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Birds And Changing Climate: A Review

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ABSTRACT

The global bird community is seriously threatened by climate change, which will modify their phenology, mating cycle, and migration. This study reviews recent findings on how the environment and human behavior are reacting to warming temperatures. Significant gaps in long-term data and geographical coverage persist despite increased awareness. In order to prevent further biodiversity loss in the bird population, the study emphasizes the necessity of conservation strategies and improved monitoring.

INTRODUCTION

Birds are fascinating animals of the animal kingdom. There are more than 10,400 living species. Birds are distinctly separated from all other living beings by the feathers that cover their bodies and while feathers are truly exclusive to birds, it is the incredible abilities these remarkable creatures possess with them that makes birds so extraordinary (Conservancy, 2019). Birds possess highly developed eyesight and rely heavily on their vision to perceive and navigate their environment. Birds are more closely related to the reptiles when compared to the mammals. Since the ancient times birds do not only serve the practical purpose but also have a very important cultural significance (Cocker & Mabey, 2020). Since the ancient times birds have been the topic of interest and in the recent times bird watching has developed as a source of enjoyment and also environmental awareness (Birkhead & Charmantier, 2009). This led to the development of the scientific study of birds. The major transformation in this study was marked by rejection of the folk lore and only focusing on the biology of the birds by Ray and Willoughby's encyclopedia, the ornithology of Francis Willoughby (1676 and 1678). This scientific study is termed as ornithology which is a branch of zoology. Ornithology, in its true sense, refers to the systematic study and understanding of birds and everything associated with them (Shufeldt et al., 1893). In other words, feathered creatures have pulled in more than their reasonable share of our zoological considerations. Birds play an important role in the ecological system as scavenger, predator, pollinator etc. They are also an indicator to the environmental health that means any loss in the diversity of the species indicates the degradation of the environment. There is a large decline in the bird

population in the recent years due to the habitat loss, global warming, environmental degradation and climate change.

This review states the changes in the climate and weather conditions and its impacts on the avian community like the changes in the phenology, route of migratory birds and rapid decline of avian population due to the increasing temperature and global warming. It also deals with the data of the avian species population and the IUCN list and at the end with the conservative methods and government policy like CAP to protect the declining avian population from the changes in the climate.

BIRDS AND THEIR ECOLOGICAL IMPORTANCE

Birds are amongst those species of animal kingdom that are found all over the world and survive in various habitats like forest, grassland, wetlands, polar islands and water bodies etc. They are able to achieve this by undergoing various physical and behavioral changes specific to various climates. Physical adaptations include specialized beaks, claws, camouflage etc. Not all avian species have the ability to soar, as certain types have adapted to thrive in various environments. Birds inhabit virtually every part of the globe, occupying nearly every kind of ecosystem. Birds display a remarkable range of shapes and sizes, from the small bee hummingbird to the enormous ostrich. Their feeding habits are diverse, ranging from herbivores that consume plants and seeds to carnivores that prey on insects, fish, and other creatures (G & Alam, 2024).



Fig 1. Different feeding habits of birds (Trichoglossus moluccanus, Magpie). (Tiffany & Carrell, 1977)



Fig 2. THE TINY BEE HUMMING BIRD [*Mellisuga helenae*](Conservancy, 2019)



Fig 3. ostrich (*Struthio camelus*)(Gilpin, 2000)

Birds are found in nearly every environment each habitat supporting unique bird community(G & Alam, 2024). Birds being sensitive to the surrounding are excellent indicators of health of the environment. They also play a very pivotal role in balancing the ecological system by acting as an agent for plant distribution, controlling pests, scavengers, They are also a very good pollinators and help in nutrient cycling. Birds have an effective system for dispersal of seeds.Following their consumption of berries, the berry seeds are disposed out with their excreta.The seeds are dropped with the excretory matter of the birds, which fertilizes them well and gives them excellent growing circumstances.Furthermore, many bird species are important forest vegetation browsers.For instance, a significant number of forest tree and shrub species, according to McEwen (1978), possessed meaty fruits that attracted birds.

