



International Journal of Fauna and Biological Studies

Available online at www.faunajournal.com

I
J
F
B
S

International
Journal of
Fauna And
Biological
Studies

E-ISSN 2347-2677

P-ISSN 2394-0522

Impact Factor (RJIF): 5.69

<https://www.faunajournal.com>

IJFBS 2025; 12(5): 120-128

Received: 21-08-2025

Accepted: 24-09-2025

DN Choudhary

Associate professor, University
Department of Zoology, TMBU,
Bhagalpur, Bihar, India

Jay Kumar Jay

Research scholar, Biodiversity
Lab, University Department of
Zoology, TMBU, Bhagalpur,
Bihar, India

Some observations on the impact of climate change on the migratory behavior of some birds in district Bhagalpur, Bihar, India

DN Choudhary and Jay Kumar Jay

DOI: <https://www.doi.org/10.22271/23940522.2025.v12.i5b.1137>

Abstract

Birds are environmentally beneficial creatures that play a crucial role in maintaining ecological balance by acting as key participants in various food chains. This study was carried out in three potential wetlands and its adjoining areas in district Bhagalpur, Bihar from January, 2023 to May, 2025. The main objective of this present work was to investigate the impact of climate change on the migratory behavior of some birds. Altogether forty two species of migratory birds were recorded during this investigation. The observation clearly revealed a significant decline in the number of various migratory species, along with the signs of untimely or irregular migratory patterns in comparison to previous years. Certain migratory birds such as the Osprey, Black tailed godwit, Brown headed Gull, Brahminy duck, Northern pintail, Green shank, Eurasian curlew, Common Sandpiper, Common teal, Great crested grebe, Grey headed lapwing, Gadwal and Pied avocet exhibited significant changes in their usual migration behavior. Some of these bird species such as Osprey, Black tailed godwit, Green shank, Eurasian Curlew, Common Sandpiper, Common Teal and and Pied avocet showed prolonged stay or late departure where as early migration (arrival) was recorded in Northern pintail, Brahminy duck, Gadwall, Grey headed lapwing, Great crested grebe and Brown headed Gull. The sudden decline in their population and the alteration in their migratory patterns may be attributed to either rapid rise in atmospheric temperature and less rainfall or may be due to sudden atmospheric changes. These observations will be helpful for the researchers and academicians and has contribution to the conservation of birds and their habitats.

Keywords: Climate change, migratory birds, migratory behaviour, wetlands and Bhagalpur

1. Introduction

Birds have been found to play a significant role in maintaining the ecological balance and protecting nature's greenery ^[1, 2]. Birds are bio-indicators and ecofriendly creatures. These are very important components of the ecosystem ^[3, 4]. Around 2000 bird species are found in the Indian subcontinent including migratory birds that visit during winter season ^[1, 5]. Presently, these birds are facing many threats like habitat destruction, illegal poaching, lack of suitable feeding grounds and climate change ^[4].

Climate change caused by human activities is one of most popular topic in this century, is globally accepted and considered to have negative effects on the survival of a large number of species on the earth including avifauna. Climate change is of much interest to birds for both resident and migratory species, because birds are widely known to respond to various factors of the climate and their responses are well documented ^[6]. Birds are among the most vulnerable species to weather and climate change due to their high sensitivity to weather and climate change ^[7]. The researchers found that climate change is also has a adverse effect on the migratory pattern and behaviour of many birds species ^[8, 9]. Bird migration is a regular to and fro movement between their breeding ground located in the northern hemisphere and wintering grounds in the southern hemisphere to overcome extreme weather conditions. It is an amazing natural phenomenon performed by the migratory birds every year ^[10]. Anthropogenic climate change is widely recognized as a significant environmental conditions in the 21st century, negatively affecting the biodiversity and threatening the survival of many species ^[11]. Since 1970, the number of migratory birds around the world has dropped a lot. Climate change makes it harder for these birds to survive, which is a main reason for this decline ^[12, 13, 14]. This drop in bird numbers can lead to imbalances in ecosystem and the loss of their important ecological functions ^[15, 16].

Climate change is widely believe to have shifted the distribution of various species towards

Corresponding Author:

Jay Kumar Jay

Research scholar, Biodiversity
Lab, University Department of
Zoology, TMBU, Bhagalpur,
Bihar, India

towards mountain tops and pole. The habitat transformation in birds is caused by higher atmospheric temperature or climate warming is also considered as measure threats of the survival of certain bird species^[17]. Freeman's team also shows reduction even extinction of population of some common high altitude bird species in Peruvian mountains because increasing temperature cause a mass decline of their suitable habitats^[18]. Thus, the above statements clearly showed that in the climatic conditions like global warming, changed precipitation routes, increased frequency of extreme weather have gradually affected the birds behaviour and their habitats too.

The present investigation was aimed to study the changes in the migratory behaviour of some birds in response to climatic changes in district Bhagalpur Bihar.

