

Shorebird Diversity in UP Wetlands and Their Conservation Concern

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Shorebirds are associated with seashore as well as inland water habitats. Their incidence was studied in inland water habitats of UP in temporal and spatial form at different times and significant wetlands. Such wetlands were either government managed or community protected. Data presented in the text were collected from the field as well as the office record of the Chief Wildlife Warden while the author was working as Chief Conservator of Forests, Eco-Development, UP. Thirty seven species from four families (Jacanidae, Charadriidae, Scolopacidae and Laridae) of the order Charadriiformes were represented in the shorebird diversity. They were avocet, courser, curlew, godwit, greenshank, gulls, jacas, lapwings, plovers, redshanks, ruff, sandpipers, skimmer, snipes, stilt, stints, and terns. Most of them were migrants, a few residents and fewer occasionals or vagrants. Out of the thirty seven bird species recorded so far one is critically endangered (Sociable Lapwing *Vanellus gregarius*), four near threatened (Black-tailed Godwit *Limosa limosa*, Eurasian Curlew *Numenius arquata*, River Lapwing *Vanellus duvaucelli* and River Tern *Sterna aurantia*), one vulnerable (Indian Skimmer *Rynchops albicollis*) and rest are of least concern. They inhabited both kinds of wetlands spread all over the state but the diversity was higher on government managed ones. However, these wetlands served as stopover and wintering sites for the migratory shorebirds on the way to their destination and regular habitat for the resident ones indicating their important role in conservation of avian species. Conservation issues of these wetlands, otherwise deteriorating, need to be addressed to provide a healthy habitat to the shorebirds in order to conserve them.

Introduction

Shorebirds belong to the avian order Charadriiformes, divided into sixteen families from Jacanidae to Alcidae (Liet and Grindle 1978). They could be migratory as well as resident birds inhabiting in different ecological conditions, mainly the shoreline of the coastal landmass. Other habitats include inland freshwater wetlands, agricultural fields as well as interior grasslands (Sivaperuman and Jayson 2012). Charadriidae and Scolopacidae primarily enlist the migratory shorebirds (Kannan and Pandiyan 2012)

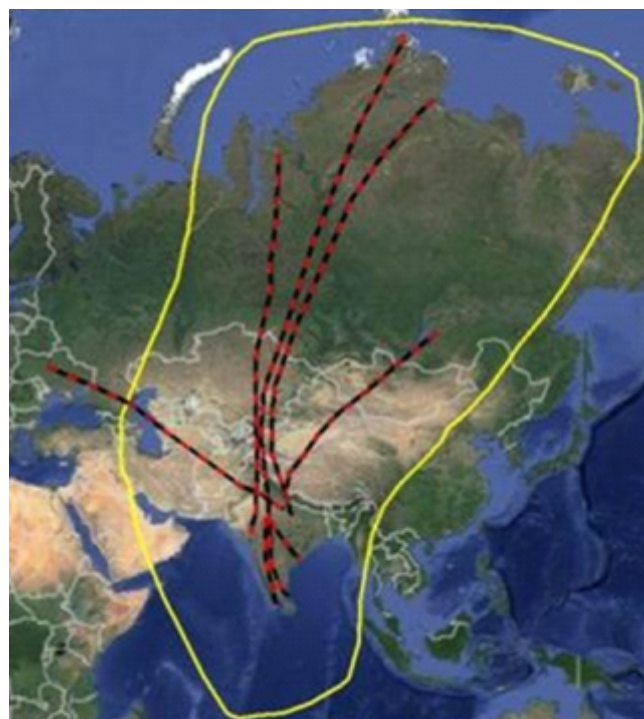


Figure 1 : This diagrammatic representation is redrawn as the combination of three different figures: Courtesy Google Maps (NK), Ali (2005) and CCMS (2005). The tentative boundary of the Central Asian Flyway (yellow polygon) and the migratory routes of Shorebirds (broken red and black lines) have been superimposed on the map of Eurasia. At the southern end of the flyway lies the Indian sub-continent. UP is one of the northern states of India where these birds use the wetlands as a stopover or for wintering.

