

**Faunal Resources of
NALABAN WILDLIFE SANCTUARY
Chilka, Orissa**

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**Faunal Resources of Nalaban Wildlife Sanctuary,
Chilka, Orissa**

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INTRODUCTION

Chilka lake, is one of the ecologically and socio economically important wetland in Orissa, indeed it is the largest brackish water lagoon on the east coast of India and a unique waterfowl habitat of international importance. Declared a *Ramsar site* (1981), it extends from the southeast corner of Puri (in the north) to Ganjam (in the south). Its geomorphic, physiographic, hydrographic and faunistic features conform to the characteristics attributed to a *typical lagoon* (Phleger, 1981). It is famous for its rich *avian diversity* of resident and migratory birds. The lagoon covers a maximum area of 1165 km² during the rainy seasons and gradually shrinks to a minimum of 906 km² during summers. This wetland has a variety of ecologically important features such as water body, mangroves, tidal flat, island and sand bar, *etc.* The important wetland classes in the Chilka Lake are featured in Table 1. The semi enclosed pear shaped lagoon holds in its lap several small sandy and ephemeral islands, prominent among which are Nalaban, Kalijai, Somolo, Breakfast and Bird island. Nalaban island, a *shallow marshy habitat*, indeed one of the most potential of all the islands in the lagoon, sustains a huge congregation of local and migratory avifauna. It was rightly declared as Bird Sanctuary *Nalaban Wildlife Sanctuary*. (Govt. notification 23404, 17.12.1987) under Indian Wildlife (Protection) Act, 1972.

Table-1. Wetland classes and their aerial extent of Chilka lake

Lake in km ²	Mangrove in km ²	Tidal flats in km ²
1165	1.48	1.30

The oval shaped Nalaban island, is located within the *central* sector of Chilka lake, Puri dist., which is paradise for both the local as well as migratory birds and is a part of Orissa's natural heritage. Birds in Nalaban island have been attracting human attention for ages. It is still fresh in memory, when the great congregation of water birds, which took off into the sky, formed a thick cloud that never allowed sunlight to reach the ground at Nalaban. This submerged island is literally a forest of weeds and is full of Nala (*Phargmites karka*), as its name implies. This offered an ideal habitat and resting place to thousands of water birds. The island alone hosts over 75% of total bird population of the lake (Acharya, 2000). During south-west monsoons, it presents a view, which is normally difficult to comprehend. The entire island remains submerged, with only reeds and the three watch tower visible on the northern, southern and western ends of the island.

Though Nalaban marshy island is a part of Chilka lagoon, comprehensive studies on the faunal resources of the island have not been attempted to date, save some detailed studies on the avifaunal profile (Hussain and Mohapatra, 1984, acharya, 2000, Sahu, 2000, Balachandran and Rahmani, 2003). As a result, the overall general faunal profile of the island or the wildlife bird Sanctuary remains largely undocumented. The reasons for neglect of this important habitat are not far to seek. First, the excessive obsession with the

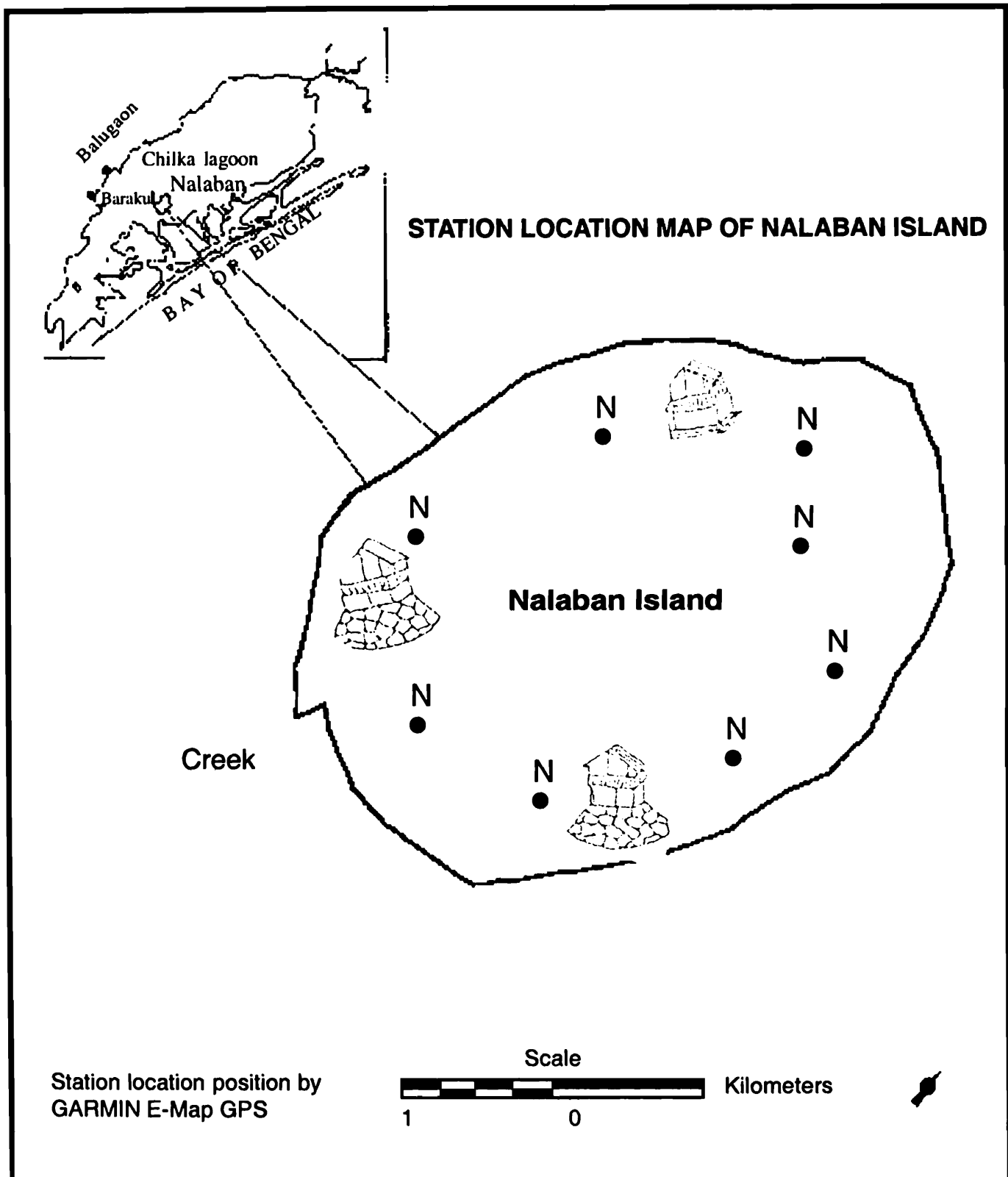


Fig. 1. Outline map of Nalaban island (Nalaban Wildlife Sanctuary) in Chilka lagoon, Orissa $N_1 - N_8$ eight randomly selected sampling stations in 15.53 km^2 oval shaped submerged island. Insert - Location of Nalaban Island in Chilka lagoon, Orissa.

much larger and sprawling Chilka, a Ramsar Site, a waterfowl habitat of international importance and an important fishery resource is only understandable. Second, and equally important, is the natural aversion to biological studies (*insular biology*) on island ecosystems –inland or offshore, in view of not only their highly insulated nature but equally challenging ecosystem dynamics. Nalaban island in the ca. 1165 km² of the tropical lagoon is no exception too. It has a biologically interesting changing profile, a submerged habitat during south-west monsoons and winters to dry exposed lake basin in summers. Even though extensive faunal studies on Chilka have been undertaken by ZSI, 1995, no specific study on the *Nalaban Wildlife Sanctuary* has been conducted so far. Efforts were therefore made to explore, study and document major invertebrates/vertebrates faunal groups available for helping draw a faunal profile. Earlier endeavour on the explorative study in the fauna of Chilka are by Annandale and Kemp (1916); Pattnaik (1971); Sarma and Satapathy (1978); Sarma and Rao (1980) and Murthy (1987). Preston (1915) worked extensively upon the malacofauna and Fauvel (1953) on annelida and polychaeta. Hussian and Mohapatra (1988); Acharya (2000) and Sahu (2000) studied the avifauna.

The Department of Environment (DOEn), under the Ministry of Environment and Forest (MoEF), New Delhi, has initiated Protected Area Network studies for inventorying faunal resources in the various Protected Areas in the country. Under the PAN studies, the ZSI, Berhampur (Gm.), Orissa was authorised to undertake faunal inventorying in Nalaban Wildlife Sanctuary, in the central sector of the sprawling 1165km² Chilka lake, Therefore, a two year field cum laboratory study was initiated at *multi-taxa inventorying* of the faunistic diversity in the submerged island, for generating a *baseline* data for systematic evaluation of the protected areas faunistic diversity, for eventual use in monitoring and evaluation of conservation, plan assessment of threats, if any, *etc.*

LOCATION AND GEOLOGY

The total area of the bird sanctuary is 15.53 km² of which 6.72 km² forms core zone and 8.81 km² buffer zone. It is situated in between 85°14' to 85°17' E longitudes and 19°17' to 19°39' N latitudes. The 15.53 km². wildlife sanctuary, part of the 1165 km². Chilka lagoon, remains inundated for the most part of the year, and unlike other protected areas, has no man made/natural landmarks that separate it save sheets of water on all sides. Nalaban island (shallow and marshy habitat) gets completely submerged for most part of the year and remains dried up in summer. Therefore, it is a highly dynamic and transitional ecosystem. A *unique* feature of it is its salinity fluctuations, which plays a vital role in maintenance of the rich aquatic biodiversity. The island is about 42 km. away from the mouth. Therefore, most of the fauna present in the island are marine in habitat, transported from the sea, through the mouth, into the island. This tiny marshy island is well aerated and nutrient rich and supports a good variety of invertebrate fauna, attracting huge flocks of local and migratory avifauna for feeding and roosting.

Chilka lagoon has a typical geomorphic feature and it experiences dynamics of the coastal processes along with freshwater flow. Because of the close relationship of the

environment of Chilka with depositional features, they serve as valuable geologic or geomorphic record. Wave current and tide, along with storm are the coastal process responsible for shoreline characteristics and coastal morphology (Davies, 1977). Generally wave and storm effects decrease and the tidal influence increase with increasing tidal range. Thus the micro tidal coasts (Less than 2 m of tidal range at spring) tend to be wave and storm dominated; meso-tidal or macro tidal coasts (2.4 m or more than 4 m tidal range at spring) are tide dominated. Chilka coasts experiences tidal variation of less than 2ms and as such barrier island, sandy beach and beach ridges are found in the area.

The major geomorphology in and around the Chilka lake can be classified into 1. *Denudational*. It consists mainly of the denudational and inselbergs bordering mostly south-west and west north-western part of the Chilka lake. Hillocks of khondalite, charnockite, gneisses, anorthsites and granites constitute this geomorphic unit, which occurs in areas near Paluru, Balugaon, Tangi and Bhusandapur. The unit is under active process of denudation. 2. *Marine*. The eastern part of the southern half of the lake is covered by coastal plain in the form of small sandbar islands, part of which, where the tidal action is more get submerged. 3. *Fluvial*. The other geomorphic unit is the deltaic plain extending between the river Daya and the coast form the alluvial plain with very gentle slope towards southwest. 4. *Aeolian*. The coastal and sand dunes form a part of this unit, which lies all along the northern part with width ranging 1 to 8 km. The sand dunes are discontinues with their linear direction paralleling the coast (Asthana, 1979).

