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UNDER PEE

33 1. Introduction

34 The varied landscapes of South Asia are decorated with numerous ecosystems that
35 play a vital role as habitats for a wide range of wild and migratory bird species. These
36 habitats are crucial for maintaining the ecological equilibrium and biodiversity of the
37 region. South Asia contains a wide range of bird species, including those found in
38 tropical rainforests, wetlands, and high-altitude mountain ranges (Nirmal Kumar et al.
39 2011). This review aims to explore the importance of these habitats, illuminate the
40 difficulties and dangers they encounter, and suggest approaches for their improved
41 preservation. The significance of wild and migratory bird habitats cannot be
42 exaggerated, as they function as crucial sanctuaries for several species (Terborgh 1989).
43 These habitats serve as locations for migratory birds to procreate, stopover, and spend
44 the winter, thereby facilitating the complex patterns of their seasonal movements (Ruth
45 et al. 2012). The interdependence of these habitats impacts various ecological processes,
46 including seed dispersal, pollination, and insect management, thereby contributing to
47 the overall well-being of ecosystems (Blitzer et al. 2012). Additionally, a flourishing
48 ecosystem is signified by the presence of numerous bird species, which serves as an
49 indicator of the overall health of the environment (Shochat et al. 2010). Nevertheless, in
50 spite of their ecological importance, these habitats are progressively facing an extensive
51 array of obstacles and perils (Kiringe and Okello 2007). These natural refuges are
52 progressively being encroached upon by anthropogenic activities such as
53 industrialization, deforestation, and urbanization, which fragment habitats and deplete
54 available resources (Lindsey et al. 2022). The situation is additionally compounded by
55 climate change, which disrupts migration patterns, modifies the timing and accessibility
56 of food sources, and presents novel obstacles for avian populations (Sattar et al. 2021).
57 Environmental degradation, excessive utilization of natural resources, and the
58 proliferation of invasive species introduce further intricacies to the conservation enigma
59 (Williams and Grosholz 2008). A critical examination of the status of wild and
60 migratory bird habitats in South Asia is the objective of this exhaustive analysis, which
61 aims to identify critical issues and assess current conservation efforts. Our objective is
62 to offer a comprehensive comprehension of the present condition of these habitats and
63 the obstacles they encounter through this approach. This will subsequently contribute to
64 the formulation of conservation strategies that are efficacious and customized to the
65 distinct ecological and socio-economic circumstances of the area.

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

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

81

82 **2. Materials and Methods**

83 Data for this study were collected from peer-reviewed journal publications, books,
84 and reports from international, governmental, and non-governmental organizations, as
85 well as selected pieces from print and electronic news sources. Google, Google Scholar,
86 Pubmed, and ReseachGate databases were searched using various keywords such as
87 "wild birds", "migratory birds", "present condition", "conservation status", and "future
88 impacts". We used Microsoft Office (2013) for data curation and analysis.

89

90 **3. Current Conservation Practices**

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

102 **Table 1. Conservation Practices of wild and migratory birds**

Steps	Description
Protected Areas and Reserves	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Identifying resilient habitats, understanding species vulnerability. • Implementing measures to mitigate climate-related threats.

103

104 **3.1 Habitat Assessment and Monitoring**

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

136 **3.2 Restoration and Rehabilitation Techniques**

137 Habitat restoration is an important component of conservation activities aimed at
138 revitalizing ecosystems and improving their appropriateness for wild and migratory
139 birds (Wang et al. 2023). To repair and rehabilitate bird a habitat in South Asia, a
140 combination of traditional and novel strategies is used (Hossain et al. 2008). The
141 restoration and rehabilitation of wild and migratory bird habitats involves a combination
142 of conventional and modern strategies. While conventional approaches rely on local

143 knowledge and tried-and-true procedures, innovative approaches utilize advances in
 144 technology and biology to address modern concerns. For successful habitat restoration
 145 in the region, a comprehensive and adaptive approach that combines the best of both
 146 traditional and modern techniques is essential (Upreti et al. 2012).

