

Invasion of Alien Species in Wetlands of Samaspur Bird Sanctuary, Uttar Pradesh, India

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Abstract: The expansion of invasive alien plants in wetlands leads to loss of native plant diversity. Invasive weeds are also responsible for shrinking of water bodies and becoming a severe environmental problem. In this context, plant diversity of wetlands in Samaspur Bird Sanctuary, Rae Bareilly district, Uttar Pradesh, was surveyed. 149 species of higher plants have been listed of which 108 were dicots followed by 40 monocots, and one pteridophyte. Species are distributed in 129 genera and belongs to 60 families. Poaceae is the dominant family with 28 species followed by Euphorbiaceae (9), Papilionaceae (8), Asteraceae (7) and Mimosaceae (7). Various members have been categorized into nine morpho-ecological groups. Out of all species, planted species (48), dry bank species (46) and wetland hydrophytes (38) contribute to the high diversity. Of the 101 natural species, alien plants represent 41.6% of the flora. Habit-wise analysis of natural flora shows that herbs are occupying higher proportion (86.1%) with 87 species followed by shrubs (6.9%) and climbers (4%). Among the 48 planted species, 25 are alien ones. The presence of *Eichhornia crassipes*, *Typha angustata*, *Prosopis juliflora* and *Ipomoea carnea* are considered as one of the most serious threat to the Samaspur wetlands. Effective steps are to be taken for conserving these wetlands.

Key words: Wetland, invasion, flora, Samaspur Bird Sanctuary, Uttar Pradesh.

Introduction

Invasion of wetlands, globally, by invasive alien species has become a common phenomenon. The worldwide vulnerability of wetlands to biological invasion cannot be over emphasized. The spread of non-native or alien or exotic species has emerged in recent years as one of the most serious threats to biodiversity, undermining the ecological integrity of many native habitats and pushing some rare species to the edge of extinction, second only to habitat loss. The introduction of invasive alien species is considered to be a leading cause of species endangerment and extinction in freshwater systems (Claudi and Leach, 1999; Harrison and Stiassny, 1999; Sala et al., 2000). It can produce profound and irreversible changes to ecosystem structure and function (Mooney and Hobbs, 2000; Sakai et al., 2001). It competes with

native species and causes severe economic losses (Dukes and Mooney, 2004; D'Antonio and Hobbie, 2005). Convention on Biological Diversity, 1992 visualize 'biological invasion of alien species as the second worst threat after habitat destruction'.

Modern ecologists are now well aware of the problems caused by the invasion of alien species into natural areas and the associated negative effects on global patterns of native biodiversity. Once established, some alien species have the ability to displace or replace native plant and animal species, disrupt nutrient and fire cycles, and cause changes in the pattern of plant succession. Studies are underway to better understand the impacts of these species on native ecosystems. The work of conservation must envisage wetlands since they cover about 6% of earth surface and are well known for four broad categories of functions, viz. physical/hydrological, chemical, biological and socio-economic (Williams, 1990). Wetlands support plant species intermediate between true

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aquatic and terrestrial habitats. They harbour plants with extremely modified morphology, physiology and biochemistry. Wetland vegetation provides natural barrier to fast moving water and, therefore, aids in flood speed reduction. Recently, wetlands have fallen victim to high rate of extinction due to developmental activities, pollution, biological invasion, and over-exploitation as a consequence of which biodiversity sustained with them is under threat to great extent. In view of this, the present study is focussed on plant diversity of Samaspur Bird Sanctuary with reference to non-native species invasion, which needs immediate conservation.

Study Area

The six lakes known as Samaspur wetlands in Rae Bareilly district of Uttar Pradesh, India were declared as Samaspur Bird Sanctuary in 1987 and lies between $25^{\circ} 58'$ to $26^{\circ} 01'$ N latitudes and $81^{\circ} 21'$ to $81^{\circ} 25'$ E longitudes (Figure 1). Samaspur Bird Sanctuary is listed as one of the Important Bird Areas (IBAs) in India. Out of the 800 ha of total area of the sanctuary, about 370 ha is private and community lands. There are five connected lakes namely Samaspur, Mamani, Gorwa Hasanpur, Hakganj and Rohnia. The sixth lake Bissaiya is close to other five lakes but not connected to the main water body. However, this also forms a part of the sanctuary. These wetlands are included in the list of wetlands identified under national wetland conservation programme by the

Ministry of Environment and Forests (MoE&F), Government of India. Each year about one-lakh birds migrate from various regions of the world like Siberia and Tibet during the months of November to March. But according to local estimates, the number of arriving birds has reduced to one fourth in last eight to ten years. This sharp decline has become a critical issue in conservation of the wetlands. Now, the sanctuary has become a tourist destination for bird lovers as well as tourists from different places of the country.