The soil in *Nalaban island* is formed of clay, sandy, and muddy. The geological profile in the island favours growth of various life forms.

MATERIALS AND METHODS

Field studies were undertaken, to cover south west monsoons, winter and summer seasons. Various standard/random survey sampling methodologies were used for field studies in the protected area. Standard methodology in vogue was followed for field collections/analyses and laboratory studies (Lind, 1979; APHA, WPCF and AWWA 1985; Heywood and Watson, 1995, Barnes, 1980; Subba Rao, 1995; Talwar and Jhingran, 1984 and others). Field collection (voucher specimens) wherever feasible, and permissible, were made for taxonomic identification to help document the whole gamut of faunal diversity in the island. The mechanized boat facilities for logistics were provided by Chilka Development Authority (CDA) for the random survey/sampling during the course of study. The island was invariably accessed by road, using the office vehicle, covering ca 80 km distance from base (Berhampur, Gm.).

The study area (15.53 km²) was divided into eight sampling stations, on a grid pattern, and geographic coordinates and exact location ascertained using Garmin E-map Geographical Position System (GPS) (Fig. 1). Sediment samples were collected from 8 random sampling stations (N1-N8) in the Nalaban marshy island (Table 2) using Petersons grab (K.C. Denmark, Van-vin, .025 m²) and sieved through U. S. sieve (0.5mm) to separate the macro invertebrates. The animals retained by the sieve were sorted group wise and

preserved in 5% formalin. Back in the laboratory on the same day, the animals were enumerated and preserved in 10% formalin, for follow up taxonomic studies. Besides, nekton (fishes/crustaceans) was also collected from khonda jal/gill nets of different mesh sizes used by the fishermen. The samples were preserved in 10% formalin, after slit opening the abdomen of larger fish specimen. The phytoplankton samples for qualitative evaluation were collected using 50 cm. diameter plankton net made of bolting silk (mesh size 0.33mm), 100L water was filtered through plankton net for 20-25 ml. concentrate, for quantitative studies and preserved in 4% formalin. Taxonomic identification were done using following regional/other works – Biswas (1923, 1926, 1949), Geitler (1932), Prescott (1951), Desikachary (1959) and Hum and Wicks (1980).

Simultaneously, field data on other physical parameters, like the depth (lead weight, m), transparency (*Zsd*, m) bottom water temperature (°C), and salinity (‰) collected at each sampling site. Besides ecological observation on distribution/abundance of macrophytes in 15.53 Km² Island were also made. The water samples for nutrient analysis were filtered through 0.45mm filter paper and acidified to pH < 2. The analyses of various physico-chemical parameters were completed within 24 hours of collection using standard methods (APHA/WPCF and AWWA, 1985) while inorganic nutrients got analysed using outside laboratory facilities.

Table 2. Showing various sampling sites in 15.53 km² submerged Nalaban Island

Name of the sampling sites	Description	Direction
N1	Near to Balugaon.	North
N2	2km. away from N1 towards north.	Northeast
N3	Near watchtower no. 1.	East
N4	1km. Away from watchtower no. 1.	South-east
N5	2km. Away from n4 towards south.	South-east
N6	Near watchtower no.2.	South
N7	Near creek.	West
N8	Near watchtower no. 3.	West

OBSERVATIONS AND DISCUSSIONS

Physico-chemical parameter

- (i) The physico-chemical parameters are susceptible to variations due to change in the prevailing environment in the lake and also due to external influences. The physico-chemical milieu of the lake has therefore undergone changes in the course of time.
- (ii) The range of values for various physiochemical parameters in the surface and bottom water in the Nalaban island at various sampling sites are furnished in

Table 3. (iii) Marked seasonal changes in the hydrographic factors of this wildlife sanctuary were observed during study period (South-west monsoons, winter and summer). The temperature was highest in the surface water during May (32°C) and is lowest during January (23.3°C). The bottom water temperature is almost the same as that of the surface water temperature and was observed to be highest during May and reaches lowest during winter. (Tripathy, 1985). The sanctuary area is shallow and the depth ranging from 0.5 m to 3.2 m and average of 1.28 meters. The depth also varies according to the seasons; it is lowest during April to June and highest during August- September, due to inflows from the rains. The range of transparency (Zsd) varied between 0.4 to 1.69 meter. The pH did not show any significant change, normally fluctuating between 8.4 to 8.6 indicating that the water quality of the sanctuary is basic or alkaline in nature.

Salinity play an important role because of its ever changing values across different regions and seasons, and strong influence it exerts on the ecology of Nalaban marshy island. It varies from seasons to seasons, being low in monsoons and high in summer and has a range of value 2.8 to 38‰. The variation in salinity is due to the differential influx of freshwaters from Malaguni, Dhanua, Salia Rivers from Ranpur, Puri Distt. In to the island across the seasons. Nutrient values for various forms of Nitrogen (N-NO₃µg/l) and phosphorous (P-PO₄µg/l) and silica (SiO₂µg/l) ranged between 0.23-1.17, 4.23-5.94 and 14.53-19.9µg/l. respectively.

Table 3. Showing range of value of various physico-chemical parameters in subsurface waters in Nalaban island, Chilka, Orissa.

Physico chemical parameters	Seasons			Mean
	S. W-Monsoons	Summers	Winters	
Transperency (Zsd, m)	0.4-1.69	0.4-1.28	0.4-1.4	0.76
Depth (leadweight, m)	0.5-3.21	0.5-1.44	0.4-2.8	1.18
Water temp.(°C)				
Sub-surface	29.5-31.8	26.5-32.0	23.3-28.5	28.3
Bottom	29.2-31.8	26.5-32.0	23.4-28.5	28.3
Conductivity (milimho/cm)	5.3-10.4	-	6.7-9.4	8.02
PH	7.65-8.01	8.39-9.11	8.04-8.73	
Salinity (‰)	2.8-30	11-38	5-17	14.2
Turbidity(NTU)	-	-	5-33	13.8
Do(mg/l)	-	-	6.04-7.6	6.9
Nutrients (µg/l)				
Nitrates (µg/l)	-	-	0.23-1.17	
Phosphates (µg/l)	-	-	4.23-5.94	
Silicate (µg/l)	-	-	14.53-19.9	

As per the recommendations of the Central Water Power Research station, Pune in 2001, a new mouth was opened, near magarmukh, to save the ecosystem of Chilka lagoon, which is considered as an historic intervention. The opening of the new mouth has led to significant changes in salinity and related chemical profile finally leading to improvement in fish, prawn crab catch landings in the lagoon.

BIOLOGICAL FEATURES

Flora and fauna are the two vital components of an ecosystem, and the two are inter-dependent at tropic level in aquatic ecosystem. The rich biodiversity of this sanctuary has witnessed significant changes from past. These changes can be attributed to both natural and anthropogenic causes which have adversely affected the overall faunal/avian biodiversity in this small island, a protected area. Frequent water level changes in marshy island, coupled to complete drying up of the submerged island during summer, results in relatively few animals residing as permanent residents of island. The flora and fauna vary according to changes in water level and salinity. Further, they depend on the wetland habitat for food, shelter, reproduction or other minor resources at different times of their life cycle, and also may depend upon each other. Therefore, changes in water level in the submerged island largely influence the overall biotic diversity both floral and faunal, in the inundated island and are central to maintenance of its overall character. While the avian elements- aquatic waterfowl of all shades and hues, have increased significantly following protection, the intermittent drying up of the island has ceased of late, affecting the occurrence and abundance of especially the short lived temporary fauna- crustaceans, *etc.*

FLORAL CHARACTERISTICS

Chilka has been home to wide variety of lower and higher forms of flora, various forms of aquatic macrophytes (emergent, floating and submerged) inhabiting the littoral and shallow regions of the lake. A number of abiotic factors like substratum, depth, salinity, *etc.* determine the growth and abundance of predominantly aquatic plant communities in the island. Pattnaik (1973), Panigrahi (1988), Panda and Pattnaik (1988) have conducted studies on the flora, supplementing other classical studies. Since aquatic macrophytes are an important component of the Chilka ecosystem, observations were also made on the various types of macrophytes available and distributed through out the 15.53 km² island, and their possible role in regulating the islands predominantly aquatic ecosystem and its dynamics.

The major macrophytes observed, during the course of two years studies, have been categorized, on the basis of frequency scale/ estimate of abundance (Taylor, *pH. al.* 2002) as under: abundant. (>50%)- *Phargmites karka*, *Potamogeton pectinatus*, *Najas sp.*, *Halophila ovalis*; and frequent (1-10%)- *Scripus littoralis*, *Eichhornia crassipes*, and *Pistia stratiotes*. Further, they have been categorised here on the basis of their habit as emergent species- *Scripus littoralis*, *Cyperus sp.* and *Phargmites karka*, submerged- *Ruppia spp.*, *Potamogeton pectinatus*,

Najas sp., and *Halophila ovalis*, and freefloating- *Eichhornia crassipes*, *Pistia stratiotes* and *Azolla piñata* (Table 4). Of these macrophytes *Najas sp.* and *Phragmites karka* serve as natural water purifier of the marshy island (Banerjee and Roy 1998). The bottom in littoral region of the island continued to remain blanketed with macrophytes like *Potamogeton pectinatus*, *Najas spp.*, *H. ovalis*. which provide conducive ecological habitats for growth of *macrobenthic fauna* (gastropods, bivalves, amphipods etc.).

Table 4. Showing zonation of macrophytes in Nalaban island, Chilka and estimates of abundance [A–Abundant, F–Frequent, (-)–NIL) O–occasional].

Type	Name	Sampling sites							
		N1	N2	N3	N4	N5	N6	N7	N8
Emergent species	<i>Phragmites karka</i>	-	-	-	-	A	A	-	A
	<i>Scripus littoralis</i>	-	F	-	-	-	-	-	-
	<i>Cyperus sp.</i>	-	-	-	-	-	F	-	-
Submerged species	<i>Potamogeton pectinatus</i>	-	-	-	A	F	A	-	F
	<i>Naja faveolata</i>	-	-	-	A	F	A	-	F
	<i>Naja graminea</i>	A	-	-	A	A	A	-	-
	<i>Halophila ovalis</i>	-	-	A	-	O	-	A	A
	<i>Ruppia martima</i>	-	A	-	-	-	-	-	-
Free floating species	<i>Eichhornia crassipes</i>	-	-	-	-	-	F	F	F
	<i>Pistia stratiotes</i>	-	-	-	-	-	F	F	F
	<i>Azolla pinata</i>	-	-	-	-	-	F	F	F

Of late, it has been observed that there has been an substantial increase in the growth and abundance of freshwater aquatic macrophytic weeds- *Eichhornia crassipes*, *Pistia stratiotes*, *Azolla piñata* following marked changes in the salinity regime of the lake, from brackish water to fresh water environment/habitat, due perhaps to decreases in the salinity and inflows of inorganic plant nutrients - various forms of phosphorous and nitrogen into the lake, from the surrounding environment. The importance of aquatic macrophytes and their functional role in regulating various ecological processes in a wetland has been well acknowledged.