apart from Laridae and others. They are among the world's longest migrants nesting in one country and spending non-breeding time in another, distantly located country (Howes and Bakeswell 1989). Many of them start from the northern end of the flyway in Europe and travel to the southern end of it, landing in different parts of India along the coastlines and more concentrated at particular points of east and west coast like, Bhitarkarnika mangrove, Chilka lake, Coringa Wildlife Sanctuary, Pulicat lake, Kaliveli lake, Point Calemere, Gulf of Mannar, Kanyakumari, Vembanad lake, Kole wetland, Mahul Sewri mudflat, Bhavnagar

Saltpan, Kaj lake, Charakla Saltpan and Khijadia Wildlife Sanctuary (Islam and Rahmani 2008, Balachandran 2012). However, they utilize innumerable freshwater wetlands of different states of India along almost 3000 km of last stretch of Central Asian Flyway falling in the subcontinent (Figure 1). Uttar Pradesh (UP) being one of the first cis-Himalayan Indian territories embedded with plenty of wetlands provides the opportunity for a stopover en route the long migration. All these wetlands also support a variety of resident shorebirds or waders of Jacanidae and other families. Therefore, these wetlands have a very important role in the life history of migratory as well as resident shorebirds indicating that the conservation of these birds is dependent on the condition of these wetlands. Based on the observation of shorebirds' incidence and habitat conditions at different wetlands an attempt was made to understand the diversity of shorebirds and the adverse factors to the living conditions of these birds, and to come up with some management recommendations.

Study sites and methodology

The wetlands studied and presented in this text are situated in the northern Indian state of UP. UP has a tropical climate with a wide temperature fluctuation from 2°C to 48°C. There are three main seasons: summer- March to mid June; the rainy season-mid June to September; and winter - October to February. There is great variation in rainfall as well. The *Bhabhar* and *Terai* area have rainfall ranges between 1200 to 2500 mm. In the Gangetic plains the rainfall varies from 600 to 1200 mm (Islam and Rahmani 2004). The state is divided into four Eco-zones having different ecological conditions north to south ward: moist to dry region, forested to agricultural landscape, alluvial to lateritic area, etc. In total eighteen wetlands, dispersed through these conditions, were studied for shorebird ecology. These wetlands were broadly categorized into two types - government managed (12) and community protected (6). They are listed in Table 1 and shown on the map in Figure 2. Although the provisions of Wildlife (Protection) Act 1972 are applicable to the whole of the State, they were more intensely implemented on government managed wetlands since human resource, infrastructure facilities and financial provisions were designated for conservation activities on a regular basis. In contrast, the level of protection or conservation in community owned wetlands was low, and mostly



Figure 2. Map of Uttar Pradesh showing the location of wetlands in different Eco-zones of the state. Tarai, Gangetic plain, Semi-arid and Vindhyan-Bundelkhand Eco-zones are marked prussian blue, fawn, sky blue and mauve, respectively. Red circles are the location of government managed wetlands, popularly known as bird sanctuaries. Green circles indicate the community protected wetlands.

voluntary and inclusive of community interest regarding use or abuse of the wetland resources.

Bird observation was undertaken in the winter months (November to February) of 2005 through 2012 for the collection of temporal data at Nawabganj, Samaspur, Lakh Bahosi and Sandi Wetlands. The community protected wetlands were in observation during 2008-09 and 2009-10. For spatial data all the government managed wetlands were studied in the winters of 2010-11 and 2011-12. Every month a minimum of two visits were made by the census team to the wetlands to assess the number of shorebirds. Population assessment was done following the point count method. *Indian Birds* (Ali 1964) and *Birds of Northern India* (Grimmett and Inskipp 2003), were used for the identification and the latest nomenclature of birds observed in and around the wetlands under study.