Almost 250 species of resident and migratory birds are found to be sheltered here. The important aquatic birds frequently found are: Egrets, Painted stork, Purple Moorhen, Purple Heron, White breasted water hen, Whistling teal, Phaesant Teal, Jacana, Little grebs, Cormorants, Kingfisher, Bronzed winged Jacana, Darter, Cotton Teal, Brahmany kite, Black Drago, Green Bee Eater, Indian Sarus Crane, Pintail etc. Many of these species are placed in IUCN threatened category and occur in much higher numbers than their one percent biogeographic population threshold, calculated by the Wetland International (2002) on the basis of total biogeographic population of water birds. The local communities are dependent on the wetlands for agriculture, grazing, fishing, groundwater recharge etc. for their day-to-day activities. Large-scale poaching of birds is also major concern in the sanctuary area (Korgaonkar and Gokhale, 2006).

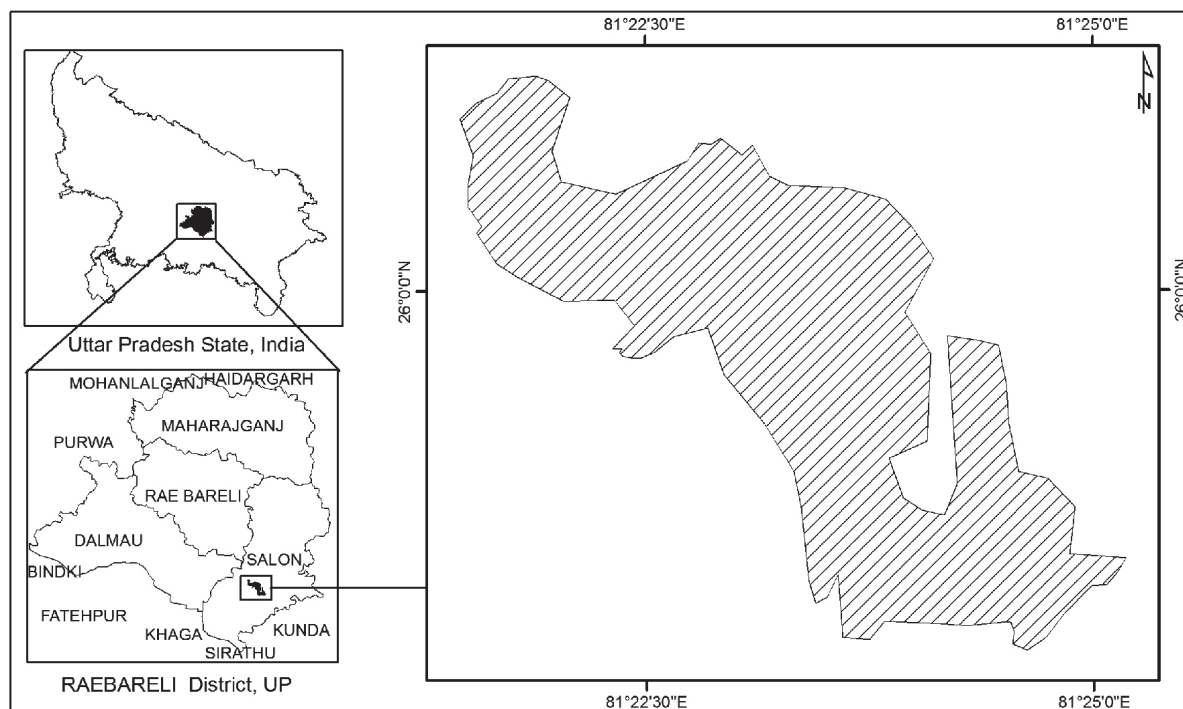


Figure 1: Location map of Samaspur Bird Sanctuary, Uttar Pradesh.

