

## Can We Ensure the Long - Term Arrival of Winter Migratory Avian Species in Lesser Himalayan Zone, Northern India?

<sup>1</sup>Ritesh Joshi, <sup>1</sup>C.M. Dobhal, <sup>2</sup>Raju Pushola, <sup>3</sup>M.S. Negi and <sup>1</sup>Alok Dixit

<sup>1</sup>Environmental Sciences Unit, Doon Institute of Engineering and Technology,  
Shyampur, Rishikesh, Dehradun, 249 204, Uttarakhand, India

<sup>2</sup>Summer House, Society Area, Clement Town, Dehradun - 248 002, Uttarakhand, India

<sup>3</sup>Chilla Forest Range, Rajaji National Park, Pauri - Garhwal, Uttarakhand, India

**Abstract:** Avian migratory species are vulnerable to local extinction in fragmented protected landscapes mainly due to large scope developmental and anthropogenic activities and drastic change in land use pattern. The present study investigated the status and threats to migratory bird species in lesser Himalayan zone, north-west India. We assessed the current status of arrival of migratory avian species at Dudhia and Jhabargarh forests of the Rajaji National Park and Bhimgora barrage near to Haridwar city from October 2009 to June 2010. Besides, various ground - based surveys were also carried out to know their population status during 2008 - 2009 and 2009 - 2010 (October to June). A total of 11 winter migratory avian species were recorded from both the study areas, which include three species of storks, one species of crane and seven species of aquatic water birds (*Tadorna ferruginea*, *Aythya ferina*, *Anas platyrhynchos*, *Anas acuta*, *Anas clypeata*, *Anser indicus*, *Mycteria leucocephala*, *Ephippiorhynchus asiaticus*, *Ciconia nigra*, *Grus virgo* and *Larus ridibundus*) however, during 2008 - 2009, a total of 16 species were observed in the same area. Notably, the population of painted stork was found to be increasing whereas the population of black - necked stork and black stork was declining slightly as compared to 2008 - 2009. On the other hand the population of all the other species was found decreasing as compared to few previous years. Understanding how bird populations react to such vast superfluous activities and their behavioural response is thus essential for addressing future challenges for management and conservation of these avian migratory species and for ensuring their long - term arrival and survival.

**Key words:** Avian winter migratory species • Rajaji national park • Bhimgora barrage • Status • Threats • Conservation • Northern india

### INTRODUCTION

India and south - east Asia form the greater part of one of the world's six zoo-geographical regions - natural provinces first described in the last century, within each of which the animal life is more closely related than it is to that of the others. The Indian sub - continent is host in winter to a multitude of birds which have nested further north in Asia and migrate over the mountains to seek congenial winter quarters [1]. Bird migration is the traditional seasonal journey undertaken by several species primarily for feeding and breeding requirements. Migration includes journeys over different countries and activities but during the recent past drastic changes in

natural habitats and well-connected landscapes has caused dangerous threats for these avian species. Forested areas in both the valley and the hills of Dehradun area are under threat from cattle grazing, lopping, cutting of grass, summer fires, weeds and poaching of game birds. Additionally, some areas of Dehradun city also have air pollution from traffic and limestone kilns. Rivers are threatened by fishing, mining of beds for sand, gravel and stones, all of which have led to depletion of habitat for birds and aquatic fauna [2]. With the onset of winter in November each year, several migratory birds arrive at Bhimgora barrage in Haridwar, Aasan barrage in Dehradun and Baan - Ganga wetland in Laksar and return back once the summer heat sets in

(nearly March - April). The breeding sites of these birds were observed from several regions of Europe and north and central Asia and at the onset of winter when northern region become entirely covered with snow they undertake journey along major river valleys. India is one such destination, which provides wintering sites for migratory avian species in different landscapes and habitats.

**Study Area:** The study was conducted in Dudhia and Jhabargarh forests (along the Ganges; 29°98594' North Latitude, 78°22803' East Longitude, altitude - 295.2 to 299.5 meter above sea level) of the Rajaji National Park and Bhimgora barrage (29°95585' North Latitude, 78°18191' East Longitude, altitude - 278.7 to 283 meter above sea level) near to Haridwar city (Figure 1). All these sites falls under a same forest stretch (7 kilometer long) and river Ganges is flowing along this landscape. Several islands are also present in between Ganges, which holds a healthy population of floral and faunal diversity along with few swampy pockets, which further ensures the

arrival of bird species. Additionally, some tributaries of river Ganges (Ghasiram, Mundal, Khara and Rawasan water stream) were also investigated to check the presence of storks.

