Challenges in Sustainable Management of Wetland Based Sanctuaries of Uttar Pradesh with Reference to Avian diversity

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Introduction

An attempt has been made to study the avian biodiversity of bird sanctuaries in Uttar Pradesh. The presentation is based on research work done by the author as Chief Conservator of Forests, Eco-development, UP. The data collection was done with the help of sanctuary staff. Self observation was undertaken during field visits between 2009 through 2012 in bird dominant sanctuaries. Spatial data presented in this text refers to data collected during 2010-2011, while the temporal data on selected wetlands cover the years 2005-2012. Some information in the text has been incorporated from secondary sources as a result of literature review. All these indicated that the conditions in and around the sanctuaries need immediate care and serious efforts to manage them sustainably so that an optimum population of avian fauna can be maintained on these wetland based sanctuaries.

Wetland based Sanctuaries

Uttar Pradesh, a state located in north India, contains 8% of the total wetland area of the country and has a large network of man-made and natural wetlands covering 121,242 ha (SAC, 2011). There are several wetlands in UP that support resident as well as migratory birds in large numbers. Twenty five of these wetlands are identified as Important Bird Areas (IBAs, Islam and Rahmani 2004, Rahmani *et al* 2011) and 20 of them have been recognized as Potential Ramsar Sites (PRSs, Islam and Rahmani 2008). In a sincere effort to conserve the wildlife of UP the state government declared some of these areas of adequate ecological, faunal, floral, geomorphological, natural and zoological significance as Sanctuaries under the provisions of Wildlife (Protection) Act 1972. The purpose was to protect, propagate and develop the wildlife and its environment. Twelve such wetland areas, with dominant resident and migratory bird populations, were declared as Bird Sanctuaries whose important features are given in following paragraphs. The year of declaration of bird sanctuaries, along with geographical location, is recorded in Table 1. These sanctuaries (Figure 1) fall in three major ecozones of UP: the Tarai region, the Gangetic Plains and the Bundelkhand region, including Vindhyan ranges (Rahmani *et al.*, 2011). The extreme western part of the Gangetic Plain is somewhat different from rest of the region as it is comprised of several semi-arid districts forming the Semi-arid Plain region. Therefore, UP wetlands are considered to belong to four major landscapes or ecozones (Jha and McKinley 2015). Physical features of the sanctuaries, mainly water spread, agriculture/private land, forest blocks, streams and roads, are presented in Figures 2, 3 and 4. These figures are redrawn from the data in forest department UP. Inter-sanctuary drawings are not to the scale. Demarcation of features within the sanctuary is tentative.

Bakhira Bird Sanctuary

Bakhira Sanctuary is the largest natural flood plain wetland in UP and is situated 44 km east of Gorakhpur in Sant Kabir Nagar district. It is a single water body stretching over a vast area of 29 km^2 of which 18.1 sq km is community land and 10.6 sq km is agricultural land. This lake provides a wintering and staging ground for a number of

Fig. 1: Relative position of different Bird Sanctuaries shown Eco-zone wise

migratory waterfowls and a breeding ground for resident birds (Tripathy 2004).Common Coot, Common Moorhen and Purple Swamphen are very common birds in this Sanctuary. Over 6,000 boats operate in the lake for collecting grasses and fishing (Singh *et al* 2011). This could be the reason we seldom see migratory birds in conspicuous number here.

Lakh Bahoshi Bird Sanctuary

Lakh Bahoshi Sanctuary is situated in the Kannauj district of UP and is made up of two water bodies separated by a wide strip of private land. The management of this protected area is difficult since a major portion of it belongs to private landowners. Illegal fishing, hunting and bird trapping are reported occasionally (Singh *et al* 2011). While Lakh is nearly free of weeds, Bahoshi is heavily infested with Ipomoea carnea. The total area of the sanctuary is 80.24 sq km which includes wetland, cultivated land, refractory land and private fields. This sanctuary has very high potential for both migratory and resident birds (Rahmani *et al* 2010). Northern Pintail, Northern Shovler, Graylag Goose, Common Teal and Common Coot are easily seen in large numbers during peak winter.

Nawabganj Bird Sanctuary

Nawabganj Sanctuary is situated on the national highway passing through Lucknow and Kanpur cities. Before being declared a sanctuary this wetland was a paradise for hunters and trappers. The initial days of the sanctuary saw significant impact of management interventions, but excessive efforts undertaken in the later years proved counterproductive. The creation of several islands, introduction of exotic trees, regulation of livestock grazing etc. turned into a bane for the water body (Rahmani *et al* 2011). The lake is fed by monsoon run-off and sometimes during periods of scarcity it is supplemented by the canal. This sanctuary has a heronry of aquatic birds. Asian Open bill could be seen breeding in large numbers on Babool (*Acacia nilotica*) trees. Gargany, Northern Pintail, Lesser Whistling Duck and Asian Openbill form the major winter population.

Samaspur Bird Sanctuary

Samaspur Sanctuary is located in the Raebareily district of UP. There are five connected lakes namely Samaspur, Mamani, Gorwa Hasanpur, Hakganj and Rohnia. The sixth lake, Bissaiya which also forms part of the sanctuary, is close by but not connected to the main water body (Korgaonkar and Gokhale 2006). The sanctuary is spread over an 8 sq km area out of which 3.7 sq km is private and community land. Much like Nawabganj, excessive management interventions have disturbed the natural characteristics of the lake (Rahmani *et al* 2010). Gadwall, Common Coot, Purple Swamphen and Little Cormorant are seen in large numbers.

Sandi Bird Sanctuary

Sandi Sanctuary is located in Hardoi district and is spread over 3.08 sq km. This sanctuary retains all essential characteristics of an ideal water bird habitat such as proper depth for waders, dabblers and divers, diverse vegetation, surrounding agriculture fields etc. The availability of food and an undisturbed ambience attracts birds evenly (Rahmani *et al* 2010). Common Teal, Common Coot, Gargany, Northern Pintail and Little Egret could be seen here in good numbers without any difficulty.

