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Review Article

Ecological Concerns of Migratory Birds in Pakistan: A Review

Muhammad Umar[1], Mubashar Hussain[1,*], Ghulam Murtaza[1], Farid Asif Shaheen[2], Fatima Zafar[1]

[1]Department of Zoology, Faculty of Science, University of Gujrat, Punjab, Pakistan
[2]Department of Entomology, PMAS-Arid Agriculture University, Rawalpindi, Pakistan

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MU drafted the manuscript. MH presented the concept and coordinated correspondence. GM, MH and FAS critically reviewed the manuscript. FZ did final revision. GR prepared the map.

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Abstract | Birds from Siberian region migrate to oriental region through different fly-zones in order to shun the perils of extreme cold annually in the winter season. Indus Fly Zone in Pakistan serves as a middle Asian flying route for the migratory birds that is connected to West Asian and East African flying routes. The ecological concerns faced by the migratory birds in Pakistan have been reviewed extensively. The disappearing trends of migratory birds are recorded from fresh water reservoirs of Pakistan and are mainly attributed to continued loss of wintering habitat, habitat modification, fragmentation, eutrophication, anthropogenic activities and illegal hunting. The adverse effects of habitat loss (Band tailed fish eagle, Black Stork and Water Pipit), pesticides (Gulls, Eagles, Terns, Ducks and Cormorants), eutrophication (Painted stork and Dalmatian pelican), Agrochemical Contamination (Black-tailed godwit and Fish bird) Heavy Metal Pollution Contamination (Cattle egrets), Unsustainable Fisheries Practices (Ducks), invasive species (Little egret and Night herone) and illegal hunting (Geese, Ducks, Siberian cranes and Bustards) have resulted in the decline of species abundance.. Regular conduct of surveys for important migratory birds to assess the population trend, abundance and patterns of their migration is another important step towards conservation of birds. To make an effective conservation of migratory birds, integration of different approaches for the protection of their habitats, and to prevent the illegal hunting and poaching, mitigating agricultural and industrial pollution, preventing water reservoirs from heavy metal poisoning are important considerations. Ceasing anthropogenic activities along with the mass awareness programs on electronic and print media could be effective conservation strategies during the period of their stay in Pakistan.

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Introduction

Pakistan is located at latitude of 30.3753°N and 69.3451°E in South Asia, and serves as a middle Asian flying route for the migratory birds that is connected to West Asian and East African flying routes. International Migratory Bird Route Number 4 also called Green Route or more commonly Indus Flyway stretching from Karakoram down to Indus delta in the south providing attractive stopovers for guest birds. Wetland areas from northern mountains to southern coast serve as a prolific habitat for water birds arriving from the Siberia (The Dawn, 2016). Pakistan is included in the list of countries which harbor > 400 of migratory birds (UNEP, 2014) annually that take an exhaustive and perilous journey of about 4500 km. The itinerary of these birds that lasts for 4-5 months in Pakistan is facilitated by wetlands and Ramsar sites located along the Indus basin providing them habitat and food requirements. These birds enter into Pakistan from September-November via Indus flyway over the Karakorum and the Suleiman mountain ranges then entering to the delta of Indus River near the Arabian Sea and stay till February - March and finally returning to their breeding habitats (Sheikh and Kashif, 2006).

***Corresponding author:** Mubashar Hussain
dr.mubashar@uog.edu.pk

Migratory birds have a long history of being observed and studied with an estimated 1,855 migratory bird species out of which 352 extant species showing regular cyclical movements during particular timings of their breeding and wintering seasons (Somveille *et al*., 2013). The importance of the study undertaken could be realized from the citations in a single book on migratory birds (2800 references) and above 4500 articles in Web of Science under the topic "bird migration" (Newton, 2008) related to their behavior, adaptations, evolutionary perspectives and status of conservation of migratory birds (Kirby *et al*., 2008). This review has been conducted to identify and highlight ecological concerns of migratory birds in Pakistan to look into the ever-increasing decline in the population of these birds in Pakistan.