**Climate:** Study area shows three distinct seasons i.e. the winter (from October to mid-March) with frost, the summer (from mid-March to mid-June) with average temperature 40-44°C and the rainy season (from mid-June to September) with average temperature 25-30°C. Minor variations in the temperature occur locally on account of altitude, but the general temperature over the entire area is always uniform. A typical sub-tropical climate prevails in this tract. The south-west monsoons account for bulk of the total annual precipitation. This area having the average temperature existing from -1°C (min) to 44°C (max). During winter the fairly cold nights are not uncommon. In low-line localities, a freezing frost is not an uncommon sight during winter. April and May are fairly hot and June is the hottest period but maximum shade temperature rarely exceeds 44°C.

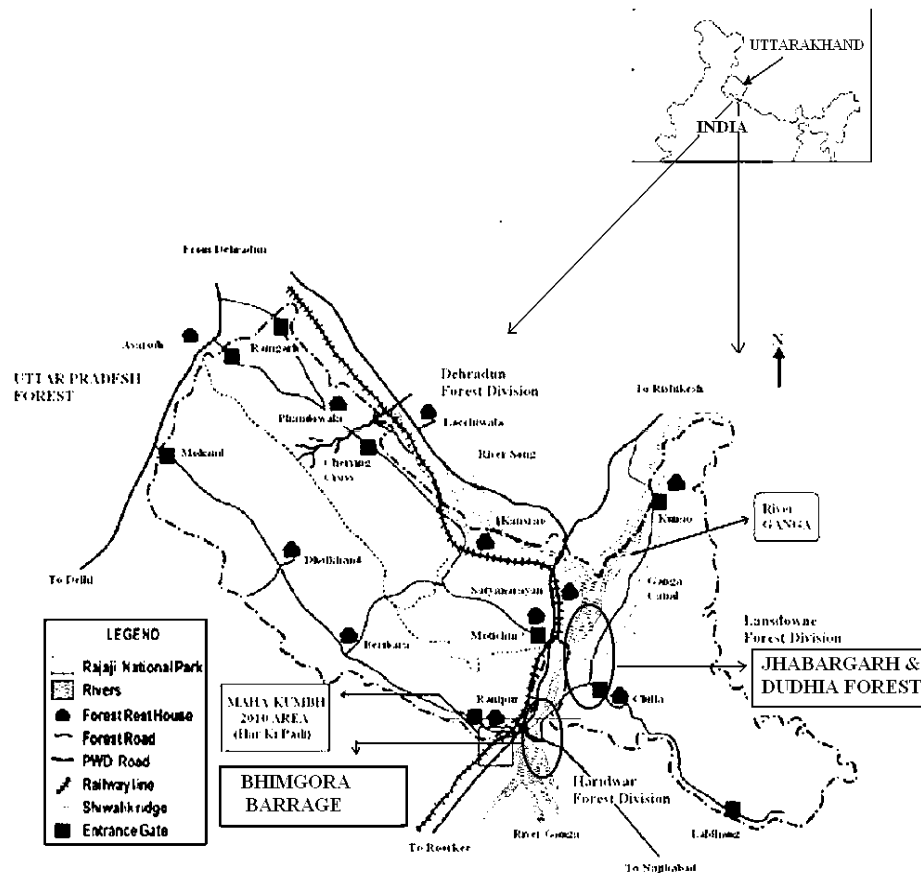


Fig. 1: Map of Rajaji National Park showing locations of study areas

**Rainfall:** There is a wide variation in annual rainfall with change in altitude and topography. The majority of rainfall occurs during the monsoon period from July to mid-September when humidity is very high, though some winter rains are also received. Average annual rainfall is 2000 mm [3]. During rainy season, the floods are quite frequent in the main river system and its tributaries. The flooded streams flow inside the park area with great fury sometimes damaging the forest roads.