Table: 1. Important features of Wetland based sanctuaries in UP. Abundance and richness shown below were recorded in 2010-11 winter.

Wetlands	Location	Abundance all species	Richness all species	Other reported Richness/abundance	Sanctuary declaration year
Bakhira	26 34 60 N 83 00 00 E	33153	44	40000-80000 birds	05/05/1990
Parvati-Arga	27 25 00 N 82 19 00 E	56683	35	>20000 waterfowls	23/05/1990
Surhatal	25 50 00 N 8410 00 E	-	-	91 species (Srivastava and Srivastava 2012)	27/03/1991
Lakh-Bahoshi	27 30 00 N 79 30 00 E	93226	97	>240 species, >50000 birds; 62 species and 33777 waterbirds (Rahmani *et al* 2010)	21/03/1988
Nawabganj	26 34 60 N 80 40 00 E	19858	61	>200 species	07/08/1984
Samaspur	26 00 00 N 81 25 00 E	42008	109	80000 birds; one lakh waterfowls (Korgaonkar and Gokhle 2006)	10/08/1987
Sandi	27 15 00 N 79 55 00 E	119050	105	--	05/05/1990
Patna	27 34 60 N 78 45 00 E	17515	40	180 species, 60000-70000 waterfowls, 40000 water birds (Rahmani *et a*l 2010)	22/12/1990
Saman	27 04 60 N 79 00 00 E	1413	47	>40000 birds; 63 species and 69303 waterbirds (Rahmani et al 2010)	23/05/1990
Sur Sarovar	27 00 00 N 77 45 00 E	23675	68	>30000 waterbirds	27/03/1991
Okhla	28 33 00 N 77 17 60 E	27255	51	>20000 birds; 52 species (Manral and Khudsar 2013); 14000-20000 birds (Urfi 2003)	08/05/1990
Vijay Sagar	25 15 78 N 79 68 20 E	8607	42	-	26/06/1990

**Islam and Rahmani, 2004

Parvati Arga Bird Sanctuary

Parvati and Arga are two connected water-bodies in Parvati Arga Sanctuary comprising of a 10.8 sq km area. They are the rain fed lakes of natural depression (Rahmani *et al* 2011). While Parvati is a deep water body Arga is a shallow one and the birds are seen distributed between them accordingly with divers in the former and waders

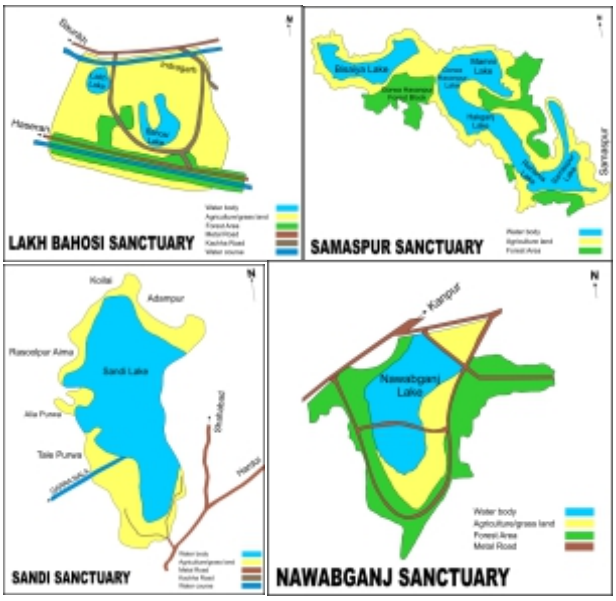

Figure 2 showing different features of 4 sanctuaries from Gangetic plains.

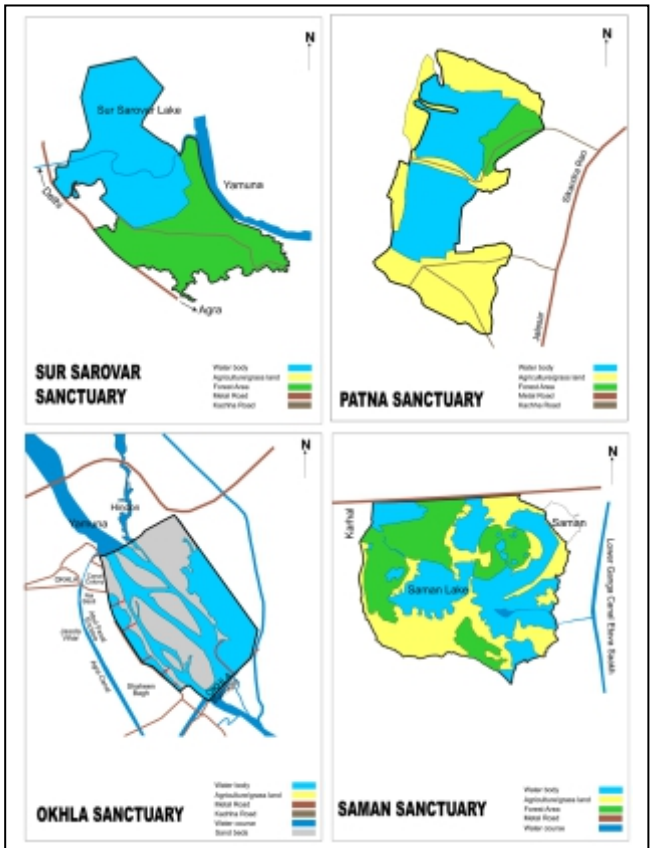

Figure 3 showing Sur Sarovar which is from Semi-arid zone. Patna and Saman belong to Gangetic plain. Okhla is also from Gangetic plain but has agro-climatic similarity with semi-arid zone.