Materials and Methods

The survey was conducted during August to September 2007. Accordingly, information on habit/habitat of plants was recorded. All the plants are listed alphabetically with author citation and family names. Plant species recorded from the sanctuary were categorized under nine morpho-ecological groups. The nativity of the species is provided based on literature (Sharma, 1968; Hajra and Das, 1982; Saxena, 1991; Negi and Hajra, 2007; Reddy 2008).

Results and Discussion

Based on recent floristic survey during 2007 in the Samaspur Bird Sanctuary, a total of 149 species of higher plants were identified belonging to 129 genera and distributed in 60 families (Table 1). Of these total plant

species, 108 were dicots, 40 were monocots and one was pteridophyte. Poaceae is the dominant family with 28 species followed by Euphorbiaceae (9), Papilionaceae (8), Asteraceae (7) and Mimosaceae (7). Out of total plant diversity, 48 are planted species followed by dry bank species (46) and wetland hydrophytes (38). Alien plants represent 41.6% of the total enumerated flora and rests are natural species (101 spp.). Habit-wise analysis of natural flora shows that herbs are occupying higher proportion (86.1%) with 87 species followed by shrubs (6.9%) and climbers (4%). Of the 101 natural species in the flora, alien plants are represented by 42 (41.6%) species. Among dicots, *Ipomoea carnea* and *Prosopis juliflora* were prevalent, whereas in monocots *Eichhornia crassipes* and *Typha angustata* are found as aggressive colonizer species and formed gregarious colonies.

Table 1: List of plant species in Samaspur Bird Sanctuary

Species	Family	Habit	Group*	Nativity
<i>Hygrophila auriculata</i> (Schum.) Heina	Acanthaceae	Herb	Wh	Indigenous
<i>Trianthema triquetra</i> Rottl. ex Willd.	Aizoaceae	Herb	Db	Indigenous
<i>Zaleya decandra</i> (L.) Burm.f.	Aizoaceae	Herb	Wh	Trop. America
<i>Achyranthes aspera</i> L.	Amaranthaceae	Herb	Db	Indigenous
<i>Amaranthus viridis</i> L.	Amaranthaceae	Herb	Db	Indigenous
<i>Gomphrena serrata</i> L.	Amaranthaceae	Herb	Db	Trop. America
<i>Peristrophe paniculata</i> (Forssk.) Brummitt	Amaranthaceae	Herb	Db	Trop. America
<i>Buchanania lanzan</i> Sprengel	Anacardiaceae	Tree	Pla	Indigenous
<i>Mangifera indica</i> L.	Anacardiaceae	Tree	Pla	Indigenous
<i>Miliusa tomentosa</i> (Roxb.) Sinclair	Annonaceae	Tree	Pla	Indigenous
<i>Polyalthia longifolia</i> (Sonner.) Thw.	Annonaceae	Tree	Pla	Sri Lanka
<i>Carissa spinarum</i> L.	Apocynaceae	Shrub	Pla	Indigenous
<i>Cascabela thevetia</i> (L.) Lippold.	Apocynaceae	Tree	Pla	Trop. America
<i>Nerium oleander</i> L.	Apocynaceae	Shrub	Pla	China
<i>Phoenix sylvestris</i> (L.) Roxb.	Arecaceae	Shrub	Db	Indigenous
<i>Roystonea regia</i> (H.B. & K) F. Cook.	Arecaceae	Tree	Pla	Trop. America
<i>Hemidesmus indicus</i> (L.) R. Br.	Asclepiadaceae	Climber	Db	Indigenous
<i>Oxystelma esculentum</i> (L.f.) R. Br. ex Schult.	Asclepiadaceae	Climber	Wh	Indigenous
<i>Ageratum conyzoides</i> L.	Asteraceae	Herb	Db	Trop. America
<i>Blumea mollis</i> (D. Don) Merr.	Asteraceae	Herb	Db	Trop. America
<i>Blumea oxyodonta</i> DC.	Asteraceae	Herb	Wh	Trop. America
<i>Eclipta prostrata</i> (L.) Mant.	Asteraceae	Herb	Wh	Trop. America
<i>Launaea procumbens</i> (Roxb.) Ramayya & Rajagopal	Asteraceae	Herb	Wh	Indigenous
<i>Vernonia cinerea</i> (L.) Less.	Asteraceae	Herb	Db	Trop. America
<i>Xanthium strumarium</i> L.	Asteraceae	Herb	Db	Trop. America
<i>Basella alba</i> L.	Basellaceae	Climber	Pla	Trop. America
<i>Ceiba pentandra</i> (L.) Gaertn.	Bombacaceae	Tree	Pla	Trop. America
<i>Cynoglossum zeylanicum</i> (vahl ex Hornem)	Boraginaceae	Herb	Db	Indigenous
Thunb. ex Lehm.				
<i>Coronopus didymus</i> (L.) Smith	Brassicaceae	Herb	Db	Trop. America
<i>Cassia fistula</i> L.	Caesalpiniaceae	Tree	Pla	Indigenous
<i>Delonix regia</i> (Boj. ex Hook.) Raf.	Caesalpiniaceae	Tree	Pla	Trop. America