**Vegetation:** This protected habitat in India's lesser Himalayan region falls under sub tropical moist deciduous forest type with extensive stands of *Shorea robusta* Sal, *Mallotus philippinensis* Rohini, *Acacia catechu* Khair, *Adina cordifolia* Haldu, *Terminalia bellirica* Bahera, *Ficus bengalensis* Bar, *Schleichera oleosa* Kusum, *Zizyphus mauritiana* Ber, *Lannea coromandelica* Jhingan, *Ehretia laevis* Chamror, *Lagerstroemia parviflora* Dhauri and *Dalbergia sissoo* Shisham in its premise besides many other important fodder plant species. Additionally, both the sites consists several islands situated in between river Ganges, which holds tremendous species of grasses (*Saccharum munja* Sarkanda, *Saccharum spontaneum* Kans, *Cynodon dactylon* Doob and *Desmostachya bipinnata* Kush) besides, some aquatic species (*Equisetum* spp. Horsetail,

*Pteris* spp. Tender brakefern, *Adiantum* spp. Common maidenhair fern, *Ceratophyllum* spp. Rigid hornwort, *Potamogeton* spp. Curlyleaf/Fennel pondweed and *Hydrilla* spp. Water weed/Hdrilla) are also found randomly in adjoining areas of river Ganges specially in small water ponds/reservoirs.

## RESULTS AND DISCUSSION

A total of eleven species of avian winter migratory species were observed and out of them one (*Grus virgo*) was observed after an interval of four years (Table 1). From October 2009 to June 2010 bird's large flocks were not observed in any site, even we have searched at Pashulok barrage (Rishikesh), which is adjoining to study area (another destination for migratory birds). Maximum number of individuals were observed during last week of February and first week of March and interestingly Ruddy shelduck was the only species, which was found to be maximum, whereas Demoiselle crane was observed to be least (n = 2) and notably during last days of May. During the last one decade, the population and arrival status of winter migratory birds was declining rapidly, might be due to changing local climate and forest ecosystem or due to human encroachment in their staying sites.

Table 1: Avian migratory species observed in Dudhia and Jhabargarh forest of the Rajaji National Park and in Bhimgora barrage (Neeldhara) during October 2009 to May 2010

Bird Species	Habitat	Status <sup>4</sup>	Arrival & departure time	Threat categories <sup>5</sup>	Local threat <sup>6</sup>	Additional information <sup>#</sup>
<i>Tadorna ferruginea</i> Ruddy Shelduck	AQ	CW	Nov. 2009 - May 2010	LC	AA, IF, DA, RT	AC, AH
<i>Aythya ferina</i> Common Poachard	AQ	LCW	Nov. 2009 - April 2010	LC	AA, IF, DA, RT	AD, SH
<i>Anas platyrhynchos</i> Mallard	AQ	NW	Nov. 2009 - April 2010	LC	AA, IF, DA, RT	AD, SH
<i>Anas acuta</i> Northern Pintail	AQ	LCW	Jan. 2010 - March 2010	LC	AA, IF, DA, RT	AD, SH
<i>Anas chrypeata</i> Northern Shoveler	AQ	LCW	Jan. 2010 - Feb. 2010	LC	AA, IF, DA, RT	AD, SH
<i>Anser indicus</i> Bar - headed Goose	AQ	LCW	Jan. 2010 - March 2010	LC	AA, IF, DA, RT	AD, SH
<i>Mycteria leucocephala</i> Painted Stork	AQ, SW	NR	Feb. 2010 - June 2010	NT	AA, IF, DA, RT	AD, SH
<i>Ephippiorhynchus asiaticus</i> Black - necked Stork	AQ, SW, OF, FA	NR	Dec. 2009 - June 2010	NT	AA, IF, DA, RT	AI, SH
<i>Ciconia nigra</i> Black Stork	AQ, SW, OF, FA	NW	Oct. 2009 - May 2010	LC	AA, IF, DA, RT	AD, SH
<i>Grus virgo</i> Demoiselle Crane	AQ	NP	May 2010*	LC	AA, IF, DA, RT	SU
<i>Larus ridibundus</i> Black - headed Gull	AQ	NW	Dec. 2009 - April 2010	LC	AA, IF, DA, RT	AC, AH

Habitat: AQ - aquatic, SW - swamp, OF - open forests, FA - forested habitat along the annual rivers

<sup>4</sup>Status: CW - common winter visitor, LCW - locally common winter visitor, NW - not common winter visitor, NR - not common resident, NP - not common passage migrant (based on: Birds of northern India, Authors - Richard Grimmett, Tim Inskipp & Satya Prakash Mehra, BNHS field guide, Mumbai, India; 2004)