In the Chilka lake and Nalaban island too, the various aquatic macrophytes and their luxuriant growth of in past is an indication that the lake act as a biological receptacle/sink absorbing natural pollutants through nutrient inflows, thereby influencing nutrient dynamics in the lake as also the swampy island environs. Besides, the island serves as a substratum to myriad forms of various periphytic algae and other macro/micro invertebrate fauna associated with aquatic macrophytes sponges, flatworms, nematodes, crustacean larvae/adult malacofauna, etc. The habitat serves as a breeding/nursing ground for a variety of fish larvae too. Above all, predominant karka vegetation also provide an important habitat for roosting and nesting of myriad population of waterfowl, both migrant and resident. Not surprisingly therefore, Nalaban is a natural home to the millions of

wintering visitors, each year and therefore, rightly earn the status as a bird sanctuary. The macrophytic therefore play a rather regulatory role in the protected area, influencing the various biotic attributes.

The CDA, Bhubaneswar with its agenda as apex regulatory authority for the conservation and management of Chilka lagoon, has an overall plan for controlling the rampant growth of fresh water weeds into the lake too, as one of the few controlling measures aimed at its conservation.

The various phytoplankton groups reported from the island waters have been listed as under (Pattnaik, 1973, and present study).

Order CLADOPHORALES

Family CHLOROPHYCEAE

- i. *Cladophora* sp.
- ii. *Chlorococcum* sp.

Family CYNOPHYCEAE

- iii. *Lyngabya* sp.

Family XANTHOPHYCEAE

- iv. *Vaucheria* sp.

Order CHROOCOCCACEAE

Family CHROOCOALE

- v. *Microcystis* sp.

Family BACILLARIOPHYCEAE

- vi. *Climacosphenia moniligera*
- vii. *Navicula* sp.
- viii. *Nitzschia plana*
- ix. *Achnanthes compacta*
- x. *Synedra tabulata*
- xi. *Diploneis weissflogii*
- xii. *Rhaphoneis discoides*

Of these phyto-planktonic organisms, *Microcystis* sp. was abundant often resulting in blooms. The widely distributed brackish water algae from the Nalaban area are *Chaetomorpha*, and *Enteromorpha* sp.; while commonly occurring ones include *Lyngbya aestuarii*, *Lyngbya* sp., *Oscillatoria* sp., *Cladophora* sp., *Ulva* sp., and *Trichodesmium erythraeum*. *Gracilaria verrucosa* (vulnerable), *Spirogyra* sp., *Chara* spp., *Nitella* spp., *Anabaena* spp., *Nostoc* spp. occur less commonly in the island waters.

FAUNAL CHARACTERISTICS

From the view point of fauna, the island is an avifaunal grandeur (Mohapatra and Hussain, 1988). Flocks of migratory waterfowl arrive from as far as the Caspian Sea, Lake Baikal, and other remote parts of Russia, central and south East Asia, Ladakh and the Himalayas for feeding and roosting. In addition to this, 13 spp. of protozoa, 11 spp. of polychaetes, 11 spp. of arthropoda, 22 spp. of mollusks, 1 sp. of chaetognath, 19 spp. of fish, 4 spp. of reptiles also inhabit the island waters/environs, including 93 spp. of avifauna (migratory-61, resident- 32), (Table 5). Based upon literature search, field observations/identification, the total number of animal taxa in *Nalaban Wildlife sanctuary* in all is ca. 175 species (Fig.2, and Appendix-1).

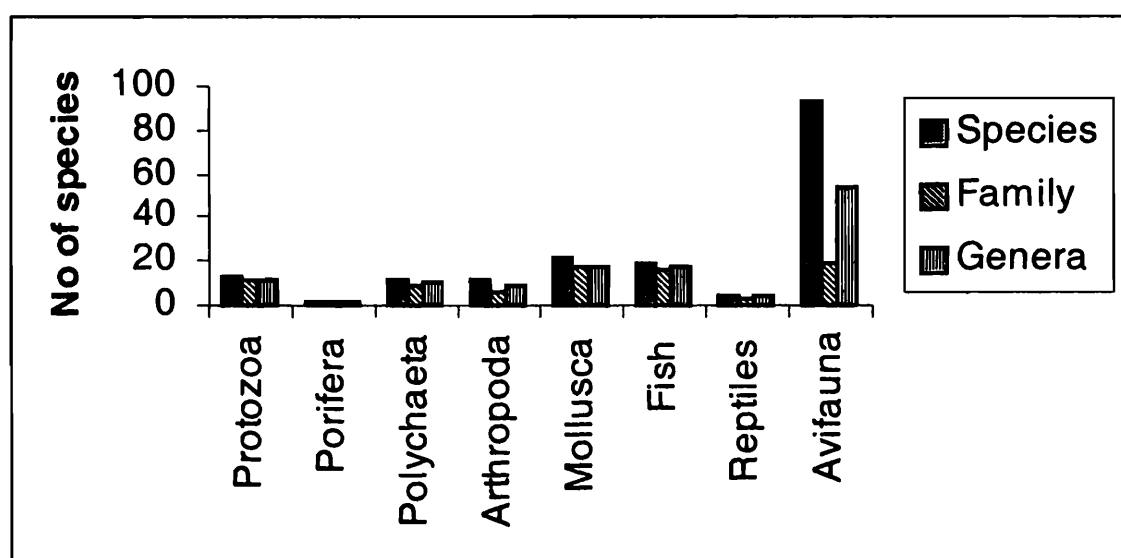


Fig. 2. Histogram showing group wise inventory of various faunal groups reported from Nalaban Wildlife Sanctuary, Chilka, Orissa. Nalaban island, famous as feeding/nesting habitat for migratory waterfowl is home to over 4.5laks ducks, geese, coots, etc.

Table 5. A groupwise profile of faunal diversity in Nalaban Wildlife Sanctuary, Puri District, Orissa.

Taxonomic groups	No. of spp.	Remarks
1. Phylum PROTOZOA (Ciliophora, free living)	13	Das (1995) reported 61 spp. of ciliates from Chilka Lagoon, 13 spp.(brackish/freshwater) recorded from the <i>Nalaban wildlife sanctuary</i> , no further study exists.
2. Phylum PORIFERA	1	Pattanayak (1995) records 6 spp. from Chilka, including one sp. from Nalaban Wildlife Sanctuary. In all, 07 spp. inventotized (Annandale, 1915).

Taxonomic groups	No. of spp.	Remarks
3. Phylum MOLLUSCA i. Class GASTROPODA ii. Class PELYCEPODS	14 08	<p>Malacofaunal benthic communities in the island comprises exclusively <i>gastropods</i> (75.7%), <i>pelecypods</i> (16.9%). Present studies yielded 2 new distributional record from island/lagoon. Predominant macrobenthic gastropods include <i>Nassarious sp</i> and <i>Cerithidea cingulata</i> occurring commonly while <i>Natica sp.</i>, <i>Indoplanrobis exustus</i> occur occasionally.</p> <p>Infauna such as <i>Macoma birmanica</i>, <i>Meritrix sp.</i> and <i>Clementia sp.</i> observed frequently, <i>Modiolus undulatus</i> commonly occurring. Pelecypods community less diverse than gastropods.</p>
4. Phylum ANNELIDA Class POLYCHAETA (Bristle worms).	11	11 spp. reported from Nalaban island of the 31 spp from Chilka. <i>Nereis sp.</i> and <i>Nephty sp.</i> (<i>errant polychates</i>) are commonly occurring.
5. Phylum ARTHROPODA i. Class CRUSTACEA STOMATOPODA DECAPODA BRACHYURA ii. Class INSECTA	1 5 1 4	<p>Predominated by decapoda and brachyuran. Among brachyurans, occurrence of spider crab is interesting from point of distribution..</p> <p>No specific explorative studies undertaken. Present investigation yielded 4 spp. of insects—<i>Odonates</i> and <i>Lepidoptera</i> first time ever from the Nalaban sanctuary, Chilka.</p>
6. Phylum CHAETOGNATHA	1	<i>Spadella cephaloptera</i> a new record from benthic Chaetognath (Acharya, <i>et al.</i> , 1999)
7. Phylum Chordata i. Class PISCES ii. Class REPTILES	19 4	<p>19 of 225 spp. (ZSI, 1995), recorded from protected area.</p> <p>Being inundated, the island does not boost of rich herpetofauna. Only 3 spp. of snakes and 1 sp. of lizard reported.</p>

Taxonomic groups	No. of spp.	Remarks
iii. Class AVIFAUNA	93	Unique waterfowl habitat, therefore, Ramsar site, groupwise predominated by <i>shore birds>ducks & geese>coot & crane>gull & terns etc.</i> <i>Haliastur leucogaster</i> (White bellied sea eagle)- <i>indicative fauna</i> . Recent BNHS study(2002), records 6 additional spp. increasing total tally to 162 species.
Total	175	

NALABAN WILDLIFE SANCTUARY, CHILKA, ORISSA—A PROFILE

➤ <i>Geog. Co-ord.</i>	85°14' E to 85°17' E longitude and 19°17' N to 19°39' N latitude. <i>Central sector, Chilka Lagoon, Puri District, along east coast of peninsular India.</i>
➤ <i>Location & Geology</i>	15.53km ² (of 1100km ² Chilka lagoon), <i>core zone 6.72 km² and buffer zone 8.81 km²</i> . Nalaban Wild life Sanctuary (Nalaban Island) is a <i>shallow, low marshy habitat, remaining completely waterlogged during the rainy season, occasionally drying up in summers.</i> Structural/ Denundational Hills around Hilloks of Khondalite, Charnockite, gneisses, anorthosites and granites main geographic unit, with intrusive anorthosites, occurring extensively (Samal, 1998)
➤ <i>Sediment Characteristics</i>	Sandy clay, clayey silt to silty clay and clay (Panda, 1993).
➤ <i>Ecology</i>	Highly dynamic transitional ecosystem, varying between aquatic to dry conditions. Average Zsd 0.76m, average depth (d) 1.18m., average bottom water temperature 28.3°C, pH 7.6-9.1, average salinity 14.2‰ average turbidity 13.8NTU, average DO 6.9mg/l, Nutrients (N-NO ₃ 0.65, P-PO ₄ 4.9, Si-SiO ₄ 17) exhibits cyclic change in its abiotic/biotic regime, with salinity regulating abundance distribution.
➤ <i>Biodiversity</i>	Ecologically dynamic dynamic waterfowl habitat, (<i>Ramsar site</i>) home to host of international migrant waterfowl (61spp.), besides 32 spp. Resident/local populations, therefore <i>bird sanctuary</i> . Additionally islands faunal profile includes 19spp. of fishes, 4spp. of reptiles, 13spp. of Protozoa, 1 sp. of Porifera, 23 spp.

	of <i>Malacofauna</i> , 11 spp. of Arthropoda, 11 spp. of Polychaetes, 1 sp. of Chaetognath, mostly <i>aquatic</i> . Indigenous spp. of grass <i>Phargmites karka</i> , locally named <i>Nala</i> , Predominant. Plant community represented by 14 spp. of Macrophytes and 02 spp. of weeds (of the 28 and 20 reported from Chilka). Plankton: Phytoplankton 23 spp.; Zooplankton 26 groups. Macrobenthic malacofaunal (22 spp.) community <i>highly diverse/ varied</i> and stable ($H = 6.17 - 0.14$ & $e = 0$ to 3.44), indicating favourable aquatic environment.
➤ <i>Indicative fauna</i>	Few avian species, besides macrobenthic malacofauna community.
➤ <i>Problems</i>	Heavy siltation, temporal and spatial variation in salinity, weed infestation traditional intensive aquaculture pen culture/gheri in fringe areas and over fishing, threaten overall biotic diversity.
➤ <i>Status</i>	<i>Wildlife Sanctuary</i> (Govt. notification No. – 23403, Dt. 17.12.1987) famous for its <i>rich, diverse, resident and migratory avifauna</i> . Following interventional restoration/conservation measures, Chilka lake deleted from the Montreaux Record by the <i>Ramsar Advisory Mission</i> (Nov. 11, 2002).
➤ <i>Protection and Conservation</i>	Protection of migratory waterfowl and other species prone to poaching for meat, Restoration of the feeding and roosting habitat of waterfowl, Research and development activities.

