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WETLAND FLORA OF SHAHEED CHANDRA SHEKHAR AZAD BIRD SANCTUARY (SCSABS) - A NATURAL RESOURCE FOR FOOD AND BREEDING FOR AVIAN FAUNA

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Abstract: The wetland flora of Shaheed Chandra Shekhar Azad Bird Sanctuary is the main food source for migratory as well as resident herbivorous birds. Twenty-eight plant species were identified to be eaten by twenty-two birds. These plants were the species of *Azolla, Ceratophyllum, Chloris, Commelina, Cyperus, Echinochloa, Eichhornia, Eleocharis, Hydrilla, Ipomoea, Lemna, Ludwigia, Najas, Nelumbo, Neptunia, Nymphaea, Nymphoides, Oryza, Pistia, Polygonum, Potamogeton, Scirpus, Spirodela, Trapa, Typha, Vallisneria, and Wolffia,* etc. Common flora consumer birds eating plant parts were Coot, Pochards, Teal, Wigeon, Gadwall, Garganey, Goose, Whistling-duck, Mallard, Pintail, and Shoveler etc. These are primarily the migratory birds except Coot and Whistling-duck. Spot-billed Duck and Indian Moorhen were occasionally seen eating submerged hydrophytes and filamentous slimy green algae. Information collected in the study could be used for habitat management, especially weed removal and ensuring food sustainability for vegetarian birds. The abundance of food resource plants in this sanctuary was pivotal in establishing co-existence between floral and faunal components and served as the driving force for bird ingression and the sustenance of the sanctuary as a whole.

Keywords: Avian fauna; Food chain; Floral diversity; Food resource; Nest tree species; Wetland.

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INTRODUCTION

The Shaheed Chandra Shekhar Azad Bird Sanctuary (SCSABS) is situated in the Unnao district of Uttar Pradesh on the Lucknow-Kanpur National Highway, about 45 km from Lucknow and almost the same distance from Kanpur (latt. 26º 48" to 27º 02" North, long. 80º to 81º East). The sanctuary occupies a 224.60 Ha. area. It was declared a 'Bird Sanctuary' by the Government of Uttar Pradesh, Lucknow, vide Gazette No. 2332/14-3-48-83, on 7th August 1984, under the Wildlife Protection Act 1972, for the protection and conservation of resident and migratory bird species in the wild. The sanctuary possesses a natural permanent water reservoir that recurrently fills up during rainy days. These water reservoirs become natural attractants for migratory birds from far-off continents which reach the sanctuary during August-September for overwintering, recreation and breeding. Wetland habits get enriched with floral components comprising of wetland plant species that are adapted to water logged soil and constitute the world's most productive ecosystems providing a crucial and wide variety of benefits to mankind, society and nature. Wetlands also act as migratory corridors for flora and 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 behavioral activities of water birds. The physical structure of vegetation is

therefore an important habitat component as it serves as food, shelter and nesting resources for birds and also provides potential cues about the onset of conditions suitable for successful breeding. The strength of the avian community structure of a particular wetland, in turn, is indicative of the ecological health of the entire wetland.

Uttar Pradesh, one of the northern Indian states of India, comes under the Central Asian flyway completely and partly under the East Africa West Asia flyway (Flyway map reproduced by Islam and Rahmani, 2008). Thousands of birds coming from northern and north-western higher latitudes alight in the wetlands in the state. The migratory birds, along with the resident birds spend their winters and survive on the food resources available therein (Rahmani et al. 2010, UP Forest Department file record). SCSABS wetlands are rich in aquatic flora of floating, submerged, and emergent types (Agnihotri et al., 2008; Mishra and Narain, 2010). Several ducks, gooses and swans as well as some resident aquatic birds consume vegetative materials like roots, shoots., foliage, fruits and seeds produced by emergent, submerged and floating plants in the wetlands (Ali and Ripley 1987, Islam and Rahmani 2008, Jha 2010). Some of the birds and ducks also use agriculture fields in the neighboring area as foraging ground (Mukherji et al. 2002).

Avifaunal diversity is one of the most important ecological indicators to evaluate the status of habitats. Birds are the crucial animal group in an ecosystem that maintains a trophic level. Therefore, a detailed study of avifauna and their ecology is important to protect them. They are one of the biological control tools to control pests in gardens, on farms, and other places. They assist in plant pollination and seed dispersal. Purple moorhen and lesser whistling duck are the most abundant residential species in the SCSABS. In Indian culture there are a number of birds that are worshiped with religious sentiments and people are emotionally involved in their conservation. Birds are crucial part of an ecosystem and contribute to maintaining trophic levels. Activities of birds are considered as an indicator of superiority of ecosystem and they also form the incurable links in many food chains, hence they imitate changes originating in several different ecosystem components (Custer and Osborne, 1977). The avian inhabitants of SCSABS comprise residential as well as non-residential migratory species. The birds immigrate across the Himalayas from Tibet, China, Europe and Siberia during winters. Some of the major migratory birds during the season are Greylag Goose, Pintail, Cotton Teal, Red-Crested Pochard, Gadwall, Shoveler, Coot and Mallard. Some major local migratory and residential birds are Spot-Bill Duck, Sarus Crane, Painted Stork, Peacock, Black Ibis, Whistling Teal, Open-Bill Stork, White-Necked Stork, Pheasant-Tailed Jacana, Bronze Winged Jacana, Purple Moorhen, Lapwing, Tern, Vulture, Pigeon, King Crow, Indian Roller and Bee Eater, etc. According to Urfi et al. (2003) avifaunal diversity especially water birds, attracts people towards the wetlands as well as being good bio-indicators and useful models for studying a variety of environmental problems. The present studies were therefore made to find out of generalized information about food plants and their consumer birds in SCSABS.

