Review Article

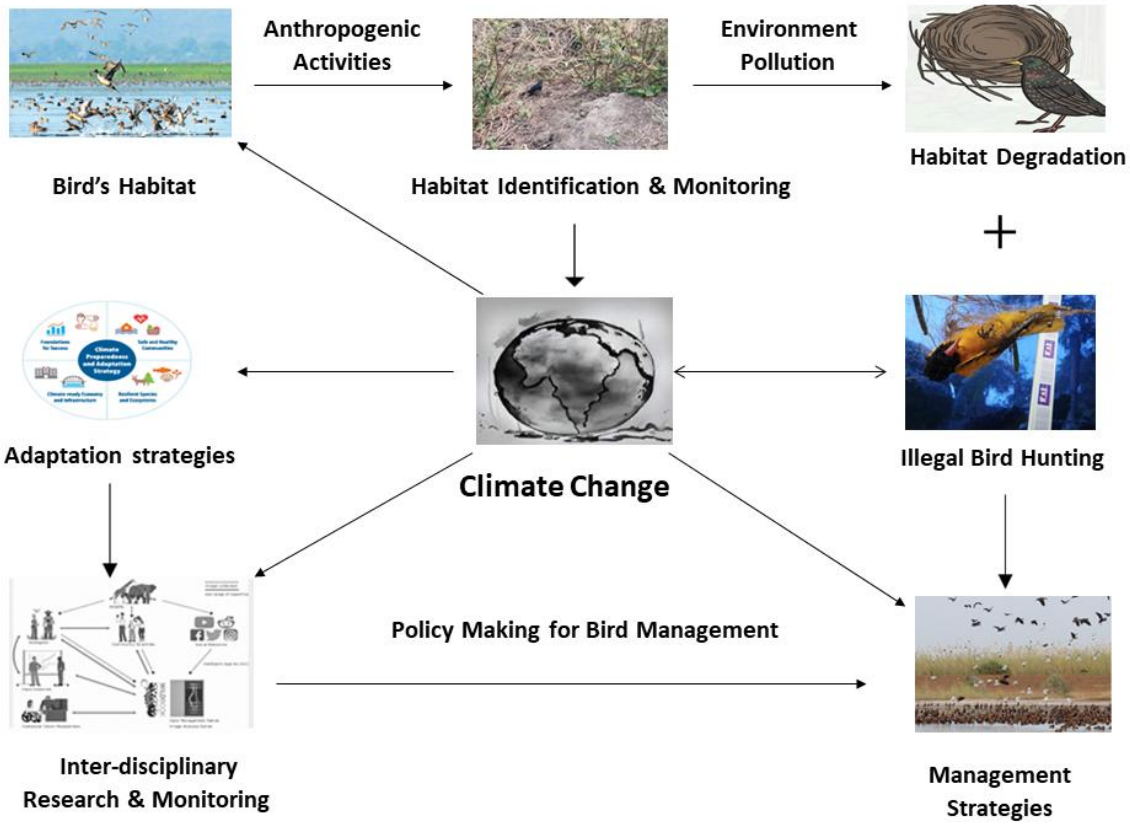
Enhancing Conservation Strategies for Wild and Migratory Bird Habitats in South Asia: A Comprehensive Review

Abstract

Birds are important elements of an environment. The review articles show the significance, challenges, and conservation strategies for wild and migratory bird habitats in South Asia which have diverse landscapes host crucial ecosystems, providing breeding grounds, stopovers, and wintering areas for countless bird species. Anthropogenic activities, climate change, pollution, and invasive species threaten these habitats, necessitating effective conservation measures. Habitat assessment, monitoring, restoration techniques, and adaptation strategies are explored. The impact of climate change on bird habitats is discussed, emphasizing the importance of habitat resilience and adaptive management. Community engagement and education are pivotal in conservation, with successful models involving local communities in decision-making processes. The article also addresses the status of illegal bird hunting in the Indian subcontinent, emphasizing the need for strengthened law enforcement and community involvement. Though birds are important element of the environment, however, they are cause to spread some disease in especially migratory birds. It's have contribution to biodiversity, pest control, and pollination but can also cause economic losses in agriculture and pose risks to aviation. Managing coexistence between birds and human activities is required for successful conservation program. Interdisciplinary research, long-term monitoring, and quantitative assessments of habitat resilience is underscored. The article concludes with a future plan for wild and migratory bird management in Bangladesh, outlining measures such as habitat protection, community involvement, and international collaboration.

Keywords: Wild and Migratory birds, Climate change, Adaptation, Habitat management,

Graphical Abstract


Anthropogenic Activities
Environment Pollution
Habitat Degradation
Bird's Habitat
Habitat Identification & Monitoring
Adaptation strategies
Climate Change
Illegal Bird Hunting
Policy Making for Bird Management
Inter-disciplinary Research & Monitoring
Management Strategies

1. Introduction

The varied landscapes of South Asia are decorated with numerous ecosystems that play a vital role as habitats for a wide range of wild and migratory bird species. These habitats are crucial for maintaining the ecological equilibrium and biodiversity of the region. South Asia contains a wide range of bird species, including those found in tropical rainforests, wetlands, and high-altitude mountain ranges (Nirmal Kumar et al. 2011). This review aims to explore the importance of these habitats, illuminate the difficulties and dangers they encounter, and suggest approaches for their improved preservation. The significance of wild and migratory bird habitats cannot be exaggerated, as they function as crucial sanctuaries for several species (Terborgh 1989). These habitats serve as locations for migratory birds to procreate, stopover, and spend the winter, thereby facilitating the complex patterns of their seasonal movements (Ruth et al. 2012). The interdependence of these habitats impacts various ecological processes, including seed dispersal, pollination, and insect management, thereby contributing to the overall well-being of ecosystems (Blitzer et al. 2012).Additionally, a flourishing ecosystem is signified by the presence of numerous bird species, which serves as an indicator of the overall health of the environment (Shochat et al. 2010).Nevertheless, in spite of their ecological importance, these habitats are progressively facing an extensive array of obstacles and perils (Kiringe and Okello 2007). These natural refuges are progressively being encroached upon by anthropogenic activities such as industrialization, deforestation, and urbanization, which fragment habitats and deplete available resources (Lindsey et al. 2022). The situation is additionally compounded by climate change, which disrupts migration patterns, modifies the timing and accessibility of food sources, and presents novel obstacles for avian populations (Sattar et al. 2021). Environmental degradation, excessive utilization of natural resources, and the proliferation of invasive species introduce further intricacies to the conservation enigma (Williams and Grosholz 2008). A critical examination of the status of wild and migratory bird habitats in South Asia is the objective of this exhaustive analysis, which aims to identify critical issues and assess current conservation efforts. Our objective is to offer a comprehensive comprehension of the present condition of these habitats and the obstacles they encounter through this approach. This will subsequently contribute to the formulation of conservation strategies that are efficacious and customized to the distinct ecological and socio-economic circumstances of the area.