INVERTEBRATES

Protozoa : Das, 1995, reported 61 spp. of ciliates from Chilka lagoon. Of these only 13 spp. (freshwater/brackish water) of free living ciliates occur in the protected area. No other study has been undertaken.

Porifera : Pattanayak, 1995 and Annandale 1916 recorded 7 species of Porifera (class-Demospongiae) from Chilka. Of these 6 spp., only one species- *Spongilla alba* is known to inhabit Nalaban island.

Mollusca : The molluscan fauna in the island/lagoon is very rich and therefore interesting. It has therefore been a subject of great interest in view of its ecological importance and as a fishery resource (Preston, 1915, Annandale, 1916 and Subba Rao, 1995). Based upon literature search, a total 136 spp. of mollusca have been reported from Chilka lagoon (Subba Rao, 1995). Of these, only 10 spp. occur in this marshy island. The present collections have brought to light 12 additional species, thus enhancing the number of molluscs

occurring in *Nalaban Wildlife Sanctuary* to 22. The collections studied, both live and dead shells, from the sanctuary area includes a total 22 species under 19 genera and 18 families.

Of these, 22 species; 14 species are gastropods, 8 are pelecypods. Further 2 species *Thais rugosa* and *Glaucanoma sculpta* new record from the sanctuary area. Again the 14 species of gastropods save for *Alba blanfordi*, *Bellamyia dissimilis*, *Thira tuberculata* and *Indoplanrobis exustus*, the rest are brackish/estuarine water forms. Similarly 08 pelecypods species are brackish/estuarine inhabit. The presence of few freshwater malacofaunal forms may be attributed to low salinity prevailing in some parts of the inundated protected area. Interestingly enough, the bottom region rich in macrophytic vegetation supported a far richer diversity of molluscan fauna, as the group are substratum dwellers and prefer substratum rich in vegetation. Further, the shallow mudflats bottom admixed with sand are preferred by *Cerithidea cingulata* (lacustrine fauna), *Natica sp.*, and *Nassarious sp.* Some in fauna species of bivalves – *Macoma birmanica*, *Meritrix sp.*, *Glaucanoma sculpta* etc. burrow inside the soil at varying depths.

Studies on seasonal abundance in bottom fauna of the lake revealed that predominant molluscan fauna also form an important dietary components of lake fishes, thereby playing an effective role in the aquatic food chain. Previous studies on the benthic malacofauna revealed maximum number of gastropods during April to June in the central sector (Pattnaik 1971). However, the present investigations revealed the molluscan peak during July-October in the island. This may be attributed to low salinity during this period, following higher inflows of nutrients with surface runoff into the island and changes in other physico-chemical factors. The estimates of abundant for the benthic malacofauna are: abundant- *Nassarious sp.*, *Modiolus undulates*; common- *Cerithidea cingulata* and *Macoma birmanica*; frequent.- *Meritrix spp.*, *Clementia sp.* and *Glaucanoma sculpta*; and occasional- *Natica sp.*, *Indoplanrobis exustus* and *Thais rugosa*.

Polychaetes : These are one of the important constituents of the benthic animal communities in the island waters. A total of 31 spp. of polychaetes have been reported from the lagoon (Rao, 1995). Of these, 11 spp. are found in the bird sanctuary. Commonly occurring errant polychaetes are *Nereis* and *Nephtys* spp. Brackish water polychaetes viz. *Ancistrosyllis constricta*, *Namalycastis indica*, *Neries spp.* *Glycinde oligodon* and *Laonome indica* etc. which prefer range of moderate salinity, also inhabit this region.

Crustacea : Reddy, 1995 reported 13 spp. Of this, only 7 spp. of crustacea occur in *Nalaban Wildlife Sanctuary*. The shallow island waters is a ground of commercial shrimp species like *Panaeus monodon*, *P. indicus*, *Scylla serrata* and *Neptunus pelagicus*.

Insecta : No specific explorative studies on entomofauna from the marshy island undertaken and present investigation yielded 4 spp. of insects (Odonates-2spp., Lepidoptera-2spp.), reported for the first time from the island. (table 2 and appendix)

Chaetognatha : Acharya *et. al.*, 1999, reported *Spadella cephaloptera*, new record of a benthic chaetognatha from *Nalaban island, Chilka*, for the first time. *Spedella spp.* are known to inhabit shallow benthic littoral regions, where they adhere to rocks and algae

by their adhesive papillae. The benthic chaetognaths are known to be highly predaceous and carnivorous animals subsisting on the macro and meiofauna of suitable sizes with which they came in contact (Hyman, 1959).

The present study therefore is a first attempt to document *alpha diversity* in benthic community in the protected area. The biotic components, representing macrobenthos which occur in the marshy island can be classified into two major groups namely *epifauna* and

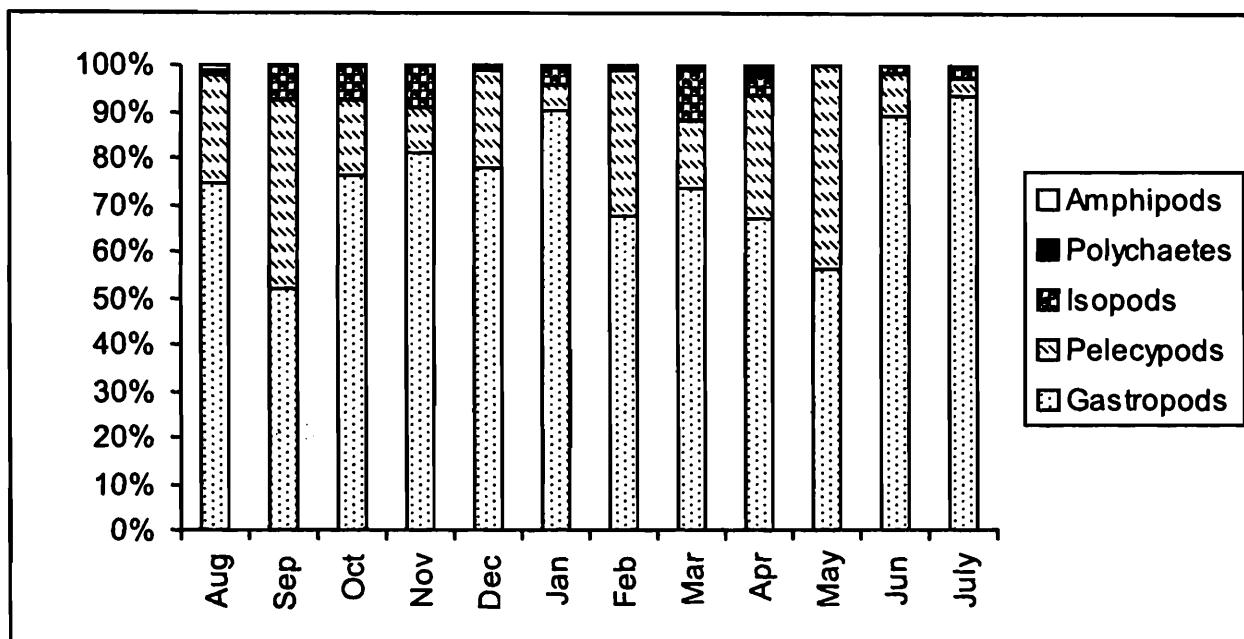


Fig. 3.. Histogram showing month wise percentage composition of various groups of macrobenthic community in Nalaban island, during 2002-2003.

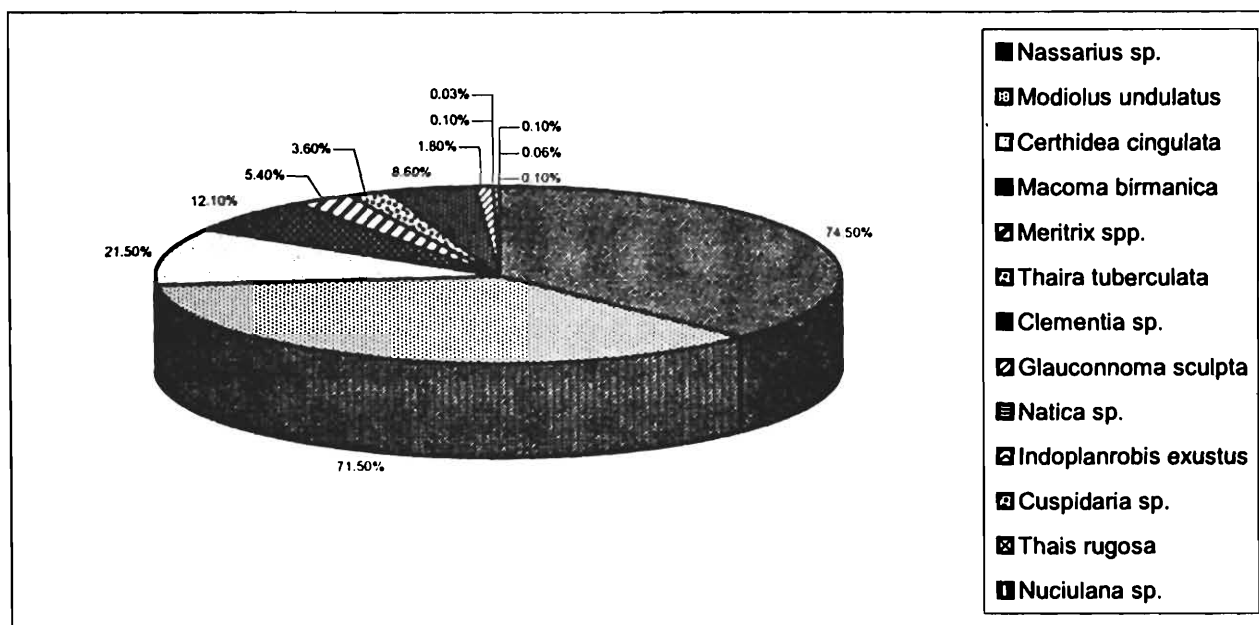


Fig. 4 Pie diagram showing percentage composition of various species of malacofaunal community in macrobenthos in 2002-2003.

infauna. Of these, macro invertebrates include gastropods (75.7%), pelecypods (16.9%), polychaetes (0.35%) and crustacea (amphipods-0.07%, isopods-4.9%) (Fig.3). Amongst these groups, mainly gastropods represent epifauna, polychaetes and pelecypods comprised infauna, while crustaceans include both epifauna and infaunal organism. Of these macrobenthic communities, only malacofauna were taken for detailed analysis. The benthic population, based on numerical counts, showed wide variations in their distribution at different stations during different seasons.