2. Study area

2.1. Jagatpur wetland

Jagatpur wetland (25°20'219''N & 87°02'623''E) is a perennial freshwater flood plain water body situated in the Gangetic plain approximately 2km away from main stream with an area about 0.4 km². It is located in the plains of river Ganga adjacent to Bhagalpur - Naugachia highway near Jagatpur village. This wetland is mainly rain-fed but underground seepage also contributes to its volume of water. The area under the wetland includes both government and private holdings. The area of this wetland varies depending on the season. However, during the rainy season the wetlands seems larger than its natural size which further enhances the beauty of the area^[19].



Fig 1 & 2: A view of Jagatpur Wetland with a flock of migratory birds

The wetland support many types of macrophytes that may be

grouped into marginal, submerged, floating and emergent categories. The surroundings of the wetland are covered by various tree species. The marginal upper land area is extensively cultivated. It is a home of a large number of resident as well as migratory birds. The suitable climatic conditions, topography and sufficient food present in this wetland provide a good roosting, feeding, breeding and wintering ground for large number of birds every year^[7].

2.2. Vikramshila Gangetic Dolphin Sanctuary

Vikramshila Gangetic Dolphin Sanctuary (VGDS), a part of lower stretch of the river Ganga covering in Bihar. This sanctuary is a 60 kms stretch of the river Ganga between Sultanganj (25° 15' 15'' N & 86° 44' 17'' E) to Kahalgaon (25°16' 54'' N & 87° 13' 44'' E) flowing through Bhagalpur. It was established in 1991 by the Government of Bihar specially to protect the endangered Ganges river dolphins (*Platanista gangetica gangetica*)^[21, 22, 23, 24]. It is the only protected area in India. Besides, this sanctuary has been an important roosting, nesting and foraging ground for a large number of resident and migratory birds for the last many years^[25, 26, 27, 28]. We have covered half area of this sanctuary i.e., Bhagalpur to Khalgaon for this present study.



Fig 3 & 4: A View of Vikramshila Gangetic Dolphin Sanctuary (VGDS), Bhagalpur, Bihar

2.3. Ghatora wetland

Ghatora wetland (25°21'43"N 86°55'08"E) is also known as Sonbarsa-Ghatora Lake or Sonbarsa-Ghatora Wetland. It is also a perennial fresh water body situated near Gauripur village, under Bihpur block in district Bhagalpur, Bihar.

It covers an area of about 4.5 sq km and lies in the flood plains of rivers Ganga. It mainly receives water from River Ganga during flood, flowing at about 1.5 kms away from this wetland. Rain water also contributes to its volume. This

wetland also include both government and private lands. During rainy season the area of the wetland increases due to influx of rain and flood water.



Fig 5 & 6: A view of Ghatora wetland with a flock of migratory birds.

This wetland Supports a variety of flora and fauna including large number of fishes and molluscs which attracts large number of resident and migratory birds for roosting, foraging and breeding. So it is one of the potential birding site in district Bhagalpur, Bihar. The Ghatora wetland is surrounded mainly by crop field, wheat (*Triticum aestivum*), mustard (*Brassica juncea*), pea (*Pisum sativum*) & maize (*Zea mays*) are the main crops cultivated around this wetland. Some macrophytes mainly kans grasses (*Saccharum spontaneum*) are growing in the marginal area of this wetland, provides a roosting site of large number of small grassland. The local farmers use the water of this wetland for irrigation purposes.



Fig 7: River map showing geographical locations (star marks) of three potential birding sites i.e., Jagatpur wetland, Vikramshila Gangetic Dolphin Sanctuary and Ghatora wetland on the Gangetic plains.

3. Materials and methods

All species of migratory birds included in this study were selected based on their occurrence and frequency of sightings from January 2023 to May 2025, in order to assess the impact of climate change. The study was mainly conducted in three wetlands in district Bhagalpur including Jagatpur wetland, Vikramshila Gangetic Dolphin Sanctuary (VGDS) and Ghatora wetland and its adjoining areas. These three wetlands are very potential birding areas in district Bhagalpur, Bihar [22].

Observations on birds and their diurnal activities were recorded primarily through direct visual method. Binoculars (Nikon 8x40) were also used at the time of survey and study. The study also focused on specific areas rich in vegetation, such as bushes and other green patches. These wetlands were visited twice a week, either on foot or by motorcycle. Boats were also used occasionally as per need.

Observations were conducted during the early morning hours (7:00 am - 9:00 am) and evening hours (2:30 pm - 4:30 pm) for optimal visibility and bird activity. Bird species were identified using standard field guides by Salim Ali (2002), Ali and Ripley (1989), and Grimmett *et al.* (2011). All observed activities were carefully recorded for scientific documentation. Photographs and videos were captured using digital camera (Nikon B600) and DSLR (Nikon D5600) for photographic evidence. The collected data were systematically compiled and tables were prepared.

4. Result

The study was conducted between January 2023 and May 2025. Altogether, 42 species of migratory birds belonging to 14 families were recorded from these three selected wetlands during study period (Table-3). Most of the birds showed normal migratory behavior in context of their arrival and departure. It was noticed that some winter birds species deviated from their typical migratory pattern.