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Species	Family	Habit	Group*	Nativity
<i>Canna indica</i> L.	Cannaceae	Herb	Pla	Trop. America
<i>Casuarina equisetifolia</i> Forster & Forster f.	Casuarinaceae	Tree	Pla	Australia
<i>Terminalia arjuna</i> (DC.) Wight & Arn.	Combretaceae	Tree	Pla	Indigenous
<i>Terminalia bellirica</i> (Gaertner) Roxb.	Combretaceae	Tree	Pla	Indigenous
<i>Commelina benghalensis</i> L.	Commelinaceae	Herb	Wh	Indigenous
<i>Amisophacelus axillaris</i> (L.). R.S.Rao et. Kamm.	Commelinaceae	Herb	Wh	Indigenous
<i>Evolvulus nummularius</i> (L.) L.	Convolvulaceae	Herb	Wh	Trop. America
<i>Ipomoea aquatica</i> Forsskal	Convolvulaceae	Herb	Wh	Indigenous
<i>Ipomoea carnea</i> Jacq.	Convolvulaceae	Shrub	Wh	Trop. America
<i>Merremia hederacea</i> (Burm.f.) Hallier f.	Convolvulaceae	Herb	Wh	Indigenous
<i>Merremia tridentata</i> (L.) Hallier f.	Convolvulaceae	Herb	Wh	Indigenous
<i>Coccinia grandis</i> (L.) J. Voigt	Cucurbitaceae	Climber	Db	Indigenous
<i>Lagenaria siceraria</i> (Molina) Standley	Cucurbitaceae	Climber	Pla	Trop. America
<i>Mukia maderaspatana</i> (L.) Roemer	Cucurbitaceae	Herb	Db	Indigenous
<i>Fimbristylis bis-umbellata</i> (Forssk.) Bubani	Cyperaceae	Herb	Wh	Indigenous
<i>Bulbostylis barbata</i> (Roltb.) Clarke	Cyperaceae	Herb	Db	Indigenous
<i>Cyperus rotundus</i> L.	Cyperaceae	Herb	Wh	Indigenous
<i>Diospyros melanoxylon</i> Roxb.	Ebenaceae	Tree	Pla	Indigenous
<i>Chamaesyce thymifolia</i> (L.) Millsp.	Euphorbiaceae	Herb	Wh	Trop. America
<i>Chrozophora rottleri</i> (Geis.) Spreng.	Euphorbiaceae	Herb	Wh	Trop. America
<i>Croton bonplandianum</i> Boil.	Euphorbiaceae	Herb	Db	Trop. America
<i>Chamaesyce hirta</i> (L.) Millsp.	Euphorbiaceae	Herb	Db	Trop. America
<i>Pedilanthus tithymaloides</i> (L.) Poit.	Euphorbiaceae	Shrub	Pla	Trop. America
<i>Phyllanthus amarus</i> Schum.	Euphorbiaceae	Herb	Db	Indigenous