EXPERIMENTAL

To study the correlation between avian fauna and flora, frequent botanical surveys were made at the Shaheed Chandra Shekhar Azad Bird Sanctuary (SCSABS) during different seasons in the year 2023 and collected healthy plant specimens and field data on habit, habitat, flowering, fruiting time, etc. were recorded. With the help of binoculars and sometimes with naked eyes the birds were observed eating upon the plants with a focus on the plant parts (roots, stem, leaves, flowers, fruits and seeds) being eaten during the day. The specimens were dried, preserved, and mounted by following the standard herbarium techniques (Jain & Rao, 1977-78), identified with the help of important flora (Hooker, 1872-1897, Duthie ,1903-1929) as well as by matching with the available identified specimens for authentication and finally deposited in the herbarium. Plants that are used by birds for nest building and nest construction activities were also assessed. The guide book of Grimmett and Inskip (2010) and Saini et al. (2010) were also used for the identification of birds and plants, respectively.

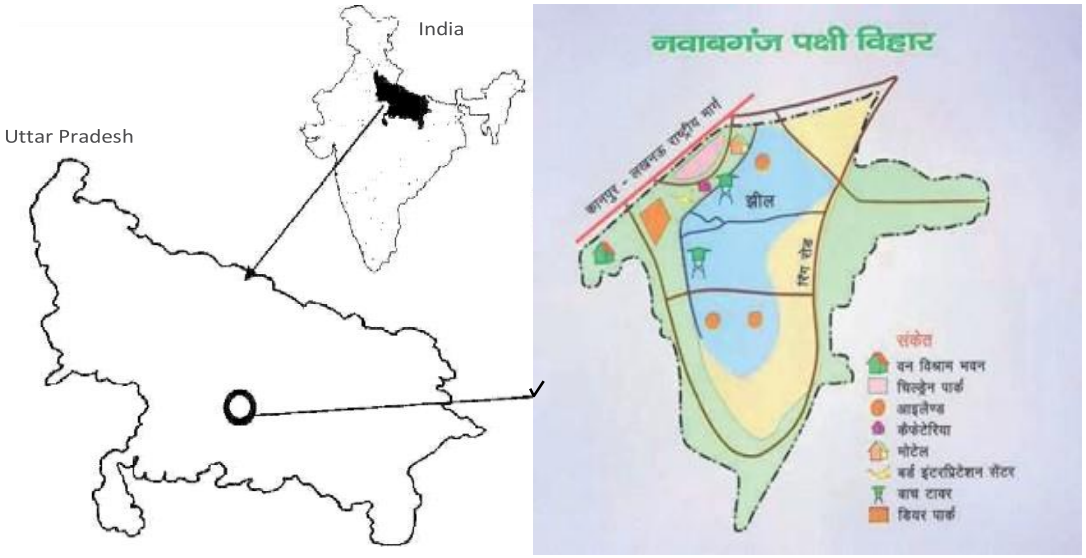

Figure 1. Map showing the location of Shaheed Chandra Shekhar Azad Bird Sanctuary (SCSABS) in Uttar Pradesh, India

RESULTS

Aquatic birds, mostly migratory, stayed during the winter months (November to February) in the wetland. These birds were seen consuming selected parts (roots, foliage, shoots, flowers, seeds and fruits) of selected plant species depending on their palatability. Such plants are grouped and described in the following paragraphs on the basis of quick identifying characters useful for wetland managers or foresters. Plant parts eaten and their consumer birds are also mentioned along with.

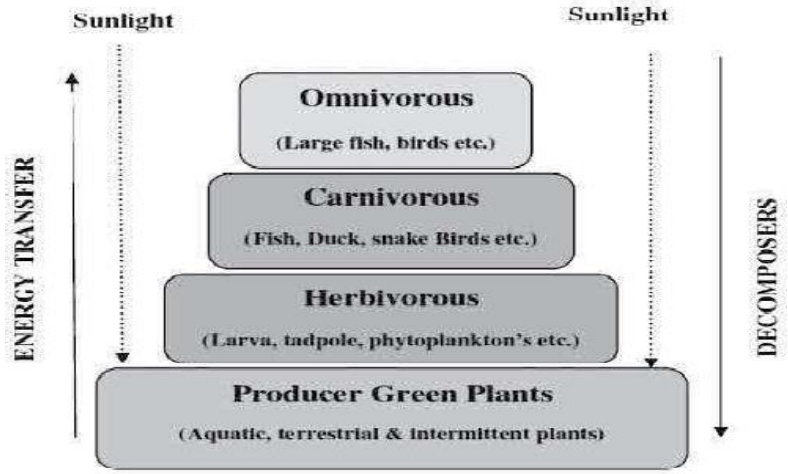

Figure 2. Floral-Faunal mutualism depicted through natural food chain in the SCSABS

Table 1: List of valuable wild plant resources used by consumer birds of SCSABS for food resources

S.No.	Botanical name of plant species (Family) and Common name	Habit	Phenology	Collection No.	Plant/plant parts used by birds
		Pteridophytes			
1.	*Azolla pinnata* R. Br. (Azollaceae)- Bhoori kai	Floating hydrophyte, Annual herb	August - December	37	Whole plant eaten by Gadwall, Shoveller, Pintail and Mallard birds Leaves are eaten by almost every duck