Birds' Census

There are total 10960 extant bird species worldwide out of which 1460 species (13% of extant species) are declared as Globally Threatened species (BirdLife, 2016). About 1029 species are Near Threatened; currently considered prone to danger of being threatened due to threats posed mainly by the climate change and man-made activities (Sekercioglu, 2004). The available data on species conservation revealed 8405 least concern, 449 endangered (EN) and 786 vulnerable bird species (BirdLife, 2016). The total number of bird species reported from Indo-Pak subcontinent is 2060 (Ali and Ripley, 1987); whereas, a total of 656 bird species belonging to 272 genera were reported from Pakistan out of which 63.4% predominantly with an influx of winter migrants and 43% are Palearctic visiting species and 28% are regular winter visitors while 33% use wetlands for food, shelter and breeding (Ali and Ripley, 1987; Roberts, 1991; Mirza and Wasiq, 2007; Grimmett *et al*., 2008).

Sociable lapwing *Vanellus gregarious*, Sindh babbler *Moupinia altirostris*, Marbled duck, *Marmoronetta angustriostris*, Sarus crane, *Grus antigone*, Long-tailed grass warbler, *Priniaburnesii,* Ferruginous duck, *Aythya nyroca*, Lesser white-fronted goose, *Anser erythropus*, Dalmatian pelican, *Pelicanus crispus* and white-headed duck, *Oxyura leucocephala* are considered as threatened birds' species in Pakistan. Out of 27 Internationally threatened bird species found in Pakistan, most are reported in Gilgit-Baltistan (BirdLife, 2001).