In the year 2024 and 2025 early migration was recorded in Northern pintail (*Anas acuta*) and Brahminy duck (*Tadorna ferruginea*) in the last week of October than expected i.e., mid-December. Few other birds like Brown headed gull (*Chroicocephalus brunnicephalus*), Gadwall (*Mareca strepera*), Great crested grebe (*Podiceps cristatus*) and Grey headed lapwing (*Vanellus cinereus*) were observed in the first week of November (table-1).

Similarly few winter birds species such as Black tailed godwit, Common sandpiper, Common teal, Eurasian curlew, Green shank and osprey showed their prolonged stay even in the month of 2nd week of May in two successive years i.e., 2024 and 2025 respectively than expected i.e. end of March (Table-2). These birds were found foraging in these wetland in small flock containing 4 to 7 individuals.

Not only this, the number of few migratory bird species such as Northern pintail, Red crested pochard, Gadwal and White eye pochard were found significantly decreased in comparison to previous years. Common coots and Common teals were recorded in sufficient numbers in the year 2023 to 2025 in comparison to other migratory birds.

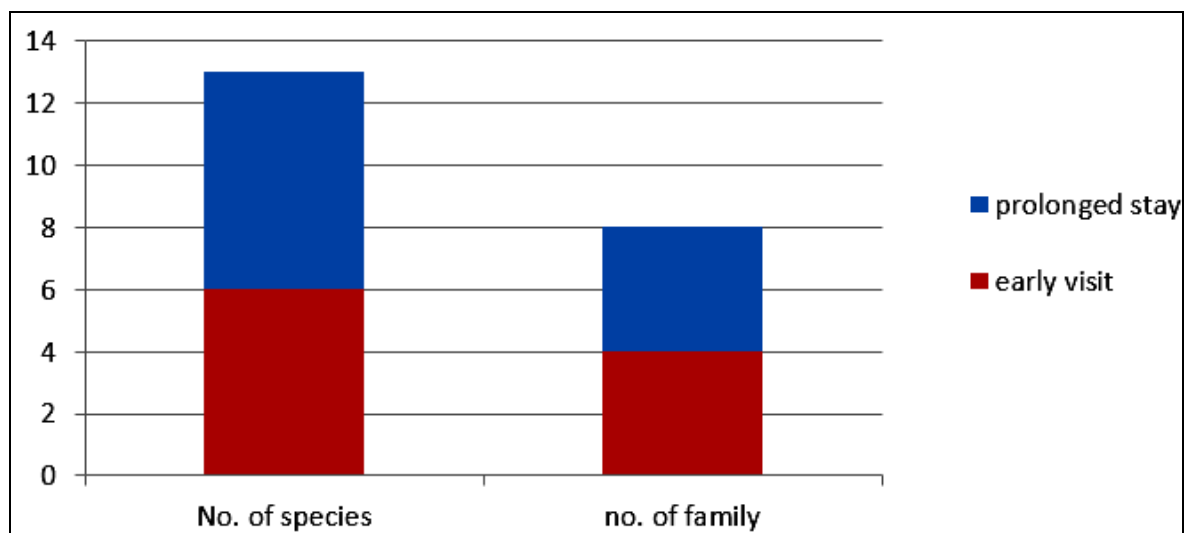
Lesser and Large whistling teals which are resident birds were recorded in largest number in all the three wetlands.

Table 1: List of some migratory birds showing early arrival Abbreviations: LC- list count, NT- Near threatened, VGDS- Vikramshila Gangetic Dolphin Sanctuary

S.NO.	Local Hindi Name	Common English Name	Scientific name	Family	IUCN Status	Place of sighting	Year of sighting
1.	Seekhper, Dighouch	Northern pintail	<i>Anas acuta</i>	Anatidae	LC	Ghatora wetland & Jagatpur wetland both.	October Last Week, 2024
2.	Surkhab	Brahminy Duck	<i>Tadorna ferruginea</i>	Anatidae	LC	VGDS	October Last Week, 2024
3.	Dhomra	Brown-headed Gull	<i>Chroicocephalus brunnicephalus</i>	Laridae	LC	VGDS	November 1 st Week, 2024
4.	Shivhansh	Great crested grebe	<i>Podiceps cristatus</i>	Podicipedidae	LC	VGDS	November 1 st Week, 2024
5.	Maila, Gugrail	Gadwall	<i>Mareca strepera</i>	Anatidae	LC	VGDS	November 1 st Week, 2024
6.	Dhusar sir titahri	Grey headed lapwing	<i>Vanellus cinereus</i>	Charadriidae	LC	VGDS & Jagatpur wetland	November 1 st Week, 2024

Table 2: List of some migratory birds showing prolonged stay or late departure in the Second week of May, 2024 & 2025. Abbreviations: LC- list count, NT- Near threatened, VGDS- Vikramshila Gangetic Dolphin Sanctuary