					(Northern Shoveller).
Angiosperms-Dicots					
2.	*Nymphaea nouchali* Burm.f., (Nymphaeaceae)- Kamalini	Floating hydrophyte, Annual herb	July - November	39	Fruits and seeds are eaten by Northern Pintail, Northern Shoveller, Common Teal, Gadwall, Red Crested Pochard, Common Pochard, Eurasian Wigeon, Ferruginous Pochard, Mallard, and Common Coot. Spot Billed Duck was seen eating seeds occasionally.
3.	*Nymphaea pubescens* Willd. (Nymphaeaceae) - Koka	Floating hydrophyte, Annual herb	May - December	40	Tuber, anther and seeds eaten by majority of water birds.
4.	*Nelumbo nucifera* Gaertn., (Nelumbonaceae) - Kamalgatta	Floating hydrophyte, Annual herb	April- January	12	Fruits and seeds eaten by birds. Seeds mostly eaten by Common Coot and Ferruginous Pochard.
5.	*Neptunia oleracea* Lour. (Mimosaceae)- Lajalu	Floating hydrophyte, Annual herb	September - April	85	Fruits, nodes and roots eaten by Whistling teal, Coot, Pintail and Gadwal.
6.	*Ludwigia adscendens* L., Hara (Onagraceae) - Gahdi	Floating hydrophyte, Annual herb	January - June	88	Roots and stem eaten by Common coot, Common teal, Gadwall, Eurasian Wigeon, Northern Pintail and Northern Shoveller
7.	*Trapa natans* L. (Trapaceae) - Singhara	Floating hydrophyte, Annual herb	August-December.	43	Fruit pulp eaten by Common Coot.
8.	*Nymphoides indica* L. Kuntze *(*Menyanthaceae) Barachuli	Floating hydrophyte, Annual herb	June-September	45	Flowers and fruits favoured food of Migratory Birds.
9.	*Ipomoea aquatica* Forssk. (Convolvulaceae)- Nari.	Floating hydrophyte, Annual herb	July-November	92	Root bud and seeds consumed by Water Birds.
10.	*Polygonum limbatum* Meisn.(Polygonaceae) - Nandi bhaji	Emergent hydrophyte, Annual herb	March-October	97	Seed and buds liked by resident as well as migratory birds. New shoots and leaves are eaten by Common Teal.
11.	*Ceratophyllum demersum* L. (Ceratophyllaceae) - Khaja chhoti	Submerged hydrophyte, Annual herb	October-February	46	Seed and leaves favoured by migratory birds (Gadwall Mallard)

12.	*Hydrilla verticillata* L.f. Royle (Hydrocharitaceae)- Sewar	Submerged hydrophyte, Annual herb	April-November	47	Flowers and seeds eaten by Ducks.
13.	*Vallisneria spiralis* L. (Hydrocharitaceae) - Feeta ghas	Submerged hydrophyte, Annual herb	December-February	49	Leaves and seeds eaten by Common Coot, Common Teal, Gadwall, Lesser Whistling Duck, Northern Shoveller, Northern Pintail and Red Crested Pochard.
14.	*Eichhornia crassipes* Mart. Solms (Pontederiaceae) -Jalkumbhi	Floating hydrophyte, Annual herb	March - December	13	Soft tissue of swollen petiole consumed by Lesser Whistling Duck.
15.	*Commelina hasskarlli* C.B. Clarke (Commelinaceae) - Oona	Emergent hydrophyte, Annual herb	November-January	90	Roots and fruits eaten by Eurasian Wigeon, Common Coot and Greylag Goose.
16.	*Typha angustifolia* L. (Typhaceaeae) -Patera	Emergent hydrophyte, Annual herb	Through out the year	14	New soft shoot eaten by Water Birds.
17.	*Pistia stratiotes* L. (Arecaceae) -Pistia	Floating hydrophyte, Annual herb	July-November	51	Young leaves eaten by Common Coots.
18.	*Lemna perpusilla* Torr. (Lemnaceae) - Hari Kai	Floating hydrophyte, Annual herb	May-November	52	Leaves eaten by Northern Shoveller and Mallard.
19.	*Spirodela polyrhiza* L. Schleid. (Lemnaceae) - Hari kai	Floating hydrophyte, Annual herb	August – December	53	Entire plant eaten by water birds. Northern Shoveller, Eurasian Wigeon and Ferruginous Pochard were seen eating the leaves of this plant.
20.	*Wolffia globos* Roxb. Hartog and Plas (Lemnaceae) - Jaljanjal	Floating hydrophyte, Annual herb	October - February	54	Whole plant is eaten by Common Pochard, Northern Shoveller, Mallard and Red crested Pochard.
21.	*Najas graminea* Delile (Najadaceae)- Katia	Submerged hydrophyte, Annual herb	September-December	60	Leaves and seeds are eaten by Common Coot, Common Teal, and Northern Pintail.
22.	*Potamogeton crispus* L. (Potamogetonaceae)- Curly leaf pondweed	Submerged hydrophyte, Annual herb	January-April	62	Common Coot and Northern Shoveller eating the seeds of this plant.
23.	*Cyperus alopecuroides* Rottb. (Cyperaceae) -Motha	Emergent hydrophyte, Annual herb	April-December	89	New leaves and fruits are eaten by Common Coot, Greylag Goose, Northern Pintail and Gadwall.
24.	*Eleocharis dulcis* (Burm.f.)	Emergent	September-	91	Tubers and nodes

	Hensch. (Cyperaceae)-Narai	hydrophyte, Annual herb	October		eaten by Purple Moorhen, Wigeon and other Water Birds.
25.	*Scirpus articulates* L. (Cyperaceae) - Chichora	Emergent hydrophyte, Annual herb	October-December	93	Seeds eaten by Purple Swamphen.
26.	*Chloris dolichostachya* Sw. (Poaceae)- Long-spike finger grass	Emergent hydrophyte, Annual herb	September-December	98	Seeds eaten by Common Teal, Northern Pintail, Gadwall and Eurasian Wigeon.
27.	*Echinochloa stagnina* (Retz.) P. Beauv. (Poaceae) - Shama	Emergent hydrophyte, Annual herb	September-December	95	Seeds eaten by Common Teal.
28.	*Oryza rufipogon* Griff. (Poaceae) - Janglidhan	Emergent hydrophyte, Annual herb	September-November	86	Seeds eaten by Red Crested Pochard, Pintail Shoveller and Common Teal.