During almost regular field visits to these wetlands between 2009 and 2012, some of the conservation threats were directly observed and a few others were identified by interviewing key persons like the local villagers, tourists, field staff involved in conservation activities, etc.

Table 1: Details of wetlands under study and shorebirds recorded in them

Wetlands	District	Latitude	Longitude	Shorebirds' code (Refer Table 2)
A. Government managed				
Nawabganj	Unnao	26° 34' N	80° 40' E	BWS BWJ CTN ISR PTJ PSE RTN RWL YWL
Samaspur	Raibareilly	26° 00' N	81° 25' E	BWJ BTG BWS CSE CTN GPS ISR MSR PSE PTJ RTN RWL YWL
Lakh Bahosi	Kannauj	27° 30' N	79° 30' E	BrHG BTG BWJ BWS CGL CSE CTN GPS ISR MSR NLG PTJ PSE RTN RWL RUF
Sandi	Hardoi	27° 15' N	79° 55' E	BTG BWJ BWS CSE CTNECW GPS ISR MSR PSE PTJ RTN RWL YWL
Bakhira	SK Nagar	26° 34' N	83° 00' E	CSR CTN MSR RTN
Okhla	GB Nagar	28° 33' N	77° 17' E	BWS BrHG CGK CRK GSR ICR PGS PAT RWL SLG
Saman	Mainpuri	27° 04' N	79° 00' E	RWL
Parvati Arga	Balrampur	27° 25' N	82° 19' E	CGK CRP
Vijay Sagar	Mahoba	25° 15' N	79° 68' E	PTJ RWL
Patna	Etah	27° 34' N	78° 45' E	BTG BWJ BWS CRK CSR CSE LST RLG PTJ RUF RWL WSR WTL
Sur Sarowar	Agra	27° 00' N	77° 45' E	BrHG BTG BWS CGK CRK CSR CSE GPS GSR JSE LRP MSR PAT RLG RTN RWL WSR
Surha Tal	Ballia			BWJ RWL
B. Community protected				
Sheikha Jheel	Aligarh	27° 49' N	78° 10' E	BTG BWJ BWS CGK CRK CSP CSR LST MSR PTJ RTN RUF RWL WTL
Ama Khera	Aligarh	27° 45' N	78° 21' E	BTG BWJ BWS CGK CRK CSR GSR LRP LST PTJ RTN RUF RWL SRK TST WSR
Daupur	Aligarh	28° 06' N	78° 02' E	BWJ BWS BTG CGK CRK CSE CSR MSR PTJ RTN RUF RWL TST WSR WTL
Sauj	Mainpuri	27° 01' N	79° 08' E	BWJ BWS PTJ RUF RWL
Kurra Jheel	Mainpuri	27° 00' N	79° 05' E	RWL
Kudaiyya	Mainpuri	27° 00' N	78° 59' E	BWJ BWS PTJ RWL

Observation and results

Shorebird Diversity

All together thirty seven shorebirds (Black winged Stilt, Black-headed Gull, Black-tailed Godwit, Bronze-winged Jacana, Black-headed Gull, Brown-headed Gull, Caspian Gull, Common Greenshank, Common Redshank, Common Ringed Plover, Common Sandpiper, Common Snipe, Common Tern, Eurasian Curlew, Greater Painted-snipe, Green Sandpiper, Indian Courser, Indian Skimmer, Jack Snipe, Little Ringed Plover, Little Stint, Marsh Sandpiper, Northern Lapwing, Pallas's Gull, Pheasant-tailed Jacana, Pied Avocet, Pintail Snipe, Red-wattled Lapwing, River

Lapwing, River Tern, Ruff, Sociable Lapwing, Spotted Redshank, Temminck's Stint, Wood Sandpiper, White-tailed Lapwing and Yellow-wattled Lapwing) were recorded over a span of seven years on different wetlands in UP. They were broadly categorized as migrant, resident and occasional or vagrant types using Grimmett and Inskipp (2003) and listed in Table 2. Most of these shorebirds were migrants except ten residents (Common Sandpiper *Actitis hypoleucos*, Greater Painted-snipe *Rostratula benghalensis*, Indian Courser *Cursorius coromandelicus*, Indian Skimmer *Rynchops albicollis*, Little Ringed Plover *Charadrius dubius*, Pheasant-tailed Jacana *Hydrophasianus chirurgus*, Red-wattled Lapwing *Vanellus indicus*, River Lapwing