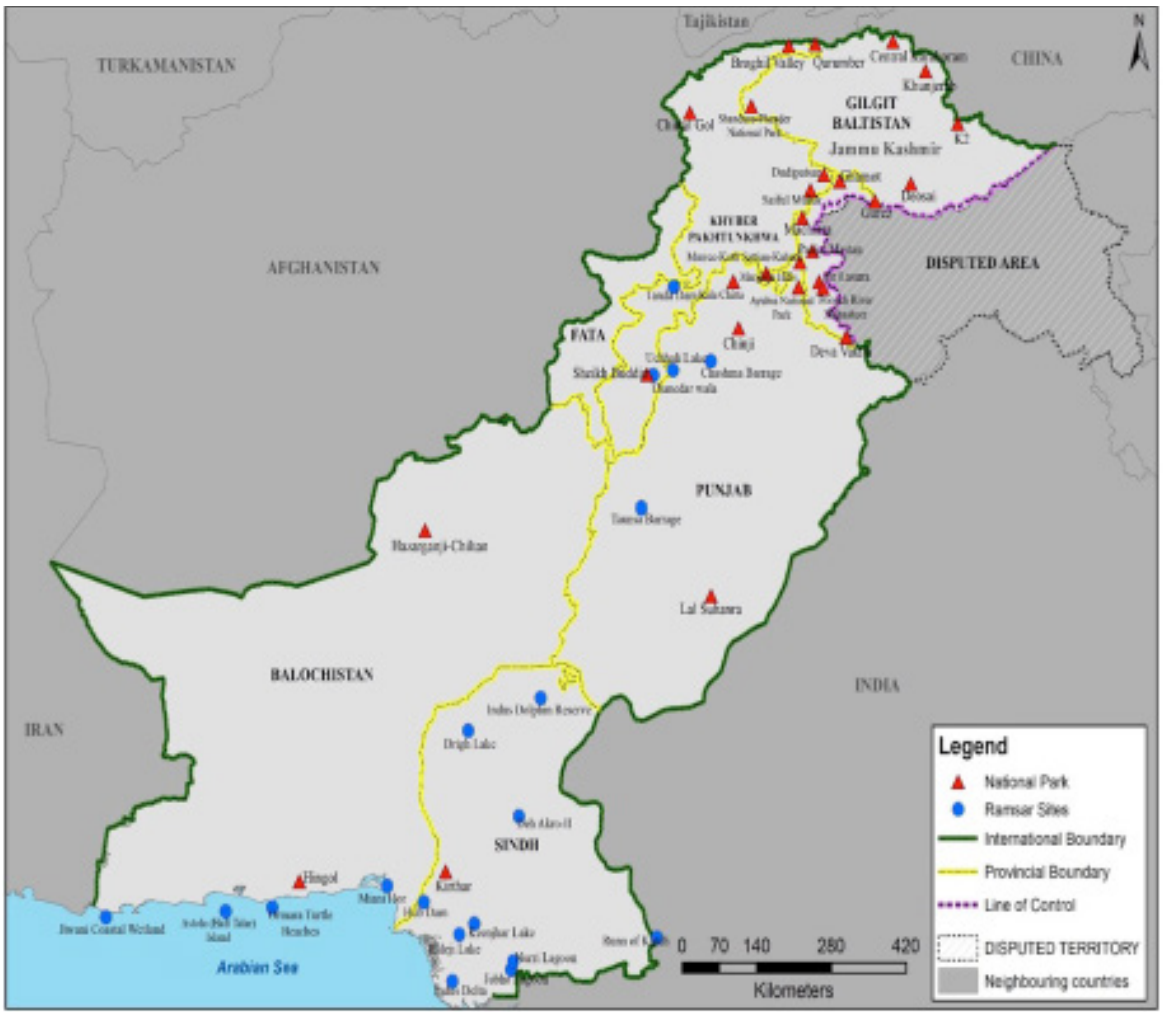

Figure 1: National Parks and Ramsar Sites offering habitat and food to migratory birds during their stay in Pakistan

Bird's Migration toward Pakistan

In search of suitable weather, thousands of birds representing many species pass through Pakistan staying temporarily at different lakes and water reservoirs on their way to other destinations in Indian subcontinent. Pakistan offering attractive wetlands to a large number of migratory bird species annually in the winter seasons. Basically, it serves as middle Asian flying route for the migratory birds (Figure 1). Wetland areas from northern mountains to southern coast serve as habitat for water birds arriving from the Siberia (Ali, 2015). It has been estimated that about 1 million birds migrate by using International Migratory Bird Route Number 4 by covering a distance of about 2800 miles (4500 km). There has been drastic decline in the number of species making stopovers at water reservoirs in Pakistan (The Dawn, 2016). The major species of birds that migrate from Siberia to Pakistani territory including Houbara bustards, Cranes, Teals, Pintails, Mallards, Geese, Spoon bills, Waders and Pelicans (Express Tribune, 2016) (Figure 2).

Reasons of Migration

Migration is most important event for animals to complete one annual life cycle (Sherry and Holmes, 1996). Many species of birds show local or long distance migration in search of food or to avoid harsh weather conditions as during winter season, large numbers of birds migrate from countries of central Asia and Europe towards Pakistan. Few bird species from Palearctic region afar from Himalayas are the sessional immigrants for breeding. Important migratory birds of Pakistan are flamingos, Falcons, swans, geese, waders, cranes and ducks. The large distance migration within breeding and wintering grounds results in evolution of certain traits in shorebirds (Piersma and Baker, 1999). Mainly bird migration takes place from northern arctic region towards southern plains. Wintering basically spends in tropical areas where they inhabit 6-7 months and breeding occurs in temperate areas where they stay for two to three months (Baillie and Peach, 1992). The occurrence of migratory birds in the particular areas indicates that the site is favorable for feeding, nesting and breeding. Different researchers showed that birds migration occur to different areas due to availability of food (Scott, 1991), seasonal changes (Lank *et al.*, 2003) and to avoid threat of predation (Shirazi, 1993).