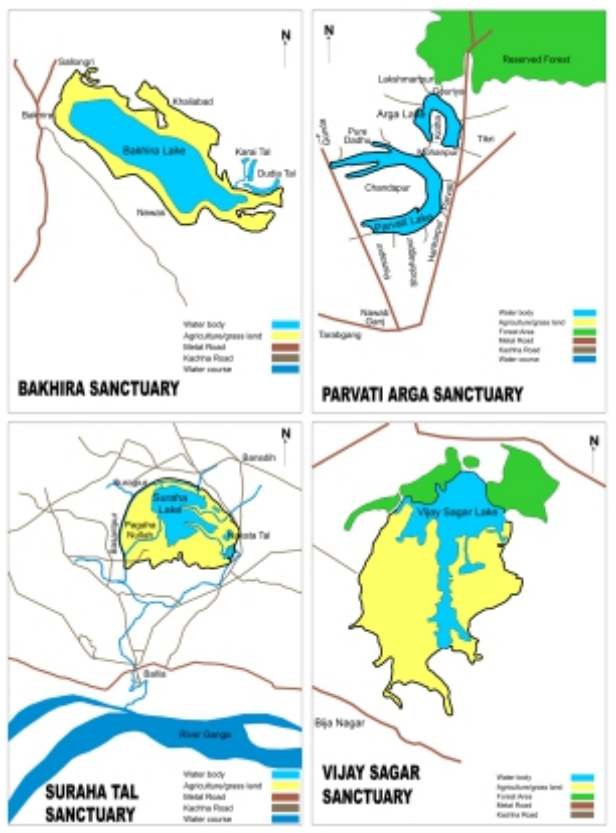

Figure 4 showing first two sanctuaries (Bakhira and Parvati Arga) from Tarai region and others (Surhatal from Gangetic plain and Vijay Sagar from Bundelkhand Vindhyan region).

in the latter. Red-crested Pochard, Common Coot, Common Moorhen, Northern Pintail and Graylag Goose are very common.

Okhla Bird Sanctuary

Okhla Sanctuary is a flood plain wetland situated within the National Capital Region of Delhi, India and is part of protected area network of the state of UP. The construction of the Okhla Barrage across the river Yamuna has resulted in a small portion of the river to become a static water system. This wetland provides a heterogeneous habitat for several migratory waterfowls, of which some species use the wetland as a stopover during their migration (Manral *et al* 2013). This is an extremely polluted water body with enormous anthropogenic pressure. Nevertheless, Bar-headed Goose, Brown-headed Gull, Northern Shovler,

Photos : Clock wise from top left: A. View of Bakhira Sanctuary showing Phragmites vegetation in the background being removed by a villager in boat. B. View of Patna Sanctuary showing tress in the foreground while agriculture field in the background where farming activities generate lot of disturbances to the birds. C. View of Samaspur Sanctuary where water level is generally very high, back ground vegetation is Typha and Eicchornia weeds playing negative role in bird conservation. D. View Nawabganj Sanctuary where open water-body is scarce depriving divers and dabblers the swimming and diving space.

Greylag Goose, Common Coot spend their winter in large number in this sanctuary.

Saman Bird Sanctuary

Saman Sanctuary is located near Saman village in the Mainpuri district and is spread over 5.25 sq km. This site is very important for large wintering water bird congregations. The wetland has a high quality habitat with sufficient shelter and foraging area for waterfowls. This sanctuary faces numerous biotic pressures which can be minimized by the involvement of the local people (Rahmani *et al* 2010).Lately the population of birds here has decreased but some important birds like Black-necked Stork, Painted Stork, Greater Cormorant, Little Greb and Common Coot could be seen in small number.

Vijay Sagar Bird Sanctuary

Vijay Sagar Sanctuary is situated in the Hamirpur (now Mahoba) district and is spread over an area of 2.62 sq km where more than 60% land is held by the community or private parties. The source of water recharge is seasonal rain which is not enough to make this lake a perennial water body. The creation of a static water body by the

Photo : wading birds clockwise from top left: A. Green Sandpiper, B. Wood Sandpiper, C. Black-tailed Godwit and D. Common Sandpiper.

construction of a dam for water harvesting led to this area becoming a refuge for wetland birds. This is a dry area sanctuary and does not attract water birds in large number but Cotton Pygmy Goose, Common Coot, Northern Pintail, and Red-crested Pochard could be seen here during winter.

Patna Bird Sanctuary

Patna Sanctuary is located in the Etah district and has an area of 1.09 sq km. It is mainly fed by rain water but the water regime is managed temporarily by the forest department by pumping additional water into it so that the wetland does not dry up before May. This sanctuary has unique vegetation in the area in the form of thickets of date palm surrounded by agriculture fields (Rahmani *et al* 2010). Although it's a small sanctuary the bird density is very high. Northern Pintail, Northern Shovler, Common Teal, Gargany and Gadwall could be seen in large number.

Sur Sarovar Bird Sanctuary

Sur Sarovar Sanctuary is in the Agra district and is spread over 7.83 sq km. The water level is regulated in this lake to supply water to the Mathura oil refinery. The surrounding area has thickets of an exotic, *Prosopis juliflora* which supports one of the best heronries in the UP wetlands (Jha 2012). Better management practices such as providing more habitats could support

more migratory birds at this site as it has a huge carrying capacity (Rahmani et al 2010).This lake is famous for heronries of 14 resident bird species (Jha 2012), and other water birds like Flamingo, Pelican, Spoonbill, Cormorants and threatened Darter.

Surhatal Bird Sanctuary

Surahatal Sanctuary is the largest floodplain lake in the Ballia District of eastern Uttar Pradesh. It is an open type 'U' shaped ox-bow lake in the floodplain of the river Ganga, with an area of 26 sq km (Srivastava and Srivastava 2012). This lake has an enormous amount of anthropogenic pressure. Several species of birds can be seen here but their number has dwindled in past few years.