This review is aiming to accomplish a number of different objectives. To begin, our primary objective is to evaluate the influence that human activities and climate change have had on the integrity of wild and migratory bird habitats, as well as to observe the current situation regarding hunting and killing. We also intend to investigate the effectiveness of existing conservation projects and look for prospective areas where they could be improved. Secondly, we will identify gaps and limitations in these initiatives. We will also highlight successful case studies and best practices that can serve as examples for future conservation initiatives. This will be the third and last part of our presentation. In conclusion, the purpose of this analysis is to provide valuable insights that will assist policymakers, conservationists, and researchers in the process of creating and implementing sustainable policies to protect these vital habitats and the bird species that are dependent on them. In the following sections of this review, we will delve into the ecological complexities of South Asia's wild and migratory bird

habitats, examining the issues that these habitats confront and providing new solutions for the preservation and enhancement of these habitats.

2. Current Conservation Practices

The conservation of wild and migratory bird habitats in South Asia is critical for the region's rich biodiversity (Rani et al. 2023). Several techniques have been implemented to address the issues that these environments face. We will delve into existing conservation techniques in this section, outlining major findings from past research within each sub-component. South Asia's current conservation efforts for wild and migratory bird habitats include a variety of strategies ranging from protected areas and community involvement to multinational partnerships and climate-resilient planning. The research findings in each sub-section add crucial knowledge to the ongoing efforts to protect these critical environments. As we continue to learn from past experiences, it is critical to adapt and develop conservation approaches to address growing issues and ensure the subcontinent's long-term well-being of bird habitats.

Table 1. Conservation Practices of wild and migratory birds

Steps	Description
Protected Areas and Reserves	• Protected areas and wildlife reserves were established to protect critical bird habitats. • Reserves that are well-managed can successfully minimize the effects of habitat loss and fragmentation. • Migratory birds require nesting sites and safe shelters.
Community-Based Conservation	• Participating in conservation activities with local communities. • Involving communities in habitat protection strengthens and cultivates a sense of ownership and responsibility. • Community-led projects have resulted in better habitat management and fewer conflicts between humans and wildlife.
International Collaborations	• Migratory birds frequently cross national borders, underscoring the importance of international cooperation. • The study emphasizes the need of collaborative efforts to conserve habitat along migratory pathways. • Identified crucial sites and migration corridors, allowing adjacent countries to coordinate conservation efforts.
Research and Monitoring Programs	• Provide critical information about the state of avian habitats. • Helps discover trends and assess the effectiveness of conservation initiatives. • The research findings provide vital information on habitat utilization, migration patterns, and the ecological needs of various bird species.
Policy and Advocacy Initiatives	• Advocacy efforts, supported by scientific evidence, play a crucial role in raising awareness, garnering support • Influencing policy changes for better habitat protection.
Climate Resilience Planning	• Identifying resilient habitats, understanding species vulnerability. • Implementing measures to mitigate climate-related threats.

2.1 Habitat Assessment and Monitoring

Bird habitat assessment and monitoring are critical for effective conservation (Nagendra et al. 2013). Various strategies are used in South Asia to understand the state of these habitats and follow changes over time. Bird habitats are frequently assessed using remote sensing and Geographic Information System (GIS) technology (Lauver et al. 2002). Aerial surveys and satellite photography give vital information on habitat structure, land cover changes, and landscape connectivity (Gottschalk et al. 2005). These technologies help us better comprehend large-scale habitat patterns. Field surveys, such as point counts, entail direct observations of bird species in specific areas (Bibby et al. 1998). These methods provide detailed information on bird abundance, variety, and behavior. The large and often isolated nature of South Asia's bird habitats presents challenges (Rajvanshi et al. 2001). Accessibility limitations, particularly in steep terrain, can hamper the effectiveness of field surveys, perhaps leading to overestimation of bird numbers (Robinson et al. 2018). Acoustic monitoring is the process of recording bird vocalizations in order to analyze their presence and behavior (Perez-Granados and Traba 2021). This non-invasive approach is very beneficial for locating nocturnal or elusive animals. The requirement for specialized technology and knowledge to evaluate complicated soundscapes is one of the challenges. Camera traps and sensor networks are increasingly being used to gather photos and data on bird movements, providing insights into habitat use, nesting patterns, and wildlife interactions (Caravaggi et al. 2017). The approaches' disadvantages include high initial costs, limited battery life in isolated places, and the possibility of upsetting delicate species during installation and maintenance (Lahoz-Monfort and Magrath 2021). Citizen science activities that involve the public in habitat monitoring have grown in popularity. Volunteers provide useful data by making observations and collecting data. The challenges include maintaining data quality and consistency, as well as eliminating any biases induced by participants' various levels of knowledge. To generate complete habitat models, integrated modeling incorporates diverse data sources and analytical methodologies. These models forecast habitat suitability, identify critical conservation sites, and analyze the possible effects of environmental changes. The key hurdles for successful application are the necessity for robust data inputs and the inherent uncertainties associated with modeling complex ecological systems.

2.2 Restoration and Rehabilitation Techniques

Habitat restoration is an important component of conservation activities aimed at revitalizing ecosystems and improving their appropriateness for wild and migratory birds (Wang et al. 2023). To repair and rehabilitate bird a habitat in South Asia, a combination of traditional and novel strategies is used (Hossain et al. 2008). The restoration and rehabilitation of wild and migratory bird habitats involves a combination of conventional and modern strategies. While conventional approaches rely on local knowledge and tried-and-true procedures, innovative approaches utilize advances in technology and biology to address modern concerns. For successful habitat restoration in the region, a comprehensive and adaptive approach that combines the best of both traditional and modern techniques is essential (Uprety et al. 2012).

Table 2. Different methods of birds (both wild and migratory) Restoration and Rehabilitation

Methods	Types	Explanation
Traditional Methods	Afforestation and Reforestation	• Planting native trees and vegetation in degraded areas • Recreate suitable habitats for birds and promote biodiversity
	Wetland Restoration	• Restoring natural water flow • Controlling invasive species • Enhancing vegetation cover • Improve water quality, provide breeding sites. • Ensure adequate food supply for water-dependent bird
	Control of Invasive Species	• Invasive plants and animals disrupt natural habitats • Control and managing invasive species • Protect native vegetation • Create a more favorable environment for native birds
	Soil Conservation Techniques	• Erosion and soil degradation affects bird habitats • Traditional methods of soil management techniques restore the natural vegetation and create stable habitats
	Community-Based Conservation	• Involving local communities in habitat restoration • Ensures restoration efforts combine with local knowledge and priorities • Traditional practices (rotational grazing and sustainable resource use) integrated into restoration plans
New and Innovative Techniques	Assisted Migration and Evolution	• Assisted migration involves relocating plant and animal species to areas with suitable climates • Assisted evolution focuses on enhancing the resilience of existing populations through selective breeding • Help species adapt to changing environmental conditions
	Precision Conservation and Technology	• Identify areas in need of restoration and monitor progress accurately with the help of remote sensing, GIS, and satellite imagery • Advanced technologies (Drones and advanced mapping) aid in assessing habitat conditions and planning targeted interventions
	Synthetic Biology and Genetic Techniques	• Synthetic biology and genetic engineering offer possibilities for restoring degraded habitats • Genetically modified plants with enhanced resistance to pests or improved adaptability to environmental stressors
	Bioacoustics Monitoring and Soundscape Restoration	• Using sound recordings to assess the health of ecosystems • Integrating soundscape restoration techniques attract

		birds and facilitate habitat recovery
	Ecological Restoration Networks	• Involving multiple stakeholders, including government agencies, NGOs, and local communities • Facilitate large-scale restoration projects • Leverage diverse expertise, and enhance the effectiveness of habitat restoration initiatives