In macrobenthic community, molluscan fauna was rich in this island. Gastropod ranked first among the total faunal groups in composition as well as abundance, followed by pelecypods, represented in all seasons. Altogether, 13 species. of malacofauna were observed during the study period. Of these *Nassarius spp.* (74%), *Modiolus undulatus* (71%), were abundant, *Cerithidia cingulata* (21.5%), *Macoma birmanica* (12%) were common, while *Meritrix sp.* (5.4%), *Thira tuberculata* (3.6%), *Clementia sp.* (8.6%), *Glauconoma sculpta* (1.8%) frequent, *Natica sp.* (0.1%), *Indoplanrobis exustus* (.04%), *Cuspidaria sp.* (0.1%), *Thais rugosa*(0.06%), *Nuculana sp.* (0.1%) were occasionally encountered.

MEASUREMENT OF DIVERSITY

Studies on the community composition spatial and temporal (seasonal) variations there in (islands maerobenthos), have been duly supplemented with statistical analyses of benthic malacofaunal communities for assessments of species diversity, both in terms of content, (species richness) and equitability (evenness of distribution) The number of density indius – Simpsons index of diversity – (d) [Simpson, 1949] Evenness index (e) [Pielou, 1966 and the Shannon–Weiner diversity index have been used for measurement of species diversity, a measure of the stability of the habitat/environment.

The number of species density of individual species and total macro-faunal density were used to compute following diversity indices.

1. Shannon's diversity index (H) (Lloyd Ghelardi 1964, Mac Artlnur and MacArthur 1961)
2. Simpson index (D) (Simpson, 1949)
3. Evennes index (e) (Pielou 1966).

The Shannon Wiener index is expressed by the formula

$$\bar{H} = 3.3219 \left(\log_{10} N - \frac{1}{N} \sum ni \log_{10} ni \right), \text{ where}$$

\bar{H} = Shannon Wiener index

N = Total number of individuals of all species

ni = number of individuals of the ith species

3.3219 = conversion factor from \log_{10} to \log_2

\bar{H} is expressed as bits for individual species diversity.

Simpson's index is expressed by the formula

N = Total number of individuals of all species

n = number of individuals of a species

Evenness (e) was calculated from the expression

$$e = \frac{\bar{H}}{\log_e S} \text{ where}$$

\bar{H} = Shannon Wiener index

S = Number of species

Although several species diversity indices have been proposed particularly on species richness and individual richness (Preston 1948, and Brillouin 1960) and the study of species diversity has produced an extensive literature, some important and useful reviews include those of Mac. Arthur (1965), Mc Intosh (1967), Whittaker (1977) and Peet (1974). One of the most promising indices of diversity measure is derived from the information theory (Margalef, 1956, Patten, 1962 and Mathis, 1968). In estimating the species diversity probably the most widely used index is the Shannon-Wiener index, which actually is not a real assessment of species diversity in community but the relative importance value of species taken into account (Whittaker, 1977).

The Shannon-Wiener index, varied considerably from 2.05 to .99 at station 1, 6.17 to 1.4, 1.9 to 1.5, 1.5 to 1.3, 1.1 to 0 .72, 1.0 to 0.1, 1.6 to 1.1 and 2.07 to 1.6 at stations 2, 3, 4, 5, 6, 7 and 8 respectively (Table 6). The maximum value of H recorded was 6.17, 2.07, 2.05 and 1.9 (Table 6) indicating a site of higher diversity. Higher diversity signifies longer food chain and more cases of symbiosis (mutualism, commensalisms *etc.*) and also more stable community (Margalef 1968). Sampling sites 2, 7 and 8 with high species diversity are generally considered to have high conservation value. Evenness index measures of the uniformity of different species in a community and the value increases as the environment becomes favorable. The evenness index values computed were found to vary between .91 to 1.1 at station1, 1.02 to 3.44, 0.95 to 1.2, 0.8 to 1.1, 0.8 to 1.04, 0 to 1.4, 0.6 to .94, 1.0 to 1.1 in stations 2, 3, 4, 5, 6, 7, and 8 respectively (Table 6).

Table 6. Showing rang of values of Shannon Wiener Index (H), Simpsons index (D) and Evenness index(e) at the different sampling stations, during different seasons.

Sampling Sites	SW Monsoons			Winters			Summers		
	H	D	e	H	D	e	H	D	e
N1	1.63	2.15	0.91	0.99	2.04	1.43	2.05	2.17	1.14
N2	1.83	2.68	1.02	1.44	2.36	1.32	6.17	13.20	3.44
N3	1.64	2.77	1.18	1.53	2.31	0.95	1.92	2.43	1.2
N4	1.30	2.04	1.19	1.59	2.65	0.99	1.49	2.31	0.83

Table 6. Contd.

Sampling Sites	SW Monsoons			Winters			Summers		
	H	D	e	H	D	e	H	D	e
N5	0.72	1.38	1.04	1.11	1.65	0.80	0.89	1.26	0.81
N6	0.32	1	0	1.00	1.94	1.45	0.14	1	0
N7	1.64	1.86	0.91	1.30	2.24	0.94	1.18	1.60	0.60
N8	1.88	2.71	1.17	1.61	2.65	1.00	2.07	2.43	1.06

In order to study the relation between the molluscan species, coefficient of co-rrrelation was calculated. Among gastropod a significant co-rrrelation between *Nassarius sp. Thira tuberculata* ($r = 0.0.563$; $P < 0.05$) and between *Cerithidia cingulata and Thira tuberculata* ($r = 0.798$; $P < 0.01$) conforms their coincidence of abundant pattern. Similarly among bivalves, a significant co-rrrelation between *Modiolus undulatus and Macoma birmanica* ($r = .430$; $P < 0.05$); *Macoma birmanica and Clementia sp.* ($r = 0.615$, $P < 0.001$) was recorded while a negative correlation between *Modiolus undulatus and Clementia sp.* ($r = -0.622$, $P < 0.01$) suggest an inverse relation due to the nature of substratum and feeding of other organism in island. Further, the ANOVA test conforms that there is significant variation within the molluscan species and no significant variation within stations.

VERTEBRATES

Fish : A total 217 species of fish fauna have been reported from the Chilka lagoon (Rama Rao, *et al.* 1995). During course of present studies, 19 spp. of fishes were collected and documented. Major fishes found in this sanctuary area *Glosogobious giuris*, *Etroplus suratensis*, *Puntius ticto*, *Carangoides praeustus*, *Ambasis gymnocephalus*, *Triacanthus biaculeatus and Mystus gulio*, *Plotosus canius etc.*

Reptiles : A total 30 species of reptiles were reported from Chilka lagoon (Murthy, 1995). Based upon literature, only 4 species of reptiles are found in Nalaban marshy area. Dog-faced water snakes and Hook nosed sea snakes occur commonly in this sanctuary. Further, there is indirect evidence of record of dead estuarine sea snake from near Nalaban island. (Dutta, 1998). The reptile fauna is not rich in Nalaban wildlife sanctuary.

Avifauna : Chilka is an ideal habitat for the largest congregation of waterfowl in India, indeed Asia too. The Nalaban marshy island acts as the resting and roosting ground for millions of avifauna from different parts of world, in view of abundance of major food plant species e.g., *Potamogeton pectinatus*, *Ruppia sp. Halophila spp. Enteromorpha spp.*, in Nalaban during the migratory seasons. The surface feeding Gadwall sp. were seen more in the *Potamogeton* rich areas in this island. Gut content analysis of one Gadwall also proved that *Potamogeton* is the primary food for this species. Other groups of water forms also congregate in the highly swampy, grassy regions of the island. (Balachandran, 2003).

The avifauna in the Chilka is very rich comprising about 156 spp. (Hussain and Mohapatra, 1985 and Chottopadhyaya, 1995). Of these, over 87 spp. inhabit the predominantly aquatic Nalaban Sanctuary. Six more bird species have been reported recently (Bombay Natural History Society), December, 2002. The species recorded are Great stone plover (*Charadrius leschenaulti*), Jungle myna (*Acridotheres fuscus*), Oriental magpie-robin (*Copsy saularis*), Red necked stint, Indian skimmer (*Rhynchops albicollis*) and Oriental Pratincole (*Glareola maldivarum*). The island avifauna is predominated by ducks and geese (Anseriformes) followed by coots, cranes (Gruiformes) 15%; wade/shore birds (Charadriiformes) 12%; Pelicans (Pelicaniformes) 1.5%; grebes (Podicipediformes) 1%; kites, eagle (Falconiformes) and kingfisher (Coraciformes) etc. 0.5%. (Wader/shore birds > ducks and geese > coot and crane > gull and tern > Pelicans, grebs > kites, eagles). Some notable and endangered species (included in the Shedule I of the Indian Wildlife Protection Act, 1972) available in this island are white bellied sea eagle (*Haliaeetus leucogaster*), white spoonbill (*Platalea leucorodia*) and spoonbilled sandpiper (*Eurynorhynchus pygmeus*).

A recent bird census (11 January 2003), revealed over more than 4,50,000 birds in Nalaban island. The duck species (about 1,00,000) noticed in maximum numbers during mid December to early January at Nalaban were *Anas acuta* (Northeren pintail), *A. clypeata* and *A. crecca* (common teal) *Tadorna ferruginea* (Brahminy shelduck), and *Anas querque* (Gargeny). The population estimated in January 2003 was the highest, but this could not be compared with the January 2002 data, as it was not monitored. However, the estimates on February 2002 and February 2003 shows a sharp decline in the total population (Fig. 5). From October to December, the wader population gradually increased in Nalaban and reaching its peak in early January (1,44,000). For all wader species, except the *Curlew sandpiper* and common Redshank *Tringa tetanus*, maximum were noted on the Nalaban island.