\*stayed only for 4 - 5 days

<sup>5</sup>Threat categories: LC - least concern, NT - near threatened [Bird life International 2008. In: IUCN Red list of threatened species 2008 (www.iucnredlist.org)]

<sup>6</sup>Local threat: AA - anthropogenic activities (fuel wood & fodder collection), IF - illegal fishing, DA - developmental activities near to Ganges, RT - running vehicle traffic

<sup>#</sup>Additional information: AC - arrival common, AD - arrival rate declines, AI - arrival rate increases, SH - very sensitive to anthropogenic activities, AH - adaptive to human activities, SU - status unknown

**Bird's Status During 2008 - 2009 and 2009 - 2010:** Just one decade before (near to year 2000), large flocks of Ruddy shelduck were observed in these sites and various other waterfowl species were also documented by different workers but with the increase in time their number felled down. Same situation is with Aasan barrage in Dehradun (Uttarakhand), where some workers have observed declining rate in their arrival and populations. In storks, the population of *Mycteria leucocephala* Painted stork was found to be increasing though, an only large flock (n = 67) was observed during the course of study. And opposite to this, the arrival rate of *Ephippiorhynchus asiaticus* Black-necked stork was observed decreasing (n = 27) and it was found frequently in perennial rivers, however few pairs were spotted moving and feeding in annual rivers flowing inside the dense forest (Rajaji National Park area). Notably the population of *Cicimia nigra* Black stork was found declining (n = 43) as compared to few previous years although this species is known to arrive here first (nearly October) and more common since last 6 - 7 years.

Except Painted storks both the storks were also observed in open forest areas and were generally found sitting in tall naked trees standing along the torrential rivers flowing inside the Rajaji National Park. A small flock (n = 12) of Black stork was also observed in Rawasan river flowing some 13 kilometers far from study site (approximate aerial distance from Bhingora barrage). But, we considered these individuals as counted at study sites because just after observing these birds at Rawasan forest, we searched this species in Jhabargarh forest and Bhingora barrage area and notably these were not found at both the sites, hopefully they had moved to new sites. River Song and Suswa further ensure the arrival of these stork species. Both the rivers are flowing inside the Rajaji National Park area and are tributaries of river Ganges and sometimes birds (very rare, 1 - 2 birds) were also observed feeding in these rivers, when separated from flock for a short period of time.

Remarkably, among water fowls *Tadorna ferruginea* Ruddy shelduck was found to be maximum (n = 181) followed by *Aythya ferina* Common poachard (n = 68), *Anas platyrhynchos* Mallard (n = 34), *Anas acuta* Northern pintail (n = 14), *Anas clypeata* Northern shoveler (n = 2) and *Anser indicus* Bar-headed goose (n = 8). On the other hand *Larus ridibundus* Black-headed gull was observed to be maximum soaring over to river Ganges near to Har-ki-Pauri and Neeldhara area and additionally, their large flocks were observed at Bhingora

barrage (n = 48) (Figure 2). As compared to the bird count of 2008 - 2009 (October - June), it was revealed that their population is declining rapidly (Figure 2) and the arrival rate of number of different species is falling down. During 2008 - 2009 a total of 16 species of avian winter migratory species were documented whereas during this study (2009 - 2010) only 11 species were documented (Figure 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 & 12). Looking into the field data and as compared to previous year, a total of six species didn't arrived this year (during the study period), which include *Tadorna tadorna* Common shelduck, *Rhodonessa rufina* Red-crested poachard, *Anas penelope* Eurasian wigeon, *Anas crecca* Common teal, *Anser anser* Greylag goose and *Larus ichthyæetus* Pallas's gull (Figure 2), whereas Demoiselle crane was not observed during 2008 - 2009 and only a pair was found moving at Neeldhara this year. A preliminary study shows that the number of species of water birds visiting Bhingora barrage was more than the number of species visiting Aasan reservoir. A total of 18 species of water fowls were reported from Bhingora barrage during 2005, which included Ruddy shelduck, Northern pintail, Red-crested poachard, Gadwall, Common poachard, Mallard, Coot, Wigeon, Common teal, Tufted duck, Northern shoveler, Comb duck, Cotton teal, Falcated duck, Spot-billed duck, Bar-headed goose, Common shelduck and Greylag goose [4].