Avian Population

Table 1 contains historical data as well as spatial observation on the richness and abundance of birds during 2010-11. On the spatial level, 0.0486 million birds were recorded across twelve wetland based sanctuaries of UP (Samaspur, Sandi, Lakhbahosi, Sursarovar, Nawabganj, Okhla, Saman, Bakhira, Vijay Sagar, Patna, Parvatiarga and Surhatal) during the winter months of 2010-11. This abundance included 161 species of aquatic, semi-aquatic and non-aquatic birds or resident, migrant and vagrant birds. The most common migratory birds in the wetlands were Northern Pintail, Northern Shovler, Common Teal, Common Coot, Red-crested Pochard and Greylag Goose. Common resident birds included Asian Openbill, Darter, Little Egret, Common Coot, Little Cormorant, Grey Heron, Purple Heron, Indian Pond Heron, Common Moorhen, Purple Swamphen, Cattle Egret, Indian Sarus Crane and White-throated Kingfisher (Jha and McKinley 2015). On observation of four of these wetlands (Samaspur, Sandi, Lakhbahosi and Nawabganj) on a temporal basis (2005-2012 winter seasons) the richness of the birds increased to 175 species (unpublished data). It is difficult to speculate about the increase in the richness of the birds but one can guess based on the author's observation on some IBAs, PRSs and literature survey (Rahmani 2011) that additional wetlands would support at least half of the spatially recorded birds in the sanctuaries. Category wise details of the birds on a temporal-spatial scale studied on bird sanctuaries of UP are presented in Table 2.

Management Challenges

The sustainable management of wetlands with regard to bird conservation would result in it carrying an optimum number of avian fauna. This ideal condition could exist in the wetland when almost all management challenges or adverse conditions are brought down close to zero. Keeping the anthropogenic pressure and sociopolitical conditions in the area in view, the environment within and around the UP wetlands is very complex, and bringing the situation under absolute control is very difficult. However, we need to think of avian-centric development in the sanctuary and exercise stringent measures to reduce the constraints prevalent in these wetlands, some of which may vary from year to year, depending on the control measures taken by the forest department. These are mentioned in the following paragraphs.

i. **Livestock Grazing** : All the bird sanctuaries of UP exist in rural areas. For example, the Bakhira Sanctuary is surrounded by at least 24 villages and this exerts heavy pressure on the wetland especially through livestock grazing (Rahmani *et al* 2010). Surhatal has the maximum pressure since private land from 44 villages is involved here. Similarly Parvati Arga has a village boundary with 12 revenue villages surrounding it. In spite of the regulation mechanism established in place by the management authority, the cattle do enter the sanctuary area for grazing resulting in temporary modification of habitat and disturbance to birds.

ii. **Poaching incidences** : The number of migratory birds in Surhatal Bird Sanctuary has decreased over the years with an increase in

Table 2: Spatial and Temporal richness of avian fauna in the wetland based sanctuaries of UP

SN	Aquatic Migrant	Semi-aquatic Migrant	Non-aquatic Migrant	Aquatic Resident	Semi-aquatic Resident	Non- aquatic Resident	Non-aquatic Resident
1	*Anas acuta*	*Botaurus stellaris*	*Aquila clanga*	*Amaurornis akool**	*Actitis hypoleucos*	*Accipiter badius*	*Milvus migrans*
2	*Anas clypeata*	*Ciconia ciconia*	*Clamator jacobinus*	*Amaurornis phoenicurus spatensis*	*Alcedo atthis*	*Accipiter nisus**	*Motacilla madera-*
3	*Anas crecca*	*Circus aeruginosus*	*Loriculus vernalis*	*Anas poecilorhyncha*	*Amandava amandava*	*Acridotheres fuscus*	*Nectarinia asiatica**
4	*Anas penelope*	*Grus grus**	*Motacilla cinerea*	*Anastomus oscitans*	*Bubulcus ibis*	*Acridotheres ginginianus*	*Neophron percnopterus*
5	*Anas platyrhynchos*	*Hirundo rustica*	*Streptopelia orientalis*	*Anhinga melanogaster*	*Butorides striatus*	*Acridotheres tristis*	*Ocyceros birostris*
6	*Anas querquedula*	*Motacilla alba*	*Vanellus gregarius*	*Ardea cinerea*	*Ceryle rudis*	*Anthracoceros coronatus**	*Oriolus chinensis**
7	*Anas strepera*	*Motacilla flava*		*Ardea purpurea*	*Charadrius dubius*	*Apus afinis*	*Oriolus oriolus*
8	*Anser anser*			*Ardeola grayii*	*Dupetor flavicollis*	*Aquila rapax**	*Oriolus xanthornus*
9	Anser indicus			Casmerodius albus	Esacus recurvirostris	Athene brama	Otus bakkamoena
10	*Aythyaferina*			*Ciconia episcopus*	*Grus a antigone*	*Centropus sinensis*	*Passer domesticus*
11	Aythyafuligula			Dendrocygna javanica	Halcyon smyrnensis	Circaetus gallicus*	Pavo cristatus
12	*Aythya nyroca*			*Egretta garzetta*	*Hirundo smithii**	*Columba livia*	*Perdicula asiatica*
13	*Gallinago gallinago*			*Ephippiorhyn-chus asiaticus*	*Ixobrychusc innamomeus*	*Copsychus saularis*	*Perdicula erythro-rhyncha**
14	*Himantopus himantopus*			*Fulica atra*	*Ploeceus benghalensis*	*Coracias benghalensis*	*Ploeceus philippinus*
15	*Larus brunicephalus*			*Gallicrex cinerea**	*Pseudibis papillosa*	*Corvus macrorhynchos*	*Psittacula cyanocephala*
16	*Larus cachinnans**			*Gallinula chloropus*	*Vanellus duvaucelli*	*Corvus splendens*	*Psittacula eupatria*
17	*Larus ichthyaetus*			*Haliastur indus*	*Vanellus indicus*	*Coturnix coromandelica**	*Psittacula krameri*
18	*Larus ridibundus*			*Hydrophasianu schirurgus*	*Vanellus malabaricus*	*Coturnix coturnix*	*Pycnonotus cafer*
19	*Limosa limosa*			*Ixobrychus sinensis*	*Vanellus vanellus**	*Cursorius coroman-delicus*	*Pycnonotus jocosus*
20	*Lymnocriptes minimus*			*Mesophoyx intermedia*		*Cypsiurus balasiensis*	*Saxicola caprata**