The behavior, distribution, seasonal cycles, and demographic patterns of birds strongly correspond to the temporal and spatial scales of agricultural development. Features of the agricultural ecosystems are reflected in the foraging, nest-site selection, and breeding performance. Important life events like breeding or migration are influenced by the pattern of events in the yearly farming calendar (Tabur, M. A., & Ayvaz, Y, 2010). Birds are very important in agricultural sector as they help farmers get rid of insects, rodents as birds act as a predator. They are good sanitary agents because of their ability of scavenging in many locations; the capacity of birds to scavenge rubbish is a crucial method of disposing of waste and preventing disease epidemics that may arise from an accumulation of animal carcasses. There are many scavenger birds in agro-ecosystems. In agriculture, bird excrement has substantial utility. Because bird excreta include potassium, nitrogen, phosphate, and other nutrients, they are utilized as fertilizer in agriculture. By increasing the soil's nitrogen level, this can quickly turn into ammonia and act as a beneficial fertilizer for plants. It was recently demonstrated that birds provide 38.0% of the world's agricultural output. Birds play a crucial role in maintaining biodiversity, however they are widely affected by the current trend of climate change altering their behavior, nesting, migration etc. (Mariyappan et al., 2023), (Martín, 2013), (Cohen et al., 2020)

CLIMATE CHANGE IMPACTS

The influence of weather and climate on the population dynamics of birds has been a significant area of research for ornithologists and researchers over the last fifty years. It has been a key focus in literature on the topic, starting from Lack's influential works, *The Natural Regulation of Animal Numbers and Population Studies of Birds* (Lack 1954, 1966), to more recent publications like *Newton's Population Limitation in Birds* (Newton 1998). Although climate change has a far-reaching implication on birds it has only recently started to be addressed. There are many convincing evidence and examples that the climate change has deteriorating impacts on population of birds. Studies show that more than two-thirds of bird species in North America are at risk due to climate change, with 76% of these species likely to gain from keeping global warming to 1.5°C rather than 3.0°C. This susceptibility is worsened by alterations in habitat and food sources, resulting in reductions in bird populations. Prolonged droughts and frozen periods are examples of extreme weather occurrences that can have disastrous impacts on bird populations, including long-term repercussions on entire cohorts. El Niño events are one example of frequently occurring catastrophic occurrences that have a big regional impact on seabirds. Some consequences include earlier breeding, altered migratory timing, and altered breeding performance (egg size, nesting success), small population sizes, changes in population distributions and selection differentials among population components. Because birds are popular and frequently have an iconic status worldwide (for instance, storks are known as "rain birds" in Africa, and eagles have been used as heraldic symbols for centuries in Europe and North America), they have the potential to be significant bioindicators (Stotz, 1996), (Wilsey et al., 2022)