2.3 Impact of Climate Change on Bird Habitats

Climate change is drastically affecting the ecosystems on which wild and migratory birds rely in South Asia (Şekercioğlu et al. 2012). These changes emerge in a variety of ways, posing major concerns to bird habitat resilience and sustainability. Rising temperatures and changed precipitation patterns are causing changes in bird distribution and the timing of important life events such as breeding and migration (Dunn et al. 2010). Some ecosystems may become unsuitable for specific species, while others may see new entrants. Rising sea levels and increased storm strength are threatening coastal habitats, which are critical for many bird species (Michener et al. 1997). Nesting places, feeding grounds, and migration stops near coastlines are at risk of erosion and submersion, threatening their viability (Harris and Mirande 2013). More frequent and severe weather events, such as storms, droughts, and wildfires, can destroy habitat (Dale et al. 2001). Intense weather events can harm flora, alter landscape architecture, and disrupt food availability, all of which have a direct impact on bird populations (Brawn et al. 2001). Climate change can worsen habitat fragmentation, separating populations and limiting birds' ability to find optimal breeding, feeding, and resting locations (Lindenmayer and Fischer 2013). Population loss and genetic diversity might result from disconnected environments (Canales- Delgadillo et al. 2012).

2.4 Habitat Resilience and Adaptation

Climate change impacts on bird habitats are being addressed through a combination of proactive conservation efforts and adaptive management approaches (Morrison et al. 2011). Protected area expansion and strengthening aid in the preservation of crucial bird habitat. Restoration programs, such as afforestation and wetland rehabilitation, aim to improve habitat resilience by creating safe zones for birds to adapt to changing conditions (Gonzalez et al. 2023).Ecological corridors unite fragmented habitats, allowing birds to move freely (Lukies 2020).These corridors act as migration paths, allowing species to adapt to changing climatic conditions and locate adequate habitat along the way. Local communities frequently have traditional knowledge that can be used to develop effective adaptation strategies (Mekonnen et al. 2021).Encouragement of sustainable land use practices, such as agroforestry and community-based conservation, contributes to the creation of resilient landscapes that lead adaptive management techniques, ensuring interventions are based on the most recent scientific findings (Plieninger et al. 2020).Managed retreat in coastal locations entails enabling natural habitats to relocate inland when sea levels rise (Griggs and Reguero 2021).Building climate-resilient infrastructure protects habitats from catastrophic weather events while also allowing ecosystems to adapt to changing conditions. Migratory birds frequently traverse boundaries, underscoring the importance of international cooperation. Collaboration across governments and organizations makes it easier to develop transboundary conservation programs and coordinated climate

adaptation measures (Kark et al. 2015).It is vital to raise awareness about the effects of climate change on bird habitats and gain support for conservation efforts. Education and advocacy campaigns encourage sustainable behaviors, influence lawmakers, and develop a shared commitment to habitat conservation (Krasny 2020). While some solutions show potential, obstacles remain. Obstacles to effective implementation include funding limits, conflicting land-use objectives, and the requirement for long-term commitment. Furthermore, uncertainty about the rate and type of climate change complicate adaptation planning. Adapting bird habitats in South Asia to climate change necessitates a multifaceted and coordinated strategy (Lister et al. 2015).To address the dynamic difficulties provided by a changing climate, conservation policies must be adaptable, community-centered, and scientifically grounded (Buffa et al. 2023).Only by working together can we assure the survival of bird habitats and the varied avian species that rely on them.

2.5 Community Engagement and Education

Effective community engagement is critical for bird habitat protection, and several strategies have proven successful in South Asia (Şekercioğlu 2012). Participatory resource management and co-management agreements, for example, are community-based conservation projects that actively involve local communities in decision-making processes (Dyer et al. 2014).These strategies enable communities to take ownership of habitat protection by using traditional knowledge and instilling a sense of responsibility. Furthermore, collaborative projects that provide economic incentives, such as sustainable ecotourism and livelihood programs, help to integrate conservation goals with the well-being of local populations (Allgood et al. 2019).Concurrently, education and awareness activities are critical to these efforts. These projects improve environmental literacy by educating communities on the ecological relevance of bird habitats, the value of biodiversity, and the effects of climate change (White et al. 2018). This understanding, combined with education activities that provide training on sustainable land-use practices, lays the groundwork for educated decision-making and builds a community commitment to long-term bird habitat conservation. The collaboration of community involvement methods and education programs creates a complete approach that ensure conservation initiatives are not only ecologically sound but also socially viable and firmly anchored in the communities they seek to help.

3. Status of Illegal Bird Hunting in Indian Sub-continent

Illegal bird hunting is a major problem in India, causing the extinction of many bird species and endangering both resident and migratory bird populations (Umar et al. 2018). The government, non-governmental organizations (NGOs), and wildlife conservation organizations are working to tackle this issue through stronger law enforcement, public awareness campaigns, and habitat conservation measures. The Wildlife Protection Act of 1972 serves as India's fundamental legal foundation for wildlife protection (Ramesh 1999). However, the success of these efforts varies, and obstacles exist, such as a lack of enforcement resources, the involvement of organized crime, and the demand for birds in illegal trade (Zimmerman 2003). Northeast India, the northern plains, Rajasthan, the Andaman and Nicobar Islands, and the Western Ghats are some historically connected places. To address these challenges, conservation activities, educational campaigns, and stronger law enforcement are continuing. Bharatpur, Rajasthan, the *Chambal* River Basin, *Wular* Lake, *Pulicat* Lake, *Harike* Wetland, and *Sundarbans*. West Bengal are among the areas suffering illegal bird

hunting difficulties (Parikh and Datye 2003).Conservation activities are still underway, and the status of these areas may have altered. Bangladesh is strategically significant for bird migration since it crosses two migratory flyways (East Asian-Australasian and Central Asian). Illegal wildlife hunting, particularly of birds, is a serious global conservation issue for many endangered species. Birds in the *Ardeidae* family, such as herons, egrets, bitterns, and night herons, were mostly taken using trapping (40%) and netting (27%) tactics (Datta 2022). The major reason for hunting was to make some quick money during the winter season. The Bangladesh Forest Department's existing Wildlife Crime Control Unit should be enhanced, and legislation should be enacted to prevent additional illegal bird killing in Bangladesh. Based on a report published in a daily newspaper from 2010 to 2022, maps depict the biggest hunting areas of Bangladesh. The three main hotspots of illegal bird hunting in Bangladesh are Rajshahi, Sylhet, and Khulna (Datta 2022). Several bird species are threatened due to habitat destruction, poaching, and illegal commerce, making illegal bird hunting in Pakistan a severe problem (Sadam et al. 2022). This issue is especially obvious during the spring and fall migrations of birds. Waterfowl and migratory bird species are important, as is the Houbara Bustard, a migratory bird (Azar et al. 2022). Although its enforcement has been challenging, the Pakistan Wildlife (Protection, Preservation, Conservation, and Management) Ordinance is one of the laws that preserve wildlife, particularly birds (Zamirr et al. 2023). The Thar Desert, Khyber Pakhtunkhwa, Sindh, Punjab, and Baluchistan are the most popular bird-hunting destinations in Pakistan (Iqbal et al. 2023).