147

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

Methods	Types	Explanation
Traditional Methods	Afforestation and Reforestation	<ul style="list-style-type: none"> Planting native trees and vegetation in degraded areas Recreate suitable habitats for birds and promote biodiversity
	Wetland Restoration	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Erosion and soil degradation affects bird habitats Traditional methods of soil management techniques restore the natural vegetation and create stable habitats
	Community-Based Conservation	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> • Using sound recordings to assess the health of ecosystems • Integrating soundscape restoration techniques attract birds and facilitate habitat recovery
	Ecological Restoration Networks	<ul style="list-style-type: none"> • 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

150

151 **3.3 Impact of Climate Change on Bird Habitats**

152 Climate change is drastically affecting the ecosystems on which wild and
 153 migratory birds rely in South Asia (Şekercioğlu et al. 2012). These changes emerge in a
 154 variety of ways, posing major concerns to bird habitat resilience and sustainability.
 155 Rising temperatures and changed precipitation patterns are causing changes in bird
 156 distribution and the timing of important life events such as breeding and migration
 157 (Dunn et al. 2010). Some ecosystems may become unsuitable for specific species, while
 158 others may see new entrants. Rising sea levels and increased storm strength are
 159 threatening coastal habitats, which are critical for many bird species (Michener et al.
 160 1997). Nesting places, feeding grounds, and migration stops near coastlines are at risk
 161 of erosion and submersion, threatening their viability (Harris and Mirande 2013). More
 162 frequent and severe weather events, such as storms, droughts, and wildfires, can destroy
 163 habitat (Dale et al. 2001). Intense weather events can harm flora, alter landscape
 164 architecture, and disrupt food availability, all of which have a direct impact on bird
 165 populations (Brawn et al. 2001). Climate change can worsen habitat fragmentation,
 166 separating populations and limiting birds' ability to find optimal breeding, feeding, and
 167 resting locations (Lindenmayer and Fischer 2013). Population loss and genetic diversity
 168 might result from disconnected environments (Canales- Delgadillo et al. 2012).

169

170 **3.4 Habitat Resilience and Adaptation**

171 Climate change impacts on bird habitats are being addressed through a
 172 combination of proactive conservation efforts and adaptive management approaches
 173 (Morrison et al. 2011). Protected area expansion and strengthening aid in the
 174 preservation of crucial bird habitat. Restoration programs, such as afforestation and
 175 wetland rehabilitation, aim to improve habitat resilience by creating safe zones for birds
 176 to adapt to changing conditions (Gonzalez et al. 2023). Ecological corridors unite
 177 fragmented habitats, allowing birds to move freely (Lukies 2020). These corridors act as
 178 migration paths, allowing species to adapt to changing climatic conditions and locate
 179 adequate habitat along the way. Local communities frequently have traditional
 180 knowledge that can be used to develop effective adaptation strategies (Mekonnen et al.
 181 2021). Encouragement of sustainable land use practices, such as agroforestry and
 182 community-based conservation, contributes to the creation of resilient landscapes that
 183 lead adaptive management techniques, ensuring interventions are based on the most
 184 recent scientific findings (Plieninger et al. 2020). Managed retreat in coastal locations
 185 entails enabling natural habitats to relocate inland when sea levels rise (Griggs and

186 Reguero 2021). Building climate-resilient infrastructure protects habitats from
187 catastrophic weather events while also allowing ecosystems to adapt to changing
188 conditions. Migratory birds frequently traverse boundaries, underscoring the importance
189 of international cooperation. Collaboration across governments and organizations makes
190 it easier to develop transboundary conservation programs and coordinated climate
191 adaptation measures (Kark et al. 2015). It is vital to raise awareness about the effects of
192 climate change on bird habitats and gain support for conservation efforts. Education and
193 advocacy campaigns encourage sustainable behaviors, influence lawmakers, and
194 develop a shared commitment to habitat conservation (Krasny 2020). While some
195 solutions show potential, obstacles remain. Obstacles to effective implementation
196 include funding limits, conflicting land-use objectives, and the requirement for long-
197 term commitment. Furthermore, uncertainty about the rate and type of climate change
198 complicate adaptation planning. Adapting bird habitats in South Asia to climate change
199 necessitates a multifaceted and coordinated strategy (Lister et al. 2015). To address the
200 dynamic difficulties provided by a changing climate, conservation policies must be
201 adaptable, community-centered, and scientifically grounded (Buffa et al. 2023). Only by
202 working together can we assure the survival of bird habitats and the varied avian species
203 that rely on them.