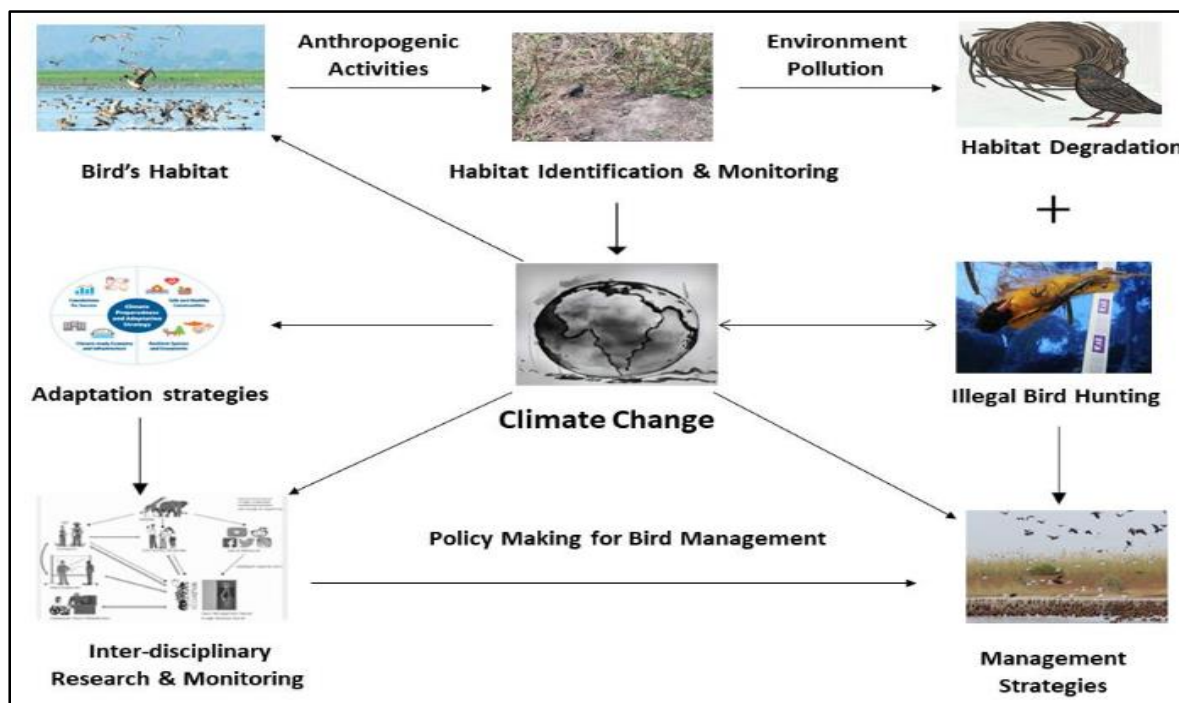


Fig4. climate change impacts (Kabir et al., 2024c)

POPULATION DECLINE

The decrease in bird populations resulting from climate change is a complex problem, shaped by numerous ecological and evolutionary influences. Studies show that climate change has caused alterations in migration behaviors, breeding success, and the availability of food, all of which together lead to declines in bird species populations. (Buskirk et al., 2010). The "State of India's Birds" report reveals that around 60% of Indian bird species have experienced long-term population declines in the year 2024 (State of India's Birds Partnership, 2020). Decrease in Suitable Habitat a case study on Indian birds : This study projected the impact of global climatic changes on habitat suitability of 478 birds in India, which has the 9th highest number of bird species globally, under the conditions in (2015). The study predicted that the average amount of suitable habitat for birds that do not live in forests or other specialized habitats will decline. This suggests that as climate changes take place, these birds may have a harder time locating acceptable dwelling conditions (Diengdoh & Srinivasan, 2024). Other reports also revealed that avian population is 40 percent declined in the last 8 years. Extensive alterations in bird species populations and ecological communities have been linked to changing climate; rising temperatures have been connected to declines in long-distance migrators and habitat specialists.

Long-term population patterns showed a stronger correlation with species' sensitivity to temperature rather than to precipitation, indicating that rising temperatures have exerted a larger effect on population trends than shifts in precipitation levels. The months that experienced the most significant warming emerged as the key

factors influencing long-term changes. Based on 30 million bird observations, the findings were included in the State of India's Birds 2023 study, by a group of 13 government and nonprofit conservation groups. According to this report, 178 birds have including the Nilgiri laughingthrush, the Andaman serpent eagle, the Indian courser, and the sarus crane need high conservation priority with immediate conservation action plans (State of India's Birds Partnership, 2020). The downward trajectory of bird populations in India is consistent with global trends; the 2022 State of the World's species report states that 48% of species have dropped off the approximately 1,350 bird species in the world, 78 are unique to India. There was 40 percent decline in overall avian community across the globe. The report of bird's life international of 2018 have mentioned that there are approximately 1469 globally threatened species. That means one out of 8 birds is in verge of extinction. This represents a growth of 40% in extinction of the species since 1988. (BirdLife International, 2018).

Table 1. Indicate the trend abundance index of the bird species in India. (State of India's Birds Partnership, 2020, Pp 199).

Trend status	Long term trend	Current status
Rapid decline	98	64
Decline	107	78
Stable	98	189
Increase	19	17
Rapid increase	17	11
Trend inconclusive	185	284
Data insuffecient	419	299
TOTAL	942	942

CHANGES IN PHENOLOGY

The study of plant and animal life cycle events that are brought on by changes in the environment, particularly temperature, is known as phenology. From the early openings of leaf and flower buds to the hatching of insects and the return of birds, a wide variety of events are covered. Each provides a quick assessment of the surroundings as perceived by the related organism. Phenological occurrences are therefore perfect markers of how local and global weather and climate change affect the earth's ecosystem (Schwartz, 2003). Climate change seems to be affecting the phenology of avian migration. Disparities in the timing of these yearly cycles that appear to be in conflict (Thorup et al., 2006). In migratory species of aves, rising temperatures have been associated with their sooner arrival at breeding locations, allowing for an earlier initiation of breeding and resulting in shifts in population size. Consequently, long-term population patterns might indicate a species' ability to adapt to climate change. Nonetheless, when a species is more numerous, it is also simpler for observers to notice, resulting in an earlier recognition of its arrival. (Koleček et al., 2020). It is unclear how the circumstances in their winter habitats offer insights on the optimal timing for migration, and climate change could pose specific difficulties for migratory birds that occupy various locations throughout different segments of the yearly cycle. Essential factors influencing migrant bird's reproductive success and fitness are when they arrive and how they appear on the breeding grounds. The factors affecting alterations in migratory phenology are not completely comprehended, even though the impacts of global climate change on temperate species are increasingly being documented. Although laboratory experiments demonstrate that evolutionary adaptations in migration timing can happen over a brief timespan, and empirical research suggests there is considerable phenotypic plasticity in migration timing, long-distance migrants might be constrained in their plastic reactions to climate change by internal rhythms that govern migration (Cotton, 2003). Birds breeding behavior and migration is closely linked to many environmental factors like temperature, weather, food availability as they serve as an indicator to the avian community but due to significant rise in temperature these indicators have become less accurate causing birds to reach their breeding areas earlier than in the past decades causing shortage in the food availability. According to the research done by the Bombay Natural History Society (BNHS). The Eurasian Golden Oriole now reaches its nesting grounds in India almost five years earlier when compared 30 years ago. These changes may result in inconsistencies between the availability of food and breeding habits, which are essential for the survival of their offspring (Sharma, 2024). Populations of long-distance migratory birds experienced adverse impacts from May temperatures, aligning with the possibility that phenological mismatches could negatively influence their breeding success (Pearce-Higgins et al., 2015).