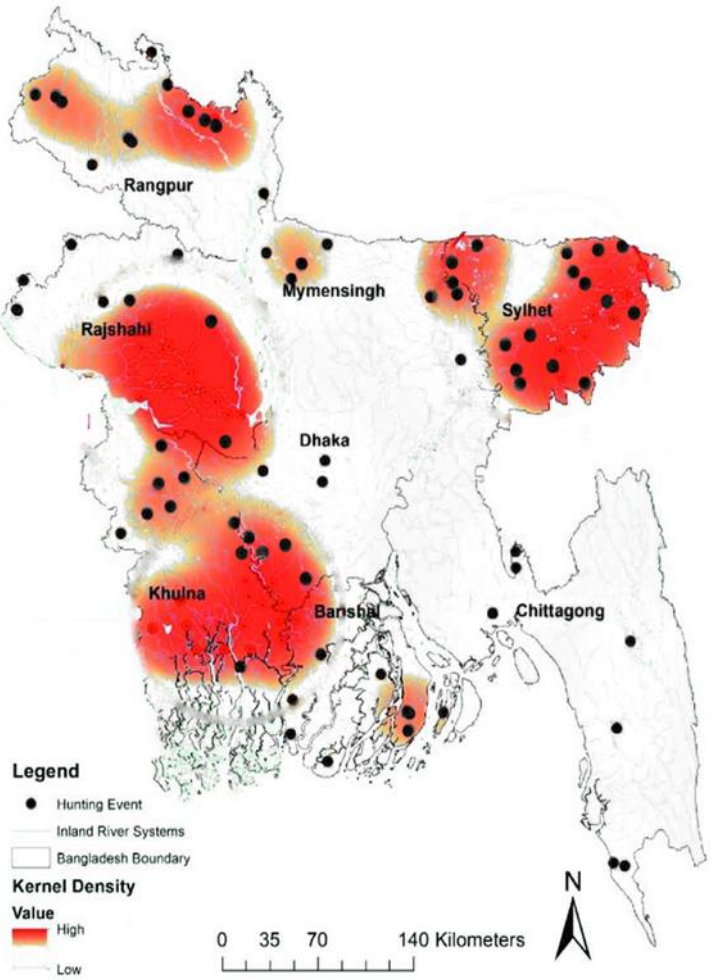


Figure 1: Status of illegal bird Hunting of Bangladesh developed from Datta (2022)

4. Impacts of Migratory Birds on environment and human health

4.1*Positive impacts*

Migratory birds play an important role in many ecosystems, and their presence has both direct and indirect environmental effects. Birds frequently ingest and defecate fruits and seeds in different locations. This technique aids in the dispersal of plant species, hence preserving biodiversity and regenerating vegetation in various places. Insects and other invertebrates are eaten by birds. They help to manage insect populations and maintain the balance of local ecosystems by doing so. Bird droppings include nutrients such as nitrogen and phosphorus, which enhance the soil in locations where birds rest or breed, aiding in nutrient cycling and increasing soil fertility (Fujita et al. 2016). Some wild and migratory bird species, particularly hummingbirds, parrots, tailorbirds, and others, aid in pollination (Acharya et al. 2022). Their visits to flowers aid in the transmission of pollen, allowing plant species to reproduce. Birds move between breeding, feeding, and wintering grounds, therefore they connect diverse environments. This connectedness is critical for ecosystem health, as it promotes genetic diversity and allows organisms to adapt to changing environments. The presence of migrating birds draws birdwatchers and tourists, which helps local economies through eco-tourism (Ginantra et al. 2020). This monetary value encourages the preservation of avian habitats. GOs and NGOs organize bird-watching fairs at various locations to observe both wild and migratory birds. The ornithology tourism business is expected to be worth $59, 7 billion by 2022. According to the analysis, sales are expected to grow at a healthy 5.2% CAGR, with the market valued at US$100.2 billion by 2032. The presence of migratory bird species is often an indicator of a healthy ecosystem (Gregory and Van 2010). Their absence or decline could indicate environmental issues including habitat degradation, pollution, or climate change. Some migratory birds, particularly ducks, help to keep water clean (Post et al. 1998). Their efforts can aid in the prevention of the spread of certain waterborne diseases as well as the overall health of the aquatic ecosystem. Through their feeding activities, migratory birds can impact the structure of plants. Migratory bird migration allows for gene flow and the exchange of genetic material between groups (Webster et al. 2002). This genetic diversity can help species to be more resilient in the face of environmental changes, especially those caused by climate change.

4.2 *Negative impacts*

Certain bird species, particularly *Granivores* and *Frugivores*, may cause crop damage in agricultural settings (Hiron et al. 2014). Farmers may suffer economic losses if large numbers of birds graze on crops. Migratory birds may sometimes compete with resident species for resources including nesting locations, food, and breeding territory. Intense competition can have a negative impact on native species' survival and reproductive performance. Invasive plant seeds can adhere to birds' feathers or be conveyed in their droppings, resulting in the introduction of non-native plants into new areas and the spread of noxious weeds (McGowan 2019). Birds, particularly migratory birds, can function as carriers of diseases such as avian influenza. Movement of sick birds across regions can lead to disease spread among bird populations and, in certain circumstances, domestic poultry.

Table 3: Disease detection according to country, family and species of native, wild and migratory birds

Disease name	Detected in		Country	References
	Common species	**Family**		
Avian Influenza	Ducks, geese, swans	*Anseriformes Anatidae*	Worldwide	FAO (2007)
West Nile	Lesser Sand Plove, Common Redshank	*Charadriidae, Scolopacidae*	Malaysia	Ain-Najwa et al. (2020)
Marek's	Red-crowned crane	*Gruidae*	Japan	Lian et al. (2018)
Newcastle Disease	Doves, Pigeon, Parrot	*Columbidae, Psittacidae*	India	Bansal et al. (2022)
Infectious Bronchitis	Pheasants, Quail, Patridge, Geese, Pigeon, Guinea Fowl, Duck And Peafowl	-	India, Nigeria	Parveen et al. (2017); Musa et al. (2017)

Large numbers of migrating birds, especially in vulnerable environments, can cause habitat disruption. Nesting and foraging activities have the potential to damage local flora and wildlife, particularly in locations with fragile ecosystems. Bird strikes are a serious air traffic danger, especially when big migratory species cross flight routes (Evans 1996). Collisions between birds and aircraft can jeopardize aviation safety, resulting in both economic losses and significant human life threats. Furthermore, migratory bird flocks, such as waterfowl on lakes, can cause significant noise and disturbance, harming the quality of life for neighboring human populations (Chace and Walsh 2006).Bird droppings can contribute to nutrient loading in water bodies in locations with large bird populations, particularly waterfowl, potentially resulting in water quality issues such as algal blooms and oxygen depletion (Chaichana 2008). Furthermore, in some circumstances, migrating birds may interact negatively with endangered or vulnerable species, engaging in resource competition or predation on resident fauna. Large groups of migrating birds in metropolitan or peri-urban settings may result in human-wildlife conflicts, since the noise, droppings, and other disruptions associated with these congregations pose problems for residents and businesses. To establish a harmonic balance between ecological preservation and human well-being, managing the coexistence of migrating birds and human activities necessitates careful consideration of these potential negative repercussions.

