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Conservation of Migratory Avifauna and Influences of Water Quality in Wetlands of Majuli River Island, Assam, India

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ABSTRACT

Today, the Majuli River Island, located in the Brahmaputra Khadar region of Eastern Assam Valley, is in danger as intensive flooding and erosion of the banks has reduced the land area drastically and affected differently the rich biodiversity. This paper deals with the importance, threats, status and the conservation challenges of migratory bird species visiting the six wetlands of Majuli River Island. The observations made during August, 2013 to March, 2014 show that maximum number of migrant species such as Grey lag Goose *(Anser anser),* Ruddy Shelduck *(Tadorna ferruginea*), Pintail (*Anas acuta*), Bar headed goose (*Anser indicus*) arrive in the winter season (December to February). Minimum numbers of water bird were observed in the summer (May and June). There were significant changes in the water quality in terms of nutrients, light, toxicity and oxygen depletion and also in encroachment for agriculture and erosion at the study sites. A management plan is required to prevent further stresses, fragmentation, flooding, and loss of biodiversity as it is crucial to restore these wetlands for the winter visitors.

Key Words : Abiotic Factors; Flood; Habitat Restoration; Winter Visitors

INTRODUCTTON:

One of the best known functions of wetlands is to provide a habitat for birds (Stewart 1972). Many factors shape the relation between wetlands and birds. These factors include the availability, depth and quality of water, abundance of food and shelter. For food and other life-support systems birds have daily and seasonal dependencies on these wetlands. Wetland vegetation provides shelter to the migratory birds from predators and from the weather. The duration and timing of flooding and the presence of surface water on moist soils affects the value of a wetland to a specific bird species. Migratory birds visit the wetlands in search of plants, vertebrates and invertebrates which is a main source of food for them. The wetland soils provide food for some feeder birds; the water column is another source for the foragers while some feed on the vertebrates and invertebrates that live on submerged and emergent plants. Use of wetlands differs greatly among the migratory species as there is a great variety of these wetlands. Of the more than 1,900 bird species that breed in North America, about 138 species in the conterminous United States are wetland dependent (American Ornithologists' Union 1983).

Majuli River Island is located in the flood plains of the Brahmaputra river and bounded by the main stream of the River Brahmaputra in the South and the Lohit and Kherkatia river (Sumit) on the North. It has a population of about 1,50,000 people from various ethnic origins whose main occupation is agriculture and pisciculture. The Indian Government has proposed that UNESCO accord 'World Heritage Site' status to the island for its biodiversity and great cultural landscape (Das 2000). Majuli is purely a region of fluvial geomorphology with islands within islands and its landmass changes shape after every summer. Being a wetland, the island is a biodiversity hotspot for its unique and rich variety of flora and fauna. It is bounded by the river Subansiri and her tributaries Ranganadi, Dikrong, Dubla, Chici and Tuni on the North West, Kherkatia Suli (a spill channel of the River Brahmaputra) in the northeast and the main

Brahmaputra River on the South and the Southwest. Another significant feature of this system is the formation of the islets locally called the *Chaporis* around the Majuli Island. As a result of the braiding of the river, 22 numbers of *Chorchapar* (local names for the numerous small and relatively recent formed island near the main land) are present in the water surrounding the island. The wetlands, locally known as "*Beels*" on the banks of Majuli Island are a characteristic feature of the hydrology of the system and abode of freshwater (Wade 1972). Flooding and erosion over the recent years on the river island have affected differently the rich biodiversity and socio-economic conditions of the local population of Majuli. There are 243 small and large villages. To tide over heavy flooding, people live in unique houses built on bamboo stilts. The main processes affecting the Majuli Island ecosystems were hypothetically identified as cultural eutrophication and hydrological changes. The decline of biodiversity and productivity was induced by significant changes in water quality in terms of nutrients, light, toxicity and oxygen depletion.