Azolla pinnata R. Br. (Family- Azollaceae)
Common name- Bhoori kai, Mosquito fern
Habit- Floating hydrophytes
Morphological features- Herbs, aquatic, perennial. Roots simple, numerous, hanging down bearing numerous root hairs. Leaves in two rows, bilobed, with one floating and one submerged lobe, upper surface papillose, old leaves deep red. Sporocarps borne in pairs in axil of first leaves of branches on older parts.
Flowering & Fruiting: August -December
Collection Number- 37
Plant/plant parts used by birds-Whole plant eaten by Gadwall, Shoveller, Pintail and Mallard birds. Leaves are eaten by almost every duck (Northern Shoveller).

Nymphaea nouchali Burm. f. (Family- Nymphaeaceae)
Common name- Chhota Kamal, Kamalini
Habit- Floating hydrophytes
Morphological features- Herbs, 1 to 1.5 m long, aquatic, submerged, with small corms. Leaves subpalette, floating, base sagittate, margins faintly sinuate, lower surface purple with many fleshy warts beneath, globous. Flower pink or white, gently fragrant.
Flowering & Fruiting: July - November
Collection Number- 39
Plant/plant parts used by birds-Fruits and seeds are eaten by Northern Pintail, Northern Shoveller, Common Teal, Gadwall, Red Crested Pochard, Common Pochard, Eurasian Wigeon, Ferruginous Pochard, Mallard, and Common Coot. Spot Billed Duck was seen eating seeds occasionally.

***Nymphaea pubescens* Willd**. (Family- Nymphaeaceae)
Common name- Kumudini, Koka
Habit- Floating hydrophytes
Morphological features- Herbs, aquatic, rhizomatous. Leaves oblong or rotundate, with violet tinge above, fades when dry, veins prominent, raised, hastate, base deeply sagittate up to one-fourth distance, margins sinuate-dentate, tooth sharply pointed, apex obtuse rounded, villous, glistening above, blackish pubescent beneath. Flower white or purplish.
Flowering & Fruiting: May - December
Collection Number- 37

Plant/plant parts used by birds-Tuber, anther and seeds eaten by majority of water birds.

Nelumbo nucifera Gaertn. Fruct. (Family-Nelumbonaceae)
Common name- Kamal
Habit- Floating hydrophytes
Morphological features- Herbs, aquatic. Leaves palmately nerved. Orbicular, flat when floating, somewhat cupped when emersed. peltate, glaucous above, petioles and peduncles sparsely prickly. Flower solitary, deep pinkish. Receptacle spongy, yellow colour during anthesis, turning green and then dark brown.
Flowering & Fruiting: April - January
Collection Number- 12
Plant/plant parts used by birds-Fruits and seeds eaten by birds. Seeds mostly eaten by Common Coot and Ferruginous Pochard.

Neptunia oleracea Lour. (Family- Mimosaceae)
Common name- Lajalu
Habit – Floating hydrophytes
Morphological features- Aquatic herbs, with stout, widely creeping or floating stems rooting at nodes; stems soft, swollen, not much branched, stipules obliquely ovate-cordate, acute. Leaves abruptly bipinnate. Flowers yellow, in long peduncled axillary heads, dimorphic, upper hermaphrodite, lower sterile; staminodes yellow, strap shaped, yellow. Pods oblong, beaked, 6-8 seeded.
Flowering & Fruiting: September - April
Collection Number- 85
Plant/plant parts used by birds- Fruits, nodes and roots eaten by Whistling Teal, Coot, Pintail and Gadwall.

Ludwigia adscendens L., Hara (Family- Onagraceae)
Common name- Gahdi
Habit – Floating hydrophytes
Morphological features- Aquatic or semi-aquatic herbs; stems creeping or floating, rooting at nodes, usually with pseudo-pneumatophores. Leaves elliptical-oblong, base narrowed, margins entire, apex rounded, glabrous, nerves prominent below. Flowers solitary, axillary, pentamerous, white with yellowish veing towards the base. Capsules woody, sparsely pubescent, thick walled, 10 ribbed. Seeds uniseriate in each cell, pale brown.
Flowering & Fruiting: January - June
Collection Number- 88
Plant/plant parts used by birds- Roots and stem eaten by Common Coot, Common Teal, Gadwall, Eurasian Wigeon, Northern Pintail and Northern Shoveller.

Trapa natans L. (Family-Trapaceae)
Common name- Singhara
Habit- Floating hydrophytes
Morphological features- Herbs, floating, stems long, flexous. Floating leaves crenate-toothed on upper margins, glossy dark green and molted brown above, submerged leaves finely dissected into root like inner segments. Flowers solitary, axillary, white or purple, pedicels in-curved during flowering, afterwards bending down beneath water. Drupes top shaped, 2-horned, 1-seeded, dark brown, ripening under water.
Flowering & Fruiting: August - December.
Collection Number- 43
Plant/plant parts used by birds- Fruit pulp eaten by Common Coot.

Nymphoides indica (L.) Kuntze (Family- Menyanthaceae)
Common name- Barachuli
Habit- Floating hydrophytes

Morphological features- Aquatic, floating herbs; with thick rhizome, leaves orbicular, peltate, deeply cordate at base, margins coarsely crenate, thick, petiolate, Flowers densely fascicled at nodes, calyx segments ovate lanceolate, corolla white with yellow bilobed, oval lanceolate, glandular, densely fimbriate, Capsule globose, dehiscing irregularly, Seeds globose, yellow smooth,
Flowering & Fruiting: June- September.
Collection Number- 45
Plant/plant parts used by birds- Flowers and fruits favored food of migratory birds. Flowers and seeds, sometimes leaves, are eaten by Common Teal, Gadwall, Northern Pintail and Northern Shoveller.