S. No.	Local Hindi Name	Common English Name	Scientific name	Family	IUCN Status	Place of sighting
1.	Gudera	Black tailed godwit	<i>Limosa limosa</i>	Scolopacidae	NT	Jagatpur wetland, Ghatora wetland & VGDS
2.	Samanya choubaha	Common sandpiper	<i>Actitis hypoleucos</i>	Scolopacidae	LC	Jagatpur wetland & Ghatora wetland
3.	Karra	Common teal	<i>Anas crecca</i>	Anatidae	LC	VGDS & Jagatpur wetland
4.	Bada gulinda	Euresian curlew	<i>Numenius arquata</i>	Scolopacidae	NT	VGDS
5.	Timtima	Green shank	<i>Tringa nebularia</i>	Scolopacidae	LC	Ghatora wetland & VGDS
6.	Machranga	Osprey	<i>Pandion haliaetus</i>	Pandionidae	LC	Jagatpur wetland & VGDS
7.	Halmukhi or kasya chaha	Pied avocet	<i>Recurvirostra avosetta</i>	Recurvirostridae	LC	VGDS

**Fig 8:** Histogram showing deviation in migratory pattern i.e early visit and late departure or prolonged stay by the wintering birds of different families and species.**Table 3:** A checklist of total migratory birds, recorded in three different wetlands and its adjoin areas in district Bhagalpur, Bihar in between January,2023 to May, 2025. Vulnerable, (+)-Present, (-)- Absent.

S.no.	Family with Local name	Common English name	Scientific name	IUCN status	Jagatpur wetland			Vikramshila Gangetic Dolphin Sanctuary			Ghatora wetland		
					2023	2024	2025	2023	2024	2025	2023	2024	2025
	Family - Anatidae												
1	Seekhper, Dighouch	Northern pintail	<i>Anas acuta</i>	LC	+	+	+	+	+	+	+	+	+
2	Tidari battakh	Northern Shoveller	<i>Spatula clypeata</i>	LC	+	+	+	+	+	+	+	+	+
3	Karra	Common teal	<i>Anas crecca</i>	LC	+	+	+	+	+	+	+	+	+
4	Chaita	Gargeny	<i>Anas querquedula</i>	LC	+	+	+	+	+	+	+	+	+
5	Maila, Gugrail	Gadwall	<i>Mareca strepera</i>	LC	+	+	+	+	+	+	+	+	+
6	Lalsir	Red crested pochard	<i>Netta rufina</i>	LC	+	+	+	+	+	+	+	+	+
7	Karchia battakh	White eye pochard	<i>Aythya nyroca</i>	NT	+	+	+	+	+	+	+	+	+
8	Kalsira, Ablak battakh	Tufted pochard	<i>Aythya ferina</i>	LC	-	-	-	-	-	+	+	+	+
9	Chota lalsar	Common pochard	<i>Aythya ferina</i>	VU	+	+	+	+	+	+	+	+	+
10	Patari	Wigeon	<i>Mareca Penelope</i>	LC	+	+	-	+	+	+	+	+	+
11	Chakwa, Surkhab	Brahminy duck	<i>Tadorna ferruginea</i>	LC	-	-	-	+	+	+	+	+	+
12	Bada sillhi	Fulvous whistling	<i>Dendrocygna bicolor</i>	LC	+	+	+	+	+	+	+	+	+