In contrast, Ruddy shelduck was found to be a common winter visitor and large flocks were observed every year and found slight habitual to human activities ongoing near them and this behaviour made them more tolerable in extensive environmental conditions, whereas just opposite to this Common poachard, Mallard, Northern pintail, Northern shoveler and Bar-headed goose are very sensitive to anthropogenic activities. They quickly leave the area if sense any abnormal environment near to them specially if anthropogenic pressure is increasing in and adjoining habitats. Besides, Black-headed gull was most common bird seen soaring over to Ganges. On the other hand Darter is a good swimmer and can dive and grab fishes easily under water and therefore, sometimes gulls were seen associating and begging fishes from darter while feeding together.

Bhingora barrage and Ban-Ganga reservoir are considered to be more potential site as compared to Aasan barrage because of presence of myriad types of habitats and river Ganges. Every year huge number of winter migratory and locally common resident birds

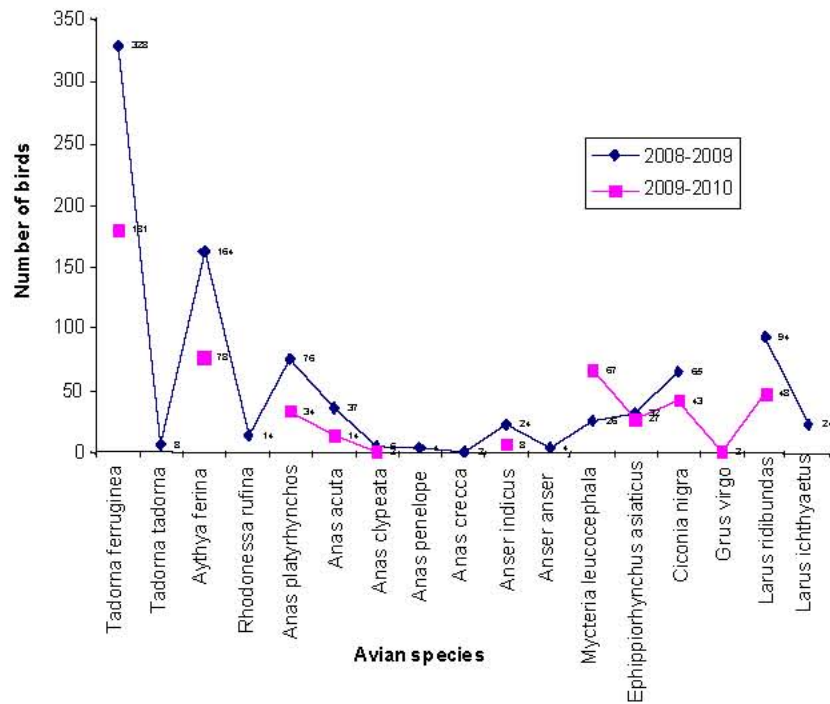


Fig. 2: Population status of winter avian migratory species at Dudhia and Jhabargarh forest of the Rajaji National Park and Bhimgora barrage, Haridwar during October - May 2008 - 2009 and 2009 - 2010

Note: All figures given are based on the ground - surveys and direct counts, however it might be possible that some minor error may occurred due to repeated counts



Fig. 3: On the track: A large flock of little cormorants at Jhabargarh forest of the Rajaji National Park during sunset



**Fig. 4: Painted stork acquiring sun-bath at Bhingora barrage**



**Fig. 5: In search of food: A flock of Painted stork at Bhingora barrage**



**Fig. 6. A pair of Black stork, feeding on fishes at Ghasiram water stream inside the Rajaji National Park**



Fig. 7: Demoiselle crane at Neeldhara, near to Haridwar city



Fig. 8: Common winter visitors: Ruddy Shelduck at Jhabargarh forest of the Rajaji National Park



Fig. 9: Declining slowly: Mallard near to Dudhia forest of the Rajaji National Park.

(*Anhinga melanogaster* Darter, *Phalacrocorax niger* Little cormorant, *Phalacrocorax carbo* Great cormorant, *Casmerodius albus* Great egret, *Egretta garzetta* Little egret, *Ardea cinerea* Grey heron and *Nycticorax nycticorax* Black - crowned

night heron) arrives at these sites and stay there for about five to six months. On the other hand, Aasan reservoir is blessed with river Yamuna, where sometimes birds were also observed moving along the riparian corridors.