Hunting

Birds are intensively hunted and captured in Pakistan, for consumption and sports (Bennett and Whitten, 2003) owing to which local populations are declining, but the overall status of the species are regarded as stable (Richard *et al.*, 2002). Historically, non-domesticated birds have been major element of human diets (Moss and Bowers, 2007). Robinson et al. (1995) found that migratory bird populations are decreased due to predation. Dalmatian pelican (*Pelecanus crispus*), a winter visitor in Pakistan, has shown decline in its population due to hunting and disturbance. Similarly, black-headed Ibis is a local and irregular migratory visitor of Pakistan throughout the year which encounter extreme risk of being hunted and habitat destruction mainly by drainage and cultivation in their foraging and breeding habitats. Painted stork is local winter tourist of Pakistan facing marked decline in population size due to over hunting (Grimmett *et al.*, 2008; BirdLife, 2016). Illegal hunting is another main threat to many migratory birds like geese, coot and ducks. The bar-headed geese are hunted brutally.

During winter season, a tremendous amount of migratory birds visit the Mangla Dam and hunted excessively *i.e.,* waterfowl's population (Ali, 2005; Khalique *et al.*, 2012). Khan and Ali (2015) reported the marked reduction in migratory birds' population each year *i.e.*, in Uchalli Wetland Complex (Ali, 2006). AJK wildlife is facing dramatic reduction due to over hunting and trapping (Kiani et al., 2013). The avifauna of Taunsa Barrage wetland consists of 110 species; 34 species visit only in winter while 2 species in summer. In Jiwani Coastal Wetland, total 109 bird species are reported among them 77 are migratory. These species undergo high risk of being threatened due to habitat destruction and illegal hunting (Ali *et al.*, 2011). In Mangla and its nearby vicinity around 347 species of birds are reported (Roberts, 1991). Among the 336 species, 153 (Breeding), 115 (Wintering), 15 (summer), 39 (Passage) and 14 (occasional) species. It provides an importance site for breeding and wintering *i.e.,* for Shorebirds, Anatidae and Piscivorous birds (Grimmit *et al.*, 2001). Similar trend of decline was observed by Ali *et al.* (2011), 141 bird species of Mangla Dam and highlighted the threats of decline of avifauna. Noted there that the forest areas of Mangla dam is oppressed due to over grazing and fires that resulted in diminished grasses and exploited wood sources that serve as habitat for migratory birds. This implement marked reduction in populations of migratory birds due to habitat destruction. A ten-year survey was conducted to estimate the avifauna of at Rasool Barrage, Jhelum. The population of waterfowl was decreasing due to habitat degradation, netting, fishing, and livestock grazing and illegal hunting. The main factors of decline were low level of water and illegal hunting (Akbar *et al.*, 2010).

Food Deficiency

Availability of food serves as a significant factor that greatly influences the diversity and dynamics of migratory birds (Hockey *et al.*, 1992). Janzen (1980) reported that insects' biomass reduced in the late winter dry season, which is the major food item for most of the winter migrant birds