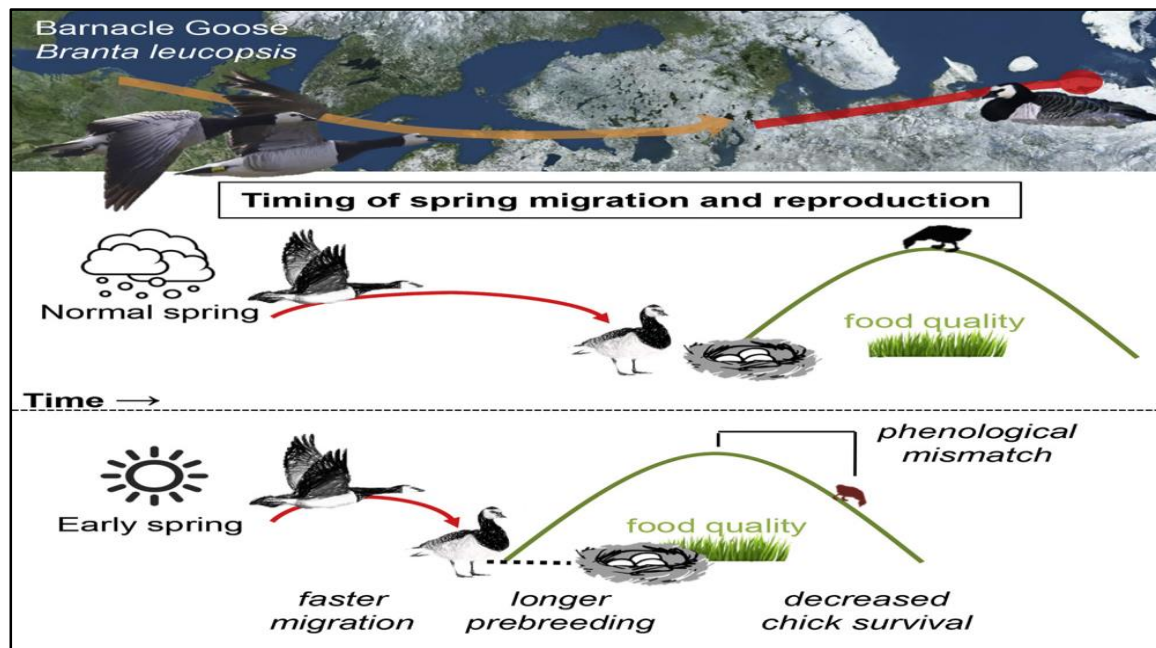


Fig5. Timing of spring migration (Lameris et al., 2018)