<i>Phyllanthus emblica</i> L.	Euphorbiaceae	Tree	Pla	Indigenous
<i>Phyllanthus simplex</i> Retz.	Euphorbiaceae	Herb	Db	Trop. America
<i>Ricinus communis</i> L.	Euphorbiaceae	Shrub	Pla	South Africa
<i>Pongamia pinnata</i> (L.) Pierre	Fabaceae	Tree	Pla	Indigenous
<i>Hydrilla verticillata</i> (L.f.) Royle	Hydrocharitaceae	Herb	Sah	Trop. America
<i>Anisomeles malabarica</i> (L.) R. Br. ex Sims	Lamiaceae	Shrub	Db	Indigenous
<i>Lemna perpusilla</i> J. Torrey	Lemnaceae	Herb	Ffh	Indigenous
<i>Wolffia globosa</i> (Roxb.) Hartog & Van	Lemnaceae	Herb	Ffh	Indigenous
<i>Utricularia exoleta</i> R.Br.	Lentibulariaceae	Herb	Sh	Indigenous
<i>Hibiscus rosa-sinensis</i> L.	Malvaceae	Shrub	Db	China
<i>Sida cordifolia</i> L.	Malvaceae	Herb	Db	Indigenous
<i>Marsilea quadrifolia</i> L.	Marsileaceae	Herb	Ffh	Indigenous
<i>Azadirachta indica</i> A. Juss	Meliaceae	Tree	Pla	Indigenous
<i>Cissampelos pariera</i> L.	Menispermaceae	Climber	Db	Indigenous
<i>Nymphoides indica</i> (L.) Kuntze	Menyanthaceae	Herb	Flh	Indigenous
<i>Acacia farnesiana</i> (L.) Willd.	Mimosaceae	Tree	Db	Trop. America
<i>Acacia nilotica</i> (L.) Willd. ex Delile.	Mimosaceae	Tree	Db	Indigenous
<i>Albizia lebbek</i> (L.) Bentham	Mimosaceae	Tree	Pla	Himalayas
<i>Leucaena leucocephala</i> (Lam.) de Wit	Mimosaceae	Tree	Pla	Trop. America
<i>Mimosa pudica</i> L.	Mimosaceae	Herb	Db	Brazil
<i>Pithecellobium dulce</i> (Roxb.) Bentham	Mimosaceae	Tree	Pla	Trop. America
<i>Prosopis chilensis</i> (Molina) Stuntz (<i>P. juliflora</i>)	Mimosaceae	Shrub	Db	Mexico
<i>Ficus benghalensis</i> L.	Moraceae	Tree	Pla	Indigenous
<i>Ficus racemosa</i> L.	Moraceae	Tree	Pla	Indigenous
<i>Ficus religiosa</i> L.	Moraceae	Tree	Pla	Indigenous
<i>Moringa pterygosperma</i> Gaertner	Moringaceae	Tree	Pla	Indigenous
<i>Psidium guajava</i> L.	Myristaceae	Tree	Pla	Trop. America
<i>Callistemon lanceolatus</i> DC.	Myrtaceae	Shrub	Pla	Australia