SN	Aquatic Migrant	Semi-aquatic Migrant	Non-aquatic Migrant	Aquatic Resident	Semi-aquatic Resident	Non- aquatic Resident	Non-aquatic Resident
21	*Motacilla citreola*			*Metopidius indicus*		*Dendracitta vagabunda*	*Saxicoloides fulicata*
22	*Pandion haliaetus*			*Mycteria leucocephala*		*Dicrurus macrocercus*	*Spizaetus cirrhatus**
23	*Pelecanus onocrotalus*			*Nettapus coroman-delianus*		*Dinopium benghalense*	*Streptopelia chinensis*
24	*Pelecanus philippensis*			*Numenius arquata**		*Ducula aenea*	*Streptopelia decaocto*
25	*Philomachus pugnax*			*Nycticorax nycticorax*		*Elanus caeruleus*	*Streptopelia senegalensis*
26	*Phoenicopterus ruber*			*Phalacrocorax carbo*		*Eudynamys scolopacea*	*Sturnus contra*
27	*Plegadis falcinellus*			*Phalacrocorax fuscicollis*		*Falco jugger**	*Sturnus pagodarum*
28	*Podicepscristatus*			*Phalacrocorax niger*		*Francolinus francolinus*	*Timalia pileata*
29	*Recurvirostra avocetta*			*Platelea leucerodia*		*Francolinus pondicerianus*	*Treron phoenicoptera*
30	*Rhodonessa rufina*			*Porphyrio porphyrio*		*Galerida cristata*	*Turdoides caudatus*
31	*Tadorna ferruginea*			*Rostratula benghalensis*		*Gracula religiosa*	*Turdoides striatus*
32	*Tadorna tadorna*			*Rynchops albicollis*		*Gyps indicus**	*Tyto capensis**
33	*Tringa glareola*			*Sarkidiornis melanotos*		*Hieraaetus pennatus**	*Upupa epops*
34	*Tringa nebularia*			*Sterna aurantia*		*Ketupa zeylonensis*	
35	*Tringa ochropus*			*Tachybaptus ruficollis*		*Lonchurama labarica**	
36	*Tringa stagnatilis*			*Threskiornis melanocephalus*		*Luscinias vecica**	
37	*Tringa totanus*					*Merops orientalis*	

*Birds not recorded during spatial study of 2010-11.

indiscriminate poaching. A number of hunters kill birds illegally either by trapping or poisoning. Poachers adopt very special methods for birds hunting. They insert insecticides (Furadan) in the abdominal cavity of insect *viz.* (*Forficula auricularia*) and spread them in the vicinity of the lake and on the floating leaves of aquatic plants. Birds consume these poisoned insects, become lethargic and ultimately unconscious thus becoming easy prey for the poachers. The poachers revive them by putting water drops in the bird's mouth and sell the live birds furtively (Srivastava and Srivastava 2012).

Approximately one lakh waterfowl visit Samaspur Sanctuary each year between the months of November and March. But according to local estimates, the number of these birds has reduced to one fourth in the last eight to ten years. This sharp decline has become a critical issue in the conservation efforts for wetlands. Poaching of visiting birds along with water hyacinth invasion seemed to have contributed to this decline (Korgaonkar and Gokhale 2006). Although Sandi sanctuary is well protected and supports the highest number of birds, waterfowl poisoning is not uncommon (Rahmani *et al* 2010). There are casual reports of poaching for meat collection. Lakh Bahoshi, being a remote area, is another sanctuary where poaching of birds was prevalent few years ago.

iii. **Illegal fishing :** Since almost all the sanctuaries are well protected there is a very good population of fish varieties in them. The locals are tempted into illegal fishing for their consumption as well as occasional earning. Management of Lakh Bahoshi Bird Sanctuary is difficult since a major portion of the area belongs to private landowners. Illegal fishing, hunting and bird trapping are reported occasionally. Illegal fishing by the people of surrounding villages of Samaspur Sanctuary has also been reported. Despite constant vigilance by the forest department in Bakhira Sanctuary incidents of illegal fishing are reported and over 6,000 boats operate in this area. The fishing method is traditional and includes capturing fish using pointed sticks (Singh *et al* 2011). Illegal fishing is also reported in Sur Sarovar Sanctuary (Rahmani *et al* 2010) by the locals of the six surrounding villages, many times for livelihood purpose.

iv. **Grass collection :** A large population around Bakhira Sanctuary depends on the collection of Phragmites and Typha grass for hut thatching, fuel and fodder purposes. Men and women are both engaged in this activity and use boats to haul large bundles of grasses on a regular basis. Not only does this cause disturbance to other birds, it also destroys the habitat of purple swamphen (Tripathy 2004).Villagers near Okhla Sanctuary were also reported as collecting these two grasses for domestic use.

