57′ 08.3″	79° 44′ 38.5″	3.0
	15	11° 57′ 10.9″	79° 44′ 38.0″	3.0
	16	11° 57′ 14.1″	79° 44′ 37.5″	2.9
	17	11° 57′ 17.4″	79° 44′ 36.9″	2.9
	18	11° 57′ 20.9″	79° 44′ 36.0″	2.8
	19	11° 57′ 23.8″	79° 44′ 35.6″	2.7
	20	11° 57′ 27.0″	79° 44′ 35.1″	2.5
	21	11° 57′ 30.2″	79° 44′ 34.3″	2.5
	22	11° 57′ 36.4″	79° 44′ 32.6″	2.4
	23	11° 57′ 39.7″	79° 44′ 31.3″	2.4
	24	11° 57′ 45.7″	79° 44′ 29.6″	2.1
	25	11° 57′ 13.0″	79° 44′ 27.5″	1.9
	26	11° 57′ 41.8″	79° 44′ 5.91″	0.0
Transect No. 2: from western bank of lake to entry of canal	1	11° 57′ 41.8″	79° 44′ 5.91″	0.0
	2	11° 57′ 13.0″	79° 44′ 27.5″	2.6
	3	11° 57′ 17.2″	79° 44′ 00.4″	2.9
	4	11° 57′ 14.5″	79° 44′ 57.6″	2.9
	5	11° 57′ 10.7″	79° 44′ 52.7″	3.0
	6	11° 57′ 08.4″	79° 44′ 50.2″	3.1
	7	11° 57′ 06.0″	79° 44′ 47.4″	3.1
	8	11° 57′ 04.1″	79° 44′ 45.1″	3.1
	9	11° 57′ 02.0″	79° 44′ 42.8″	3.1
	10	11° 56′ 59.8″	79° 44′ 39.9″	3.1
	11	11° 56′ 57.9″	79° 44′ 37.5″	3.1
	12	11° 56′ 56.0″	79° 44′ 35.2″	3.1
	13	11° 56′ 53.5″	79° 44′ 32.3″	3.0
	14	11° 56′ 51.6″	79° 44′ 29.9″	2.9
	15	11° 56′ 49.9″	79° 44′ 27.4″	3.0
	16	11° 56′ 47.7″	79° 44′ 24.9″	2.8

Transect -Sampling point No.		Longitude	Latitude	Water depth (m)
	17	11° 56' 45.3"	79° 44' 22.3"	2.9
	18	11° 56' 43.6"	79° 44' 20.2"	2.8
	19	11° 56' 40.9"	79° 44' 17.2"	2.6
	20	11° 56' 39.0"	79° 44' 15.1"	2.4
	21	11° 56' 36.6"	79° 44' 12.7"	2.3
	22	11° 56' 34.3"	79° 44' 10.0"	2.1
	23	11° 56' 32.0"	79° 44' 07.3"	2.0
	24	11° 56' 29.8"	79° 44' 04.4"	2.1
	25	11° 56' 29.0"	79° 44' 02.1"	3.4
	26	11° 56' 28.2"	79° 44' 01.6"	0.0
Transect No. 3: Canal entry to boat house	1	11° 56' 28.2"	79° 44' 01.6"	0.0
	2	11° 56' 26.9"	79° 44' 08.9"	2.5
	3	11° 56' 26.4"	79° 44' 15.3"	3.3
	4	11° 56' 28.3"	79° 44' 22.6"	2.6
	5	11° 56' 28.3"	79° 44' 22.6"	2.9
	6	11° 56' 29.2"	79° 44' 28.6"	4.5
	7	11° 56' 30.7"	79° 44' 37.5"	4.4
	8	11° 56' 31.4"	79° 44' 43.3"	4.2
	9	11° 56' 30.9"	79° 44' 47.9"	3.6
	10	11° 56' 30.0"	79° 44' 48.6"	3.6
	11	11° 56' 29.6"	79° 44' 46.4"	0.0
Average water depth of the lake was 3.0 meter. The locations with water depth of 0.0 mtr are locations along lake bank/shore				