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<i>Eucalyptus camaldulensis</i> Eehnh.	Myrtaceae	Tree	Pla	Australia
<i>Syzygium cumini</i> (L.) Steels	Myrtaceae	Tree	Pla	Indigenous
<i>Bougainvillea spectabilis</i> L.	Nyctaginaceae	Climber	Pla	Brazil
<i>Nelumbo nucifera</i> Gaertn.	Nymphaeaceae	Herb	Flh	Indigenous
<i>Ludwigia perennis</i> L.	Onagraceae	Herb	Fsah	Trop. America
<i>Oxalis corniculata</i> L.	Oxalidaceae	Herb	Wh	Trop. America
<i>Argemone ochroleuca</i> Sweet	Papaveraceae	Herb	Db	Trop. America
<i>Alysicarpus monilifer</i> (L.) DC.	Papilionaceae	Herb	Db	Indigenous
<i>Alysicarpus vaginalis</i> DC.	Papilionaceae	Herb	Db	Indigenous
<i>Butea monosperma</i> (Lam.) Taubert	Papilionaceae	Tree	Db	Indigenous
<i>Cicer arietinum</i> L.	Papilionaceae	Herb	Pla	Trop. America
<i>Dalbergia sissoo</i> Roxb.	Papilionaceae	Tree	Pla	Indigenous
<i>Medicago sativa</i> L.	Papilionaceae	Herb	Db	Indigenous
<i>Melilotus alba</i> Desv.	Papilionaceae	Herb	Wh	Indigenous
<i>Melilotus indica</i> (L.) All.	Papilionaceae	Herb	Wh	Indigenous
<i>Pedaliium murex</i> L.	Pedaliaceae	Herb	Db	Trop. America
<i>Aristida depressa</i> L.	Poaceae	Herb	Wh	Indigenous
<i>Arundo donax</i> L.	Poaceae	Herb	Wh	Indigenous
<i>Cenchrus ciliaris</i> L.	Poaceae	Herb	Db	Trop. America
<i>Chloris barbata</i> Sw.	Poaceae	Herb	Db	Trop. America
<i>Chloris dolichostachya</i> Lagasca	Poaceae	Herb	Wh	Trop. America
<i>Chrysopogon fulvus</i> (Spreng.) Chiov.	Poaceae	Herb	Db	Indigenous
<i>Chrysopogon verticillatus</i> (Roxb.) Trin.ex Steud.	Poaceae	Herb	Db	Indigenous
<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	Herb	Wh	Indigenous
<i>Desmostachya bipinata</i> (L.) Stapf	Poaceae	Herb	Wh	Indigenous
<i>Dichanthium annulatum</i> (Forsskal) Stapf	Poaceae	Herb	Wh	Indigenous
<i>Dichanthium pertusum</i> (L.) Clayton	Poaceae	Herb	Wh	Indigenous
<i>Echinochola colona</i> (L.) Link	Poaceae	Herb	Eah	Trop. America
<i>Eragrostis tenella</i> (L.) P. Beauv. ex Roemer & Schultes	Poaceae	Herb	Wh	Indigenous
<i>Eragrostis unioloides</i> (Retz.) Nees ex Steud.	Poaceae	Herb	Wh	Indigenous
<i>Eremopogon foveolatus</i> (Del.) Stapf	Poaceae	Herb	Wh	Indigenous
<i>Eulaliopsis binata</i> (Retz.) Hubbard	Poaceae	Herb	Db	Indigenous
<i>Heteropogon contortus</i> (L.) P. Beauv. ex Roemer & Schultes	Poaceae	Herb	Db	Indigenous
<i>Imperata cylindrica</i> (L.) Raensch.	Poaceae	Herb	Db	Trop. America
<i>Iseilema laxum</i> Hackel	Poaceae	Herb	Eah	Indigenous
<i>Oryza sativa</i> L.	Poaceae	Herb	Pla	Indigenous
<i>Panicum repens</i> L.	Poaceae	Herb	Eah	Indigenous
<i>Pennisetum purpureum</i> Schum.	Poaceae	Herb	Wh	Trop. America
<i>Saccharum spontaneum</i> L.	Poaceae	Herb	Eah	Trop. America
<i>Setaria pumila</i> (Poiret) Roemer & Schultes	Poaceae	Herb	Db	Trop. America
<i>Sporobolus diander</i> (Retz.) P.Bauv.	Poaceae	Herb	Eah	Indigenous
<i>Themeda quadrivalvis</i> (L.) O. Ktze.	Poaceae	Herb	Db	Indigenous
<i>Triticum vulgare</i> L.	Poaceae	Herb	Pla	Trop. America
<i>Vetiveria zizanioides</i> (L.) Nash	Poaceae	Herb	Eah	Indigenous
<i>Polygonum glabrum</i> Willd.	Polygonaceae	Shrub	Eah	Indigenous
<i>Eichhornia crassipes</i> (C. Martius) Solms-Loub.	Pontederiaceae	Herb	Ffh	Trop. America
<i>Portulaca grandiflora</i> Hook.	Portulacaceae	Herb	Pla	Brazil
<i>Portulaca oleracea</i> L.	Portulacaceae	Herb	Wh	Trop. America
<i>Portulaca quadrifida</i> L.	Portulacaceae	Herb	Wh	Trop. America
<i>Anagallis arvensis</i> L.	Primulaceae	Herb	Wh	Indigenous
<i>Veronica anagallis</i> L.	Primulaceae	Herb	Wh	Indigenous