v. **Disturbance to birds:** Most of the Bird Sanctuaries of UP, especially Nawabganj, Sandi, Samaspur, Lakh Bahoshi, Sur Sarovar, Patna, Okhla and Parvati Arga are tourist destinations, especially in the winter months. In spite of regulations they tend to go very close to the birds and create noise. Activities such as boating in the water body (Bakhira), illegal fishing in most of the sanctuaries, agricultural activities in the vicinity or at the periphery etc. disturb the resting birds. Vehicles of tourists and picnickers were also observed to be noisy at least in Okhla and Sur Sarovar sanctuaries which are close to urban areas. (Details figure 5)

There are reports that the distribution of water birds is influenced by human activity and migratory birds are more sensitive to it than resident ones (Van der Zande *et al* 1980; Bruger, 1981; Bruger and Gochfeld, 1991). There were some other factors like sewage disposal, fertilizer and pesticide inflow etc. (Vyas *et al* 2010) which worsened the water quality of the wetland and possibly decreased the residency of birds. High traffic and movement of visitors on the road is a serious concern as well since traffic is considered the most extensive source of anthropogenic interference, particularly in urban areas (Sun and Narins, 2005; Warren *et al* 2006; Slabbekoorn and Ripmeester, 2008; Barber *et al* 2010). The traffic noise was reported to have altered the composition of the bird community. In fact, the relative abundance of birds and the richness of bird species decreased significantly with increasing traffic noise in the dry and wet season (Arevalo and Newhard, 2011; Herrera-Montes & Aide, 2011).

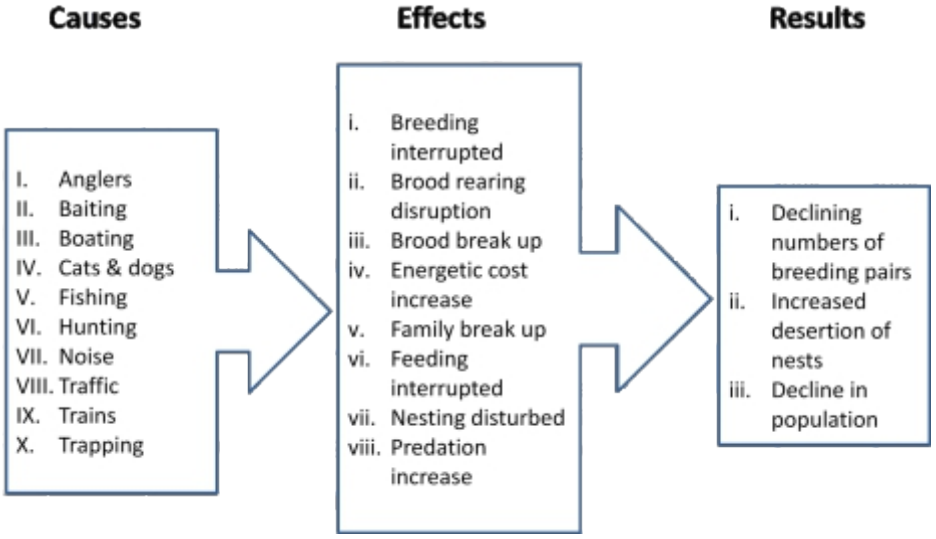

Figure 5 : containing details of disturbance causing factors, their impacts and final results in relation to conservation of birds. Adopted and modified from Korschgen and Dahlgren (1988)

vi. **Weed infestation :** The invasion of Echhornia crassipes (water hyacinth) could be considered to be one of the most serious threats to the Samaspur wetlands. During the last 10-12 years this problem has become prominent (Korgaonkar and Gokhale 2006). The forest department tries every year to remove it completely. Sur Sarovar too used to be covered with water hyacinth (Islam and Rahmani 2004). While the sanctuary management is clearing it on a regular basis, the problem may persist or reoccur since the inlet to the lake (Agra canal drain) does not contain a mechanism to check weed inflow. Okhla sanctuary is still highly infested with Eicchornia crassipes as well as Pistia stratiotes weeds which compete with food plants by taking up space and resources. Amphibious weeds such as Typha and Alternanthera along with terrestrial weeds such as Cannabis are also modifying avian habitat in a negative fashion (WII 2011). Parvati Arga Sanctuary has no weeds but some wild Cannabis which has made an appearance on the banks needs to be removed to maintain the wetland (Singh *et al* 2011). *Ipomea carnea* is another weed which is present in many sanctuaries such as Nawabganj, Sandi, Samaspur, Bakhira etc. Almost all the sanctuaries are severely affected by the aquatic menace, water hyacinth in particular. Due to financial constraints, which are sometimes coupled with administrative reasons, no serious attempts are taken by the management to completely remove weeds from wetlands. This is a doubly detrimental situation as not only does it result in eutrophication but it also checks the growth of food plants for the birds.

vii. **Pesticides and fertilizers :** Almost all the sanctuaries are in agricultural areas into which most of the rain water drains. This causes the pesticides and fertilizers used by the farmers to turn into wetland pollutants, directly or indirectly affecting bird life. Examples include the profuse use of pesticides in paddy fields around Surhatal Bird Sanctuary (Srivastava and Srivastava 2012) and pesticide use in the surrounding fields of Parvati Arga Sanctuary (Singh *et al* 2011).

viii. **Pollution :** Okhla bird sanctuary is one of the most polluted wetlands of UP as most of the urban sewage drains into the river Yamuna before the barrage. Though the site has been protected for more than 20 years, the health of the sanctuary and the birds that make this

their home is not ensured. Low DO and high BOD and COD values indicate high pollution load in the wetland. This coupled with high phosphate levels have resulted in algal bloom in the area. There is an urgent need for implementation of proper management steps, and studies in different seasons of the year need to be undertaken for the conservation of this wetland. Being a barrage, the management of the water level would also be ecologically important to maintain the more shallow water area. There is a need for detailed ecological studies in order to establish a relationship between environmental changes due to human activities, changes in species composition of vegetation and declining bird diversity in the area (Manral and Khudsar 2013).