		duck											
13	Kalhans	Greylag goose	<i>Anser anser</i>	LC	-	-	-	-	-	-	+	+	+
14	Pattidhari savan	Bar headed goose	<i>Anser indicus</i>	LC	-	-	-	+	+	+	+	+	+
	Family - Podicipedidae												
15	Shivhans	Great crested grebe	<i>Podiceps cristatus</i>	LC	-	-	-	+	+	+	+	+	+
	Family - Pandionidae												
16	Machranga	Osprey	<i>Pandion haliaetus</i>	LC	+	+	+	+	+	+	+	+	+
	Family - Falconidae												
17	Khermutia baaz	Common kestrel	<i>Falco tinnunculus</i>	LC	+	+	+	+	+	+	+	+	+
18	Saheebaaz	Peregrine falcon	<i>F. peregrinus</i>	LC	+	-	-	+	+	+	+	+	+
	Family - Accipitriformes												
19	Chota baaz	Booted eagle	<i>Hieraetus</i>	LC	-	-	+	+	+	+	+	+	+
	Family - Rallidae												
20	Tilakdhari, Kesrar	Common Coot	<i>Fulica atra</i>	LC	+	+	+	+	+	+	+	+	+
	Family - Charadriidae												
21	Merwa	Little ringed plover	<i>Charadrius dubius</i>	LC	-	-	-	+	+	+	+	+	+
22	Merwa	Kentish plover	<i>Anarhynchus alexandrinus</i>	LC	-	-	-	+	+	+	+	+	+
23	Dhusar sir tithari	Grey headed lapwing	<i>Vanellus cinereus</i>	LC	-	-	+	+	+	+	+	+	+
	Family - Recurvirostridae												
24	Kashya chaha	Pied avocet	<i>Recurvirostra avosetta</i>	LC	-	-	-	+	+	+	-	-	-
	Family - Scolopacidae												
25	Chupka	Common sand piper	<i>Tringa hypoleucos</i>	LC	+	+	+	+	+	+	+	+	+
26	Van jalrank, Chupka	Wood sandpiper	<i>Tringa glareola</i>	LC	+	+	+	+	+	+	+	+	+
27	Runni	Little stint	<i>Calidris minutus</i>	LC	+	-	-	+	+	+	+	+	+
28	Chota panlauwa	Temminck's stint	<i>Calidris temminckii</i>	LC	-	-	-	+	+	+	+	+	+
29	Timtima or harit jalrank	Common green shank	<i>Tringa nebularia</i>	LC	-	-	-	+	+	+	-	-	-
30	Bada gulinda	Euresian curlew	<i>Numenius arquata</i>	NT	-	-	-	+	+	+	-	-	+
31	Gudera	Black tailed godwit	<i>Limosa limosa</i>	NT	-	-	+	+	+	+	+	+	+
	Family - Laniidae												
32	Lambpucha Lahtora	Long tail shrike	<i>Lanius schach</i>	LC	-	+	-	-	-	-	-	-	-
33	Bhura Lahtora	Brown shrike	<i>Lanius cristatus</i>	LC	+	+	+	-	-	-	+	+	+
	Family - Muscicapidae												
34	Neelkanthi	Bluethroat	<i>Luscinia svecica</i>	LC	-	-	-	-	-	-	+	+	+
35	Bhatpidda, Kharpidda	Siberian stonechat	<i>Saxicola maurus</i>	LC	-	-	-	+	+	+	+	+	+
36	Nargoti	Taiga flycatcher	<i>Ficedula albicilla</i>	LC	+	+	+	-	-	-	+	+	+
37	Thirthira	Black red start	<i>Phoenicurus ochruros</i>	LC	+	+	+	-	-	-	-	-	-
	Family - Motacillidae												
38	Panika	Citrine wagtail	<i>Motacilla citreola</i>	LC	-	+	+	+	+	+	+	+	+
39	Safed khanjn	White wagtail	<i>Motacilla alba</i>	LC	+	+	+	+	+	+	+	+	+
	Family - Hirundinidae												
40	Ababeel	Common swallow	<i>Hirundo rustica</i>	LC	+	+	+	+	+	+	+	+	+
	Family - Laridae												
41	Dhomra	Brown headed gull	<i>Chroicocephalus burnicephalus</i>	LC	-	-	-	+	+	+	+	+	+
42	Kurri	Whiskered tern	<i>Chlidonias hybrida</i>	LC	+	+	+	-	-	-	+	+	+

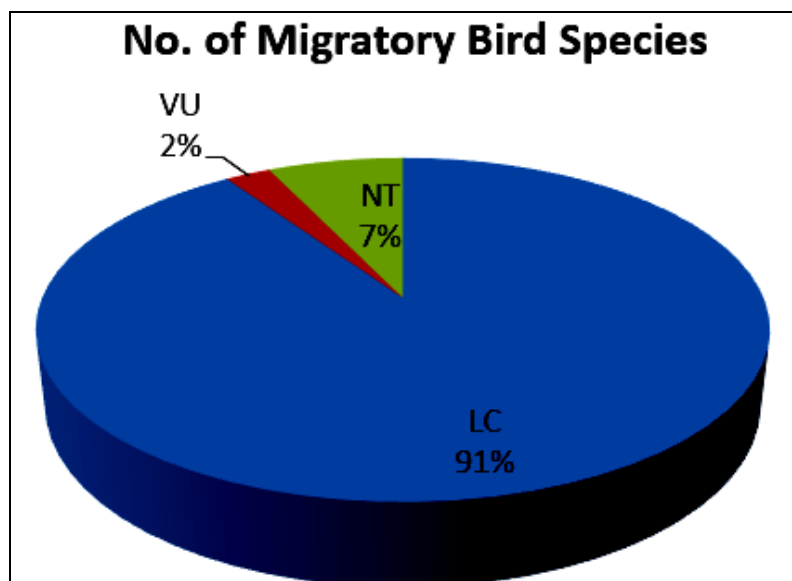


Fig 9: Pie chart showing percent distribution of migratory birds as per IUCN status

