

# Nawabgunj Bird Sanctuary - A versatile miniature wetland ecosystem

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## ABSTRACT

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Phytodiversity and microclimate of the Nawabgunj Bird Sanctuary in Unnao district, Uttar Pradesh is assessed and its impact on the strength of bird population and ingress model is studied in reference to the sanctuary management. A total number of 219 angiospermous species under 150 genera belonging to 68 families were recorded with rich concentration of aquatic plants. Economically and medicinally useful plants were also well represented while there were 87 species of invasive alien elements. Occurrence of *Acacia nilotica* (L.) Willd. ex Delile and *Prosopis juliflora* (Swartz.) DC. within pond islands was instrumental in attracting the Asian openbill storks as they use it for making nests.

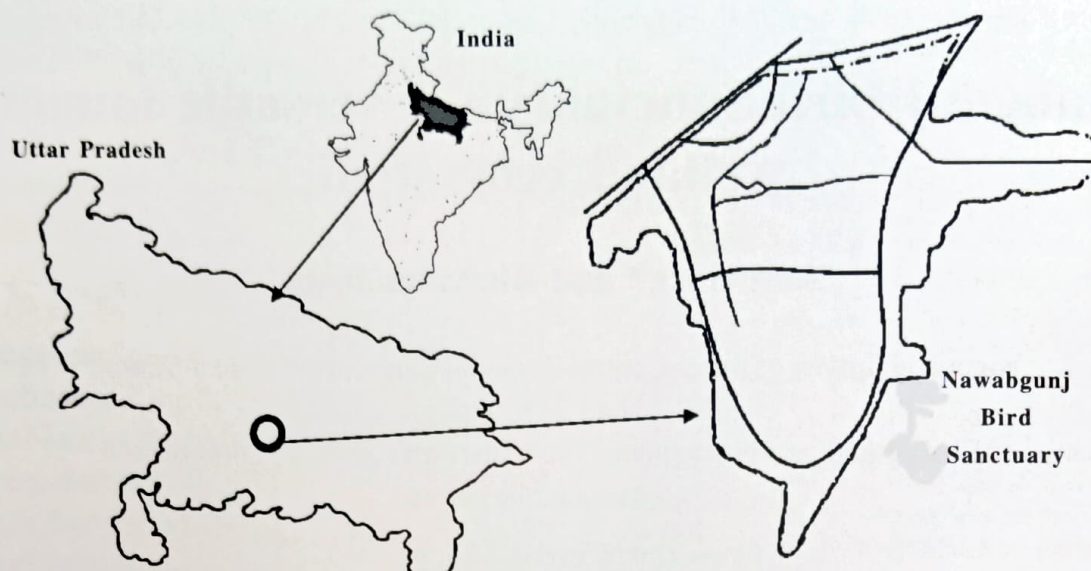
**Key-words:** Phytodiversity, wetland, medicinal plants, Nawabgunj Bird Sanctuary, Uttar Pradesh, India.

## INTRODUCTION

Areas of marsh, fen, peatland and of water, whether natural or artificial, permanent or temporary, static or flowing, fresh, brackish or salt water, including areas of marine water not exceeding six metres in depth at low tide (Biswas & Calder 1936) are denoted as wetlands. These comprise c. 6% of the earth's land mass. The wetland regions remain waterlogged or submerged under water, either seasonally or almost throughout the year and are recurrently flushed with water following monsoon storms and get flooded almost every year, due to which their soil gets water logged for very long durations even after the water recedes. Such water logged regions form swamps and other damp areas of land surrounding water body (Ambasht & Ram 1976).