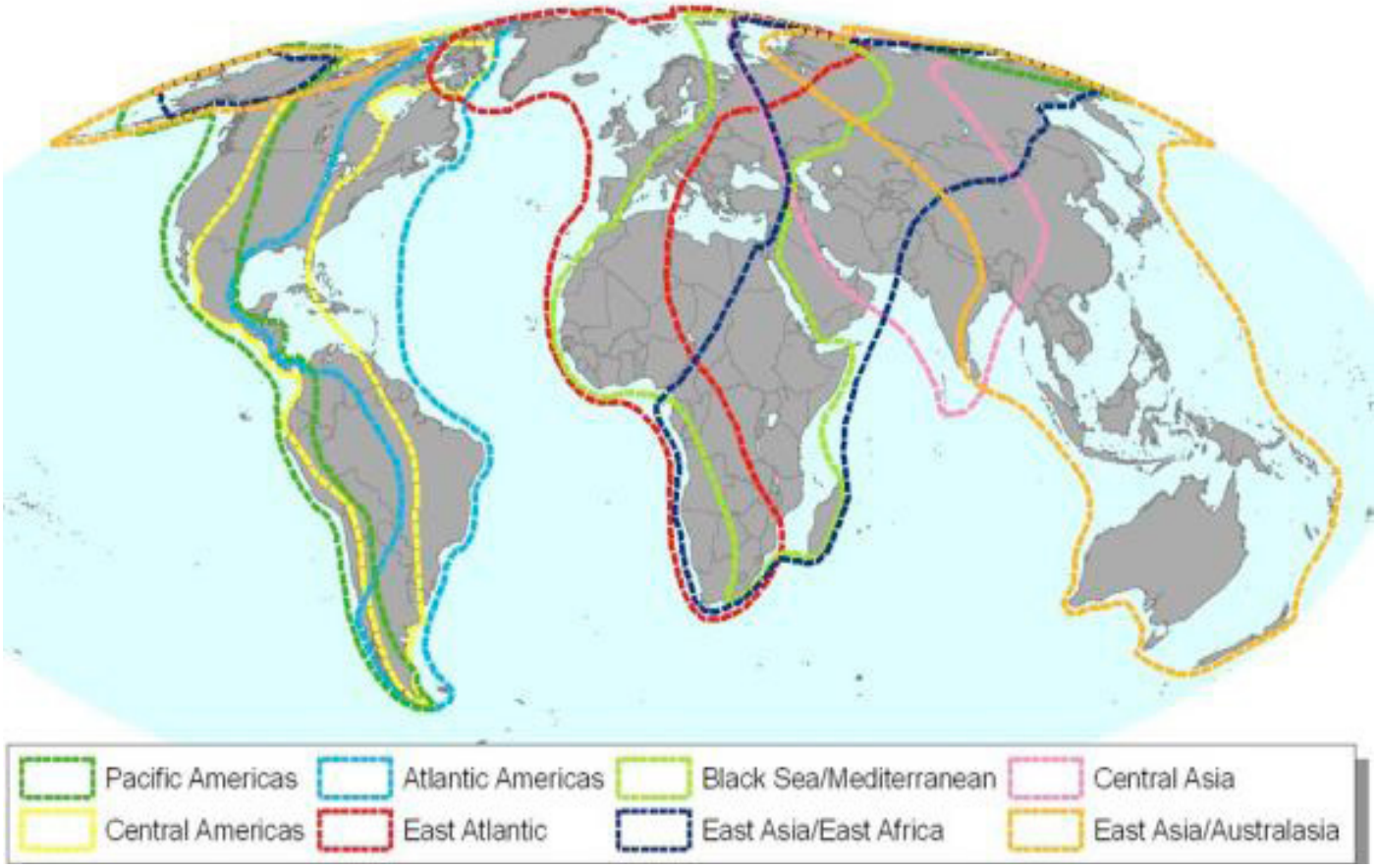

Figure 2: Flyways of migratory birds (Source: Birdlife International).

in tropical areas. The avifauna diversity decreases primarily by habitat un-availability in the tropical wintering areas (Marra et al., 1993) and also by deficiency of food items (Johnson and Sherry, 2001). Gaston et al. (2000) observe that availability of food resources round the year in the wintering areas have strong impact on abundance of migratory birds.

Habitat Loss

White-eyed pochard (*Aythya nyroca*) and Dalmatian pelican (*Pelecanus crispus*) are irregular winter visitors and passage migrant in Pakistan. The population of these birds has declined by the destruction and degradation of vegetated wetland habitats (Grimmett *et al*., 2008). Wetlands and other habitats of migratory birds in Mangla dam are exploited by human beings and mostly used for irrigation and agricultural purposes (Ali *et al*., 2011). The list of rare bird species is increasing and the population is declining like Greater painted snipe, Buzzard, Band tailed fish eagle, Common tawny eagle, *Ciconia nigra*, Black stork, Bubo coromandus and Water pipit. Their decline is associated with habitat loss and anthropogenic impact on Mangla wetland (Khan and Ali, 2015). A total of 59 bird species of which ten were recorded as rare along the both side of river Neelum and Jhelum in Muzaffarabad during 2000-2001. The anthropogenic activities such as disturbance of habitat, removal of shrub cover or fragmentation and grazing of livestock are the major threats of declining of bird's number and species (Awan *et al*., 2004).