Majuli Island forms an ideal habitat for a variety of migratory species as it has fertile floodplains and highly productive wetlands and more than 250 species of birds have been recorded in the water bodies. These include not only the resident birds found round the year but also many winter migrants from northern latitudes such as Tibet and Siberia. Some passage migrants have been included along with at least some 90 winter migrants. At least 13 globally "threatened" and five "near-threatened" species were recorded in Majuli. Some threatened species (Bird Life International 2001) such as the Spot billed Pelican (*Pelecanus philippinus*), Slender billed Vulture (*Gyps tenuirostris*), White – backed Vulture, (*G. bengalensis*), Greater Adjutant-Stork (*Leptoptilos dubuis*) and Lesser Adjutant Stork *(L. javanicus*) also breed in Majuli.

The Southern part of the island is a bird lover's paradise. The three areas famous for watching the migratory birds are the southeast, southwest and northern part of Majuli Island. Flyways are broad corridors or migration routes used by migratory birds. A major flyway known as "The Central Asia/Indian Flyway" covers Assam. The Brahmaputra River and its long valley stretching from Sadiya to Dhubri is a major route of migratory birds within the "Central Asia/ Indian Flyway". The winter visitors use this flyway to come to Majuli. The "passage migrants" who fly across the sea boards are mostly sea shore birds who use Majuli for resting and stop over along their migration route during their arrival in September-October and return in March-April. Small numbers remain till early part of May. During winter, a few migratory species come for breeding like the Pallas's Fish Eagle. Changes in daylength primarily control the timing of migration. Migrating birds navigate using celestial cues from the sun and stars, the earth's magnetic field, and probably also mental maps. Migration has developed independently in different groups of birds and does not appear to require genetic change; some birds have acquired migratory behavior since the last ice age (Wikipedia en.wikipedia.org/wiki/Birdmigration).

River Brahmaputra is characterized by high seasonal variability in flow, sediment transport and channel configuration. In the valley of Assam, it flows in a highly braided channel with the presence of numerous laterals as well as mid channel bars and islands. Most of them are transient in nature, being submerged during high monsoon flows and this drastically changes their geometry and location. The very existence of Majuli, the world's largest river island and home of about 1.3 million people, based on 1991 census, is endangered because of this erratic behavior of the river (Mani et al. 2003). The island faces an acute erosion problem as no permanent anti-erosion measures based on proper geohydrological models have been adopted so far. Thus, the aim of the present study is to identify the general trends of changes and the basic requirements of Majuli River Island on the basis of a critical analysis of existing data and data collected over the last three years and its influence on the avian fauna visiting every year and to propose an unitary reference framework for development of specific programs as part of the Brahmaputra Ecological Network.

STUDY SITE

The Majuli River Island is located in the Brahmaputra Khadar region of Eastern Assam Valley North within the limit of 25^0 47' N to 27^0 10' N latitude and 93^0 35' E to 94^0 35' E longitude. It has an area of 925 km^2 and is the largest river Island in the world (Mani et al. 2003). It is a flat level plain of new alluvial deposits characterized by the presence of lowlands and small lakes (beels) (Mani et al. 2003). The vegetation is mainly riverine with grasses such as *Themeda villosa* (kher), *Erianthus ravennae* (Ekora), *Phragmites karka* (Nal), *Imperata cylindrica* var. *koenigi* (Khagari), *Saccharum spontaneum* and *Simalu* trees (*Bombax ceiba*). Auniati

Dubi, Saraimari Beel, Gormura Dubi Beel, Kamalabari Tuni Water body, Dakhinpat and Raunapar Fishery Beel areas are selected as study sites. This island has mesothermal, muggy, winter dry, Brahmaputra type of climate.

METHODS

Migratory birds were surveyed for one year (2013-2014), covering four seasons: pre-monsoon, retreating monsoon, autumn and winter. More recent, detailed and reliable data of various researches on the islands were also used for a comparative analysis of the trend of changes in the ecological state of the wetlands of this island. For the study of visiting migratory birds a total of six sites (wetlands) were selected. Periodic fortnightly visits were conducted over the study period in aquatic habitats in the area in the early morning and later in the evening to record the migratory species. Binoculars (Nikon 7x50CF) were used to locate / identify the distant birds, Sony handycam model DCR-HC-42E and digital camera Nikon L-120 model were used to photograph the birds encountered.