Ipomoea aquatica Forssk. (Family- Convolvulaceae)
Common name- Nari/ Kamali sag/ Karmua
Habit – Floating hydrophytes
Morphological features- Herbs, semi-aquatic, floating, with hollow stem. Leaves clliptic-oblong or hastate, base chordate-sagittate, entire, apex acuminate, Flowers in axillary, peduncled cymes, pink-purplish; corolla funnel-shaped, throat and tube deep pink, margins wavy, glabrous; filaments woolly at base. Capsule ovoid, glabrous, Seeds clothed with minute silky hairs.
Flowering & Fruiting: July-November
Collection Number- 92
Plant/plant parts used by birds- Root bud and seeds consumed by water birds. Stem, leaves and flowers are eaten by Common Coot, Eurasian Wigeon, Ferruginous Pochard and Northern Shoveller.

Polygonum limbatum Meisn. (Family- Polygonaceae)
Common name- Nandi bhaji/ Anjuar/Kolonchh
Habit – Emergent hydrophytes
Morphological features- Herbs stout, erect. Leaves lanceolate or linear-lanceolate, base cuneate, margins ciliate, apex acuminate, stipules strigose, with ciliate mouth. Flowers in erect, slender, weak racemes or panicles, bracts crowded, perianth white, glandular, styles 3- cleft. Nutlets trigonous.
Flowering & Fruiting: March-October
Collection Number- 97
Plant/plant parts used by birds- Seed and buds liked by resident as well as migratory birds. New shoots and leaves are eaten by Common Teal.

Ceratophyllum demersum L. (Family- Ceratophyllaceae)
Common name- Khaja chhoti
Habit- Submerged hydrophyte
Morphological features- Herbs, aquatic, forming a much-branched tangle of slender branches and leaves which collapse in a tassel when taken out of the water. Leaves dichotomously forked, spreading in water, variable in thickness and dentation. Male flowers solitary, in separate axils from female, but on same plant. Nutlets ellipsoid or ovoid, laterally compressed, blackish, minutely tuberculate.
Flowering & Fruiting: October-February
Collection Number- 46
Plant/plant parts used by birds- Seed and leaves favoured by migratory birds (Gadwall Mallard). Flowers and seeds are eaten by Common Coot, Common Teal, Gadwall and Northern Shoveller.

Hydrilla verticillata (L.f) Royle (Family- Hydrocharitaceae)
Common name- Sewar
Habit- Submerged hydrophyte
Morphological features- Herbs, submerged; stems flaccid, often rooting at nodes. Leaves sessile, whorled, 4-8 in a whorl, linear or linear-oblong, margins denticulate, apex acute. Spathes green, flowers

in axillary cymes, white, sepals ovate, green, petals reflexed, oblong. Female flower sessile. Fruit smooth or muricate, with 2 spine-like projections.
Flowering & Fruiting: April-November
Collection Number- 47
Plant/plant parts used by birds- Flowers and seeds eaten by ducks. Shoot, leaves and flower are eaten by Common Coot, Common Teal, Gadwall, Northern Pintail and Northern Shoveller.

Vallisneria spiralis L. (Family- Hydrocharitaceae)
Common name- Feeta ghass
Habit- Submerged hydrophyte
Morphological features- Herbs, submerged, anchored, rooting in mud. Leaves radical, narrowly linear, varying in length with the depth of water, translucent, entire, or serrulate at the tips. Male flowers many, minute, in shortly stalked, spathes when ready to open they become detached and rise to the surface of the water, the expanded perianth acts as a float. Female flowers solitary within a 3 toothed spathe, borne on a long spiral stalk, the uncoiling of which brings the flower to the surface to be fertilized by the floating males, after which the female scape coils up again into a close spiral dragging the young fertilized female flower. Fruit 5-7 cm long, distance of the muddy bottom of the water to ripen. Fruit 5-7 cm long.
Flowering & Fruiting: December - February
Collection Number- 49
Plant/plant parts used by birds- Leaves and seeds eaten by Common Coot, Common Teal, Gadwall, Lesser whistling Duck, Northern Shoveller, Northern Pintail and Red Crested Pochard.

Eichornia crassipes (Mart.) Solms (Family- Pontederiaceae)
Common name- Jalkumbhi
Habit – Floating hydrophytes
Morphological features- Herbs, aquatic, floating on surface, or grows in swamps. Leaves rosette forming, fleshy, base rounded subcordate, margins faintly crenate, apex obtuse, petioles swollen, spongy. Flowers in dense spikes, perianth slightly curved, limbs 2 lipped, light mauve blue, lobes 6, posterior with a yellow median blotch. Capsule ovoid-oblong. Seeds many.
Flowering & Fruiting- March - December
Collection Number- 13
Plant/plant parts used by birds-Soft tissue of swollen petiole consumed by Lesser Whistling-Duck.

Commelina hasskarlli C.B. Clarke (Family- Commelinaceae)
Common name- Oona
Habit – Emergent hydrophytes
Morphological features- Herbs much branched, diffuse. Leaves narrowly lanceolate, base sheathing, sheath ciliated, margin entire, apex subacute. Spathes solitary, axillary, ovate cordate at the base, with rounded lobes, glabrous scabrid or hispid. Flowers is unequal, pubescent cymes, upper most branch 2-4-flowered; lower 1-2- flowered. Capsules quadrate, apiculate, membranous. Seeds cylindrical truncate at one end, subacute or rounded on other, appendage absent.
Flowering & Fruiting- November - January
Collection Number- 90
Plant/plant parts used by birds- Roots and fruits eaten by Eurasian Wigeon, Common Coot and Greylag Goose.