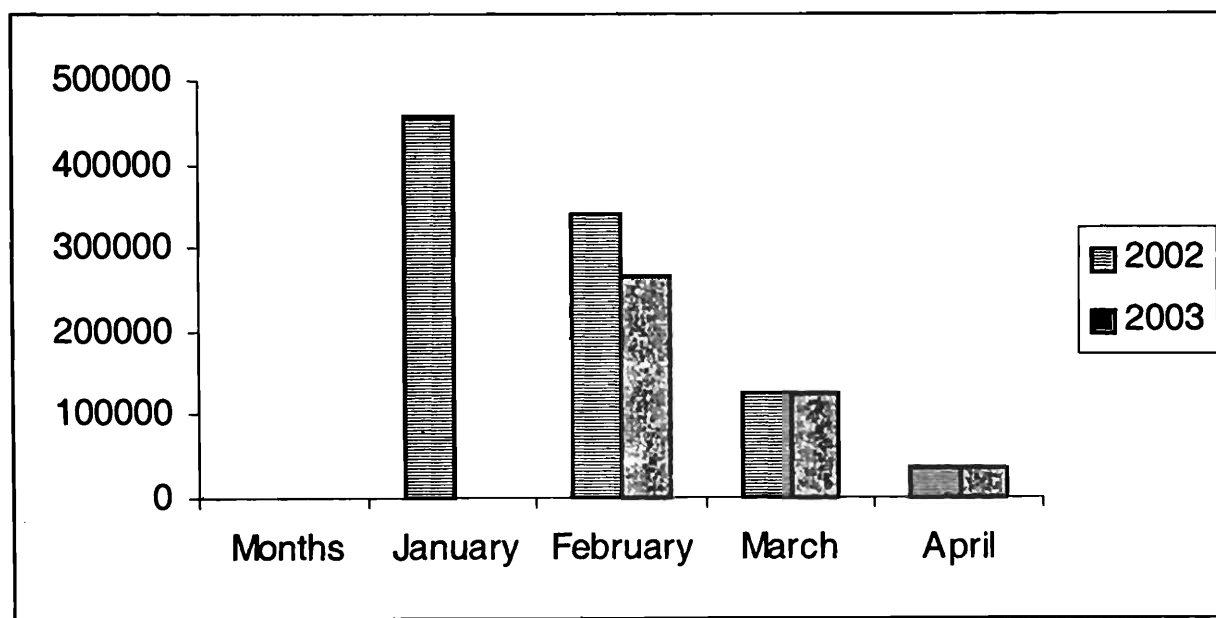


Fig. 5. Comparison of birds population in Nalabana island during 2002 and 2003 (Source : BNHS)

FISHERY RESOURCES

Apart from its immense biodiversity value and intrinsic potential biotic endemicity, the sprawling 1165km² largest brackish water lagoon supports a rich and diverse fisheries. Not unsurprisingly therefore, the natural tropical wetland, a *Ramsar site*, also supports over 12,363 fishermen families in *ca* 132 villages, dispersed all along the coast and 06 islands, who directly or indirectly depend for their lively hood from the lake or the wetland. Further, there are about 12 jetties and over 66 fisheries cooperatives societies catering to the primary needs of the fishermen community, besides a good number of small time traders. The fisheries mainly comprises of crustaceans (prawns/crabs) and mullet fisheries. The reported figures of the fish catch between 1997–1998 to 1999–2000 ranged between 1492–1556 metric ton (MT) excluding crustaceans fisheries (137–180 MT). The total fisheries from the wetland ranged between 1652–1746 MT for the period (CDA, 2003) following progressive decline in the overall fisheries from the lake following major ecological degradation to the wetland, the CDA, on the basis of expert advice initiated a number of bold international major towards restoration of the Chilka lagoon. Desiltation of the outer channel at mugarmukh, linking the lagoon to the sea and opening of the new mouth, have had major positive impact in ensuring salinity regime and exchange of water in the lagoon, fetching better results in the form of higher and varied fisheries. As a result, the total fisheries catch has increase substantially and now hovers around 9530 MT (fisheries) and 2629 MT crustacean fisheries. Sector wise catches indicates that the northern sector, central sector (Nalaban and its periphery areas), southern sector and the outer channel sector shared 32%, 45%, 14% and 9% of the total catch respectively. Of these fish fauna, clupeids (24%) were dominant, followed by catfishes (12%), mullets, perches, sciaenids and cichlids which in turn constitutes 6% to 10% of total catch. Similarly among crustaceans, *Metapenaeus dobsoni* was the highest (42%), followed by *M. monoceros* (25%), while *Penaeus indicus* and *P. monodon* formed 15% and 13% respectively. Mud crabs-*Scylla sp.*, constitute in the total crustacean landing (*Chilka News letter*, 2003).

THREATS AND CONSERVATION

Of late, the highly fragile yet ecologically resilient marsy ecosystem in the island has been under threats primarily emanating from enhanced anthropogenic activities from the major fishing activities (Balugaon nearby) and small village settlements around, besides natural geomorphic changes taking place in the lagoon, over spaces and time. The island and its ecology and dynamics are entirely dependent on the much larger the Chilka lagoon, as it is an integral part of the 1165 km², Chilka lake: Therefore, the threat perceptions are common, so much so that the survival of the island and its biotic attributes are at stake. In short, the mother Chilka not only strongly influences but regulates the ecosystem profile, its dynamic in entirety and thus controls or dictates its biotic composition too. Nonetheless, the island has its own identity and biodiversity too. Therefore the 15.53 km² area calls for specific or sectoral approach (sectoral management) for amelioration of its problems, besides, multi-faceted and integrated approach for Chilka.

Broadly speaking, the environmental problems plaguing the Nalabai island, or by extension the Nalabai wildlife sanctuary have been categorized/discuss as under:

1. Salinity : The salinity being the most important factor for the growth and distribution of aquatic biota- fish, prawn and crab, besides others aquatic life forms, are more susceptible to salinity gradients changes, especially with respect to their abundance/distribution. Depending on the concentration of salinity, three types of water environment like fresh, brackish and marine water co-exist in Nalabai marshy island. The magarmukh (gateway between lake and outer channel), indicated that the summer depth is alarmingly low (CDA, 1997). This is preventing the discharge of freshwater and sediment during monsoons to sea through outer channel, thereby causing flood in the northern sector. Similarly the Nalabai bird Sanctuary remains submerged during the month of October causing management problems. At the same time, tidal ingress into the lagoon is reduced, decreasing the population of different types of animal's life in the lagoon. The breeding migration from sea to the lagoon and lagoon to the sea is also adversely effected due to decreasing salinity. To mitigate this problem, a new mouth was open in 2001 near magarmukh, which was considered as an historic intervention to save the ecosystem of unique Chilka lagoon as per the recommendation of the Central Water Power Research Station, Pune.

2. Siltation : Primarily a major threat to general ecology and survival of any freshwater/ costal wetland environment, it results from sediment inputs or flows into the lake by fluvial, aeolian, and marine aelian. The inflowing rivers Daya, Bhargabhi, Malaguni, Kusumi and Salia in north bring in sediment load into the lagoon. It has also been observed that the breeding and spawning ground of mollusks, crustaceans, *etc.* have been destroyed due to Siltation. To prevent siltation, massive forestation, and plantations of appropriate species the undertaken to stabilize the sand dunes, neo-dunes, *etc.*

3. Aquaculture : In and around the Nalabai marshy island, illegal, unauthorized prawn fields (Gheri) increases soil salinity of the lake water. The chemicals and prawn feed used in the prawn field also effects the aquatic life and pollutes lake waters. Bottom trawling nets have a fine meshed cod end which indiscriminately traps all marine life, including even eggs and young ones. This destroys natural food chain and damages the bottom habitat, submerging bottom vegetation and other organisms.

4. Overfishing : The act of unregulated, indiscriminate fishing activity which cross the conservational magnitude of fishing resources is known as over fishing. The fishing activities in Chilka lagoon fully corroborated this. It can be mainly attributed to over fishing. Hence over fishing can be taken as the primary cause of concern for the sustainable fisheries and associated socio-economic progress in the region.

5. Poaching : People have been using migratory birds, arriving in Chilka for wintering as a source of protein supplement for quite sometime. With the passage of time, this source of protein supplement has also became a source of livelihood for them.

As a matter of the fact, the sustainability and biodiversity of this lagoon became critical and created concern among the environmentalist and conservationists. As a result

the Government of Orissa took interest to conserve the flora and fauna by states environmental conservation and management Programme. In 1991, a separate autonomous body namely Chilka Development Authority, was established to protect the environmental characteristics, restoration of ecosystem of Nalaban island and fishery resource development *etc.* Habitat development inside the sanctuary is being done with funds received from Government of India and Chilka Development Authority. These measures include raising up of plantations, digging and renovation of creeks and digging of ponds.

Above all, conservation of ecological heritage of such international/national important depends not only on government legislation/efforts. In fact, it calls for combined and coordinated effort at government and non-government level, including international agencies for ecological restoration/management.

Nalaban sanctuary is presently managed by Wildlife Wing of the Forest Department, through Chilka Wildlife Division, *prima-facie* created for intensive plantations in buffer and core area of Nala (*Phargmites karka*) for serving as perching grounds for avifauna, and protection of migratory waterfowl and other species *etc.* in the island. Chilka has been recently deleted from the Montreaux Record of Ramsar sites by the Ramsar Advisory Mission (Nov. 11, 2002), following timely hydrological interventional restoration/measures, aimed at abetting ecological degradation of the vast wetland for conservation.

CONCLUSION

A long term multidisciplinary investigations in the island ecosystem, for detailed biodiversity survey/inventory, the range of the seasonal and annual variability if any and possible co-relations to key causative factors – physicochemical/ecological, will go a long way in helping draw complete picture of the island and its biotic attributes and potential as a water fowl habitat of international repute – a Ramsar site.

A scientific/multi-taxa floral/faunal inventory will help reveal a clear picture of the alpha or regional diversity, the database so generated serving as technical inputs for wetland managers/policy makers in framing an effective long term management strategy (through site specific management action plans) for wise-use and in judicious management of the wetland and its resources for posterity and stake-holders with equity.

The present painstaking endeavours by the author, based upon 02 years field studies permissible aquatic faunal collections, besides extensive literature search – contemporary/classical works, have yielded an impressive tally – multi-taxa faunal inventory of 175 spp. of invertebrates and vertebrates, including bird nekton.

Despite good management practices, the island ecosystem has been facing alarming, deteriorating changes in its overall ecology, following the onslaught of anthropogen pressures – unregulated, indiscriminate, obtrusive 'bheries' or pen culture, besides excessive mechanized fishing. A sectoral management action plan, in addition to increased environmental education of the stake-holders have been suggested to restore back the pristine avian splendor of the Nalaban Island.

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APPENDIX

List of various groups of species reported from Nalaban Island, Chilka, Orissa. Inventory includes spp. inhabiting 15.53km² inundated island and not entire Chilka lake. Asterisk (*) preceding species name indicates first record.

FREE LIVING PROTOZOA

Phylum CILIOPHORA

Class KINETOFRAGMINOFOREA

Order PROSTOMAIDA

I. Family HOLOPHRYIDAE

1. *Holophrya nairi* sp. nov.

II. Family PRORODONTIDAE

2. *Prorodon discolor* (Ehrenberg).

Order PLEUROSTOMATIDA

III. Family AMPHILEPTIDAE

3. *Loxophyllum grande* (Entz).

Order NASSULIDA

IV. Family NASSULIDAE

4. *Nassula ornata* (Muller).

Order CYRTOPHORIDA

V. Family CHLAMYDODONTIDAE

5. *Chlamydodon mnemosyne* Ehrenberg.

VI. Family DYSTERIIDAE

6. *Dysteria ovalis* (Gourret & Rooser).

Order SCUTICOCILIATIDA

VII. Family URONEMATIDAE

7. *Uronema marinum* Dujardin.

VIII. Family COHNILEMBIDAE

8. *Cohnilembus subulatus* (Kent).

9. *Cohnilembus verminus* (Muller).

Order PERITRICHIDA

IX. Family VORTICELLIDAE

10. *Vorticella marina* Greef.

Order HETEROTRICHIDA

X. Family METOPIDAE

11. *Metopus fuscus* Kahl.