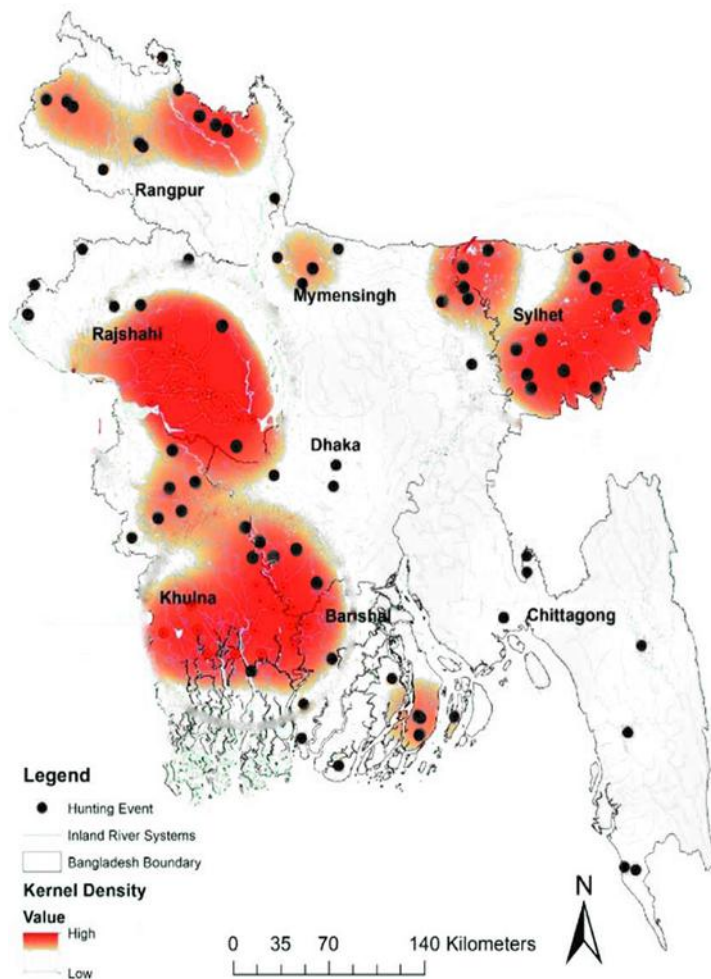
204 **3.5 Community Engagement and Education**

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

223 **4. Status of Illegal Bird Hunting in Indian Sub-continent**

224 Illegal bird hunting is a major problem in India, causing the extinction of many
225 bird species and endangering both resident and migratory bird populations (Umar et al.
226 2018). The government, non-governmental organizations (NGOs), and wildlife
227 conservation organizations are working to tackle this issue through stronger law
228 enforcement, public awareness campaigns, and habitat conservation measures. The
229 Wildlife Protection Act of 1972 serves as India's fundamental legal foundation for
230 wildlife protection (Ramesh 1999). However, the success of these efforts varies, and
231 obstacles exist, such as a lack of enforcement resources, the involvement of organized
232 crime, and the demand for birds in illegal trade (Zimmerman 2003). Northeast India,

233 the northern plains, Rajasthan, the Andaman and Nicobar Islands, and the Western
234 Ghats are some historically connected places. To address these challenges, conservation
235 activities, educational campaigns, and stronger law enforcement are continuing.
236 Bharatpur, Rajasthan, the *Chambal* River Basin, *Wular* Lake, *Pulicat* Lake, *Harike*
237 Wetland, and *Sundarbans*. West Bengal are among the areas suffering illegal bird
238 hunting difficulties (Parikh and Datye 2003). Conservation activities are still underway,
239 and the status of these areas may have altered. Bangladesh is strategically significant for
240 bird migration since it crosses two migratory flyways (East Asian-Australasian and
241 Central Asian). Illegal wildlife hunting, particularly of birds, is a serious global
242 conservation issue for many endangered species. Birds in the *Ardeidae* family, such as
243 herons, egrets, bitterns, and night herons, were mostly taken using trapping (40%) and
244 netting (27%) tactics (Datta 2022). The major reason for hunting was to make some
245 quick money during the winter season. The Bangladesh Forest Department's existing
246 Wildlife Crime Control Unit should be enhanced, and legislation should be enacted to
247 prevent additional illegal bird killing in Bangladesh. Based on a report published in a
248 daily newspaper from 2010 to 2022, maps depict the biggest hunting areas of
249 Bangladesh. The three main hotspots of illegal bird hunting in Bangladesh are Rajshahi,
250 Sylhet, and Khulna (Datta 2022). Several bird species are threatened due to habitat
251 destruction, poaching, and illegal commerce, making illegal bird hunting in Pakistan a
252 severe problem (Sadam et al. 2022). This issue is especially obvious during the spring
253 and fall migrations of birds. Waterfowl and migratory bird species are important, as is
254 the Houbara Bustard, a migratory bird (Azar et al. 2022). Although its enforcement has
255 been challenging, the Pakistan Wildlife (Protection, Preservation, Conservation, and
256 Management) Ordinance is one of the laws that preserve wildlife, particularly birds
257 (Zamirr et al. 2023). The Thar Desert, Khyber Pakhtunkhwa, Sindh, Punjab, and
258 Baluchistan are the most popular bird-hunting destinations in Pakistan (Iqbal et al.
259 2023).