Typha angustifolia L. (Family-Typhaceaeae)
Common name- Patera
Habit – Emergent hydrophytes
Morphological features- Herbs, amphibious. Leaves semicylindrical, exceeding the flowering stem, base sheathing, margins entire, apex acuminate, glabrous. Flowers in cylindrical spikes separated by

short intervals, reddish brown, male and female spike separate. Fruits fusiform, or spathulate, brown, ellipsoid, minute.
Flowering & Fruiting- Throughout the year
Collection Number- 14
Plant/plant parts used by birds- New soft shoot eaten by water birds.

Pistia stratiotes L. (Family- Arecaceae)
Common name- Pistia / Jal-khumbi
Habit – Floating hydrophytes
Morphological features- Herbs, stemless, stoloniferous, floating, with a peculiar muriatic odour; Roots Tufted, simple white fibres clothed with fibrillae. Leaves obovate-cuneate, rounded at the apex, pubescent, flabellately arranged, converging within the margin. Spathes obliquely campanulate, white, gibbous and closed below contracted about the middle, dilated and nearly orbicular above.
Flowering & Fruiting- July - November
Collection Number- 51
Plant/plant parts used by birds- Young leaves eaten by Common Coots.

Lemna perpusilla Torr. (Family- Lemnaceae)
Common name- Hari Kai
Habit - Floating hydrophytes
Morphological features- Herbs, free floating, minute, forming gregarious patches on water surface, root solitary, from lower surface of leaf, root sheath with two lateral wings. Leaves 1-5, ovate-elliptic, asymmetrical, base broad, margins entire, apex rounded. Flowers unisexual, in marginal cleft of fronds, initially spathaceous, perianth absent. Utricles bottle-shaped.
Flowering & Fruiting- May - November
Collection Number- 52
Plant/plant parts used by birds- Leaves eaten by Northern Shoveller and Mallard.

Spirodela polyrhiza L. Schleid. (Family-Lemnaceae)
Common name- Hari Kai
Habit – Floating hydrophytes
Morphological features- Herbs, free floating, minute, gregariously spreading, with numerous roots, Roots long, usually 10-11 from one leaf and small roots in another leaf. Leaves ovate or orbicular, base broad, margins entire, apex rounded or apiculate. Spathe bilipped, with 2 male and 1 female flower. Stamens 2. Utricles winged.
Flowering & Fruiting- August - December
Collection Number- 53
Plant/plant parts used by birds- Entire plant eaten by water birds. Northern Shoveller, Eurasian Wigeon and Ferruginous Pochard were seen eating the leaves of this plant.

Wolffia globose (Roxb.) Hartog and Plas (Family- Lemnaceae)
Common name- Jaljanjal
Habit – Floating hydrophytes
Morphological features- Herbs, free floating, minute, the smallest flowering plant. Fronds subglobose or oblong, convex above, pale, inflated, globose beneath, flat near the base. Floral pocket often with a distinct collar of elongated cells. Inflorescence dorsal, of 1 staminate and pistillate flower; anthecous. Ovary with solitary ovule.
Flowering & Fruiting- October - February
Collection Number- 54
Plant/plant parts used by birds- Whole plant is eaten by Common Pochard, Northern Shoveller, Mallard and Red Crested Pochard.

Najas graminea Delile (Family- Najadaceae)
Common name- Katia
Habit - Submerged hydrophytes
Morphological features- Herbs, submerged, grassy, rooting from basal nodes. Leaves pseudo-whorled, linear subulate, obtuse, with many minute, oblique spinules on each side, basal auricles erect, lanceolate, denticulate. Flowers greenish, solitary, naked, monoecious. Fruits ellipsoid-oblong, acute. Seeds areolate, ellipsoid-ovoid.
Flowering & Fruiting- September - December
Collection Number- 60
Plant/plant parts used by birds- Stem, leaves, fruits and seeds eaten by all water ducks. Leaves and seeds are eaten by Common Coot, Common Teal and Northern Pintail.

Potamogeton crispus L. (Family- Potamogetonaceae)
Common name- Curly leaf pondweed
Habit – Submerged hydrophytes
Morphological features- Herbs, floating or submerged. Leaves all submerged, translucent, sessile, semi-amplexicaule, margins finely serrulate, crisped, stipules small, caducous. Peduncle long, often curved, tapering upwards. Flower is aerial few-flowered, lax spikes, perianth lobes suborbicular. Drupelets obliquely ovoid, terminated by a slightly recurved compressed beak.
Flowering & Fruiting- January - April
Collection Number- 62
Plant/plant parts used by birds- Root, stem and fruits eaten by water birds. Common Coot and Northern Shoveller eating the seeds of this plant.

Cyperus alopecuroides Rottb. (Family-Cyperaceae)
Common name- Motha
Habit – Emergent hydrophytes
Morphological features- Herbs, robust, glabrous, stems trigonous above, Leaves strap-shaped, with prominent and many secondary parallel nerves, courteous, Umbels large, compound, terminal, with 46 primary rays, slender; secondary rays bearing clusters of oblongs, sessile and pedunculated spikes densely covered with small spikelet; rachis stout not winged, spikelet elliptic, or ovate-oblong, compressed, straws coloured; glumes, not keeled, ovate-oblong, concave. Nuts obovate, compressed,
Flowering & Fruiting: April-December
Collection Number- 89
Plant/plant parts used by birds- new leaves and fruits are eaten by Common Coot, Greylag Goose, Northern Pintail and Gadwall.