They are formed in regions where water table is at or near the surface of land, or where the land is covered by shallow water. They construct lands transitional between terrestrial and aquatic eco-systems with habitats in succession from open water to land and vice versa, having distinct ecosystems and specific ecological characteristics, functions and values. Wetland habits get enriched with floral components comprising of wetland plant species which are adapted to water logged soil and constitute the world's most productive ecosystems providing crucial ecological services and wide variety of benefits to mankind, society and nature. They also serve as landscape sinks by creating canopy gaps which accumulate debris, sediments, water and nutrients. Wetlands also act as migratory corridors for flora and





**Text-figure 1.** Map showing the location of Nawabgunj Bird Sanctuary in Uttar Pradesh, India.

fauna. They provide habitat for numerous wildlife, invertebrate, and plant species and help in flood mitigation, nutrient cycling, aquifer recharge, improving water quality, and providing timber and other mercantile products. They also provide suitable habitat for various behavioural activities of water birds. The physical structure of vegetation is therefore an important habitat component as it serves as food, shelter and nesting resources of birds and also provides potential cues about the onset of conditions suitable for successful breeding. Strength of the avian community structure of a particular wetland in turn, is indicative of the ecological health of the entire wetland.

Despite the immense ecological services rendered through wetlands, they remain among the most threatened habitats of the world being exposed to several anthropogenic pressures during the rapid expansion of human settlements, coupled with changes in land use, land cover and improper use of watersheds as well as pollution threats from industrial, agricultural effluents, etc. Unsustainable levels of grazing and fishing activities also result in wetland degradation (Kanaujia et al. 2014). The phytodiversity of Nawabgunj Bird Sanctuary in Uttar Pradesh was therefore taken up under the MOEF & Cc-BSI project during 2012 with the intention of estimating its floristic composition, upon which the birds' ingress and overwintering depends.

## STUDY AREA

The Nawabgunj Bird Sanctuary (Text-figure 1) is situated in Unnao District of Uttar Pradesh on Lucknow-Kanpur National Highway, at about 45 km from Lucknow and almost the same distance from Kanpur, (Lat. 26°48'-27°02'N, Long. 80°-81°E). The sanctuary occupies 224.60 hectares area. It was declared as 'Bird Sanctuary' by the Government of Uttar Pradesh, Lucknow vide gazette No. 2332/, 14-3-48-83, on 7<sup>th</sup> August, 1984, under the Wildlife Protection Act 1972 for protection and conservation of resident and migratory bird species in wild. The sanctuary possesses a natural permanent water reservoir and a temporary shallow lake which recurrently fills up during rainy season and dries in ensuing summers. These water reservoirs become natural attractants for migratory birds from far off continents which reach the sanctuary during August-September for over-wintering, recreation and breeding and retreat during March-April.

## METHODOLOGY

Botanical surveys were made to the Nawabgunj Bird Sanctuary during different seasons in the year 2011-2012, for field studies including plant collections under the project on Floral diversity studies of the Nawabgunj Bird Sanctuary, Unnao, Uttar Pradesh. Healthy and complete plant specimens were collected



and field data on habit, habitat, flowering, fruiting time, etc. were recorded. The specimens were dried, preserved and mounted by following the standard herbarium techniques (Jain & Rao 1977-78), identified with the help of important floras (Hooker 1872-1897, Duthie 1903-1929) as well as by matching with the available identified specimens for authentication and finally deposited in BSA.

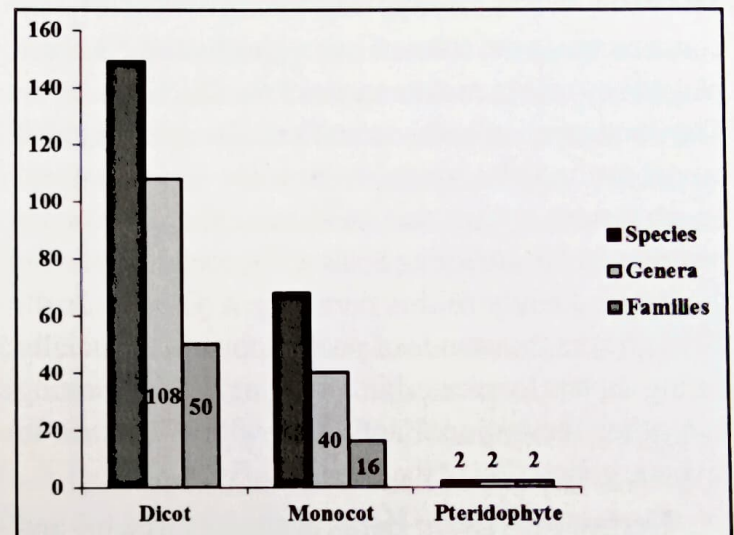
Analysis of all the floristic constituents was made after identification of each and every plant specimen collected, in order to assess the complete floral diversity within the sanctuary. The dominant floral constituents were analysed and concentration of invasive plant species were also established. Plants used in different ways by the local people and those of potential usefulness in different ways such as the therapeutically useful, edible, economical resources, fodder plants and those used by birds for nest building and nest construction activities were assessed. Within each groups, the species were further separated into the respective aquatic, wetland and terrestrial species, dicot and monocot species, habit types mainly herbs, shrubs, trees and climbers.