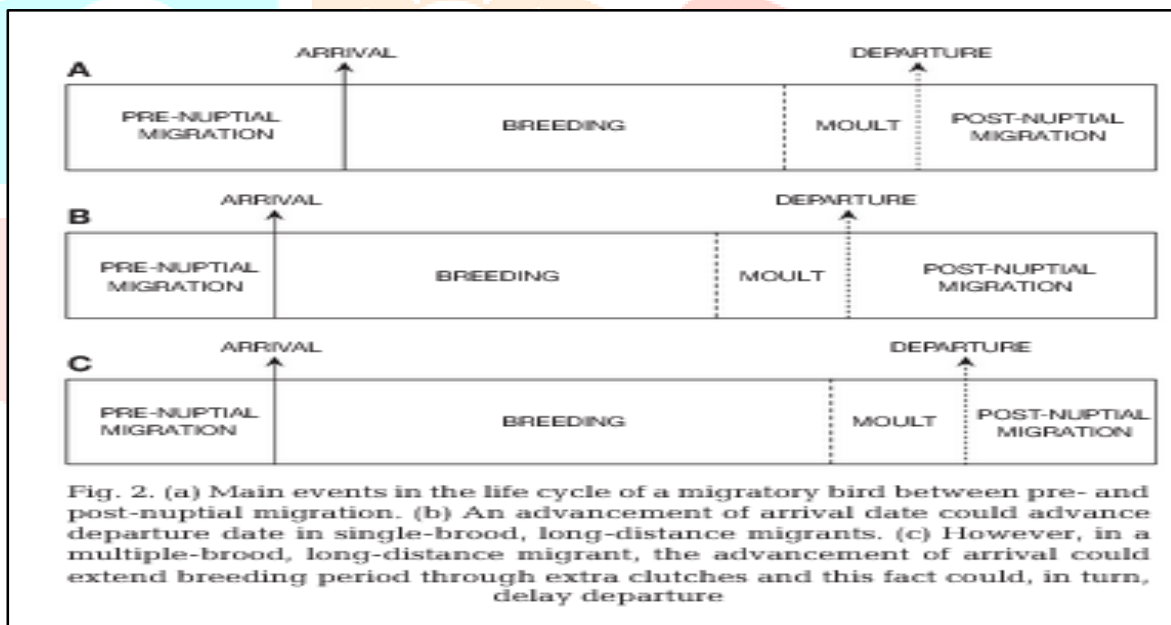


Fig6. event in life cycle of migratory birds (Gordo, 2007)

CHANGES IN MIGRATORY ROUTE

The term “migration” means to travel from one place to another to obtain advantages of the favorable environment and escape from the unfavorable one. Term Migration is derived from a latin word [migrara] which means to travel. In birds migration occur in a particular time period they have a inbuilt biological clock which regulate this phenomenon. Birds usually follow the same route. Migration is wide ranging movements between their breeding regions and their wintering regions(Thomson, 1926). Many research findings imply that more birds in India may face habitat loss over the course of the next 50 years as a result

of shifting climatic conditions. Many birds in India may see changes in their ranges due to climate change, including variations in height and distance from the equator, as well as changes in where they are located. Because long-distance migratory birds' migration habits are strongly correlated with the temperature, 68% of their habitat area is more vulnerable to climate change. The habitats that birds in India depend on are shifting as a result of rising global temperatures. Numerous bird species are extremely specialized and only flourish in particular ecological niches. These habitats are changing and occasionally going extinct as a result of climate change.

Due to deforestation and shifting climate, the Indian Pitta, which lives best in the thick underbrush of forests, is losing its habitat. As these areas warm and vegetation zones move upward, birds that rely on alpine meadows, such as the Himalayan Monal, are losing their habitat. Similar to this, increasing sea levels and more frequent storm surges are causing habitat loss for coastal birds like the Indian Skimmer. These changes disturb the complex network of biodiversity in addition to endangering the survival of the birds (Sharma, 2024). Bird studies have revealed that birds' migration is impacted by climate change in both direct and indirect ways. Bird movements are strongly correlated with summer and winter temperatures, and rising temperatures brought on by climate change may have an immediate impact on birds by requiring them to expend more energy for regulation of body temperature. This can interfere with their procreation, breeding time and migration, maintenance (the energy needed by living beings to uphold their basic activity levels and state), and survival or fitness. Although birds may eventually move to regions with better thermal conditions in response to these expenses, habitat and other resources might not be adequate or appropriate for their requirements (Manglani et al., 2023).

CONSERVATION

There are total 11,188 species of birds across the globe. India alone has 1358 avian species out of which 79 are endemic. The Indian central state Chhattisgarh has 414 bird species and 6 endemic species. 65 species are vulnerable and 21 are categorized as endangered species and 18 as critically endangered (G & Alam, 2024). Conservation of the avian species is very important for enhancing the biodiversity. Monitoring and evaluation of bird habitat are essential for successful conservation. Remote sensing and Geographic Information System (GIS) technology are widely used to evaluate bird habitats. Satellite photography and aerial surveys provide crucial data on habitat structure, changes in land cover, and landscape connectivity. The practice of recording bird sounds to examine their existence and behavior is known as acoustic monitoring, which is a great method of finding and locating the nocturnal or elusive species. Habitat restoration is an essential part of conservation initiatives to restore ecosystems and make them more suitable for migratory and wild birds. A thorough and flexible strategy that incorporates the best aspects of both