Water birds were surveyed every month. Surveys and censuses were undertaken from both ground and air, although in March 2014 only an aerial count was made, and from August to October, 2013 only ground counts were made. Ground counts were conducted over periods of 2-8 days from small boats and on foot, using binoculars and spotting scopes. Aerial counts lasted upto five hours and were made from tree tops at regular intervals covering all the areas of the wetlands, by trained observers. When possible aerial counts were used to estimate overall numbers and numbers of most individual species, while ground counts provided supplementary data for species that were difficult to identify from the air.

Water bird nomenclature follows those of Ali and Ripley (1948) and Bhattacharjee and Bora (1985). Different levels of biodiversity indices were used between species/ ecosystem level and the wetland ecosystem complex of Majuli River Island (species richness, species distribution, population size, density and abundance, key and dominant species, productivity, types of ecosystem and communities).

Water temperature (^{o}C), dissolved oxygen (DO, percent saturation) and pH were measured using Water Quality Monitor. Vertical profiles of temperature and DO were taken at the deepest location, with measurements recorded at 50 cm intervals from the surface to the bottom. The other variables studied for comparative analysis were transparency, water levels, major aquatic fauna, phytoplankton and zooplankton.

RESULT AND DISCUSSION

Besides beings ideal indicators of health of wetlands, the wetland birds' play a significant role in human live culturally, socially and scientifically (Stewart 2007). As a wetland ecosystem, Majuli Island provided varied habitats with low laying marshy areas for nesting and feeding of the migratory bird species. It was observed from our study site that local migrants such as, Greater Egret, Open Billed Stork visited the spot at irregular intervals from the paddy fields. Maximum number of migrant species was reported in the winter season from December to February when the water bird species like Greylag Goose (*Anser anser*), Ruddy Shelduck (*Tadorna ferruginea*), Pintail (*Anas acuta*), Bar-headed Goose (*Anser indicus*) visit this place. Minimum numbers of water bird were observed in the months of May and June (Table 1). Most water birds occurred near the edge of the wetland in shallow water while large flocks occurred towards the centre of the lake, counted by observers from tree tops over the surrounding areas. Wetland bird species adapt differently to different water levels as the food preference of water birds changes with fluctuations in the water level (Mukherjee 1972). With reduction in water level of the wetlands in summer, species that could avail the food easily by probing into the mud were observed, such as Green Sandpipar (*Tringa ochropus*), Common Red Shank (*Tringa tetanus*), etc. Similar observations were made earlier on water birds of Sunderban (Mukherjee 1972) and Anekere wetland of Karnataka (Bhat et al. 2009). During the study, the visiting migratory birds over the six wetlands, namely, Auniati Dubi, Saramari Beel, Gormura Dubi Beel, Kamalabari Tuni Waterbody, Dakhinpat, Kakarikata, Merbazana and Raunapar fishery Beel have shown that their diversity is affected by ecological changes over the years. Our study showed the species numbers to be significantly lower than recorded earlier. Indication of an overall decrease in fish captures during the last three years was supported by the primary data generated through a house hold survey of 100 families of fishing community living in the fringe areas of these wetlands. This may have a direct effect on the numbers of thousands of winter visitors who are basically fish eaters.

Table 1. Birds found on Majuli River Island and their status.
A= abundant; c=common; r= rare; vr= very rare; R= resident v; M= migratory, Lm= local migratory.