### RESULT AND DISCUSSION

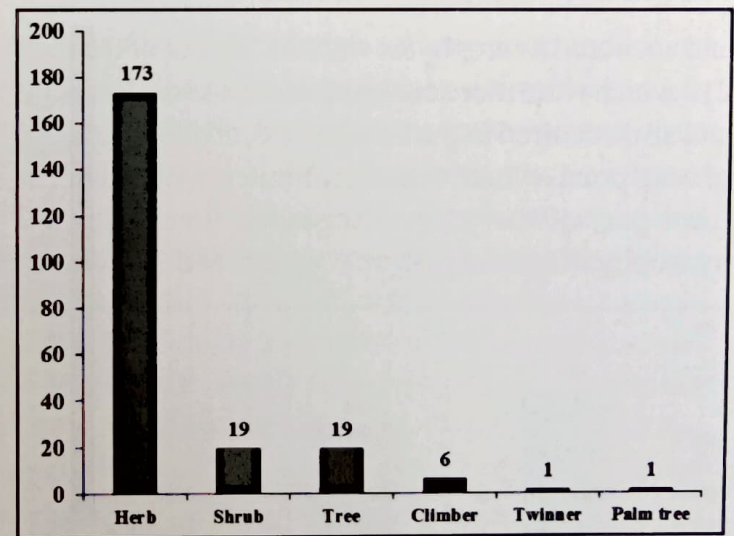
Within the Nawabgunj Bird Sanctuary, there were 219 plant species under 68 families and 150 genera and as expected, the wetland possessed rich strength of the aquatic and wetland species along with terrestrial plants. Among these species, many were found to be of high economic values which are used in various ways by the local inhabitants as edible species, fodder plants and in therapeutic uses. Among the native species, 87 alien invasives species were also found to have established successfully within the sanctuary precincts. Many plants were used by birds in various ways - selected for nesting site, plant parts used for nest construction, seeds and fruits used for feeding and hence they had direct influence on the avian community structure and these plants were preferred by birds, both migratory and resident.

**Total diversity of species:** Among the 219 plant species the dicots were most dominant with a total of 108 genera, 149 species under 50 families, followed

by monocots with 68 species under 40 genera and 16 families and there were two pteridophytes. These were further represented by 173 species of herbaceous taxa under 103 dicots, 68 monocots and 2 pteridophytes. Besides these, there were 19 shrubs, 19 trees, 6 climbers, 1 twiner and 1 palm tree (Text-figures 2-3). The maximum numbers of species were represented under the families Fabaceae, Asteraceae, Acanthaceae,



Text-figure 2. Ratio of the dicot, monocot and pteridophytic species in the Nawabgunj Bird Sanctuary.



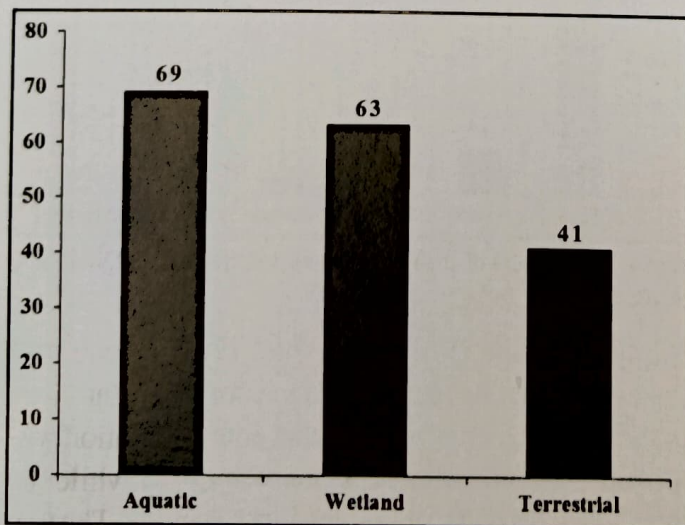
Text-figure 3. Habit distinction of plants occurring in the Nawabgunj Bird Sanctuary