Fig. 10: A large flock of Mallard and Common pochard is swimming in river Ganges near to Bhimgora barrage



Fig. 11: Black - headed Gull's flock soaring over to Dudhia forest



Fig. 12: Inside the home: Local winter migrants during rest near to Jhabargarh forest (Rajaji National Park)

**Unusual Arrival and Stay of *Grus Virgo*:** This year a pair of *Grus virgo* (Demoiselle Crane) arrived delayed than the usual time at Bhimgora barrage, giving rise to several

questions about the changing migratory pattern. A pair was arrived (spotted thrice) during the last week of May 2010 and stayed for about 4 - 5 days at Neeldhara area



moving together with grey heron. This species of crane is smaller than common crane but has a similar plumage and notably the breeding sites of this species are reported to be Har Us Lake in Mangolia (where the largest populations exist) and Kopa in Kazakhstan and wintering sites were reported in north-west India specially near the Thar Desert. Wintering sites were also reported from Nepal, some parts of Pakistan and Assam in India. Migratory route of this bird also includes some parts of China. This species is very rare in Haridwar and had not been spotted near the Ganges during last four years. During 1995, complete migration routes were monitored from crane breeding sites at Har Us Lake in Mangolia and Kopa in Kazakhstan to wintering sites in northern India and it was found that the cranes spent 18 - 35 days migrating 2710 - 3332 kilometers and rested at 7 - 9 locations for 1 - 20 days in the route besides one rest period extended for 9 - 20 days but the remainder lasted only a day [5].

**Alteration in Arrival and Departure Timing:** A drastic change in the arrival and departure timings of avian winter migratory species has been observed since last five years. Normally, the arrival time of these birds was recorded to be October and early November and departure time near to March, but during the last five years erratic changes was observed in their arrival and departure timing. We have made discussions with local people and correlate it with our field data and it was revealed that just a decade before this area was one of the vital identifiable habitat for winter migrants and thousands of birds were known to arrive here but rapidly their population is falling down besides the fact that this area is one of the ideal natural habitat and traditional landscape for avian migratory species. During 2005 - 2007 bird's arrival was observed maximum during October - November and departure was observed till April end.

Opposite to this in 2008 bird's arrival was observed during November - December and only Ruddy shelduck was the species that arrived in October, whereas Greylag goose arrived during January and their departure time was found to be delayed. Some birds returned during April whereas maximum returned during May. Similarly, during 2009 bird's arrival was observed randomly in different months (October, November, December 2009, January & February 2010) and notably most of the birds arrived during December and they returned back near to May - June. No single species was found returned during March - April, which indicated that, their arrival, departure and

staying timings is changing to some extent. Further work needs to be undertaken on the arrival and departure timing of these species, impact of climate change, ecology of migratory species along with threats and conservation measures.

Climatic changes, which include irregular monsoon, global rise in atmospheric temperature and developmental activities, are responsible for this catastrophic change in bird's migration. However, bird's arrival near to protected habitats of Shivalik landscape indicated that local climate favour their arrival but some research oriented conservation studies should be needed to be carried out and implemented so that we can manage and conserve bird's habitat for their long-term arrival and survival. In 2007, monsoon was quite healthy and this area received good rains besides, some areas were severely affected by flood and moderate monsoon was observed in 2008 whereas during 2009 monsoon was found to be very weak and local area suffered with water scarcity. Irregular monsoon, winter and summer and changing local environmental condition might be responsible behind this. Besides, this can be correlated with catastrophic change in the landscape available to them and in their different staying sites, which forms part of their altitudinal journey and entire migration. Increasing evidence suggests that climate change has impacted on avian breeding phenology. Some bird populations in Europe and North America have shown this kind of response to climatic warming in addition to range changes. Although no consensus has been reached among academics about the specific impacts of climate change on birds, ample evidence has demonstrated the ecological consequences, including impacts on their geographical distribution, migration phenology, breeding performance and population dynamics [6].

**Impact of Maha - Kumbh 2010:** Several small-scale developmental projects were carried out during the pre - Kumbh period from September 2009 to January 2010, which includes construction of temporary huts and centers in dry bed of river Ganges and in the islands situated in between Ganges and renovation of Haridwar - Chilla - Rishikesh motor route. And during that period, vehicle traffic was diverted to Jhabargarh forest of the Chilla forest range (Rajaji National Park) and as the result of which approximately five kilometers forest stretch was severely affected and notably maximum number of migratory avian species has disappeared for a short period.