Eleocharis dulcis (Burm.f.) Hensch. (Family- Cyperaceae)
Common name- Pola/Poli/Narai
Habit - Emergent hydrophytes
Morphological features- Sedge, caespitose, stoloniferous; stems septate, glaucous. Leave sheaths reddish-brown, membranous. Spikes straw-coloured, rachilla angled, spikelets terete. Glumes stramineous, ovate-oblong, with red dots, coriaceous. Perianth bristles 6-9, yellowish, subequal. Nuts brown, glossy, biconvex, truncate at top.
Flowering & Fruiting- September - October
Collection Number- 91
Plant/plant parts used by birds- Tubers and nodes eaten by Purple Moorhen, Wigeon and other Water birds.

Scirpus articulates L. (Family- Cyperaceae)
Common name- Chichora
Habit - Emergent hydrophytes

Morphological features- Herbs, densely tufted, stems spongy, transversely septate within. Leaves absent, or the sheaths with membranous acute tip. Inflorescence capitate, pseudolateral; spikelets terete or obscurely angular, rusty-brown, sessile in lateral, stellately spreading, clusters of 15-60. Glumes broadly ovate, membranous, concave, persistent, scarcely keeled. Nuts obovoid, sharply triquetrous, black, opaque, shortly pointed, striate with transverse wavy lines.
Flowering & Fruiting- October - December
Collection Number- 93
Plant/plant parts used by birds- Seeds eaten by Water birds.

Chloris dolichostachya Sw. (Family- Poaceae)
Common name- Long-spike finger grass
Habit - Emergent hydrophytes
Morphological features- Herbs, nodes glabrous. Leaves flat, glabrous near sheath, sheaths compressed, hairy at mouth, ligules hairy. Inflorescence of 4-10, digitate spikes; rachis scabrid. Spiklets 2-seriate, subsessile. Florets awned, lower floret perfect, upper imperfect. Lodicules 2, small. Caryopsis brown, subtrigonous.
Flowering & Fruiting- September - December
Collection Number- 98
Plant/plant parts used by birds- Seeds eaten by Common Teal, Northern Pintail, Gadwall and Eurasian Wigeon.

Echinochloa stagnina (Retz.) P. Beauv. (Family- Poaceae)
Common name- Shama
Habit - Emergent hydrophytes
Morphological features- Herbs, spongy, leaves rigid, glabrous margins scabrid, sheaths glabrous, ciliated at mouth, ligule hairy. Florets in appressed racemes, spikelets paired, elliptic. Glumes elliptic, acute-cuspidate, membranous, pubescent, 5-nerved. Lemma's male or barren, similar to upper glume, dorsally depressed, cuspidate or awned, polished. Caryopsis yellowish-white, broadly ellipsoid.
Flowering & Fruiting: - September - December
Collection Number- 95
Plant/plant parts used by birds- Seeds eaten by Common Teal.

Oryza rufipogon Griff. (Family- Poaceae)
Common name- Jangli dhan
Habit - Emergent hydrophytes
Morphological features- Herbs, lower parts spongy. Leaves linear, base tapering, sheaths terete, loose, glabrous, auricled, ligules splitting at tips. Floret is exserted, compound panicles. Spikelets, falling with age. Lemmas nerved, strongly folded. Caryopsis elongate ovoid.
Flowering & Fruiting- September - November
Collection Number- 86
Plant/plant parts used by birds- Seeds eaten by Red Crested Pochard, Pintail, Shoveller and Common Teal.

DISCUSSION

The wetland possessed the 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. 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 a direct influence on the avian community structure and these plants were preferred by birds, both migratory and resident. The food chain in wetland regions originates from aquatic plants as primary producers and is at all trophic levels. The soft vegetative tissues of aquatic plants provide sufficient dietary supplements to primary consumers, while their leaves, flowers, fruits and

seeds are recurrent food resources for birds in different seasons (Tucker & Sellers 1986). The secondary consumers, mainly birds, small insects and herbivores, regularly feed on plants while the tertiary consumers, mainly carnivores and omnivores, feed on herbivores, insects as well as some birds. Herbaceous plants therefore, served as the most useful components in maintaining the energy pathway in this ecosystem as they trap solar energy and convert it into chemical, at the base of the food chain. The plants and plant parts of each resource species, preferred as food by the faunal community, mainly birds. It was also evidenced that the site of occurrence of these food resources coincided with the congregation of birds in the same area of the wetland, within the precincts of the sanctuary expanse. These species included, the Common Coot (*Fulica atra*), Common Pochard (*Aythyaferina*), Common Teal (*Anas crecca*), Eurasian Wigeon (*Anas penelope*), Ferruginous Pochard (*Aythya nyroca*), Gadwall (*Anas strepera*), Gargany (*Anas querquedula*), Greylag Goose (*Anser anser*), Lesser Whistling Duck (*Dendrocygna javanica*), Mallard (*Anas platyrhynchos*), Northern Pintail (*Anas acuta*), Northern Shoveller (*Anas clypeata*) and Red Crested Pochard (*Rhodonessa rufina*) (Islam & Rahmani, 2008). The majority of these birds were observed pecking on small insects and other invertebrates, both in core wetland zones as well as in adjacent agricultural fields.

Uninterrupted food resource availability acts as a key to the successful operation of the wetland food chain and energy flow from producers to consumers. A number of similar food chains operate simultaneously in an integrated way and even in the construction of the food web, with aquatic plants and phytoplanktons at the base. With a definite role of each plant, animal and bird, a dynamic equilibrium is sustained in the entire wetland ecosystem through this biological cycle which becomes a repository of all respective constituents interlinked and interdependent on each other. This integrated floral-faunal mutualism is key to survival of interdependent plants, insects and other invertebrates, fishes, amphibians, reptiles, birds and mammals (Mitsch & Gosselink 1986) . In light of these facts, any wetland management strategies adopted should essentially be oriented in such a manner so as to conserve the wetlands in terms of their floral and faunal riches without obliterating the habitat of flora and fauna mainly the nutritional plant resources of fauna so that their interdependence is not plugged at any tropic level and an uninterrupted food chain is sustained in nature without hampering energy flow from producers to consumers.