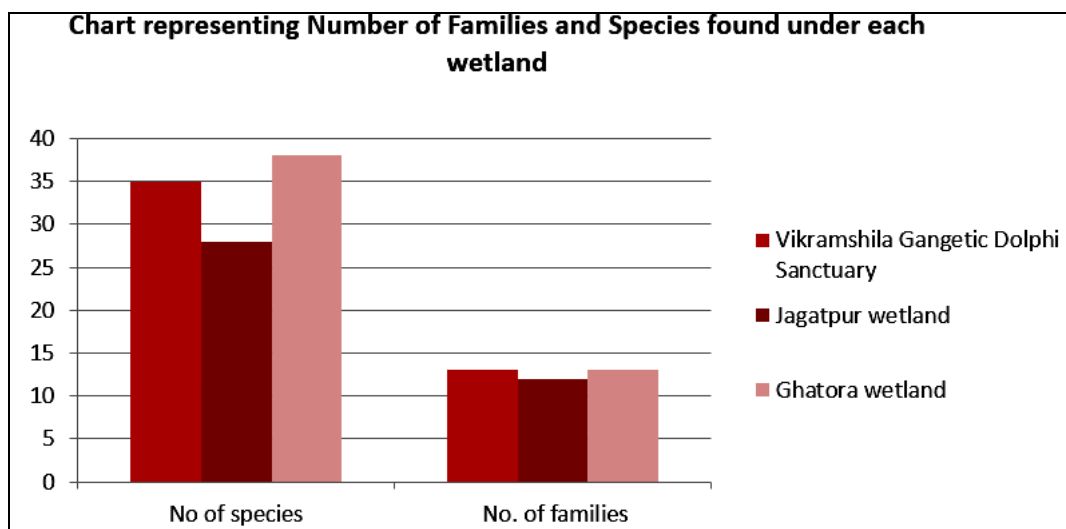


Fig 10: Histogram showing number of migratory birds species belong to different families recorded in three consecutive years 2023-2025.



Plate 1: Photographs of some migratory species showing early migration

**Plate 2:** Photographs of some migratory species showing late departure

5. Discussion

Birds are among the most vulnerable species to weather in climate change due to their higher sensitivity to whether and climate [7]. Climate change is widely believed to have shifted the distribution of various bird species towards mountain tops and the habitat transformation in birds is caused by higher atmospheric temperature or climate warming [17]. Birds are sensitive to landscape modifications as well as to the presence of persistent pollutants [8, 29]. Birds particularly are diverse and are high in the food chain which makes them very sensitive to changes in the environment [30]. There are already evidences that changed in weather pattern and climate change have impacted bird's behavior [31, 32].

Rising temperature caused by the climate has big impact on bird migration. Variation in temperature cause birds to change when and where they migrate because they respond new environmental signals [33, 34].

During the present investigation it was recorded that some migratory birds showed early arrival and visited these selected wetlands very earlier than normal (table 1). It may be due to the effects of temperature variations or warmer weather as it

causes the birds to start their migration earlier or later than normal. So, they can match changes in their food availability for breeding conditions along their route [35]. Early arrival of some migratory birds such as Northern pintail (*Anas acuta*) and Brahminy duck (*Tadorna ferruginea*), Brown headed gull (*Chroicocephalus brunnicephalus*), Gadwall (*Mareca strepera*), Great crested grebe (*Podiceps cristatus*) and Grey headed lapwing (*Vanellus cinereus*) may be due to variation in their periods of reproduction and migration or may be due to sudden change in weather pattern and climate which have impacted birds behaviour including alteration in the timing of migration and change in breeding performance and breeding success [28, 36, 37].

Some migratory birds as mentioned in (Table 2) were recorded in the selected wetlands in 2nd week of May in two successive years that is 2024 and 2025. These birds are showing their prolonged stay may be due to improvement in the quality of habitat (air and water), less noise pollution, undisturbed and calm wildlife [38]. The late departures of these migratory birds also may be due to drastic changes in the weather pattern of climate [8, 37, 39]. The availability of large

number of foods, less disturbance and less human interferences making the climate favourable for these birds, cause them to stay longer in the warmer period and so spotted in the second week of May in both the years i.e., 2024 and 2025, may be the another reasons^[8].

sometimes low level of pollution unexpected reduction in human activity and sudden silence in the locality and climate change surprise the birds and other animals to show some uncommon behaviours^[28, 40]. There is a certain correlation between atmospheric changes with the behavioural changes of animals^[4, 41]. Climate change have also an impact on the timing of egg laying birds and late to mismatch between the timing of breeding and availability of staple food for birds^[42]. Late departure of certain migratory birds as recorded in this present investigation may the effects of injury caused by some predatory animals or sickness due to some infectious diseases, cannot be ignored. As the climate change causes variation in the habitat of many birds increasing the risk of contrasting diseases in birds^[43].

6. Conclusion

Thus the above observations clearly revealed that the changes in the climate such as temperature variation or warming, changed precipitation, increased frequency of extreme weather, habitat change and infectious diseases caused by the climate change have gradually affected the migratory pattern as well as the other behaviours of the species of birds and their habitats too. Changes in temperature and rainfall are negative factors which is affecting both population dynamics as well as migratory behaviour that is time of arrival and departure of the bird species that depend on wetlands. There is a urgent need of some flexible conservation strategies to protect these birds from the effect of climate change.

7. Author's contribution

First author designed the work and prepare the manuscript. Second author surveyed the study area and collected the data.