5. Challenges and Opportunities

The primary problem in protecting migratory birds is that their annual cycles spatially connect breeding, passage and staging, and wintering regions (Yong et al. 2018). A global review of significant bird sites, however, reveals that the existing range of protected areas is insufficient for only 9% of the 1451 migratory bird species at all stages of their annual cycle (Runge et al. 2015). Loss of habitat at some staging sites or loss of crucial sites can thus have a significant impact on migratory species flyway populations (Murray et al. 2018). As cities grow and farms expand, the places where birds live and find food are shrinking (Satterthwaite et al. 2010). This makes it more difficult for them to survive. Climate change and pollution are also causing problems

for birds. The weather is becoming more unpredictable, altering where birds go at various periods of the year and producing problems (Şekercioğlu et al. 2012). Dirty water and air harm the places where birds live and can make them sick (Bird 2007). Illegal hunting is also a significant concern. Some people hunt birds for sport or to sell them, which can have a major impact on bird populations (Hirschfeld et al. 2005).Invasive species, like plants or animals from other places, can be a problem as well (Simberloff 2013). They may take over areas where birds normally live, making it difficult for local birds to find sufficient food and shelter. Finally, few people are aware of these issues, and it is difficult to assist birds if we do not understand how essential they are and the difficulties they confront.Despite these obstacles, there are numerous ways to improve things. People who live near bird habitats may be eager to assist safeguard the birds if they realize how vital they are (Beatley 2020). Opportunities for sustainable livelihoods, such as jobs that do not destroy bird habitats, may also exist. Everyone benefits if people can make a living while helping birds. Bird protection laws and regulations are critical. Strong rules against hunting and hurting birds can dissuade individuals from engaging in these activities. Another important conservation approach is education. We can develop a stronger sense of responsibility for birds' well-being by informing people why birds important and what threatens them. We can also benefit from technology. Satellite tracking tools can help us understand where birds go and how to protect their habitats. Reserves and protected areas can provide a secure haven for birds to rear their young. The public's involvement is critical. We can better safeguard the birds if everyone, from average people to scientists, keeps an eye on them and reports any concerns. Collaboration with neighboring countries is also essential since birds do not stay in one location; they migrate across boundaries. Collaboration ensures that all countries engaged are doing their part to protect these avian visitors.

6. Future plan for wild and migratory bird management of Bangladesh

In the future, Bangladesh can take numerous steps to improve the management of wild and migratory birds, ensuring their protection and long-term coexistence with human activities. Improve and expand protected areas, wildlife sanctuaries, and reserves to protect essential bird habitat (Vimal et al. 2021). Implement and implement regulations to protect and restore wetlands, which are critical habitat for many migratory bird species (Ma et al. 2023). Involve local communities in bird conservation activities, highlighting birds' cultural, ecological, and economic importance (Steven et al. 2017). Community involvement can lead to more successful conservation methods and long-term resource management. Encourage community-based ecotourism and other sustainable livelihoods that are compatible with bird conservation (Teshome et al. 2021). This has the potential to benefit local communities while also protecting bird habitats. Conduct extensive research on bird populations, migration patterns, and behavior in order to better understand and inform conservation measures (Faaborg et al. 2010). Regular monitoring systems should be implemented to track changes in bird populations and habitats (Maxwell et al. 2022). Create and put into action solutions to address the effects of climate change on bird habitats and migration patterns (Byrd et al. 2023). This could involve habitat restoration, the development of climate-resilient ecosystems, and the promotion of sustainable practices (Simonson et al. 2021). To create awareness about the importance of bird conservation, conduct educational programs in schools, communities, and through various media channels. Encourage the

people to take responsibility for the protection of wild and migratory birds. Enhance wildlife protection legislation and ensure its effective enforcement (Du et al. 2023). Penalties should be imposed for illegal acts such as hunting, trapping, and habitat degradation (Wellsmith 2011). Implement habitat restoration programs to restore degraded regions and provide safe havens for birds. Control invasive species that may harm bird habitats (Happach et al. 2022). Collaborate with neighboring countries and international organizations to ensure coordinated efforts for migratory bird conservation (Kark et al. 2015). Participate in global efforts and share information and best practices. Monitor bird movements, migration patterns, and habitat conditions using technology such as satellite tracking, remote sensing, and data analytics (Si et al. 2015). This data can be used to guide effective conservation measures. Encourage citizen science projects that involve the public in bird monitoring and protection. Encourage citizens to feel ownership and pride in the country's unique bird species. Bangladesh can make a substantial contribution to the protection of wild and migratory birds by implementing these measures, ensuring their continuous presence and ecological relevance in the region. Collaboration between government agencies, non-governmental groups, local communities, and international partners is critical to the success of these efforts.

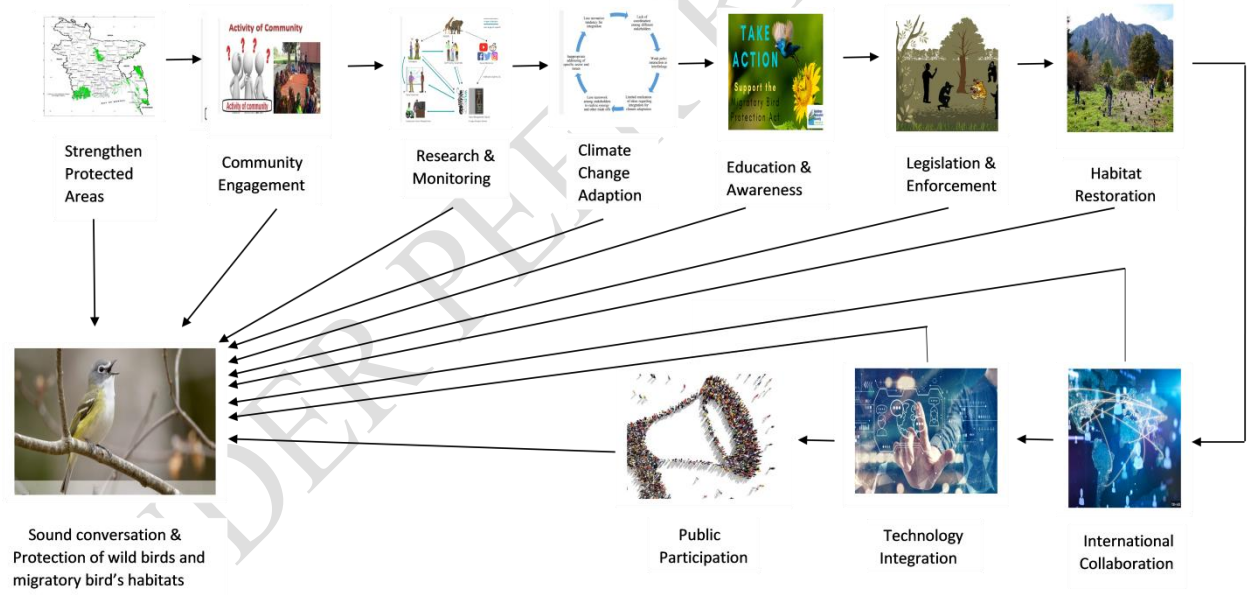


Figure 2: Future wild and migratory bird management strategies for Bangladesh

7. Scope for future research

Despite advances in monitoring technology, there remains a significant lack in long-term monitoring studies that track changes in bird habitat over lengthy periods of time. Longitudinal studies are critical for understanding the cumulative effects of different stresses and assessing the efficacy of conservation strategies. According to the literature, there is a need for more interdisciplinary research that merges ecological and social sciences. Understanding the human components of bird habitat protection, such as socioeconomic issues impacting land use and community engagement, is critical for designing comprehensive and effective conservation programs. While the impact of

climate change is acknowledged, quantitative assessments of habitat resilience to climate stressors are lacking. In the face of changing climatic conditions, research concentrating on identifying and characterizing climate-resilient habitats might inform targeted conservation measures. Although migration patterns are regarded as critical features of bird conservation, in-depth studies on individual migration routes in South Asia are lacking. Understanding the difficulties that migratory birds confront on their migrations is critical for developing effective trans-boundary conservation projects. While the literature provides improved and creative conservation measures, full evaluations of their real-world implementation are lacking. It is critical to assess the feasibility, scalability, and actual impact of these techniques in order to guide future conservation measures.