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

262 **5. Impacts of Migratory Birds on environment and human health**

263 **5.1 Positive impacts**

264 Migratory birds play an important role in many ecosystems, and their presence has
 265 both direct and indirect environmental effects. Birds frequently ingest and defecate
 266 fruits and seeds in different locations. This technique aids in the dispersal of plant
 267 species, hence preserving biodiversity and regenerating vegetation in various places.
 268 Insects and other invertebrates are eaten by birds. They help to manage insect
 269 populations and maintain the balance of local ecosystems by doing so. Bird droppings
 270 include nutrients such as nitrogen and phosphorus, which enhance the soil in locations
 271 where birds rest or breed, aiding in nutrient cycling and increasing soil fertility (Fujita et
 272 al. 2016). Some wild and migratory bird species, particularly hummingbirds, parrots,
 273 tailorbirds, and others, aid in pollination (Acharya et al. 2022). Their visits to flowers
 274 aid in the transmission of pollen, allowing plant species to reproduce. Birds move
 275 between breeding, feeding, and wintering grounds, therefore they connect diverse
 276 environments. This connectedness is critical for ecosystem health, as it promotes
 277 genetic diversity and allows organisms to adapt to changing environments. The
 278 presence of migrating birds draws birdwatchers and tourists, which helps local
 279 economies through eco-tourism (Ginantra et al. 2020). This monetary value encourages

280 the preservation of avian habitats. GOs and NGOs organize bird-watching fairs at
 281 various locations to observe both wild and migratory birds. The ornithology tourism
 282 business is expected to be worth \$59, 7 billion by 2022. According to the analysis, sales
 283 are expected to grow at a healthy 5.2% CAGR, with the market valued at US\$100.2
 284 billion by 2032. The presence of migratory bird species is often an indicator of a healthy
 285 ecosystem (Gregory and Van 2010). Their absence or decline could indicate
 286 environmental issues including habitat degradation, pollution, or climate change. Some
 287 migratory birds, particularly ducks, help to keep water clean (Post et al. 1998). Their
 288 efforts can aid in the prevention of the spread of certain waterborne diseases as well as
 289 the overall health of the aquatic ecosystem. Through their feeding activities, migratory
 290 birds can impact the structure of plants. Migratory bird migration allows for gene flow
 291 and the exchange of genetic material between groups (Webster et al. 2002). This genetic
 292 diversity can help species to be more resilient in the face of environmental changes,
 293 especially those caused by climate change.

294 **5.2 Negative impacts**

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

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

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

308
 309 Large numbers of migrating birds, especially in vulnerable environments, can
 310 cause habitat disruption. Nesting and foraging activities have the potential to damage

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

328

329 **6. Challenges and Opportunities**

330 The primary problem in protecting migratory birds is that their annual cycles
331 spatially connect breeding, passage and staging, and wintering regions (Yong et al.
332 2018). A global review of significant bird sites, however, reveals that the existing range
333 of protected areas is insufficient for only 9% of the 1451 migratory bird species at all
334 stages of their annual cycle (Runge et al. 2015). Loss of habitat at some staging sites or
335 loss of crucial sites can thus have a significant impact on migratory species flyway
336 populations (Murray et al. 2018). As cities grow and farms expand, the places where
337 birds live and find food are shrinking (Satterthwaite et al. 2010). This makes it more
338 difficult for them to survive. Climate change and pollution are also causing problems
339 for birds. The weather is becoming more unpredictable, altering where birds go at
340 various periods of the year and producing problems (Şekercioğlu et al. 2012). Dirty
341 water and air harm the places where birds live and can make them sick (Bird 2007).
342 Illegal hunting is also a significant concern. Some people hunt birds for sport or to sell
343 them, which can have a major impact on bird populations (Hirschfeld et al.
344 2005). Invasive species, like plants or animals from other places, can be a problem as
345 well (Simberloff 2013). They may take over areas where birds normally live, making it
346 difficult for local birds to find sufficient food and shelter. Finally, few people are aware
347 of these issues, and it is difficult to assist birds if we do not understand how essential
348 they are and the difficulties they confront. Despite these obstacles, there are numerous
349 ways to improve things. People who live near bird habitats may be eager to assist
350 safeguard the birds if they realize how vital they are (Beatley 2020). Opportunities for
351 sustainable livelihoods, such as jobs that do not destroy bird habitats, may also exist.
352 Everyone benefits if people can make a living while helping birds. Bird protection laws
353 and regulations are critical. Strong rules against hunting and hurting birds can dissuade
354 individuals from engaging in these activities. Another important conservation approach
355 is education. We can develop a stronger sense of responsibility for birds' well-being by
356 informing people why birds are important and what threatens them. We can also benefit
357 from technology. Satellite tracking tools can help us understand where birds go and how