8. Acknowledgement

The authors are grateful to the University Department of Zoology, T.M.B.U, Bhagalpur for providing necessary facilities and support.

We are also thankful to all the teachers of the department and Research Scholars mainly Mr. Pintu Kumar Azad, Mr. Deepak Kumar and Ms. Priyanka Sagar for their Continuous support and encouragement.

The authors also convey their thanks to some birders including Mr Rahul Rohitashwa, Mr. Sumit Kumar Sum, Mr. Gyan Chandra Gyani and Mr. Divyanshu (Research Scholar) for their various support during the course of field work.

9. Reference

1. Ali S. The Book of Indian Birds. Edn 13th, BNHS, Oxford University Press, Mumbai, India, 2002.
2. Grimmett R, Inskipp C, Inskipp I. Birds of the Indian subcontinent. Edn 2nd, Oxford Univ press, New Delhi.
3. Chaudhary DN, Mishra A, Ghosh TK, Rohitashwa R. Avi-fauna of eco park of Barauni Refinery, Begusarai, Bihar. Newsletter for Birdwatchers. 2009;49:11-13.
4. Rohitashwa R, Choudhary DN. Threatened birds on postage stamps of India: A step towards conservation. BUCEROS. 2024;29(3):22-27.
5. Ali S. and Ripley SD. Compact Edition of the Handbook of the Birds of India and Pakistan. Oxford University Press, New Delhi; 1987.
6. King D, Finch DM. Climate Change Resource Center U.S, The effects of climate change on terrestrial birds of North America, U.S. Dept. Of Agriculture, Forest Service, Climate Change Resource Center, Washington, Dc, 2013.
7. Sparks TS, Crick HQP, Elkins N, Moss R, Myllne K. Birds, weather and climate. Weather. 2002;57(11):399-410. <https://doi.org/10.1256/004316502321951264>.
8. Choudhary DN, Chintapalli B, Rohitashwa, R. Behavioral response of some migratory birds and Gangetic dolphins to COVID-19 induced lockdown: A case study in the Vikramshila Gangetic Dolphin Sanctuary (VGDS), Bhagalpur, Bihar, India. Asian Journal of Environment & Ecology. 2022;17(3):1-8. <https://doi.org/10.9734/ajee/2022/v17i330291>
9. Choudhary DN, Abdullah. Some Observations on the Nest Site Selection, Nesting and Other Breeding Behaviors of Greater Adjutant Stork (*Leptoptilos dubius*) in the Flood Plains of Kosi River in District Bhagalpur, Bihar, India. Asian Journal of Environment & Ecology. 2023;20(2),19-31. <https://doi.org/10.9734/ajee/2023/v20i2434>.
10. Sivakumar S. Bird Migration and Related Studies in India. Science reporter. 2025;62 (6):38-40.
11. Li X, Liu Y, Zhu Y. The Effects of Climate Change on Birds and Approaches to Response. IOP Conference Series:Earth and Environmental Science. 2022;1011:012054. <https://doi.org/10.1088/1755-1315/1011/1/012054>.
12. Saino N, Ambrosini R, Rubolini D, von HJ, Provenza A, Hueppop K *et al.* Climate warming, ecological mismatch at arrival and population decline in migratory birds. Proc. R. Soc. B-Biol. Sci. 2011;278(1707):835-842. <https://doi.org/10.1098/rspb.2010.1778>.
13. Pearson RG, Phillips SJ, Loranty MM, Beck PSA, Damoulas T, Knight SJ, Goetz SJ. Shifts in Arctic vegetation and associated feedbacks under climate change. Nat. Clim. Change. 2013;3(7):673-677. <https://doi.org/10.1038/nclimate1858>.
14. Spooner FEB, Pearson RG, Freeman R. Rapid warming is associated with population decline among terrestrial birds and mammals globally. Glob. Change Biol. 2018;24 (10):4521-4531. <https://doi.org/10.1111/gcb.14361>.
15. Hewson CM, Thorup K, Pearce-Higgins JW, Atkinson PW. Population decline is linked to migration route in the Common Cuckoo. Nat. Commun. 2016;7:1-8. <https://doi.org/10.1038/ncomms12296>.
16. Cohen JM, Lajeunesse MJ, Rohr JR. A global synthesis of animal phenological responses to climate change. Nat. Clim. Change. 2018;8(3):224-231. <https://doi.org/10.1038/s41558-018-0067-3>.
17. Lehikoinen A, Virkkala R. North by north-west climate change and directions of density shifts in birds. Global Change Biology. 2015;22:1121-1129.
18. Freeman BG, Scholer MN, Ruiz-Gutierrez V, Fitzpatrick JW. Climate change causes upslope shifts and mountaintop extirpations in a tropical bird community. Proceedings of the National Academy of Sciences. 2018;115:11982-11987.
19. Kumar BN, Choudhary SK. Avifauna of Jagatpur wetland near Bhagalpur (Bihar, India). Indian Birds.