8. Conclusion

The review provides a thorough examination of South Asia's conservation plans for wild and migratory bird habitats. The review's primary points are the importance of these ecosystems, the issues they confront as a result of factors like as habitat loss, climate change, and human activity, and the continuous work to protect and restore them. The assessment considers both classic and novel methods of protecting and restoring ecosystems, such as protected areas, community involvement, enhanced monitoring technology, and climate-resilient planning. These improved techniques, which incorporate cutting-edge technologies, community involvement, and climate adaption measures, understand the dynamic nature of the issues encountered by bird habitats. The convergence of precision conservation, international collaboration, and education activities strengthens these habitats and contributes to the overall well-being of the region's various bird species. Furthermore, increasing international collaboration and knowledge sharing among South Asian countries can aid in the establishment of trans-boundary conservation projects. Community involvement models should always adapt to be more inclusive and responsive to local communities' needs and perspectives, ensuring their active participation in and benefit from conservation activities.

Reference

Acharya, V., Charan, P. D., &Chhangani, A. K. (2022). Avian fauna in the human landscape around bikaner city, Rajasthan, India.

Ain-Najwa, M. Y., Omar, A. R., Arshad, S. S., Abu, J., Mohammed, H. O., Kumar, K., ... & Mohd-Kharip-Shah, A. K. (2020). Evidence of West Nile virus infection in migratory and resident wild birds in west coast of peninsular Malaysia.*One Health*, *10*, 100134.

Allgood, B., Hofberg, M., Musikanski, L., Michelini, L., & Moser, M. (2019). Assessing community-based wildlife conservation programs with the gross national happiness framework. *International Journal of Community Well-Being*,*2*, 301-337.

Azar, J. F., Ferlat, C., Landsmann, C., &Hingrat, Y. (2022). Timing of Release Influence Breeding Success of Translocated Captive-Bred Migrant Asian Houbara Bustard.*Frontiers in Conservation Science*,*3*, 815506.

Beatley, T. (2020). *The bird-friendly city: Creating safe urban habitats*. Island Press.

Bibby, C. J., Jones, M., & Marsden, S. (1998).*Bird surveys*(pp. 1-137). London: Expedition Advisory Centre.

Bird, W. (2007).*Natural thinking*. Royal Society for the Protection of Birds.

Blitzer, E. J., Dormann, C. F., Holzschuh, A., Klein, A. M., Rand, T. A., & Tscharntke, T. (2012). Spillover of functionally important organisms between managed and natural habitats.*Agriculture, Ecosystems & Environment*,*146*(1), 34-43.

Brawn, J. D., Robinson, S. K., & Thompson III, F. R. (2001). The role of disturbance in the ecology and conservation of birds. *Annual review of Ecology and Systematics*,*32*(1), 251-276.

Buffa, D. C., Thompson, K. E., Reijerkerk, D., Brittain, S., Manahira, G., Samba, R., & Douglass, K. (2023). Understanding constraints to adaptation using a community-centred toolkit.*Philosophical Transactions of the Royal Society B*,*378*(1889), 20220391.

Byrd, K. B., Matchett, E., Mengelt, C., Wilson, T. S., DiPietro, D., Moritsch, M., & Reiter, M. E. (2023). Knowledge coproduction on the impact of decisions for waterbird habitat in a changing climate. *Conservation Biology*,*37*(5), e14089.

Canales- Delgadillo, J. C., Scott- Morales, L., & Korb, J. (2012). The influence of habitat fragmentation on genetic diversity of a rare bird species that commonly faces environmental fluctuations.*Journal of Avian Biology*,*43*(2), 168-176.

Caravaggi, A., Banks, P. B., Burton, A. C., Finlay, C. M., Haswell, P. M., Hayward, M. W., & Wood, M. D. (2017). A review of camera trapping for conservation behavior research.*Remote Sensing in Ecology and Conservation*,*3*(3), 109-122.

Chace, J. F., & Walsh, J. J. (2006). Urban effects on native avifauna: a review.*Landscape and urban planning*,*74*(1), 46-69.

Chaichana, R. (2008).*Birds and the eutrophication of a system of small lakes*. The University of Liverpool (United Kingdom).

Dale, V. H., Joyce, L. A., McNulty, S., Neilson, R. P., Ayres, M. P., Flannigan, M. D., & Wotton, B. M. (2001). Climate change and forest disturbances: climate change can affect forests by altering the frequency, intensity, duration, and timing of fire, drought, introduced species, insect and pathogen outbreaks, hurricanes, windstorms, ice storms, or landslides.*BioScience*,*51*(9), 723-734.

Datta, A. K. (2022). Status of Illegal Bird Hunting in Bangladesh: Online news portal as the source.*Human Dimensions of Wildlife*,*27*(2), 183-192.

Du, N., Fathollahi-Fard, A. M., & Wong, K. Y. (2023). Wildlife resource conservation and utilization for achieving sustainable development in China: main barriers and problem identification.*Environmental Science and Pollution Research*, 1-20.

Dunn, P. O., Winkler, D. W., Møller, A. P., Fiedler, W., & Berthold, P. (2010). Effects of climate change on timing of breeding and reproductive success in birds.*Effects of climate change on birds*,*11*, 17.

Dyer, J., Stringer, L. C., Dougill, A. J., Leventon, J., Nshimbi, M., Chama, F., &Syampungani, S. (2014). Assessing participatory practices in community-based natural resource management: Experiences in community engagement from southern Africa.*Journal of environmental management*,*137*, 137-145.

Evans Ogden, L. J. (1996). Collision course: the hazards of lighted structures and windows to migrating birds.*Fatal Light Awareness Program (FLAP)*, 3.

Faaborg, J., Holmes, R. T., Anders, A. D., Bildstein, K. L., Dugger, K. M., Gauthreaux Jr, S. A., ... & Warnock, N. (2010). Conserving migratory land birds in the New World: Do we know enough?.*Ecological applications*,*20*(2), 398-418.

Fujita, M., Kameda, K. O., Şekercioğlu, Ç. H., Wenny, D. G., & Whelan, C. J. (2016). Nutrient dynamics and nutrient cycling by birds.*Why Birds Matter: Avian Ecological Function and Ecosystem Services (ÇH Şekercioğlu, DG Wenny, and CJ Whelan, Editors). University of Chicago Press, IL, USA*, 271-297.