Table 2: Details of shorebirds appearing at different wetlands of UP

Name of the birds	Familly	Scientific name	Status*	residency	Bird Code
Black winged Stilt	Charadriidae	<i>Himantopus himantopus</i>	LC	migrant	BWS
Black-headed Gull	Laridae	<i>Larus ridibundus</i>	LC	migrant	BIHG
Brown-headed Gull	Laridae	<i>Larus ridibundus</i>	LC	migrant	BrHG
Black-tailed Godwit	Scolopacidae	<i>Limosa limosa</i>	NT	migrant	BTG
Bronze-winged Jacana	Jacanidae	<i>Metopidius indicus</i>	LC	resident	BWJ
Brown-headed Gull	Laridae	<i>Larus brunicephalus</i>	LC	migrant	BHG
Caspian Gull	Laridae	<i>Larus cachinnans</i>	LC	migrant	CGL
Common Greenshank	Scolopacidae	<i>Tringa nebularia</i>	LC	migrant	CGK
Common Redshank	Scolopacidae	<i>Tringa totanus</i>	LC	migrant	CRK
Common Ringed Plover	Charadriidae	<i>Charadrius hiaticula</i>	LC	vagrant	CRP
Common Sandpiper	Scolopacidae	<i>Actitis hypoleucos</i>	LC	resident	CSR
Common Snipe	Scolopacidae	<i>Gallinago gallinago</i>	LC	migrant	CSE
Common Tern	Laridae	<i>Sterna hirundo</i>	LC	vagrant	CTN
Eurasian Curlew	Scolopacidae	<i>Numenius arquata</i>	NT	migrant	ECW
Greater Painted-snipe	Scolopacidae	<i>Rostratula benghalensis</i>	LC	resident	GPS
Green Sandpiper	Scolopacidae	<i>Tringa ochropus</i>	LC	migrant	GSR
Indian Courser	Laridae	<i>Cursorius coromandelicus</i>	LC	resident	ICR
Indian Skimmer	Laridae	<i>Rynchops albicollis</i>	VL	resident	ISR
Jack Snipe	Scolopacidae	<i>Lymnocyrtus minimus</i>	LC	migrant	JSE
Little Ringed Plover	Charadriidae	<i>Charadrius dubius</i>	LC	resident	LRP
Little Stint	Scolopacidae	<i>Calidris minuta</i>	LC	migrant	LST
Marsh Sandpiper	Scolopacidae	<i>Tringa stagnatilis</i>	LC	migrant	MSR
Northern Lapwing	Charadriidae	<i>Vanellus vanellus</i>	LC	migrant	NLG
Pallas's Gull	Laridae	<i>Larus ichthyæus</i>	LC	migrant	PGL
Pheasant-tailed Jacana	Jacanidae	<i>Hydrophasianus chirurgus</i>	LC	resident	PTJ
Pied Avocet	Charadriidae	<i>Recurvirostra avocetta</i>	LC	migrant	PAT
Pintail Snipe	Scolopacidae	<i>Gallinago stenura</i>	LC	vagrant	PSE
Red-wattled Lapwing	Charadriidae	<i>Vanellus indicus</i>	LC	resident	RWL
River Lapwing	Charadriidae	<i>Vanellus duvaucelli</i>	NT	resident	RLG
River Tern	Laridae	<i>Sterna aurantia</i>	NT	resident	RTN
Ruff	Scolopacidae	<i>Philomachus pugnax</i>	LC	migrant	RUF
Sociable Lapwing	Charadriidae	<i>Vanellus gregarius</i>	CE	migrant	SLG
Spotted Redshank	Scolopacidae	<i>Tringa erythropus</i>	LC	vagrant	SRK
Temminck's Stint	Scolopacidae	<i>Calidris temminckii</i>	LC	migrant	TST
Wood Sandpiper	Scolopacidae	<i>Tringa glareola</i>	LC	migrant	WSR
White-tailed Lapwing	Charadriidae	<i>Vanellus leucurus</i>	LC	migrant	WTL
Yellow-wattled Lapwing	Charadriidae	<i>Vanellus malabaricus</i>	LC	resident	YWL