358 to protect their habitats. Reserves and protected areas can provide a secure haven for
359 birds to rear their young. The public's involvement is critical. We can better safeguard
360 the birds if everyone, from average people to scientists, keeps an eye on them and
361 reports any concerns. Collaboration with neighboring countries is also essential since
362 birds do not stay in one location; they migrate across boundaries. Collaboration ensures
363 that all countries engaged are doing their part to protect these avian visitors.

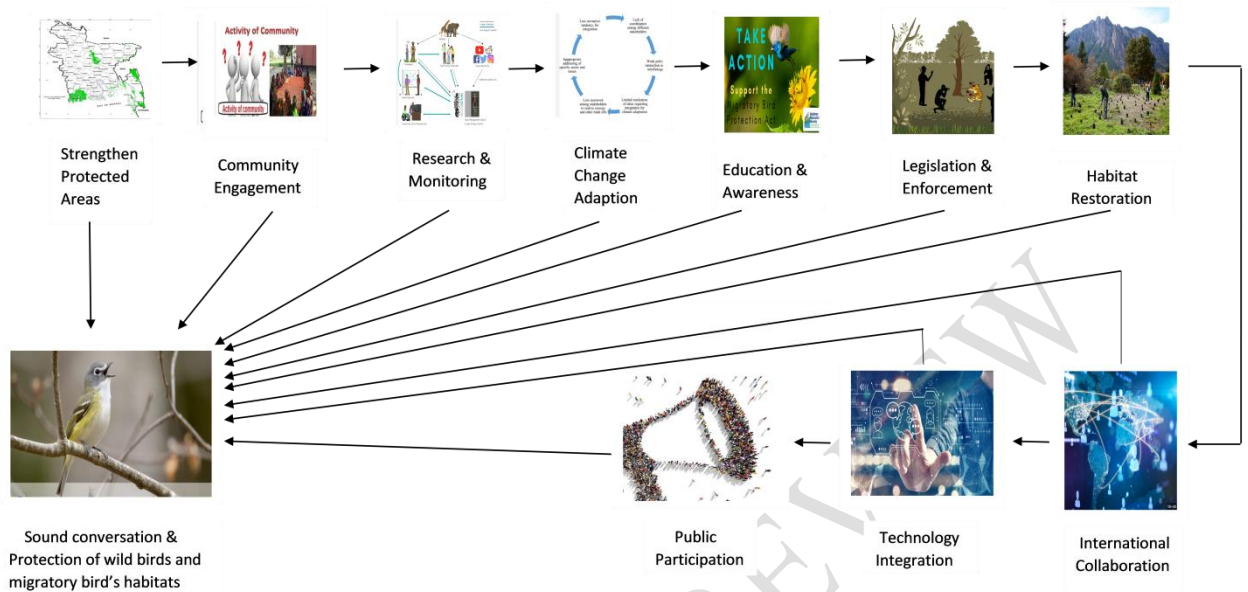
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365 **7. Future plan for wild and migratory bird management of Bangladesh**