- 2010;6(1):15-17.
20. Chintapalli B, Patra R, Kumar A, Kumar S. Jagatpur Wetland: A Hidden Gem of Wilderness from Bhagalpur. ResearchGate; 2022. Retrieved from https://www.researchgate.net/publication/361259684_Jagatpur_Wetland_A_Hidden_Gem_of_Wilderness_from_Bhagalpur.
 21. Sinha RK. The Gangetic Dolphin and action plan for its conservation in Bihar. Department of Environment and Forests, Govt. of Bihar, Patna. 2013.
 22. Choudhary DN, Mishra A. Sighting of some threatened bird species in Vikramshila Gangetic Dolphin Sanctuary (VGDS) Bhagalpur, Bihar. Newsletter for Birdwatchers. 2006;46(5), 68-70.
 23. Kelkar N, Krishnaswamy J, Choudhary S, Sutaria D. Co-existence of fisheries with river dolphin conservation. Conservation Biology. 2010;24:1130-1140.
 24. Kumar M, Choudhary SK, Varma MC. Fish fauna distribution pattern, Threats and their conservation issues in protected areas: A case study from Vikramshila Gangetic Dolphin Sanctuary in Lower Ganga, Bihar, India. Int. J. Sci. and Technol. Res. 2019;8(9):1210-1217.
 25. Choudhary SK, Smith BD, Dey S, Dey S, Prakash S. Conservation and biomonitoring in the vikramshila sanctuary, Bihar, gangetic dolphin India. Oryx. 2006;40(2):1-9.
 26. Choudhary DN, Mishra A, Singh AK. Breeding of Little Tern and other wetland birds in VGDS, Bhagalpur, Bihar. MISTNET. 2007;8(2):13-14.
 27. Choudhary DN, Mishra A, Choudhary N. A mixed breeding colony of Little tern, Black winged stilt and Red wattled lapwing in VGDS, Bhagalpur, Bihar. NL Bird Watchers. 2008;49(1):17-18.
 28. Choudhary DN, Rohitashwa R. Some observations on the behavioral changes in few resident birds during COVID-19 induced lockdown in Bhagalpur, Bihar. Int. J. Adv. Res. Biol. Sci. 2022;9(1):58-64.
 29. Backhaus Th, Snape J, Lazorchak. The impact of chemical pollution on Biodiversity and Ecosystem Services: The need of an improved understanding. Integrated Environmental Assessment and Management. 2012;8:575-576.
 30. Thomas CD. Climate, climate change and range boundaries. Diversity and Distributions. 2010;16(3):488-495.
 31. Parmesan C. Ecological and evolutionary responses to recent climate change. Annual Review of Ecology, Evolution, and Systematics. 2006;37Z:637-669.
 32. Both C, Bouwhuis S, Lessels CM, Vissor ME. Climate change and population declines in a long distance migratory birds. Nature. 2006;441:81-83.
 33. . Keogan K, Daunt F, Wanless S, Phillips RA, Walling CA, Agnew P *et al.* Global phenological insensitivity to shifting ocean temperatures among seabirds. *Nature Climate Change*. 2018;8(4):313-320. <https://doi.org/10.1038/s41558-018-0115-z>.
 34. Wilson KL, Skinner MA, Lotze HK. Projected 21st-century distribution of canopy-forming seaweeds in the Northwest Atlantic with climate change. Divers. Distrib. 2019;25 (4):582-602. <https://doi.org/10.1111/ddi.12897>.
 35. . Cox G W. Bird migration and global change. Island Press, 2010.
 36. Bar H. COVID-19 lockdown: Animal life, ecosystem and atmospheric environment. Environment, Development and Sustainability. 2021;23(1):8161-81718.
 37. Crick HPQ. The impact of climate change on birds. Ibis. 2004;146(1):48-56.
 38. Arora S, Bhaukhandi KD, Mishra PK. Corona virus lockdown helped the environment to bounce back. J. Sci. Total. Environ. 2020;742:140573.
 39. Rushing CS, Ryder TB, Marra PP. Quantifying drivers of population dynamics for a migratory bird throughout the annual cycle. Proc. R. Soc. B-Biol. Sci. 2016;283 (1823):1-10. <https://doi.org/10.1098/rspb.2015.2846>.
 40. Rutz C, Loretto MC, Cagnacci F. COVID-19 lockdown allows researchers to quantify the effects of human activity on wildlife. Nature Ecology & Evolution. 2020;4(9):1156-1159. <https://doi.org/10.1038/s41559-020-1237-z>.
 41. Narayani PA. Pandemic-induced lockdown gives migratory birds and animals a reason to cheer. 2020, April 29. The Hindu. <https://www.thehindu.com>
 42. Crick HPQ, Dudley C, Glue DE, Thomson DL. UK birds are laying eggs earlier. Nature. 1997;388:526-526.
 43. Gilbert M, Slingenbergh J, Xiao X. Climate change and avian influenza. Revue Scientifique et Technique (International Office of Epizootics). 2008;27:459-466.