*IUCN (2013)



Plate 1 : Shorebirds clockwise from top left : River Tern, Indian Skimmer, Yellow-wattled Lapwing and Red-wattled Lapwing.

Photo Courtesy : Suresh Chaudhary

Vanellus duvaucelli, River Tern *Sterna aurantia* and Yellow-wattled Lapwing, *Vanellus malabaricus*) and four occasionally appearing birds like vagrants (Common Ringed Plover *Charadrius hiaticula*, Common Tern *Sterna hirundo*, Pintail Snipe *Gallinago stenura* and Spotted Red shank *Tringa erythropus*). Their conservation status according to the IUCN (2013) list is also mentioned in this table. Out of thirty seven bird species recorded so far, one is critically endangered (Sociable Lapwing *Vanellus gregarius*), four near threatened (Black-tailed Godwit *Limosa limosa*, Eurasian Curlew *Numenius arquata*, River Lapwing *Vanellus duvaucelli* and River Tern *Sterna aurantia*), one vulnerable (Indian Skimmer *Rynchops albicollis*) and the rest are of least concern. Some of the shorebirds photographed in these wetlands are presented in Photo-plates 1, 2, 3 and 4. Photo-plate 5 depicts some conservation issues of a few of these wetlands.

In general the abundance, frequency, and richness of birds were lower on community protected wetlands than government managed ones. It was recorded that

across the wetlands (or the state), as well as over the years of observation, the diversity of shorebirds was higher on government managed wetlands than on community protected ones. In total thirty four species (BlGH, BrHG, BTG, BWJ, BWS, CGK, CGL, CRK, CRP, CSE, CSR, CTN, ECW, GPS, GSR, ICR, ISR, JSE, LRP, LST, MSR, NLG, PAT, PGS, PSE, PTJ, RLG, RTN, RUF, RWL, SLG, WSR, WTL, YWL) of shorebirds were sighted on the former group of wetlands as compared to twenty (BTG, BWJ, BWS, CGK, CRK, CSE, CSP, CSR, GSR, LRP, LST, MSR, PTJ, RTN, RUF, RWL, SRK, TST, WSR, WTL) on the latter. The general observation was that population abundance also followed a similar pattern. However, on a temporal basis, the five most frequent birds as well as the five most abundant birds were BWJ, RWL, PTJ, BWS and RTN; and CSE, RUF, PSE, BWJ and RTN, respectively. Similarly, on a spatial basis the five most frequent birds as well as the five most abundant birds were RWL, BWS, MSR, BTG and CSE; and RWL, BTG, BWS, YWL and CGK, respectively. These birds were counted as low as



Plate 2 : Shorebirds clockwise from top left : Black-winged Stilt, Brown-headed gull, Pheasant-tailed Jacana and Bronze-winged Jacana

45 (Vijay Sagar) and as high as 19500 (Sur Sarovar) in number.