(Contd.)

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Species	Family	Habit	Group*	Nativity
<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	Shrub	Pla	Indigenous
<i>Anthocephalus chinensis</i> (Lam.) A.Rich.ex Walp.	Rubiaceae	Tree	Pla	Indigenous
<i>Aegle marmelos</i> (L.) Correa	Rutaceae	Tree	Pla	Indigenous
<i>Salvadora persica</i> L.	Salvadoraceae	Shrub	Db	Indigenous
<i>Madhuca indica</i> J. Gmel.	Sapotaceae	Tree	Pla	Indigenous
<i>Capsicum frutescens</i> L.	Solanaceae	Herb	Pla	Trop. America
<i>Physalis angulata</i> L.	Solanaceae	Herb	Db	Trop. America
<i>Solanum melongena</i> L.	Solanaceae	Herb	Pla	Trop. America
<i>Solanum tuberosum</i> L.	Solanaceae	Herb	Pla	Trop. America
<i>Corchorus aestuans</i> L.	Tiliaceae	Herb	Wh	Trop. America
<i>Corchorus trilocularis</i> L.	Tiliaceae	Herb	Wh	Trop. America
<i>Typha angustata</i> Bory. & Choub.	Typhaceae	Herb	Eah	Trop. America
<i>Phylla nodiflora</i> (L.) Greene	Verbenaceae	Herb	Wh	Trop. America
<i>Tectona grandis</i> L.f.	Verbenaceae	Tree	Pla	Indigenous
<i>Hybanthus enneaspermus</i> (L.) F.V Muell.	Violaceae	Herb	Db	Indigenous

*Ffh: Free floating hydrophyte; Flah: Floating-leaved anchored hydrophyte; Fsah: Floating shoots anchored hydrophyte; Sah: Submerged anchored hydrophyte; Sh: Suspended hydrophyte; Eah: Emergent anchored hydrophyte; Wh: wetland hydrophyte; Db: Dry bank species; Pla: Planted species

Various species recorded from the sanctuary are discussed under following morpho-ecological groups (Table 2).

1. *Free floating hydrophytes*: These are plants floating on the surface of water bodies and frequently form dense green covering on the surface. This category includes *Eichhornia crassipes*, *Lemna perpusilla*, *Marsilea quadrifolia*, and *Wolffia globosa*.

2. *Floating-leaved anchored hydrophytes*: They are rooted in the muddy substratum with their leaves lying on the water bodies. They are represented by *Nelumbo nucifera* and *Nymphoides indica*.

3. *Floating-shoots anchored hydrophytes*: They are rooted in the soil with their shoots floating on the water surface. During dry months, when there is paucity of

water recedes, these species become terrestrial and survive in sub-swampy to nearly dry habitat. Constituents of this category are *Ludwigia perennis*.

4. *Submerged anchored hydrophytes*: They are entirely, or for the most part, submerged in the water but attached to the soil. Components of this category are *Hydrilla verticillata* etc.

5. *Suspended hydrophytes*: These are root-less submerged water plants that form pure tangled masses of vegetation. This category includes only *Utricularia exoleta*.

6. *Emergent anchored hydrophytes*: The root, the lower part of the stem and sometimes even the lower leaves of these hydrophytes are usually submerged under water. The plants are growing on the marginal belts on the marshy banks of ox-bow lakes. These are subjected to periodic flooding and are liable for complete submersion. Plants of this group include eight species. *Typha angustata*, *Panicum repens*, *Echinochloa colona* are common ones.

7. *Wetland hydrophytes*: Here the soil is usually saturated with water at least in the earlier part of life. Their appearance coincides with the gradually drying of water sources. These include 38 species. *Eclipta prostrata*, *Ipomoea carnea*, *Cynodon dactylon* are prominent.

8. *Dry bank species*: Most of these species have migrated from nearby catchments and formed communities. Soil is dry in most part of the year. Dry bank communities are more productive than marshy land species and represented by 46 species.