Euphorbiaceae, Polygonaceae, Cyperaceae and Poaceae which were therefore the dominant families. In the entire sanctuary, the herbaceous vegetation was most prevalent and created a green cover while the trees formed a dense, but interrupted canopy. The tree canopy within the sanctuary was useful in attenuation



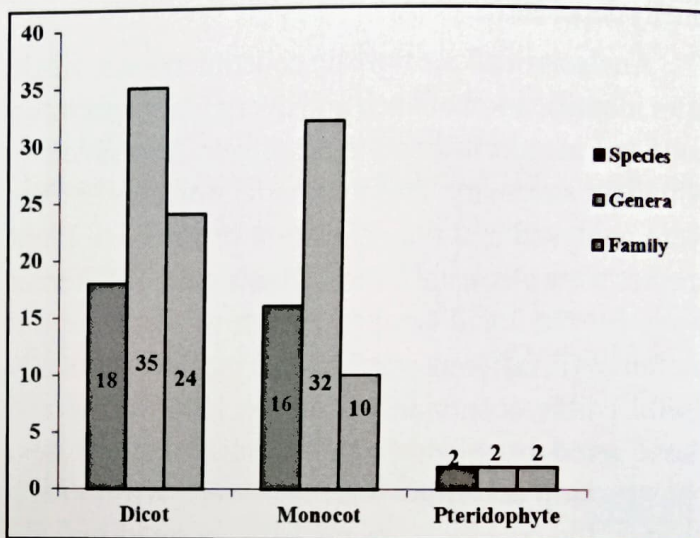
of the sanctuary temperature which helped in promoting a moderate climate for the migratory birds which arrive into the sanctuary from far and wide continents for overwintering and breeding. The scattered shrubs had various utility as food and medicinal plant resource of the inhabitants in nearby villages and the ornamental species helped in imparting beauty to the sanctuary, a famous picnic spot, while the climbers added on to the aesthetic value. Hence the composite floristic constituents in the form of trees, shrubs and climbers played key role in maintenance of the sanctuary biota. The dominance of herbaceous flora also offered green cover around the water reservoirs and a natural environment within this miniature wetland, being instrumental in attracting birds while also maintaining the scenic beauty of this picnic spot (Garg & Joshi 2014) where thousands of people pour in, especially during winters for picnic, bird watching, fishing, boating and other recreational activities which adds on to revenue generation of the state.

**Herbaceous flora:** Herbs of aquatic, wetland and terrestrial environment were most dominant in the whole sanctuary over trees, shrubs and climbers (Text-figure 4). The aquatic herbs in the form of submerged, floating and anchored hydrophytes were 31.5% out of the total 219 which were more concentrated in the central pond and also occurred in the lateral pond, and pond fringes of both ponds which remain saturated with water for most part of the year. Altogether, there were 69 hydrophytic species under 36 genera and 36 families



Text-figure 4. Aquatic, wetland and terrestrial species occurring in the Nawabgunj Bird Sanctuary.

of which there were 35 species of dicots under 18 genera, 24 families, and 32 species of monocots under 16 genera under 10 families and 2 pteridophytic species (Text-figure 5). The wetland flora was 28.7 %, mostly occurring in the core region in catchment area of the two water reservoirs, the central and the lateral ponds, which is recurrently inundated and is almost submerged



Text-figure 5. Ratio of the aquatic dicot, monocot and pteridophytic species in the Nawabgunj Bird Sanctuary.