Food and foraging

The feeding habits of shorebirds are chiefly carnivorous, including insects, but some of them have adapted to consume vegetal matter also, mainly seeds. Avocets and stilts were seen eating small mollusks, crustaceans and insects but the latter were also observed eating seeds and soft shoots of marshy vegetation. Coursers were predominantly seen taking insects like beetles and grasshoppers but sometimes seeds as well. The jacanas (BWJ, PTJ) were seen frequently running over the floating vegetation like lily for catching insects, crustaceans, small snails and even seeds of lily and other plants. The plovers were also seen eating mollusks, worms, crustaceans and insects along with marshy vegetal matter and seeds occasionally. The stints were

chiefly carnivorous but sometimes ate aquatic plants also. The snipes and sandpipers were seen eating worms and mollusks along with tadpoles and tiny fishes. The gulls and terns consumed animals, fish, crabs and insects. The terns most frequently were seen flying over the surface of the water and suddenly plunge diving to grab feed from subsurface water. Seeds of some of the emergent plants eaten by these shorebirds were *Nymphaea nauchali*, *Nymphoides indicum*, *Jussiaea repens*, *Oryza rufipogon*, *Polygonum barbatum* and *Potamogeton pectinatus*.

Conservation issues

UP being one of the most populous states of India faces tremendous pressure on all the kinds of natural resources it has in any form. The wetlands here, which are primarily the second home of migratory birds and harbor resident birds, were also under excess utilization



Plate 3 : Shorebirds clockwise from top left : Little Stints, River Lapwings, Little Ringed Plover and Pied Avocet.

leading to different kinds of conservation threats. In general the conservation threats were less severe at government managed wetlands in comparison to uncontrolled problems at community protected wetlands. However, being part of the agricultural landscape, certain wetlands (Bakhira, Parvati Arga, Surha Tal, Samaspur and Kurra Jheel) faced the problem of drainage for irrigation of agricultural crops. Sur Sarovar wetland was regularly drained for water supply to the nearby refinery. Sheikha Jheel and Daupur wetlands faced the problem of ground water extraction. The poaching of birds was the main concern in government managed wetlands (Bakhira, Samaspur and Sandi), though under control at Samaspur and Sandi it was found unregulated in Bakhira. This problem was severe at community wetlands like, Kudaiyya, Kurra and Daupur. Unregulated and illegal fish harvesting was a

serious concern in Bakhira, Lakh Bahosi, Parvati Arga, Sandi, Sur Sarovar, Surha Tal, Samaspur and Daupur wetlands. In the catchment of some wetlands (Bakhira, Nawabganj, Parvati Arga, Samaspur and Saman) agriculture was being practiced. Heavy use of pesticides in the surroundings was a serious threat to conservation. Weed infestation and eutrophication, due to the menace of water hyacinth growth, Kudaiyya, Sheikha Jheel, Nawabganj, Samaspur and Surha Tal were among the worst sufferers. Cultivation of water chestnut and other agricultural crops within wetlands like Kudaiyya, Sauj, Patna and Samaspur was hampering the conservation efforts. Agricultural expansion around Kudaiyya, Sauj and Surha Tal posed a serious threat to shorebird conservation. Frequent visits by local villagers for wetland resource exploitation, tourists for recreation and persecution of birds caused disturbances



Plate 4 : Shorebirds clockwise from top left : Common Sandpiper, Green Sandpiper, Black-tailed Godwit and Wood Sandpiper

to the shorebirds of almost all the wetlands in general, but was a serious cause of concern in Ama Khera, Sauj, Nawabganj, Parvati Arg and Patna.

Discussion

The wetlands under discussion are some examples which supported the life of shorebirds of migratory as well as resident nature. The presence of migratory birds and their high diversity in the wetlands of UP indicated the use of such wetlands as stopover or wintering sites most likely due to availability of food materials in abundance (Newton 2008). Balachandran (2012) has also reported that during peak annual migration periods, hundreds of thousands of birds migrating along the Central Asian Flyway descend upon the coastal wetlands of India in search of refuge and

food. Some shorebirds fly as far as 9,000, km from the arctic breeding grounds and South Indian wintering grounds. Prior to breeding, they again fly northwards to their nesting grounds, thus, in one year they may fly 18,000 km. During both the trips, to and fro, thousands of such migrating birds also descend on the inland freshwater wetlands of northern and central India. UP is one of the north Indian states where wetlands are in abundance and plenty of them are being utilized by such birds (Rahmani *et al* 2010).