A surprising incident was highlighted on April 05, which caused a big trouble for Rajaji's officials. Approximately 150 foreigners (men, women and kids) from more than 50 countries entered to the Jhabargarh forest of the RNP, who came to Haridwar for royal bathe of Kumbh. They resided inside the protected habitat for about 11 days (from 4<sup>th</sup> of April to 14<sup>th</sup> of April) adjoining to river Ganges and in the area, which falls under Chilla - Motichur wildlife corridor. Notably, encroachers cooked food there and took bathe in Ganges flowing adjoining to forest. Besides, they were found engaged always in their activities primarily include singing and dancing the religious hymns and folk of lord Krishna and Rama and enjoying the swing boards they made on trees. Their movement within the crucial wildlife habitat and adjoining to river Ganges forced the bird species to leave the area till these revelers were evacuated from the park area.

### Threats

- Shrinking of natural water in seasonal rivers (tributaries of river Ganges) flowing inside the Rajaji National Park area and Haridwar forest division (Shyampur forest).
- Increasing rate of anthropogenic activities inside the protected habitats basically for collection of fuelwood and fodder. Additionally, developmental works near to riparian corridors and Neeldhara area.
- Wildfires not only make a huge impact on mega-fauna of any ecosystem but also make an impact on other groups living within like rodents, reptiles, amphibians and specially on migratory avian species.
- Illegal fishing by local people in river Ganges. Besides, mining in river Ganges at Shyampur forest of the Haridwar forest division, which is adjoining to study area.
- Heavy vehicle traffic running in Haridwar - Chilla - Rishikesh motor road.
- Local people's illegal movement and cattle grazing in Jhabargarh forest.
- Gujjar should be rehabilitated from the park area (nomadic community still living inside the Gohri forest of the Rajaji National Park).

### Recommendations

- Satellite - tracking of bird's migration may be helpful in knowing the accurate tracks and resting sites, which may be helpful in their management and conservation.

- Proper census of avian migratory species should be carried out at different sites along with their arrival and departure time.
- Environmental awareness programmes and training programmes, which will focus on biological diversity importance and conservation and bird's conservation, should be organize time to time so that community participation may be ensured.
- Additional scientific studies are required regarding to land use pattern and conversion, landscape management and habitat analysis, with the help of which we can prepare a scientific research - oriented action plan, which will be helpful in ensuring the long - term arrival and conservation of these winter migrants.
- Anthropogenic activities must be controlled specially near to river Ganges and in adjoining forests besides, movement of local people inside the protected forest and illegal fishing should also be controlled and stopped up.
- Weeds like *Lantana camara* Lantana, *Parthenium hysterophorus* Congress grass and *Ageratum conyzoides* Nilphool / Goat weed are causing severe threat to bird's habitat. Eradication of these noxious weeds with scientific approach is highly recommended so that natural vegetation of the riparian corridors may be protected.
- Dudhia forest (island), which falls under the Rajaji National Park area, should be restored from local people's movements.

### ACKNOWLEDGEMENTS

We are thankful to Dr. Rambir Singh, Director, Department of Science & Technology, New Delhi and Mr. O.P. Bhatt, Chairman of Doon Institute of Engineering and Technology, Rishikesh and to various forest officers and media persons for their cooperation, suggestions and providing us relative information. We would like to thank Mr. Sandeep Sharma for his useful comments and suggestions.

### REFERENCES

1. Woodcock, M., 1980. Birds of India, Nepal, Pakistan, Bangladesh and Sri Lanka. Harper Collins Publishers, London, UK.
2. Singh, A.P., 2000. Birds of lower Garhwal Himalayas: Dehradun valley and neighbouring hills. Forktail, 16: 101-123.

3. ENVIS, 1998. Wildlife and protected areas. Wildlife Institute of India, Dehradun, India.
4. Pathak, E., 2005. Baseline assessment of avifaunal population of Asan barrage and Bhingora barrage in Uttaranchal, M.Sc. dissertation, Gurukul Kangri University, Haridwar, India.
5. Higuchi, H., M. Nagendran and J.P. Pierre, 2006. Satellite-tracking the migration of cranes and storks. *Acta Zoologica Sinica*, 52: 206-210.
6. Jian-bin, S., Li Di-qiang and X. Wen-fa, 2006. A review of impacts of climate change on birds: implications of long - term studies. *Zoological Res.*, 27(6): 637-646.