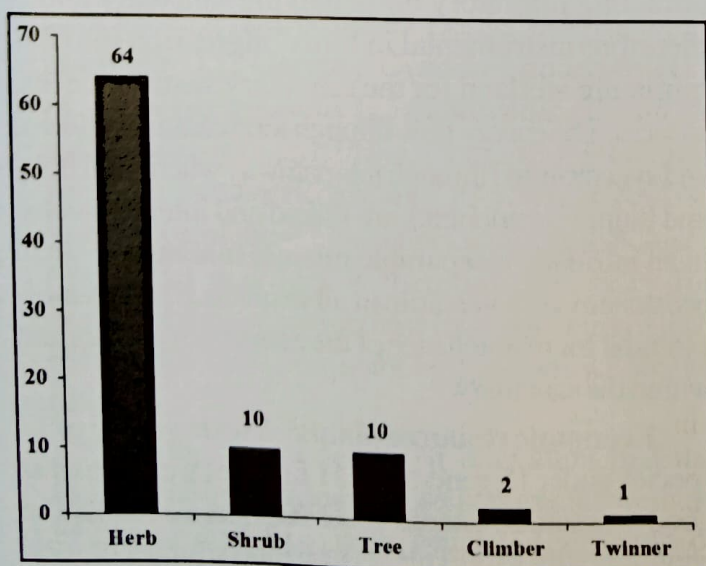
under water for 3-4 months continuously, more so in rainy season. The lateral rain fed pond which gets dried up during summer also contributes to this habitat. As many as 63 herbaceous species under 42 genera were found in these zones. These were represented by 40 dicot and 23 monocot species. The terrestrial region borders the wetland zone with only 18.7% herbaceous representatives with 41 species under 31 genera, 28 dicot species (under 20 genera) and 13 monocots (under 11 genera). Since the sanctuary was predominantly occupied by aquatic and wetland vegetation, the terrestrial herbs were scanty.

The herbaceous constituents of the sanctuary are more or less evenly spread throughout, but more concentrated along the pond catchments towards the sanctuary's rear end which is least accessible to anthropogenic disturbances. It forms a green carpet where birds' colonies are more common as their recreations are not interrupted here. Most common of these are the pairs of Sarus cranes, blue teels, herones and Asian openbilled storks. Most birds utilize the wetland plant species in various ways for feeding,



hatching eggs and recreation as these zones offer most suitable substratum for landing. Seed germination is also maximum in these regions due to favourable conditions such as soil, water and sunlight (Garg & Joshi 2014).

**Invasive flora:** Alien invasive species got introduced into India through various agencies, either inadvertently through various means such as food grains, nursery plants and edible fruits or deliberately brought for agriculture, forestry and ornamental use and entered into the new ecosystems falling outside their natural habitats. These are usually fast growing and get established and naturalized in the new environment becoming dominant and eventually out-compete the native flora in due course of time. Some of these may be noxious and their populations often outbreak to such an extent that they cause negative impact on the habitat, environment, ecosystem, native biodiversity, economics and even human health. The loss may even lead to habitat destruction and biodiversity loss as well as rarity and extinction of certain taxa. Ingression of these alien invasive species in the Nawabgunj Bird Sanctuary was up to 39.7% represented by 87 species under 68 genera and 38 families with 73 dicots and 14 monocots. Habit type of these alien invasives was mostly herbaceous, as there were 64 herbs (73.6%), 10 shrubs and 10 trees, 2 climbers and a single twinner species (Text-figure 6). The spread of such species throughout the sanctuary, including wetland and terrestrial areas of pond and its periphery, as well as the wasteland regions, was



Text-figure 6. Habit of Invasive alien flora of Nawabgunj Bird Sanctuary.

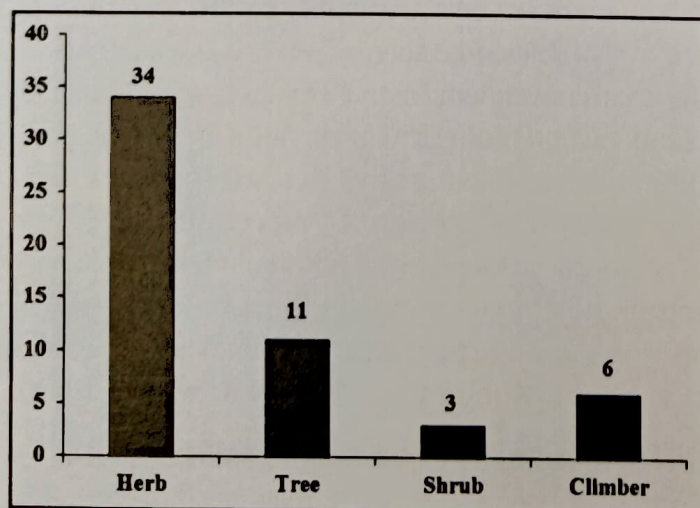
alarming.