Ginantra, I. K., Muksin, I. K., & Martin, J. O. N. I. (2020). Diversity of birds for ecotourism attractions in the mangrove ecosystem of nature conservation forum Putri Menjangan.*Journal of Environmental Management and Tourism*,*11*(1), 54-64.

Gonzalez, A. M., Espejo, N., Armenteras, D., Hobson, K. A., Kardynal, K. J., Mitchell, G. W.,& Wilson, S. (2023). Habitat protection and restoration: Win–win opportunities for migratory birds in the Northern Andes.*Perspectives in Ecology and Conservation*.

Gottschalk, T. K., Huettmann, F., & Ehlers, M. (2005). Thirty years of analyzing and modelling avian habitat relationships using satellite imagery data: a review.*International Journal of Remote Sensing*,*26*(12), 2631-2656.

Gregory, R. D., & van Strien, A. (2010). Wild bird indicators: using composite population trends of birds as measures of environmental health.*Ornithological Science*,*9*(1), 3-22.

Griggs, G., & Reguero, B. G. (2021). Coastal adaptation to climate change and sea-level rise.*Water*,*13*(16), 2151.

Happach, J., Johnson, J., Tsichlis, N., Watts, C., & Livingston, M. (2022). Long Term Habitat Restoration and Community Engagement for a Michigan Audubon Bird Sanctuary.

Harris, J., & Mirande, C. (2013). A global overview of cranes: status, threats and conservation priorities.*Avian Research*,*4*(3), 189-209.

Hiron, M., Rubene, D., Mweresa, C. K., Ajamma, Y. U., Owino, E. A., & Low, M. (2014). Crop damage by granivorous birds despite protection efforts by human bird scarers in a sorghum field in western Kenya.*Ostrich*,*85*(2), 153-159.

Hirschfeld, A. X. E. L., & Heyd, A. L. E. X. A. N. D. E. R. (2005). Mortality of migratory birds caused by hunting in Europe: bag statistics and proposals for the conservation of birds and animal welfare.*Berichte zum Vogelschutz*,*42*, 47-74.

Hossain, M. K., Alam, M. K., & Miah, M. D. (2008). Forest restoration and rehabilitation in Bangladesh. *Keep Asia Green*,*3*, 21-66.

Iqbal, M. A., Ullah, U., Khan, M. Z., Ghalib, S. A., Zehra, A., Khan, A. R., & Beg, M. N.(2023). Recent observation on the status and distribution of threatened and near threatened birds of sindh, pakistan.

Kark, S., Tulloch, A., Gordon, A., Mazor, T., Bunnefeld, N., & Levin, N. (2015). Cross-boundary collaboration: key to the conservation puzzle.*Current Opinion in Environmental Sustainability*,*12*, 12-24.

Kark, S., Tulloch, A., Gordon, A., Mazor, T., Bunnefeld, N., & Levin, N. (2015). Cross-boundary collaboration: key to the conservation puzzle.*Current Opinion in Environmental Sustainability*,*12*, 12-24.

Kiringe, J. W., & Okello, M. M. (2007). Threats and their relative severity to wildlife protected areas of Kenya.*Applied ecology and environmental research*,*5*(2), 49-62.

Krasny, M. E. (2020).*Advancing environmental education practice*(p. 312). Cornell University Press.

Lahoz-Monfort, J. J., & Magrath, M. J. (2021). A comprehensive overview of technologies for species and habitat monitoring and conservation.*BioScience*,*71*(10), 1038-1062.

Lauver, C. L., Busby, W. H., & Whistler, J. L. (2002). Testing a GIS model of habitat suitability for a declining grassland bird.*Environmental management*,*30*, 88-97.

Lian, X., Ming, X., Xu, J., Cheng, W., Zhang, X., Chen, H., & Qian, Y. (2018). First molecular detection and characterization of Marek's disease virus in red-crowned cranes (Grus japonensis): a case report.*BMC veterinary research*,*14*, 1-11.

Lindenmayer, D. B., & Fischer, J. (2013).*Habitat fragmentation and landscape change: an ecological and conservation synthesis*. Island Press.

Lindsey, P. A., Anderson, S. H., Dickman, A., Gandiwa, P., Harper, S., Morakinyo, A. B., &Tumenta, P. N. (2022). Shepherding Sub-Saharan Africa's Wildlife through Peak Anthropogenic Pressure toward a Green Anthropocene. *Annual Review of Environment and Resources*,*47*(1), 91-121.

Lister, N. M., Brocki, M., & Ament, R. (2015). Integrated adaptive design for wildlife movement under climate change.*Frontiers in Ecology and the Environment*,*13*(9), 493-502.

Lukies, K. (2020).*Ecological Corridors*. Eastern Bays Songbird Project.

Ma, Z., Choi, C. Y., Gan, X., Li, J., Liu, Y., Melville, D. S., & Zhang, Z. (2023). Achievements, challenges, and recommendations for waterbird conservation in China's coastal wetlands.*Avian Research*, 100123.

Maxwell, S. M., Kershaw, F., Locke, C. C., Conners, M. G., Dawson, C., Aylesworth, S., & Johnson, A. F. (2022). Potential impacts of floating wind turbine technology for marine species and habitats.*Journal of Environmental Management*,*307*, 114577.

McGowan, L. M. (2019).*Avian frugivory of Cinnamomum camphora in an urban environment: visiting bird species and the implications for seed dispersal and seedling emergence*(Doctoral dissertation).

Mekonnen, Z., Kidemu, M., Abebe, H., Semere, M., Gebreyesus, M., Worku, A., & Chernet, A. (2021). Traditional knowledge and institutions for sustainable climate change adaptation in Ethiopia.*Current Research in Environmental Sustainability*,*3*, 100080.

Michener, W. K., Blood, E. R., Bildstein, K. L., Brinson, M. M., & Gardner, L. R. (1997). Climate change, hurricanes and tropical storms, and rising sea level in coastal wetlands.*Ecological applications*,*7*(3), 770-801.

Morrison, S. A., Sillett, T. S., Ghalambor, C. K., Fitzpatrick, J. W., Graber, D. M., Bakker, V. J., ... & Boyce, W. M. (2011). Proactive conservation management of an island-endemic bird species in the face of global change.*BioScience*,*61*(12), 1013-1021.

Murray, N. J., Marra, P. P., Fuller, R. A., Clemens, R. S., Dhanjal- Adams, K., Gosbell, K. B., ... & Studds, C. E. (2018). The large- scale drivers of population declines in a long- distance migratory shorebird.*Ecography*,*41*(6), 867-876.

Nagendra, H., Lucas, R., Honrado, J. P., Jongman, R. H., Tarantino, C., Adamo, M., &Mairota, P. (2013). Remote sensing for conservation monitoring: Assessing protected areas, habitat extent, habitat condition, species diversity, and threats.*Ecological Indicators*,*33*, 45-59.

Nirmal Kumar, J. I., Kumar, R. N., & Soni, H. B. (2011). Ecological and Environmental Science: A Research Perspective.

Parikh, J. K., & Datye, H. (Eds.). (2003).*Sustainable management of wetlands: biodiversity and beyond*. Sage.

Parveen, R., Farooq, I., Ahangar, S., Nazki, S., Dar, Z., Dar, T., & Dar, P. (2017). Genotyping and phylogenetic analysis of infectious bronchitis virus isolated from broiler chickens in Kashmir.*Virusdisease*,*28*(4), 434-438.