Family and Species	Common Name	Status
PODICIPEDIDAE		
Podiceps ruficollis (Pallas)	Little Grebes	R c
PELECANIDAE		
Pelecanus philippensis Gmelin	Spot billed Pelican	R c
PHALACROCORACIDAE		
Phalacrocorax fuscicollis Stephens	Indian Shag	R vr
Phalacrocorax niger (Vieillot)	Little Cormorant	R A
Anhinga rufa (Daudin)	Darter	R r
ARDEIDAE		
Ardea purpurea (Linnaeus)	Purple Heron	R vr
Butorides striatus (Linnaeus)	Little green Heron	R r
Ardeola grayii (Sykes)	Pond Heron	R c
Egretta intermedia Wagler	Median Egret	R c
Egretta garzetta (Linnaeus)	Little Egret	R c
Ixobrychus cinnamomeus Gmelin	Chestnut Bittern	R c
Ixobrychus flavicollis Latham	Black Bittern	R r
CICONIIDAE		
Leptoptilos javanicus	Lesser adjutant Stork	R c
THRESKIORNIYHIDAE		
Plegadis falcinellus (Linnaeus)	Glossy Ibis	R r
NATIDAE		
Anser anser (Linnaeus)	Greylag Goose	M r
Anser indicus Latham	Barheaded Goose	M c
Dendrocygna javanica (Horsfield)	Lesser whistling Teal	R c
Dendrocygna bicolor Vieillot	Large whistling Teal	R c
Tadorna ferruginea (Pallas)	Ruddy Shelduck	M c
Anas acuta (Linnaeus)	Pintail	M r
Anas poecilorhyncha J.R.Forster	Spotbill Duk	R r
Anas platyrhnchos (Linnaeus)	Mallard	M vr
Marmaronetta angustirostris (Menetries)	Marbled Teal	M vr
Aythya baeri (Radde)	Baer's Pochard	M vr
Nettapus coromandelianus Gmelin	Cotton Teal	R c
Milvus migrans (Boddaert)	Pariah Kite	R r
Haliastur indus (Boddaert)	Brahminy Kite	R c
Aquila rapax Temminck	Tawny Eagle	R r
Icthyophaga ichthyaetus (Horsfield)	Greyheaded Eagle	R r
RALLIDAE		
Amaurornis phoenicurus (Pennant)	Whitebreasted Waterhen	R c
Porphyrio porphyria (Linnaeus)	Purple Moorhen	R c
Fulica atra (Linnaeus)	Coot	M r
JACANIDAE		
Hydrophasianus chirurgus (Scopoli)	Pheasant tailed Jacana	R r
Metopidius indicus Latham	Bronzewinged Jacana	R r
CHARADRIDAE		
Vanellus spinosus (Linnaeus)	Spurwinged Lapwing	R r
Numenius arquata (Linnaeus)	Curlew	M vr
Tringa totanus (Linnaeus)	Common	M vr
Tringa ochropus (Linnaeus)	Green Sandpiper	M vr
Calidris tenuirostris (Horsfield)	Eastern Knot	M vr
Calidris minuta (Leisler)	Little Stint	M vr
RECURVIROSTRIDAE		
Himantopus himantopus (Linnaeus)	Blackwinged Stilt	R vr
LARIDAE		
Larus ridibundus (Linnaeus)	Black headed Gull	M c
Childonias hybridus (Pallas)	Whiskered Tern	R c
Sterna aurantia J.E.Gray	Indian river Tern	R c
COLUMBIDAE		
Streptopelia dacaocta (Frivaldszky)	Ring Dove	R r
Streptopelia chinensis (Scopoli)	Spotted Dove	R c
PSITTACIDAE		
Psittacula krameri (Scopoli)	Roseringed Parakeet	R c
CUCULIDAE		
Cuculus micropterus Gould	Indian Cuckoo	R r
Eudynamys scolopacea (Linnaeus)	Koel	R r
ALCEDINIDAE		
Ceryle rudis (Linnaeus)	Lesser pied Kingfisher	
Alcedo atthis (Linnaeus)	Small blue Kingfisher	R c
Pelargopsis capensis (Linnaeus)	Storkbilled Kingfisher	R r
Halcyon syrnensis Madarasz	White-breasted Kingfisher	R c
MOTACILLIDAE		
Motacilla flava (Linnaeus)	Yellow Wagtail	M c
Motacilla citreola (Pallas)	Yellow Headed Wagtail	M c
Motacilla alba (Linnaeus)	Pied or white Wagtail	M c