Invasion, establishment, spread and naturalizations of the alien species in vast areas within the sanctuary precincts have resulted in disturbance of the environment and resource competition of the native species. It is therefore necessary to check their further growth and spread in coming years for sanctuary sustenance as further spread may cause threat and suppression of native wild and natural germplasm of high economic potential which constitute a sizeable component of the avian diet. If left unchecked, these alien species are likely to create negative impact on natural flora which in turn, may also cause adverse impact on the sanctuary ecosystem resulting in deviation in migratory patterns of birds. Conclusively, alien taxa produce two way influence on the sanctuary ecosystem – some species cast positive impact on the avian community and serve as their food, nest site and nest material, viz. *Acacia nilotica* (L.) Willd. ex Delile, *Echinochloa crusgalli* (L.) P. Beauv., *Echinochloa colonum* (L.) Link, *Prosopis juliflora* (Swartz) DC., etc. Whereas, many other species, e.g. *Eichhornia crassipes* (Mart.) Solms, *Ipomea carica* (L.) Sweet and *Typha angustifolia* L., etc. spread gregariously and their decay and deposition result in biomass accumulation and habitat destruction of the aquatic medium resulting in shrinkage, eutrophication with diminished oxygen contents of water and shallowness of the water body causing space competition for native flora. Such species pose threat to the entire wetland ecosystem. Management of the sanctuary based on eco-friendly control measures of removal of deleterious alien invasives is essential besides the usual conventional manual methods of mechanical, chemical and biological removal, which often have limitations as these create adverse effect on faunal community. This opens vistas for coordinated efforts of ecologist, weed scientist, entomologist, pathologist and physiologist to control the spread of noxious alien invasive weed taxa right at the germ line stage (Ricciardi et al. 2000, Kohli et al. 2004, Rai & Gaur 2006, Khuroo et al. 2007, Reddy 2008, Pant & Sharma 2011, Garg & Joshi 2013).

**Therapeutic plants:** Medicinal plants contain substances that can be used for therapeutic purposes



or act as precursors in synthesis of useful drugs. Their inherent active ingredients are useful in curing diseases and in relieving pains. Herbal drugs are derived from different plant parts such as roots, barks, stems, leaves, flower and seeds by physical processes involving extraction, fractionation, purification and concentration etc. for immediate consumption in form of medicine (Khanna 2002, Pandey & Verma 2002, Kumar et al. 2003, Maliya 2004, 2007, Prajapati & Verma 2004, Nigam & Kumar 2005, Upadhyay & Singh 2005, Singh et al. 2007). The antioxidant, antimicrobial and antipyretic effects of phytochemicals and other compounds contained within the plant tissues provide medicinal attributes to these plants. The Nawabgunj Bird Sanctuary is endowed with a rich concentration of 54 plant species under 50 genera belonging to 30 families which are used by the native people of villages in treatment of various illnesses. Maximum medicinal species (34 species) belong to herbaceous taxa while 11 trees, 6 climbers and 3 shrubs (Text-figure 7) are also bestowed with medicinal properties (Garg et al. 2014). However, due to environmental changes and lack of awareness on conservation of the medicinal plant resources among the local people, many species are becoming overexploited resulting in rarity. Characterization of medicinal plants and compilation of a database on local information held by the village people is therefore not only useful but essential and in this light the medicinal plant resource inventory of the Nawabgunj Bird Sanctuary finds immense value.