366 In the future, Bangladesh can take numerous steps to improve the management of
367 wild and migratory birds, ensuring their protection and long-term coexistence with
368 human activities. Improve and expand protected areas, wildlife sanctuaries, and reserves
369 to protect essential bird habitat (Vimal et al. 2021). Implement and implement
370 regulations to protect and restore wetlands, which are critical habitat for many
371 migratory bird species (Ma et al. 2023). Involve local communities in bird conservation
372 activities, highlighting birds' cultural, ecological, and economic importance (Steven et
373 al. 2017). Community involvement can lead to more successful conservation methods
374 and long-term resource management. Encourage community-based ecotourism and
375 other sustainable livelihoods that are compatible with bird conservation (Teshome et al.
376 2021). This has the potential to benefit local communities while also protecting bird
377 habitats. Conduct extensive research on bird populations, migration patterns, and
378 behavior in order to better understand and inform conservation measures (Faaborg et al.
379 2010). Regular monitoring systems should be implemented to track changes in bird
380 populations and habitats (Maxwell et al. 2022). Create and put into action solutions to
381 address the effects of climate change on bird habitats and migration patterns (Byrd et al.
382 2023). This could involve habitat restoration, the development of climate-resilient
383 ecosystems, and the promotion of sustainable practices (Simonson et al. 2021). To
384 create awareness about the importance of bird conservation, conduct educational
385 programs in schools, communities, and through various media channels. Encourage the
386 people to take responsibility for the protection of wild and migratory birds. Enhance
387 wildlife protection legislation and ensure its effective enforcement (Du et al. 2023).
388 Penalties should be imposed for illegal acts such as hunting, trapping, and habitat
389 degradation (Wellsmith 2011). Implement habitat restoration programs to restore
390 degraded regions and provide safe havens for birds. Control invasive species that may
391 harm bird habitats (Happach et al. 2022). Collaborate with neighboring countries and
392 international organizations to ensure coordinated efforts for migratory bird conservation
393 (Kark et al. 2015). Participate in global efforts and share information and best practices.
394 Monitor bird movements, migration patterns, and habitat conditions using technology
395 such as satellite tracking, remote sensing, and data analytics (Si et al. 2015). This data
396 can be used to guide effective conservation measures. Encourage citizen science
397 projects that involve the public in bird monitoring and protection. Encourage citizens to
398 feel ownership and pride in the country's unique bird species. Bangladesh can make a
399 substantial contribution to the protection of wild and migratory birds by implementing
400 these measures, ensuring their continuous presence and ecological relevance in the
401 region. Collaboration between government agencies, non-governmental groups, local
402 communities, and international partners is critical to the success of these efforts.

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

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410 8. Scope for future research

411 Despite advances in monitoring technology, there remains a significant lack in
412 long-term monitoring studies that track changes in bird habitat over lengthy periods of
413 time. Longitudinal studies are critical for understanding the cumulative effects of
414 different stresses and assessing the efficacy of conservation strategies. According to the
415 literature, there is a need for more interdisciplinary research that merges ecological and
416 social sciences. Understanding the human components of bird habitat protection, such
417 as socioeconomic issues impacting land use and community engagement, is critical for
418 designing comprehensive and effective conservation programs. While the impact of
419 climate change is acknowledged, quantitative assessments of habitat resilience to
420 climate stressors are lacking. In the face of changing climatic conditions, research
421 concentrating on identifying and characterizing climate-resilient habitats might inform
422 targeted conservation measures. Although migration patterns are regarded as critical
423 features of bird conservation, in-depth studies on individual migration routes in South
424 Asia are lacking. Understanding the difficulties that migratory birds confront on their
425 migrations is critical for developing effective trans-boundary conservation projects.
426 While the literature provides improved and creative conservation measures, full
427 evaluations of their real-world implementation are lacking. It is critical to assess the
428 feasibility, scalability, and actual impact of these techniques in order to guide future
429 conservation measures.

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431 9. Conclusion

432 The review provides a thorough examination of South Asia's conservation plans
433 for wild and migratory bird habitats. The review's primary points are the importance of
434 these ecosystems, the issues they confront as a result of factors like as habitat loss,

435 climate change, and human activity, and the continuous work to protect and restore
436 them. The assessment considers both classic and novel methods of protecting and
437 restoring ecosystems, such as protected areas, community involvement, enhanced
438 monitoring technology, and climate-resilient planning. These improved techniques,
439 which incorporate cutting-edge technologies, community involvement, and climate
440 adaption measures, understand the dynamic nature of the issues encountered by bird
441 habitats. The convergence of precision conservation, international collaboration, and
442 education activities strengthens these habitats and contributes to the overall well-being
443 of the region's various bird species. Furthermore, increasing international collaboration
444 and knowledge sharing among South Asian countries can aid in the establishment of
445 trans-boundary conservation projects. Community involvement models should always
446 adapt to be more inclusive and responsive to local communities' needs and perspectives,
447 ensuring their active participation in and benefit from conservation activities.
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