Table 2: Distribution of species in morpho-ecological groups

Sl. No.	Group	Number of species
1	Free floating hydrophytes (Ffh)	4
2	Floating-leaved anchored hydrophytes (Flah)	2
3	Floating-shoots anchored hydrophytes (Fsah)	1
4	Submerged anchored hydrophytes (Sah)	1
5	Suspended hydrophytes (Sh)	1
6	Emergent anchored hydrophytes (Eah)	8
7	Wetland hydrophytes (Wh)	38
8	Dry bank species (Db)	46
9	Planted species (Pla)	48
	Total	149

9. *Planted species*: It includes cultivated plants (37), vegetables (7) and crops (4). As part of management programmes, Forest Department planted 37 species in the sanctuary. Of these 18 are alien species. Currently, out of the 271 ha of private land which is inside the sanctuary, agriculture is practiced in about 50 ha. The main crops produced are Wheat (*Triticum aestivum*), Paddy (*Oryza sativa*), Potato (*Solanum tuberosum*), and Chickpea (*Cicer arietinum*).

From the present study, we found that most of the naturalized alien species were introduced from Tropical America. The distribution of plants with respect to countries is shown in Figure 2. The invasion of *Eichhornia crassipes* (water hyacinth), *Typha angustata* (cat tail weed), *Prosopis juliflora* and *Ipomoea carnea* can be considered as one of the most serious threat to the Samaspur wetlands. During last 10 to 12 years, this problem has become pertinent. They possess specialized growth habits, physiological characteristics and reproductive strategies that allow for rapid growth and expansion in freshwater environments. They turn out to be serious weeds in freshwater habitats, where they displace native aquatic plant and animal communities, cause substantial economic hardships and interfere with water uses.

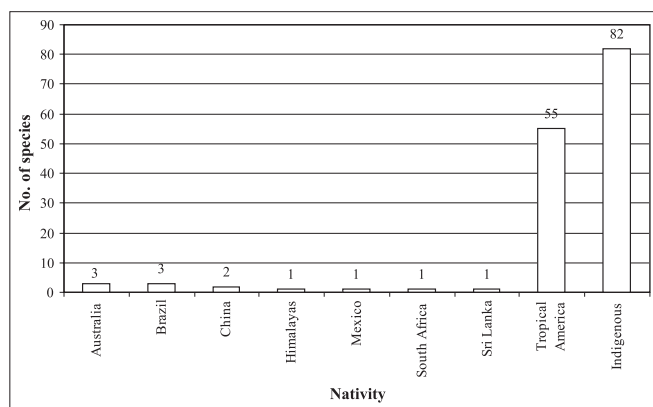


Figure 2: Distribution of plant species in Samaspur Bird Sanctuary.

Methods of controlling invasive species are: (1) Mechanical control, physically removing the invasive species; (2) Chemical control using herbicides, pesticides and (3) Biological control e.g., introducing a natural enemy—water hyacinth weevil *Neochetina* spp. for *Eichhornia*. Monitoring of invasion can be done through *qualitative approach* like species inventory (seasonally) and *quantitative approach* using phytosociological methods and *mapping* using ground-based methods (viz.

map overlays or Global Positioning System) and high-resolution remotely sensed images.

Weed management plan with the following sequential steps should be considered for reduction of invasive species: (1) Establish conservation objectives; (2) Identify and prioritize those infestations that threaten the sanctuary; (3) Assess control techniques; develop weed management and monitoring plan; (4) Implement management plan and conduct monitoring; (5) Summarize, analyze, interpret, and communicate results; and (6) Review and adjust management and monitoring approach and objectives as needed.

Conclusion

The prevention of native biological diversity has become one of the major challenges of this century and invasive alien species is an integral part of this challenge, mainly because they contribute to the demise of native species. A better planning is needed for conservation of the rapidly degrading Samaspur wetlands. There are no grazing grounds for the cattle in nearby villages. So the cattle in these villages graze inside and surrounding areas of the sanctuary causing damage to native flora. Local communities are the important stakeholders and are dependent on the wetlands for various reasons. So, the state Forest Department should share the responsibility of management and protection of the sanctuary by involving local people. A long-term commitment to the control of these perennial species both inside and outside the sanctuary area is required.

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