**Text-figure 7.** Ethno medicinal habitat representatives of plants in the Nawabgunj Bird Sanctuary.

**Edible plants:** The wild edible plants are of wide utility in meeting the food requirements of forest dwellers and tribal populations in terms of readily available food plant resources mainly in form of leaves which are used as vegetables and fruits, corms, shoots, seeds and young stems used in various ways. The floristic constituents of the Nawabgunj Bird Sanctuary comprised of 26 species of edible plants, under 24 genera and 18 families which are regularly used as food by local inhabitants, some of these are consumed by aquatic animals as well as birds, many of which are in turn consumed by human beings as meat forms more often by tribals. The various meat forms are – Varanus' tongues, Peacock's liver, fishes, birds' eggs and many kinds of insects which are highly nutritious and provide plenty of proteins, fats, vitamins salts and minerals. Hence the mutual interaction between the floral and faunal components coexisting within the sanctuary were also studied in terms of the aquatic food chain involving aquatic flora and fauna and their impact on birds (Garg et al. 2015). Small animals and herbivores obtain food from, or in the form of green plants synthesized within the plant body in the presence of sunlight which is converted and stored as chemical energy which is transferred to the primary consumers, the herbivores and then to the secondary consumers, birds, animals and human beings (Yesodharan et al. 2011, Garg et al. 2014). Availability of birds' food resources and other plants used by them in making nests is also essential for attracting migratory birds into the sanctuary and is therefore instrumental in birds' ingress into this miniature wetland for the sanctuary sustenance and success. The energy flow through food chain is regulated and synchronised through this pathway wherein all floral and faunal components are linked and interconnected in an intricate, inseparable manner making the small ecosystem very versatile in all respects which is most essential for maintenance of the ecosystem equilibrium within the sanctuary.

**Economic resource plants:** A wide variety of 17 species under 15 genera and 11 families were found as good economic plant resources (Garg et al. 2014). The economically useful plants are good sources of food directly as well as many species meet medicinal, fuel



wood, timber and other requirements in daily lives. These also help in generating economy as they provide raw materials for pharmaceutical, tobacco, coffee, alcohol and other industries.

**Plants used as fodder:** The tribals maintain cattle, goat, sheep and farm animals for various purposes and require fodder to meet the food requirements of these animals in the form of easily digestible and good source of energy. Hence the chemical composition and nutritive value of a fodder crop is very important. Within the Nawabgunj Bird Sanctuary, there were only 2 species (under 2 genera belonging to 2 family) which provided fodder of domestic animals (Garg et al. 2014).

**Nesting tree species:** The Nawabgunj Bird Sanctuary is a convergence centre of many migratory birds. The original vegetation is supported by water reservoir and thick canopy of trees with aggregation of many aquatic plants, invasive species, herbs, shrubs and grasses which provide a potential nesting and breeding ground to the migratory birds. The water reservoir supports wide variety of flora and fauna. The molluscs, frogs, large insects and small fishes and snails harbour in swampy and marshy area around the pond. In the whole sanctuary, 10 species under 10 genera belonging to 8 families used by the migratory birds for nesting and laying egg. The tree species *Acacia nilotica* (L.) Willd. ex Delile and *Prosopis juliflora* (Swartz.) DC. on islands were preferred nest-sites and nest building materials were extracted mainly from seven species - *Acacia nilotica* (L.) Willd. ex Delile, *Barringtonia acutangula* (L.) Gaertn., *Cynodon dactylon* (L.) Pers., *Cyperus rotundus* L., *Eucalyptus citriodora* Hook., *Prosopis juliflora* (Swartz.) DC. and *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn. Conservation of these plant species during sanctuary management practices is therefore necessary for providing nesting space for these migratory birds which constitute the most dominant bird species within the sanctuary.

From the above details, it is evident that the Nawabgunj Bird Sanctuary represents a small wetland ecosystem within ecosystem, which is a rich centre of migratory birds' ingress during winter season. During post-summer season from July onwards, a large number

of migratory birds are seen arriving in the sanctuary. Their number becomes highest during November to January. The richness of economical and edible plants is utilised by birds as well as the local people in nearby villages in various ways. The tree canopy helps in maintaining the sanctuary climate for healthy growth of herbaceous species and a congenial atmosphere for recreation while nesting species offer space for building nests. The sanctuary, on the whole, is maintained through floral-faunal mutualism in its natural form with all components of the wetland ecosystem. All these attributes together corroborate in classifying the Nawabgunj Bird Sanctuary as a versatile miniature ecosystem for floral and faunal coexistence.

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