ix. **Maintenance of Water level :** This is the greatest concern at Okhla, Sur Sarovar and Samaspur Bird Sanctuaries in order to maintain a conducive habitat for birds. The maintenance of the water level of these reservoirs is the responsibility of the Irrigation Department. However, the primary concern of that department is the maintenance of water supply in inhabited areas and habitat conservation is not a priority. There always exists a conflict between the forest and irrigation department authorities over the maintenance of level of water. A compromise needs to be reached so as to give avian concerns weight age as well, as suggested by WII (2011).

x. **Siltation :** Most of the sanctuaries are facing the problem of siltation which affects the water storage capacity of the wetlands. This in turn affects the bird diversity in the sanctuaries as the deep water birds are deprived of a suitable habitat. The composition of aquatic vegetation, which supports the birds by providing food material, also gets changed due to depth variation in the reservoir. Nawabganj, Sur Sarovar and Okhla Sanctuaries need to redress this issue of injudicious management at the earliest.

xi. **Introduction of exotics :** Nawabganj, Samaspur, Okhla and Sur Sarovar are the worst affected by the well intentioned introduction of the exotic species *Prosopis juliflora*. Some conservationists (Rahmani *et al* 2011, WII 2011, Islam and Rahmani 2004) suggest removal of this plant which should be done in a phase wise manner and must be replaced by indigenous species.

xii. **Settlement Issues :** Even after the lapse of at least 20 years after the declaration of a sanctuary, the settlement procedures have not been finalized to remove the rights of use of the private or community land falling within the sanctuary. Although this is a serious socio-political as well as administrative concern, a majority of conservation problems generate from this. Many times a management authority finds itself in a quandary while attempting to regulate the activities of the offending villagers. Bakhira, Surhatal, Patna, Vijay Sagar and Sandi are facing major problems on this account. The author believes that administrative and political will is required to negotiate this problem.

xiii. **Lotus and water chestnut harvesting :** A large part of many bird sanctuaries (*eg.* Vijay Sagar, Nawabganj etc.) remains completely covered by lotus plants right at the advent of winter and synchronizing with the arrival of resident and migratory birds. Lotus seed (*Nelumbo nucifera*) has been reported to be consumed by the inhabiting birds (Jha 2013a). At the same time lotus fruits and parts of the stem are harvested by the local people for consumption at home and sale in the market. Similarly, adjoining submerged private land is used by the farmers for growing water chestnut as their livelihood. The harvesting of the fruit of this plant (*Trapa natans*) not only causes immense disturbance to the birds but also reduces the availability of bird food.

xiv. **Encroachment :** Sur Sarovar, Bakhira and other sanctuaries suffer from the encroachment of government land to be used for

purposes which are not at all suitable for bird conservation. Although such encroachments do not necessarily directly influence the conservation work agriculture expansion and other land uses do harm the system. It is difficult to pinpoint the real cause in a complex sociopolitical system but the lack of encouragement for forces supporting conservation efforts hampers such activities in the future.

xv. **Water drainage for irrigation :** The early drying of water bodies forces birds to move to other wetlands due to food scarcity in dried up wetlands. This condition arises in Vijay Sagar Sanctuary very frequently because water is drained from the wetland for irrigation of private fields. Surhatal is another sanctuary where drainage of water for irrigation is very common (Islam and Rahmani 2004).

Some of the problems of wetlands, the current conditions of a few Sanctuaries and some of the wading birds are captured, respectively, in Photo plates 1, 2 and 3. Apart from the above problems in the affected sanctuaries the following general issues are also important from a bird conservation point of view.

Non-judicious interventions

There is a general tendency to build mounds and plant trees on them without assessing actual requirement and suitability. For example, in Nawabganj Sanctuary a mound was constructed very close to the tourist walking trail without taking into account the disturbance this could cause to the birds. The shallow end of the lakes was deepened for silt removal. Exotic weed like *Prosopis juliflora* was chosen as the plantation species. Such activities need to be stopped in the lakes, especially Sandi, (Rahmani *et al* 2010) Saman, Sur Sarovar, Samaspur, Sandi and Lakh Bahoshi Sanctuaries.

Protection quality

Although the wetlands discussed in this text are in the protected (managed) category, the level of protection of these wetlands varies considerably due to ecological and socio-political reasons. The grading of the various levels of protection and the concerned wetlands which require immediate attention are as follows (Jha and McKinley 2015):

Order V (Very low protection): shortage of staff for ensuring regulatory provisions, large amount of private land falling in the sanctuary area, economy and other activities dependent on the wetland. Example Sarsainawar and many other IBAs and PRSs (Islam and Rahmani 2004, 2008), which are community controlled wetlands and are not discussed in this text.

Order IV (Low protection): shortage of staff for ensuring regulatory provisions, large amount of private land falling within the sanctuary area, people's economy and other activities not dependent on wetland. Example, Vijay Sagar, Surahatal.

Order III (Just enough protection): no shortage of staff, large amount of private land falling in the sanctuary area, economy not dependent on wetland. Example, Lakh Bahoshi, Patna, Samaspur, Saman.

Order II (High protection): no shortage of staff, practically no private land, economy not dependent, but other activities dependent on the wetland. Example, Bakhira.

Order I (Very high protection): no shortage of staff, no private land and no economy nor other activities dependent on the wetland. Example, Parvati Arga, Nawabganj, Okhla, Sur Sarovar.