An analysis of species diversity in the six wetlands (beels) of Majuli River Island shows decline in the years (Figure 1). Total aquatic richness, including phyto-plankton, zooplankton, benthic fauna, fish and aquatic birds shows a continuous decrease along with an increase in temperature over the past three years. This species richness is in accordance with the increase in temperature, rainfall, humidity and severe floods during the collection period. Productivity of wetland communities is directly related to the climate change affecting these beels (Figure 1). The lakes from the nearby river bank areas experienced the most dramatic changes in their trophic status (in terms of nutrients, N:P atomic ratio, oxygen and organic matter content, transparency, trophic status index, chlorophyll a concentration) and biota. At all the six sites the biodiversity declined by (i) the loss of some components such as emerged macrophytes-epiphyte complex, phytophilous fauna, macrophytobenthos and macrofiltrators, and (ii) the decline of species richness of phyto- and zoo-plankton,

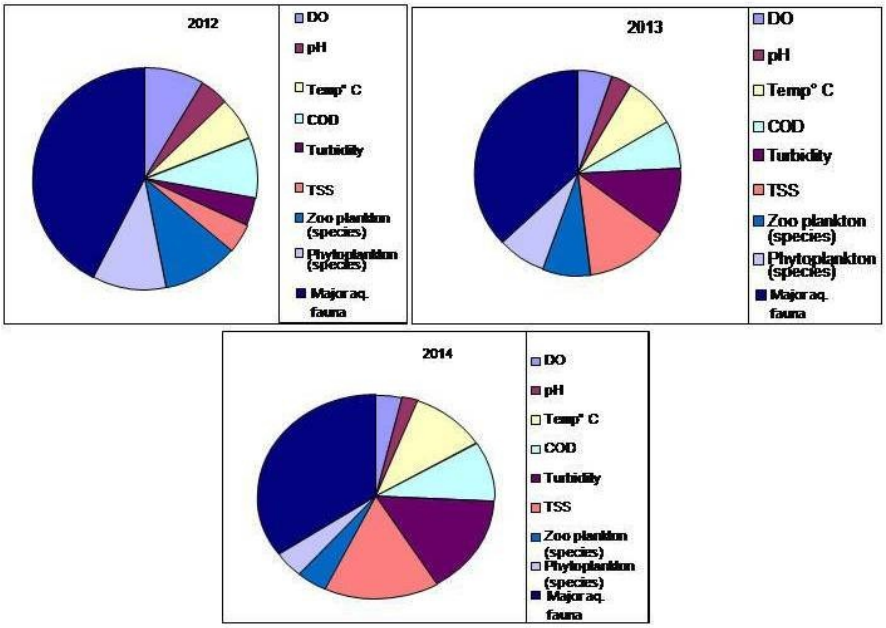

Figure 1. Physico-chemical parameters and biodiversity of Majuli River Island wetlands for year 2012-2014

submerged vegetation and benthic fauna. Flooding during the monsoon season caused disappearance of many aquatic species and species richness decreased during the past 3 years (Figure 1). The present study indicates that a considerable portion of the Majuli Island was subjected to severe annual floods during the monsoon season. This imparts remarkable imprints on the existing biodiversity of the Majuli Island (Kotoky et al. 2003). Destruction of wetlands by rise in water level would have resulted in loss of detritus and other food chain support for fish and other fauna. Increasing water levels have resulted in the submergence of crucial breeding grounds of rare and endangered migratory bird species (WWF 2009). The abundance of migratory bird species suffered major changes due to significant changes in flooding and erosion of the island.