Order HYPOTRICHIDA

XI. Family EUPLOTIDAE

12. *Euplotes eurystomus* Wrzesniowski.
13. *Euplotes woodruffi* Gaw.

Phylum PORIFERA

Class DEMOSPONGIAE

I. Family SPONGILLIDAE

1. *Spongilla alba* Carter, 1849

Phylum MOLLUSCA

Class GASTROPODA

Order MESOGASTROPODA

I. Family VIVIPARIDAE

1. *Bellamya dissimilis* (Muller).

II. Family THIARIDAE

2. *Thiara tuberculata* (Muller).

III. Family POTAMIDIDAE

3. *Cerithidia cingulata* (Gmelin)–*Cerithid Snail*

IV. Family LITIOPIDAE

4. *Alaba blanfordi* A. Adams.

V. Family FINELLIDAE

5. *Finella virgata* (Philippi).

VI. Family NATICIDAE

6. *Natica* sp.

Order NEOGASTROPODA

VII. Family NASSARIIDAE

7. *Nassarius stolatus* (Gmelin).
8. *Nassarius subconstrictus* (Sowerby).
9. *Nassarius orissaensis* (Preston).
10. *Nassarius vittatus* A. adams.

VIII. Family MURICIDAE

- *11. *Thais rugosa* (Born).

Order CEPHALASPIDEA

IX. Family CYLICHNIDAE

12. *Tornatina estriata* Preston.

Order BASOMMATOPHORA

X. Family PLANORBIIDAE

13. *Indoplanorbis exustus* Deshayes.

Class BIVALVIA

Order MYTILOIDA

XI. Family MYTILIDAE

14. *Modiolus undulatus* (Dunker).

Order VENEROIDA

XII. Family UNGULINIDAE

15. *Felania annandalei* Preston.

XIII. Family CULTELLIDAE

16. *Neosolen aquaedulcioris* (Ghose).

XIV. Family TELLINIDAE

17. *Macoma birmanica* (Philippi).

Order PTERIOIDA

XV. Family VENERIDAE

18. *Meretrix casta* (Gmelin).

19. *Clementia* sp.

Order MYOIDA

XVI. Family CUSPIDARIIDAE

20. *Cuspidaria* sp. Preston.

XVII. Family GLAUCONOMIDAE

- *21. *Glaucanome sculpta* Sowerby

XVIII. Family NUCULANIDAE

22. *Nuculana* sp.

Phylum ANNELIDA

Class POLYCHAETA

I. Family PILARGIDAE

1. *Ancistrosyllis constricta* Southern.

II. Family NEREIDAE

2. *Namalycastis indica* (Southern).

3. *Nereis chilkaensis* Southern.

III. Family NEPHTYIDAE

4. *Nephtys oligobranchia* Southern.

5. *Nephtys polybranchia* Southern.

IV. Family GLYCERIDAE

6. *Glycinde oligodon* Southern.

V. Family EUNICIDAE

7. *Marphysa gravelyi* Southern.
8. *Diopatra neapolitana* Delle chiaje.

VI. Family SPIONIDAE

9. *Prionospio cirrifera* Wiren.

VII. Family PARAONIDAE

10. *Aricidea fauveli* Hartman.

VIII. Family SABELLIDAE

11. *Laonome indica* Southern.

Phylum ARTHROPODA

Class CRUSTACEA

Order STOMATOPODA

I. Family SQUILLIDAE

1. *Cloridopsis* sp.

Order BRACHYURA

II. Family LEUCOSIIDAE

2. *Philyra alcocki* Kemp

III. Family PORTUNIDAE

3. *Scylla serrata* (Forsk.)

Order DECAPODA

IV. Family PENAEIDAE

4. *Penaeus monodon* Fabricius.
5. *P. indicus* H. Milne Edwards.
6. *Metapenaeus monoceros* (Fabricius).

V. Family PALAEMONIDAE

7. *Macrobrachium* sp..

VI. Family UPOGEBIIDAE

8. *Upogebia heterocheir* Kemp.

Class INSECTA

Order LEPIDOPTERA

VII. Family HESPERIIDAE (SKIPPERS)

- *9 *Borbo cinnera* Wallace

Order ODONATA

VIII. Family LIBELLULIDAE

*10. *Orthetrum anceps* (Schneider).

Phylum CHAETOGNATHA

1. *Spadella cephaloptera* Acharya, Bohidar and Kar, 1999.

PISCES (Fishes)

Scientific Name	Common Name
I. Order CARCHARHINIFORMES	
1. Family DASYATIDAE	
1. <i>Himantura walga</i> (Muller and Henle)	
II. Order CLUPEIFORMES	
2. Family CLUPEIDAE	
2.1. <i>Nematolosa nasus</i> (Bloch)	<i>Bloch's gizzard shad</i>
3. Family ENGRAULIDIDAE	
3.1. <i>Thryssa polybranchialis</i> Wongratana	
III. Order CYPRINIFORMES	
4. Family CYPRINIDAE	
4.1. <i>Puntius sophore</i> (Hamilton)	Spotf in swamp barb
4.2. <i>P. ticto</i> (Hamilton)	Ticto barb
4.3. <i>Salmostoma bacaila</i> (Hamilton)	Large razor belly minnow
IV. Order SILURIFORMES	
5. Family BAGRIDAE	
5.1. <i>Mystus gulio</i> (Hamilton)	Long whiskered catfish
V. Order CYPRINODONTIFORMES	
6. Family BELONIDAE	
6.1. <i>Stringylura strongylura</i> (Van Hassept)	Spottail needle fish
VI. Order PERCIFORMES	
7. Family AMBASSIDAE	
7.1. <i>Ambasis gymnocephalus</i> (Lacepede)	Bald glassy perchlet
8. Family TERAPONIDAE	
8.1. <i>Terapon jarbua</i> (Forsskal)	Jarbua terapon
9. Family CICHLIDAE	
9.1. <i>Etroplus surantensis</i> (Bloch)	Banded Pearlsport
9.2. <i>Oreochromis mossambica</i> (Peters)	Mozambique cichlid

10. Family SIGANIDAE

10.1. *Siganus javus* (Linnaeus)

11. Family GOBIIDAE

11.1. *Glossogobius giuris* (Hamilton) Tank goby

12. Family CARANGIDAE

12.1. *Carangoides praeustus* (Bennett) Brown backed trevally

13. Family GERREIDAE

13.1. *Gerres oyena* (Forsskal) Common silvery-biddy

VII. Order TETRAODONTIFORMES

14. Family TRIACANTHIDAE

14.1. *Triacanthus biacaleatus* Short-nosed tripodfish

15. Family PLOTOSIDAE

15.1. *Plotosus canius* Hamilton-Buchanan

16. Family SOLEIDAE

16.1. *Euryglossa orientalis* (Bloch) Oriental-sole**REPTILES (Snakes, Lizards, etc.).**

I. Family HYDROPHIIDAE (Water snake).

i. *Enhydrina schistosus* (Daudin), Hook-nosed sea snake.ii. *Hydrophis obscura* Daudin, Estuarine sea snake.

II. Family GECKONIDAE (Lizards).

iii. *Hemidactylus brookii*–Brook's house gecko.

III. Family ACROCHORDIDAE

iv. *Acrochordus granulatus* (Schneider), (Wart snake).**AVIFAUNA**

Scientific Name	Common Name	Status
Order PODICIPEDIFORMES		
Family PODICIPEDIDAE		
1. <i>Podiceps ruficollis</i>	Little grebe	R
Order PELECANIFORMES		
Family PELECANIDAE		
2. <i>Pelicans philippensis</i>	Spotbilled Pelecan	M
Family PHALACROCORACIDAE		
3. <i>Phalacrocorax niger</i>	Little cormorant	R

Scientific Name	Common Name	Status
4. <i>P. carbo</i>	Cormorant	R
5. <i>P. shag</i>	Indian Shag	R
Order CICONIIFORMES		
Family ARDEIDAE		
6. <i>Ardea cinerea</i>	Grey Heron	R
7. <i>A. purpurea</i>	Purple Heron	R
8. <i>A. alba</i>	Large Egret	R
9. <i>Ardeola grayii</i>	Pond Heron	R
10. <i>Egretta intermedia</i>	Intermediate Egret	R
11. <i>E. garzetta</i>	Little Egret	R
12. <i>Bubulcus ibis</i>	Cattle Egret	R
13. <i>Nycticorax nycticorax</i>	Night Heron	R
Family CICONIIDAE		
14. <i>Ephippiorhynchus asiaticus</i>	Black necked Stork	R
Family THRESKIORNITHIDAE		
15. <i>Threskiornis aethiopica</i>	White Ibis	M
16. <i>Platalea leucorodia</i>	Spoonbill	M
Family PHOENICOPTERIDAE		
17. <i>Phoenicopterus roseus</i>	Greater Flamingo	M
18. <i>Phoeniconaias minor</i>	Lesser Flamingo	M
Order ANSERIFORMES		
Family ANATIDAE		
19. <i>Anser anser</i>	Greylag Goose	M
20. <i>A. indicus</i>	Barheaded Goose	M
21. <i>Dendrocyone javanica</i>	Lesser whistling Teal	R
22. <i>Tadorna ferrugines</i>	Brahminy duck	M
23. <i>Anas acuta</i>	Pintail	M
24. <i>A. cracca</i>	Common Teal	M
25. <i>A. poecilorhyncha</i>	Spotbill Duck	M
26. <i>A. strepera</i>	Gadwall	M
27. <i>A. Penelope</i>	Wigeon	M
28. <i>A. querquedula</i>	Garganey	M
29. <i>A. clypeata</i>	Shoveller	M

Scientific Name	Common Name	Status
30. <i>Netta rufina</i>	Red crested Pochard	M
31. <i>Aythya ferina</i>	Common Pochard	M
32. <i>A. fuligula</i>	Tufted Pochard	M
33. <i>A. nyroca</i>	White eyed Pochard	M
34. <i>Nettapus coromandelianus</i>	Cotton Teal	M
Order ACCIPITRES		
Family FALCONIDAE		
35. <i>Milvus migrans</i>	Pariah kite	R
36. <i>Haliastur indus</i>	Brahmni kite	R
37. <i>Haliaeetus leucogaster</i>	White-bellied sea eagle	R
38. <i>H. leucoryphus</i>	Pallas's Fishing eagle	R
39. <i>Circus macrourus</i>	Pale Harrier	M
40. <i>C. melanoleucos</i>	Pied Harrier	M
41. <i>C. aeruginosus</i>	Marsh Harrier	M
Order GRUIFORMES		
Family RALLIDAE		
42. <i>Fulica atra</i>	Coot	M
Order LIMICOLAE		
Family CHARADRIIDAE		
43. <i>Himantopus himantopus</i>	Blackwinged stilt	M
44. <i>Hoplopterus indicus</i>	Redwattled lapwing	R
Order CHARADRIIFORMES		
Family CHARADRIIDAE		
45. <i>Pluvialis dominica</i>	Eastern Golden plover	M
46. <i>Charadrius leschenaulti</i>	Greater stone plover	M
47. <i>Charadrius hiaticula</i>	Ring plover	M
48. <i>Numenius phaeopus</i>	Whimbrel	M
49. <i>N. arquata</i>	Curlew	M
50. <i>Limosa lapponica</i>	Bartailed Godwit	M
51. <i>Tringa erythropus</i>	Spotted Redshank	M
52. <i>T. totanus</i>	Common Redshank	M
53. <i>T. stagnatilis</i>	Marsh Sandpiper	M
54. <i>T. ochropus</i>	Green Sandpiper	M