Pérez- Granados, C., &Traba, J. (2021). Estimating bird density using passive acoustic monitoring: a review of methods and suggestions for further research.*Ibis*,*163*(3), 765-783.

Plieninger, T., Muñoz-Rojas, J., Buck, L. E., & Scherr, S. J. (2020). Agroforestry for sustainable landscape management.*Sustainability Science*,*15*, 1255-1266.

Post, D. M., Taylor, J. P., Kitchell, J. F., Olson, M. H., Schindler, D. E., & Herwig, B. R. (1998). The role of migratory waterfowl as nutrient vectors in a managed wetland.*Conservation Biology*,*12*(4), 910-920.

Rajvanshi, A., Mathur, V. B., Teleki, G. C., & Mukherjee, S. K. (2001).*Roads, sensitive habitats and wildlife: environmental guideline for India and South Asia*. Wildlife Intstitute of India.

Ramesh, M. K. (1999). The Wildlife Protection Act, 1972 of India: an agenda for reform.*Asia Pac. J. Envtl. L.*,*4*, 271.

Rani, R., Singh, S. P., Sharma, N. R., & Singh, R. (2023). Unveiling the Marvels of Indian Wetlands: Distribution, Ecological Importance, Challenges, and Conservation.*Journal of Advanced Zoology*,*44*(3), 717-744.

Robinson, W. D., Lees, A. C., & Blake, J. G. (2018). Surveying tropical birds is much harder than you think: a primer of best practices.*Biotropica*,*50*(6), 846-849.

Runge, C. A., Watson, J. E., Butchart, S. H., Hanson, J. O., Possingham, H. P., & Fuller, R. A. (2015). Protected areas and global conservation of migratory birds.*Science*,*350*(6265), 1255-1258.

Ruth, J. M., Diehl, R. H., & Felix Jr, R. K. (2012). Migrating birds' use of stopover habitat in the Southwestern United States.*The Condor*,*114*(4), 698-710.

Sadam, A., Khan, R. U., Gabol, K., Awais, M., Ismail, M., Mahmood, S., & Aslam, M. (2022). Hunting and Illegal Trade of White-Breasted Waterhen Amaurornisphoenicurus: Evidence from District Mardan, Khyber Pakhtunkhwa, Pakistan.

Sattar, Q., Maqbool, M. E., Ehsan, R., Akhtar, S., Sattar, Q., Maqbool, M. E., & Akhtar, S. (2021). Review on climate change and its effect on wildlife and ecosystem. *Open J Environ Biol*,*6*(1), 008-014.

Satterthwaite, D., McGranahan, G., &Tacoli, C. (2010). Urbanization and its implications for food and farming.*Philosophical transactions of the royal society B: biological sciences*,*365*(1554), 2809-2820.

Şekercioğlu, Ç. H. (2012). Promoting community-based bird monitoring in the tropics: Conservation, research, environmental education, capacity-building, and local incomes. *Biological Conservation*,*151*(1), 69-73.

Şekercioğlu, Ç. H., Primack, R. B., &Wormworth, J. (2012). The effects of climate change on tropical birds. *Biological conservation*,*148*(1), 1-18.

Shochat, E., Lerman, S., & Fernández-Juricic, E. (2010). Birds in urban ecosystems: population dynamics, community structure, biodiversity, and conservation.*Urban ecosystem ecology*,*55*, 75-86.

Si, Y., Xin, Q., Prins, H. H., de Boer, W. F., & Gong, P. (2015). Improving the quantification of waterfowl migration with remote sensing and bird tracking.*Science Bulletin*,*60*(23), 1984-1993.

Simberloff, D. (2013).*Invasive species: what everyone needs to know*? Oxford University Press.

Simonson, W. D., Miller, E., Jones, A., García-Rangel, S., Thornton, H., & McOwen, C. (2021). Enhancing climate change resilience of ecological restoration—a framework for action.*Perspectives in Ecology and Conservation*,*19*(3), 300-310.

Steven, R., Morrison, C., & Castley, J. G. (2017). Exploring attitudes and understanding of global conservation practice among birders and avitourists for enhanced conservation of birds.*Bird Conservation International*,*27*(2), 224-236.

Terborgh, J. (1989).*Where have all the birds gone? Essays on the biology and conservation of birds that migrate to the American tropics*. Princeton University Press.

Teshome, E., Shita, F., & Abebe, F. (2021). Current community based ecotourism practices in Menz Guassa community conservation area, Ethiopia.*GeoJournal*,*86*, 2135-2147.

Umar, M., Hussain, M., Murtaza, G., Shaheen, F. A., & Zafar, F. (2018). Ecological concerns of migratory birds in Pakistan: a review.*Punjab University Journal of Zoology*,*33*(1), 69-76.

Uprety, Y., Asselin, H., Bergeron, Y., Doyon, F., & Boucher, J. F. (2012). Contribution of traditional knowledge to ecological restoration: practices and applications.*Ecoscience*,*19*(3), 225-237.

Vimal, R., Navarro, L. M., Jones, Y., Wolf, F., Le Moguédec, G., &Réjou-Méchain, M. (2021). The global distribution of protected areas management strategies and their complementarity for biodiversity conservation.*Biological Conservation*,*256*, 109014.

Wang, G., Wu, H., Dai, J., Xiong, Y., Long, Y., Cai, X., & Liu, Y. (2023). Priorities identification of habitat restoration for migratory birds under the increased water level during the middle of dry season: A case study of Poyang Lake and Dongting Lake wetlands, China.*Ecological Indicators*,*151*, 110322.

Webster, M. S., Marra, P. P., Haig, S. M., Bensch, S., & Holmes, R. T. (2002). Links between worlds: unraveling migratory connectivity.*Trends in ecology & evolution*,*17*(2), 76-83.

Wellsmith, M. (2011). Wildlife crime: the problems of enforcement.*European Journal on Criminal Policy and Research*,*17*, 125-148.

White, R. L., Eberstein, K., & Scott, D. M. (2018). Birds in the playground: Evaluating the effectiveness of an urban environmental education project in enhancing

school children's awareness, knowledge and attitudes towards local wildlife.*PloS one*,*13*(3), e0193993.

Whitworth, D., Newman, S., Mundkur, T., & Harris, P. (2007).*Wild birds and avian influenza: an introduction to applied field research and disease sampling techniques*(Vol. 5). Food & Agriculture Org.

Williams, S. L., &Grosholz, E. D. (2008). The invasive species challenge in estuarine and coastal environments: marrying management and science.*Estuaries and Coasts*,*31*, 3-20.

Yong, D. L., Jain, A., Liu, Y., Iqbal, M., Choi, C. Y., Crockford, N. J., & Provencher, J. (2018). Challenges and opportunities for transboundary conservation of migratory birds in the East Asian- Australasian flyway.*Conservation Biology*,*32*(3), 740-743.

Zamirr, A., Umrani, A. M., &Sajawal, M. (2023). Significance of the Balochistan (Wildlife Protection, Preservation, Conservation, and its Management) Act, 2014.

Zimmerman, M. E. (2003). The black market for wildlife: Combating transnational organized crime in the illegal wildlife trade.*Vand. J. Transnat'l L.*,*36*, 1657.