The Majuli River Island wetlands include a heterogeneous and dynamic complex of fresh water ecosystem of various types and in different succession stages between aquatic and terrestrial systems. During monsoon season, the wetlands of the riverine island are subjected to intense flooding; these systems are very sensitive important zones to assess biodiversity and species richness. As shown by recent studies, these wetlands provide the main livelihood to the island population. Hunting of migratory birds and fishing are some of the main causes for decrease in number of the winter visitors as the fringe villagers are dependent on these for their daily diet. Further, the main changes induced by human activity and climate change on the wetlands of Majuli include changes in ecosystem structure. Brahmaputra river is characterized by high seasonal variation in flow, sediment transport and channel configuration. The island faces an acute erosion problem on its southern side due to the erosive action of Brahmaputra River, and on its Northern side due to the Subansiri River. In 1917, the island had an area of 751.31 km^2, which gradually sank to 564.01 km^2 in 1966-1972, 453.76 km^2 in 1996 and 421.65 km^2 in 2001. Similar changes were noticed in the length and width of the island. The average annual rate of erosion was 1.77km^2 from 1917 to 1972, 1.84 km^2 from 1972 to 1996 and 6.42 km^2 from 1996 to 2001, indicating a gradual increase in the rate of erosion in the later periods. The large number of swamps and wetlands observed during 1917 was 112 covering total area of 20.13 km^2, which decreased to 50 occupying a composite area of 17.88 km^2 during 1966-1972 (Sarma and Phukan 2005). Over the years due to increase in temperature, the tributaries of Brahmaputra River bring flash floods with heavy load of fine silt and clayey sediment (Sarma and Phukan 2005).

CONCLUSION

Inundation of nesting trees due to seasonal flooding has affected the tree nesting water birds. Being in the flyover route of a number of bird species, Majuli River Island is

in a strategic location from avifaunal point of view. Much importance lies therefore in the quality of the habitat, the vegetation around the wetlands which provides shelter to the water birds and the amount of water. Infrequent floods affect submerged macrophyte and fish fauna on which the migratory species depend for food items. Fluctuations in water parameters, nutrient cycling and plantation community have disrupted the food chains. Besides this, overfishing and agriculture run off from paddy fields are the additional factors affecting the availability of food of the birds. To draw any significant conclusions from our studies regarding decline in the populations of migratory species visiting the Majuli River Island, the data reported from different sources have also to be carefully considered. From both qualitative and quantitative point of view, the existing data on the biodiversity of the wetlands of this Island are very heterogeneous. Preparing a management plan is extremely essential to prevent additional stresses, fragmentation, flooding, and loss of biodiversity in future as it is crucial to restore these wetlands and the habitat for the winter visitors.

Some of the policy related measures required for conservation of the wetlands of Majuli River Island are:-

a. During the monsoon seasons when the island is inundated by floods, prevention measures to stop erosion should be taken by redesigning the banks of the island, based on geo-hydrological models.
b. The Forest Department and NGO's should enforce better protection measures, management infrastructure and security needed urgently in the wetlands.
c. Habitat loss is mainly due to reclamation of beels (wetlands) for settlement and agriculture. Such reclaation sould not be allowed .
d. Local fisherfolk should be trained and motivated about major over-exploitation of fish on a vigorous scale as it is the major diet of the migratory birds visiting Majuli.
e. Auniati Dubi, Saraimari Beel, Gormura Dubi Beel, Kamalabari Tuni Waterbody, Dakhinpat, Kakarikata, Merbazana and Raunapar Fishery Beel are recommended for inclusion in the existing network of Protected Areas as all have rich and diverse fish and avian migratory species which have not been adequately protected in Majuli.
f. The Spot-billed Pelican, Great white-bellied Heron, Storks, Ferruginous Duck, Pallas's Fish Eagle and Swamp Partridge are recommended for inclusion in Schedule 1 of Wildlife Protection Act. Beside these, other 'threatened', 'near threatened', and 'endangered' species, which have not been given adequate legal protection, should be brought under different Schedules of the Wildlife Protection Act.

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