A high abundance of shorebirds during the present study also got support from Rahmani *et al* (2011) according to which winter incidence of migratory birds and presence of resident birds, including shorebirds in several thousand numbers indicated the sound state of the ecological conditions of UP wetlands. However, the

huge population of the state is generating tremendous anthropogenic pressure on wetlands for resource use and thus causing modification of their ecological conditions. The presence of several such modifying factors like, grazing, fishing, water harvesting, physical conversion etc. is working against the conservation of biodiversity, especially avian diversity as it is very sensitive to disturbance, food shortage, pollution etc. This might reduce the utility of wetlands in the future as also reported by other workers. According to Melville (1997) shorebirds or waders that use natural wetlands are coming under increasing threats of extinction as their habitats are reduced or modified. Migratory shorebirds are particularly vulnerable because they undertake long flights and so require adequate food, before, during and after migration for the species to survive and breed (Howes and Bakewell 1989, Haig *et al* 1998, Milton 2003). The majority of populations of waders are on decline all around the world which is a matter of international concern with respect to conservation. However, Kaminsky *et al* (2006) have concluded that habitat quality management by enhancing favourable conditions can lead to the achievement of a greater abundance and diversity of waterbirds.

Low richness and abundance of shorebirds on community protected wetlands as compared to government managed wetlands seemed to be obvious on account of the higher disturbance to the birds on the former due to unregulated, intense and unwise human use of resources. Such wetlands are maintained by democratically elected village councils (Sundar and Swati 2013) and practically the modus operandi for use of resources is like “Tragedy of Commons” of Garret Hardin due to which they are most affected with anthropogenic pressure (Jha 2013). Human disturbance and other factors are known to affect avian population adversely (Tremblay and Ellison 1979, Zhenming *et al* 2006). Spencer (2010) has also reviewed that shorebirds can suffer high disturbance on their roosting and foraging ground by fishers, watercraft, dogs, coastal development activities etc.

Though Islam and Rahmani (2004) have listed the conservation threats and issues for UP wetlands, some of these, at certain wetlands, are found not matching the ground reality after a lapse of almost a decade. For example, the infestation of water hyacinth was not visible at all at Sur Sarovar. This indicated that threats may change after some time, provided there is effective management intervention in place.

Management recommendation

Wetlands are one of the most threatened habitats of the world. Wetlands in India, as elsewhere, are increasingly facing several anthropogenic pressures. There is a universal trend of shrinkage and deterioration (Prasad *et al* 2002). UP wetlands are also following a similar trend of losses. However, to regain or at least maintain the historical status of UP wetlands, having been a treasure for migratory birds and served as havens for their conservation, quick and intensive measures to check the deterioration further and ameliorate the conditions are required. The recovery of bird communities requires availability of habitats, both in quantity and quality, adequate to the established objectives (Fletcher and Koford 2002).

Though converting a “Tragedy of Commons” into a “Comedy” is a Herculean task, the only possible way is to educate the people for arresting further deterioration and followed by quick restoration of community managed wetlands by wise use of resources. In contrast, the improvement of public wetlands appears easy as the available law on conservation could be enforced through trained machinery. Some of the steps to be taken up immediately on government managed wetlands could be as follows:

- i. Strictly regulate grazing, illegal fishing and poaching; kept to a minimum if absolute stoppage is not possible due to practical reasons.
- ii. Regulate tourism and other disturbances, water level fluctuation, agriculture expansion, crop cultivation and weed spread to as wise an extent as possible.
- iii. To reduce the disturbances a buffer of no disturbance zone should be implemented as suggested by earlier workers in order to mitigate the disturbance problem to aquatic birds (Rodgers 1991; Carlson and McLean, 1996; Carney and Sydeman 1999).
- iv. Improve habitat condition by manipulating the vegetation and open water ratio (50:50) for waterbirds in general (Smith *et al* 2004)) and maintain emergent vegetation like reeds for shorebirds or waders.

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