Scientific Name	Common Name	Status
55. <i>T. glareola</i>	Spotted Sandpiper	M
56. <i>T. terek</i>	Terek Sandpiper	M
57. <i>T. hypoleucos</i>	Common Sandpiper	M
58. <i>Arenaria interpres</i>	Turnstone	M
59. <i>Gallinago stenura</i>	Pintail Snipe	M
60. <i>G. gallinago</i>	Fantail Snipe	M
61. <i>Calidris temminckii</i>	Temminck's Stint	M
62. <i>C. alpina</i>	Dunlin	M
63. <i>C. testacea</i>	Curlew Sandpiper	M
64. <i>Philomachus pugnax</i>	Ruff & Reeve	R
65. <i>Calidris ruficollis</i>	Red necked Stint	M
Family LARIDAE		
66. <i>Larus ichthyaetus</i>	Great Blackbacked Gull	M
67. <i>L. ridibundus</i>	Lesser Blackheaded Gull	M
68. <i>L. brunnicephalus</i>	Brown headed Gull	M
69. <i>L. fuscus</i>	Lesser Blacked Gull	M
70. <i>Chlidonias hybridus</i>	Whiskered Tern	R
71. <i>C. leucoptera</i>	White winged Black Tern	M
72. <i>Gelochelidon nilotica</i>	Gull billed Turn	M
73. <i>Hydroprogne caspia</i>	Caspian Tern	M
74. <i>Sterna aurantia</i>	River Tern	M
75. <i>S. hirundo</i>	Common Tern	R
76. <i>S. acuticauda</i>	Blackbellied Tern	R
77. <i>Rhynchops albicollis</i>	Indian Skimmer	M
Family STRIGIDAE		
78. <i>Caprimulous macrurus</i>	Longtailed Night jar	R
79. <i>C. indicus</i>	Jungle Night jar	R
80. <i>C. asiaticus</i>	Indian Night jar	R
Order CORACIIFORMES		
Family ALCEDINIDAE		
81. <i>Ceryl rudis</i>	Pied Kingfisher	R
82. <i>Alcedo atthis</i>	Small Blue Kingfisher	R
83. <i>Halcyon smyrnensis</i>	Whitebreasted Kingfisher	R

Scientific Name	Common Name	Status
Order PASSERIFORMES		
Family HIRUNDINIDAE		
84. <i>Hirundo rustica</i>	Common Swallow	M
86. <i>H. daurica</i>	Redrumped Swallow	M
Family CORRIDAE		
86. <i>Coryus macrorhynchos</i>	Jungle Crow	R
Family MUSCICAPIDAE		
87. <i>Cisticola juncidis</i>	Streaked Fantail Warbler	R
88. <i>Acrocephalus stentoreus</i>	Ian Great Reed Warbler	R
89. <i>Copsychus saularis</i>	Oriental magpie	M
Family MOTACILLIDAE		
90. <i>Motacilla</i>	Blue headed Yellow Wagtail	M
91. <i>M. citreola</i>	Yellow headed Wagtail	M
Family STURNIDAE		
92. <i>Acridotheres fuscus</i>	Jungle myna	M
GLAREOLIDAE		
93. <i>Glareola moddivarum</i>	Oriental pratincole	M



Plate 1. A view of the Ticket Booking counter in the centre of the Nalaban Wildlife Sanctuary, indicating entry to the Wildlife Sanctuary , Chilika



Plate 2. A view of the inundated island during mid monsoons (August 2002) with watch tower



Plate 3 & 4. A profile of few fish nekton species collected from the protected area, *Plotosus canius* (below) recorded from Nalaban Island.



Plate 5. Sieving of benthic sample using U. S. sieve in progress, on boat at sampling site.



Plate 6. A view of the Peterson's grab (.025 m²) used for benthic collection during the study period.



(i)



(ii)



(iii)



(iv)

Plate 7. Photographs of catch of decapod fisheries [(i) *Philyra alcocki*, (ii) *Scylla serrata*, (iii) *Penaeus monodon* and (iv) *Macrobrachium* sp.]



(i)



(ii)

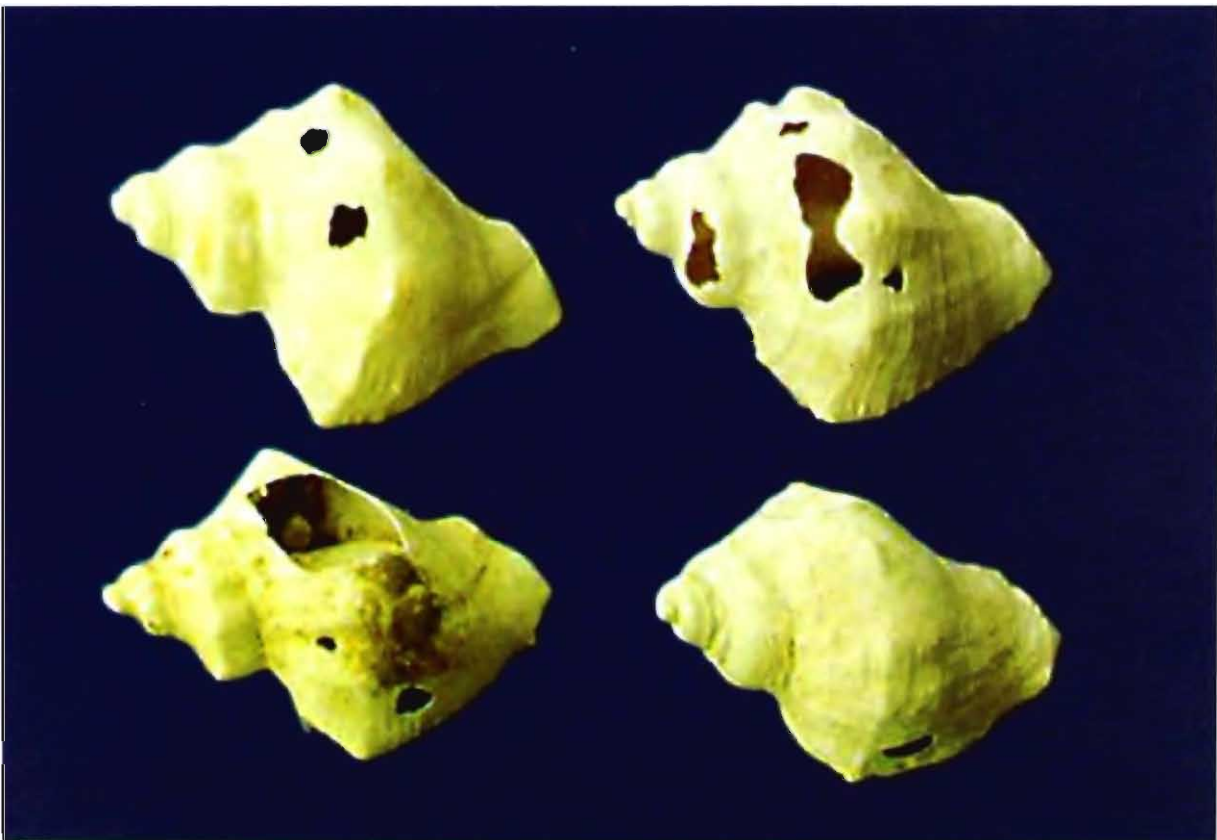


(iii)

Plate 8. A view of the macrobenthic fauna (i) Polychaetes, (ii) Isopods and (iii) Amphipod



(i)

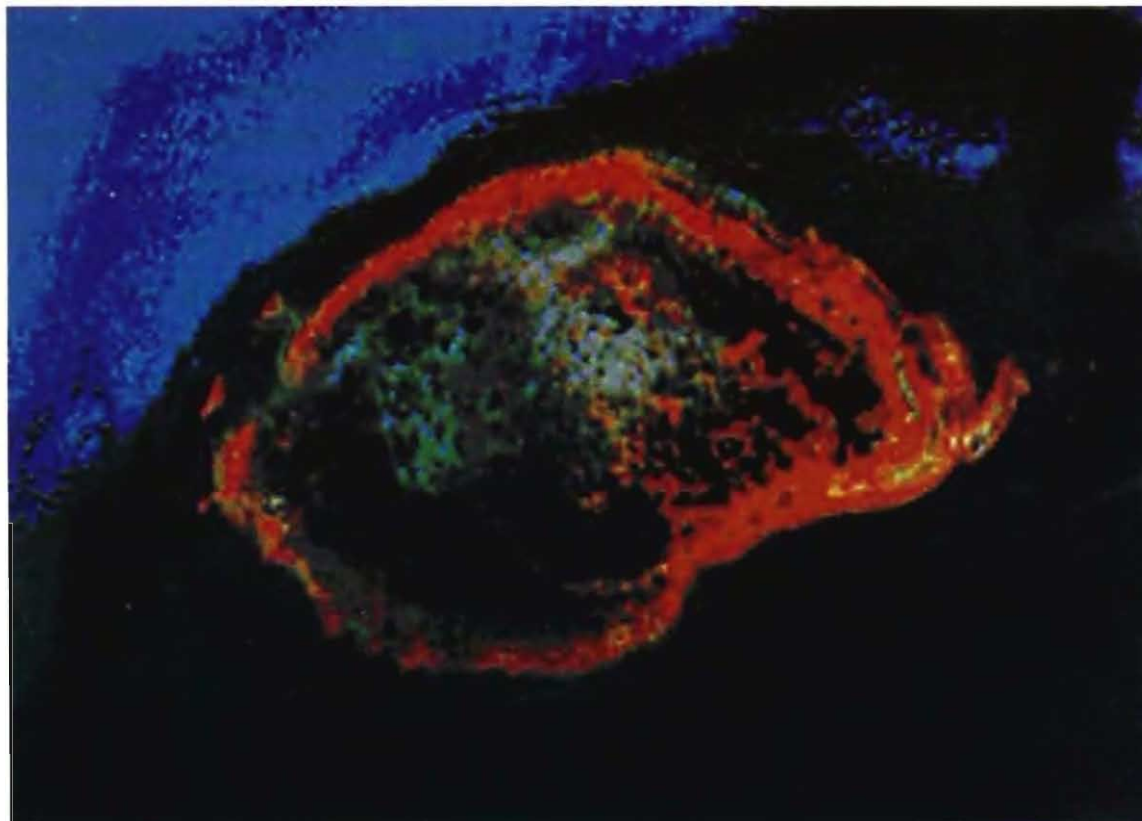


(ii)

Plate 9. Showing profile of macrobenthic malacofauna [(i) *Nassarius stolatus* and (ii) *Thais rugosa*] recorded first time from Nalaban Wildlife Sanctuary.



Plate 10. A photograph of the shallow regions submerged aquatic weeds (*Salicornia* sp.) in foreground and sponges etc. , in the background attach to sediment.



*Satellite Imagery of NLWS : IRS 1D LISS III
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