conventional and contemporary methods is crucial for the region's habitat restoration to be effective(Kabir et al., 2024). Indian government have launch many initiatives to restore and protect the avian community one such initiative is the Central Asian Flyway initiative (Press information bureau, 2023). This initiative cover across 30 countries coinciding with African–Eurasian and East Asian–Australasian flyways it is home for many migratory bird species from 84 families; among them are waterbirds, raptors and other landbirds, and seabirds(Mundkur& Selvaraj, 2023). Common Pochard, Tufted Duck, Great Crested Grebe, Kentish Plover,Little Ringed Plover, Indian Courser, Osprey, Short-toed Snake Eagle, Yellow-crownedWoodpecker, Great Grey Shrike, Rufous-tailed Lark, Sulphur-bellied Warbler, Thick-billedFlowerpecker, Tawny Pipit, Olive-backed Pipit are the highest priority species of Chhattisgarh. Success stories like the Great Indian Bustard's recovery via focused conservation efforts demonstrate that a big difference can be made.The Salim Ali Centre for Ornithology and Natural History (SACON) and the Wildlife Institute of India (WII) are two groups that are actively attempting to shield birds and their habitats from the consequences of climate change.

Table 2. Indicate the trend abundance index of the bird species in India

S.NO	IUCN CATEGORY	SPECIES NUMBER
1	CRITICALLY ENDANGERED	18
2	ENDANGERED	21
3	VULNERABLE	65
4	NEAR THREATENED	89
5	DATA INSUFFECIENT	1

(G & Alam, 2024)

Table 3. Indicate the trend abundance index of the bird species in India

		<i>Table 5: Correspondence between IUCN Red List Categories and SolB Categories of Conservation Priority</i>		
		SolB 2023 CATEGORIES OF CONSERVATION PRIORITY		
				
IUCN RED LIST		14	0	0
		15	0	1
		42	8	2
		17	39	11
		90	268	423
	Not Recognised*	0	8	4

**Some species analysed in this report are not recognised by the IUCN (see, p113).*

(State of India's Birds Partnership, 2020, Pp 113).

Birds are very important element of our ecosystem .They play a very crucial role in the ecological niche.In order to lessen the effects of climate change on birds in India, conservation initiatives are very essential.Restoring habitat, establishing protected areas that are climate resilient, and helping species adapt through conservation breeding and translocation are some strategies(Sharma , 2024). Conservation of the avian species is very important for enhancing the biodiversity.Monitoring and evaluation of bird habitat are essential for successful conservation.Remote sensing and Geographic Information System (GIS) technology are widely used to evaluate bird habitats .Satellite photography and aerial surveys provide crucial data on habitat structure, changes in land cover, and landscape connectivity.The practice of recording bird sounds to examine their existence and behavior is known as acoustic monitoring which is a great method of finding and locating the nocturnal or elusive species. Habitat restoration is an essential part of conservation initiatives to restore ecosystems and make them more suitable for migratory and wild birds.A thorough and flexible strategy that incorporates the best aspects of both conventional and contemporary methods is crucial for the region's habitat restoration to be effective (Sharma , 2024).

CONCLUSION

Birds have become the center of attention in the recent times because of there attractive appearance and a huge role in the ecosystem. Ornithological studies are major grown areas of research in the recent years .Many recent studies have shown the decline in the avian population which is very concerning. The major

reason for the reducing avian population are rise in the temperature , global warming , infrastructure development, climate change and many more. .Particularly, those pertaining to climate change may pose extensive, international difficulties. Arid landscapes, wetlands, and other ecosystems that support humans and birds will be under more stress due to worsening climate conditions, and infrastructure development may exacerbate environmental stress. Nonetheless, both people and birds may gain from implementing nature-based solutions and nature-safe energy innovations. Countries may minimize their effects on biodiversity and avoid related delays in infrastructure building by comprehending and controlling this risk. The climate change have a large influence of bird's population , migration, nesting , breeding etc. Birds being sensitive to the environment poses major threat of extinction so **proper** research on the problem faced by birds might help to protect the avian population from the verge of extinction .

Research on climate change impacts on birds faces geographical gaps, primarily focusing on North American and European species. Current studies neglect smaller species and focus on short-term analysis, limiting understanding of long-term trends. Integrating high-resolution climate models, genomic studies, AI, and remote sensing can help provide accurate trends.

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