Vegetation balance

Vegetation, aquatic or terrestrial, is an important components of the aquatic ecosystem because it influences the composition of a different biotic population in the trophic structure. Therefore, the composition of vegetation itself needs to be balanced for the optimum functioning of the system. As indicated in different findings, upland habitats immediately adjacent to wetlands attract a number of bird species that may only be facultative wetland inhabitants (Knight *et al* 2001). Vegetation outside

the water body influences woodland birds or non-aquatic population, while vegetation inside the wetland promotes aquatic bird population. In either case, vegetation provides food, shelter and nesting place. Ideally, higher vegetation levels should result in higher populations on wetlands. However, the vegetation cover and open water ratio plays an important role in marsh utilization (Duffield 1986) as the population of waterfowl is often comprised of ducks utilizing open water. A fifty-fifty ratio of covered area to open area is considered to be the ideal proportion and an increase or a decrease from this level reduces the population (Smith *et al* 2004). Out of the twelve wetlands under study, only one, Sandi, had ideal vegetation, water ratio and the highest aquatic bird population. All other wetlands, which had a higher or lower ratio than the ideal one also had much lower number of birds, thus indicating the hypothesis to be correct.

Administrative gap

It is essential that within the bureaucratic system the different levels of supervision should remain vigilant over the execution of project works in the field in order to ensure the quality as well as quantity of work, especially in remote areas. Of late, the functioning of this system has been witnessing negative impacts due to certain changes. An example of this is the reluctance of executive level officials towards staying at inconveniently placed headquarters. As a result the supervision works are left with the lowest rung of the system resulting in poor quality of watch and ward. This has resulted in an increase in activities such as fishing, poaching encroachment etc., which cause disturbance to bird populations and adversely impact conservation efforts.

Eco-sensitive Zone

As per a Government of India initiative, all states and union territories are supposed to develop an eco-sensitive zone around protected areas. For wetland bird sanctuaries such a zone could be the ecologically sensitive area around it. It would thus play the role of a shock absorber against the pressure radiating towards the sanctuary from the fringe areas around it. This zone will be a positive attempt towards maintaining the sanctuary and its precious resources for the benefit of public while at the same time not hampering the day to day activities of the inhabitants (Jha 2013b).Therefore, activities to be permitted, restricted and prohibited need to be chosen very carefully. Since land use pattern around different protected areas is different and distance dependent, a uniform eco-sensitive zone cannot be established around them. However, a generic model is presented in Figure 6 to be read with Table 3. This could be applied with area specific modifications. Although the surrounding area of a bird sanctuary or eco-sensitive zone is to be currently regulated within 10 km radius, this could be reduced or extended as per the specific requirement of the concerned sanctuary.

Management recommendation

There is sufficient indication from the available literature that the bird sanctuaries of UP are deteriorating and losing avian diversity. However, to regain or at least maintain the historical status of UP wetlands, which have been a haven for migratory birds, quick and intensive measures to check the deterioration further and to ameliorate the existing conditions are imperative. The recovery of bird communities requires availability of habitat, both in quantity and quality, adequate to the established objectives (Fletcher and Koford 2002).

Though converting a "Tragedy of Commons" of the community protected IBAs and PRSs, into a "Comedy" is a Herculean task, the only possible way is to educate the people for arresting further deterioration and then to undertake quick restoration of community managed wetlands by a wise use of resources (Jha 2014). The education drive will have to be taken up on a massive scale for a long period until the change has been effected. For the sanctuaries which are government protected wetlands further sincere efforts are required on following lines:

Table 3. List of activities in subzones around the Bird Sanctuaries linked with Figure 6.

Activities prohibited	Activities regulated	Activities permitted	Subzones
Mining, Encroachment			I, II, III, IV
Vehicular traffic, tourism establishment			I, II
	Vehicular traffic, tourism establishment		III, IV
		Agriculture	I, II, III, IV
Use of pesticides and chemical fertilizer			I, II
	Use of pesticides and chemical fertilizer		III, IV
		Plantation	I, II, III, IV
Polluting industry			I, II
	Polluting industry		III, IV

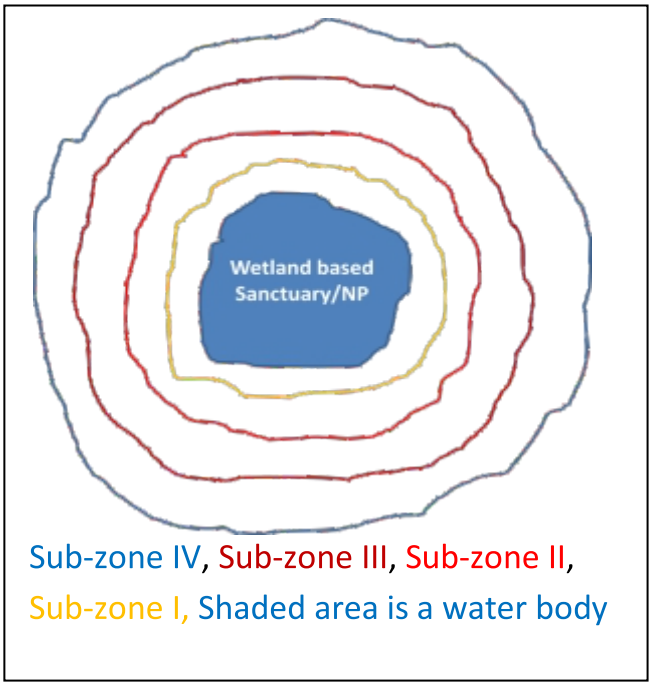

Figure 6. : Water body of the Bird Sanctuary (area shaded blue) is surrounded by different Sub-zones (I, II, III, IV) where in different activities (mentioned) in Table 3 are being effected.

(i) Land tenure settlement issue needs to be resolved immediately.

(ii) Absentee 'office lord' system of administration needs to be checked with immediate effect.

(iii) Rule provisions should be implemented religiously so that disturbing impact from tourism, agriculture, sanctuary offences etc. could be minimized to the greatest extent possible.

(iv) Monitoring and evaluation of the projects completed has to be done in stringent fashion.

(v) Management prescription should be site based and should have a scientific base. In the absence of data very strong experience could be favored.

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