SCSABS is a convergence centre for many migratory birds. The original vegetation is supported by a water reservoir and a thick canopy of trees with aggregation of many aquatic plants, invasive species, herbs, shrubs and grasses which provide a potential nesting and breeding ground for the migratory birds. The water reservoir supports a wide variety of flora and fauna. The molluscs, frogs, large insects, small fishes and snails harbour in the swampy and marshy area around the pond. In the whole sanctuary, 10 species under 10 genera belonging to 8 families are used by the migratory birds for nesting and laying eggs. 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. 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. The highest number of birds was recorded during the month of January-February and the lowest in June and July. Cattle Egret, Asian Open Bill, Little Cormorant, Pond Heron, Little Egret, Purple Moorhen, Common Coot, Lesser Whistling- Duck, White Breasted Water Hen, Bronzed Wing, Pheasant Tailed Jacana, Red Wattled Lapwing and Common Teal were the most abundant species in this sanctuary (Amita Kanaujia, et al., 2014).

Thus, the SCSABS represents a small wetland ecosystem within the ecosystem, which is a rich centre of migratory birds' ingression during winter season. During post-summer season from July onwards, a large number of migratory birds are seen arriving in the sanctuary. Their number reaches its 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. A close relationship between aquatic food plants and their consumer birds has been explained by Jha (2010) and a floristic study of this sanctuary has been done by Arti Garg (2019).

CONCLUSION

Wetlands in India are one of the most diverse and important ecosystems due to their geographical and climatic conditions. SCSABS is a biodiversity hub that supports a variety of flora and fauna. SCSABS is important as a feeding ground for migratory and residential vegetation birds and as a breeding ground for numbers of birds. It creates spaces for healthy population of birds. The ecological value of SCSABS is directly related to its faunal and floral biodiversity, changes in the distribution of species, species richness, abundance and source of the future, which would further contribute to its conservation.

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REFERENCES

Agnihotri, P., Hussain, T. and Maliya, D. (2008). Aquatic flora of some notified bird sanctuaries of Uttar Pradesh. The Indian Forester, 134:1398-1401.

Ali, S. and Ripley, S.D. (1987). Compact handbook of birds of India and Pakistan together with those of Bangladesh, Nepal, Bhutan, and Srilanka. Oxford University Press, Delhi.

Custer, T.W. and Osborne, R.G. (1977). Wading birds as biological indicators, Long Survey, US Fish and Wildlife service, Washington, DC.

Duthie J. F. (1929). Flora of Upper-Gangetic Plain and the adjacent Siwalik and Sub-Himalayan Tracts Calcutta, 1903-1929, vol-3.

Garg A. (2019). Flora of Saheed Chandra Shekhar Azad Bird Sanctuary, Uttar Pradesh (formerly known as Nawabgunj Bird Sanctuary), Botanical Survey of India Ministry Of Environment, Forest And Climate Change.

Grimmett, R. and Inskip, T. Om (2010). Field Guide: Birds of Northern India. Om Books International. Noida, India.

Hooker J. D. The Flora of British India, vol-7, Reeve & Co., London, 1872-1897.

Islam, M. Z. and Rahmani, A. R. (2008). Potential and existing Ramawar Sites in India. Mumbai: Bombay Natural History Society.

Jain S. K. & Rao R. R. (1977). A Handbook of Field and Herbarium Methods. Today & Tomorrow's Printers and Publishers, New Delhi, 1977-78.

Jha, K. K. (2010). Food plants, weeds and other management aspects of some protected biodiversity rich wetlands in Uttar Pradesh. Biodiversity, Development and Poverty Alleviation, pp. 79-85.

Kanaujia, A., Kumar, A., Kumar, A., Kushwaha,S. and Kumar, A. (20140. Blooming faunal diversity of Nawabganj Bird Sanctuary, Unnao, Uttar Pradesh, India, Journal of Environmental Science and Technology, 2(2):14-24.

Mishra, S. and Narain, S. (2010). Floristic and ecological studies of Bakhira wetland, Uttar Pradesh, India. The Indian Forester, 136:375-381.

Mitsch W. J. & Gosselink J. G. (1986). Wetlands, Van Nostrand Reinhold, New York.

Mukherjee, A., Borad, C. K. and Parasharya, B. M. (2002). A study of the ecological requirements of water fowl at manmade reservoirs in Kheda district, Gujrat, India with a view towards conservation, management and planning. Zoo Print Journal, 17:775-785.

Rahmani, A. R., Kumar, S., Deori, P., Khan, J. A., Kalra, M., Belal, M. S., Khan, A.M., Khan, N.I., George, A., Srivastava, N., Singh, V.P., Rehman, F. and Muralee Dharan, S. (2010). Migratory movements of water birds thorugh Uttar Pradesh and the surveilance of avian diseases. Mumbai: Bombay Natural History Society.

Saini, D.C., Singh, S.K. and Rai, K. (2010). Biodiversity of aquatic and semi-aquatic plants of Uttar Pradesh (with special reference to eastern Uttar Pradesh) Lucknow; Uttar Pradesh State Biodiversity Board, pp 479.

Tucker C.J. & Seuers P.J. (1986). Satellite remote sensing of primary productivity. Int. J. Remote Sensing, 7: 1395-1416.

Urfi, A. J. (2003). The birds of Okhla barrage bird sanctuary, Delhi, India. Forktail, 19:39-50.

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