Ghalib *et al*. (2008) conducted surveys to estimate the avifauna of Hingol National Park from 2005-2007 and observed 204 species of which 72 were winter visitors, 15 passage migrants, 16 summer breeding visitors, 6 summer visitors, 4 year-round visitors and 3 vagrants. A decline of population recorded due to human population pressure, developmental activities, deforestation, habitat degradation and disturbance. Urbanization and deforestation are major factor responsible for the decline of bird population both in abundance and diversity because most of the birds are sensitive to these changes (Mahboob *et al*., 2013). Raza *et al*. (2015) observed the avian diversity during winter season and reported total 52 bird species, out of which 11 (21.1%) were winter migratory species and 4 (7.6%) were summer breeders.

Pesticides

Injudicious and excessive use of pesticide also has harmful impact on the avifauna. The metabolite of DDT linked with the thinning of eggshell and diminished reproductive success in various bird species *i.e.,* gulls, eagles, terns, and cormorants (Mitra *et al*., 2011). Migratory birds acquired contamination from wide range of geographical areas. The accumulation of contaminants in bird species

has studied in Europe and North America (Fyfe, 1991). Duck *i.e.* Bar-headed geese, and Ruddy shelduck supposedly damage the crops thus killed by farmers by wheat grains mixed with pesticide granules and then sold in local market for consumption (Ali *et al.*, 2011). The immense effect of pesticides on entomophagous birds of Mangla reservoir was also reported by Khan and Ali (2015). Bibi *et al.* (2013) identified avian diversity (171 bird species during 2009-2011) and main threats at Taunsa Barrage included habitat degradation, illegal hunting and pesticide usage. Abbas *et al.* (2014) conducted surveys to estimate the avian diversity of Central Karakoram National Park during 2011-2012. This survey represents total 108 species among them 57, 26 and 25 species are residents, summer and winter visitors, respectively. The major risk to these migratory birds reported was habitat destruction and human activities *i.e.* hunting, shooting, trapping and pesticides sprays.

Eutrophication

The wading birds are directly or indirectly affected by the increase of contiguous macro algal mats. In Pakistan, painted stork (*Mycteria leucocephala*) and Dalmatian pelican (*Pelecanus crispus*) are winter visitor, irregular year round visitor and passage migrant. Environmental pollution and water drainage has affected the population of these bird species, which were assigned the status of Near Threatened (Grimmett *et al.*, 2008; BirdLife, 2016). The continuous decline of bird populations was observed at Mangla Dam that may be attributed to pollution, habitat destruction, trapping, illegal hunting, and unsustainable fisheries practices (Khan and Ali, 2015).

Agrochemical Contamination

The indiscriminate use of insecticides and pesticides and poor agricultural practices poses threats to the population of insectivorous birds. The agricultural runoff is posing a threat to the aquatic fauna directly and water birds indirectly (Ali *et al.*, 2011). Wintering site of is in Pakistan. Changes in farming practices resulted in its decline of Black-tailed Godwit rapidly in different sites of its range (Grimmett *et al.*, 2008), hence, assigned the status of Near Threatened species (BirdLife, 2012). Industrial and cultivated areas runoff aquatic fauna is adversely affecting *i.e.* fish bird (Khan and Ali, 2015).

Heavy Metal Pollution

The level of heavy metals (Cd, Pb, and Cr) above the permissible limits poses adverse effects in birds *i.e.* in the cattle egrets. The feathers of this bird are used as a bio monitoring of the heavy metal contamination (Malik and Zeb, 2009). Heavy metals pollution was alarming due break down of Pir Panjal rocks and catchments of River Jhelum imparting negative impact on birds' diversity and distribution and resulted in declining their population in given favorable localities (Ali *et al.*, 2011).

Unsustainable Fisheries Practices

The major threats noted to migratory birds including unsustainable fisheries practices, deforestation, water pollution, illegal hunting and trapping (Khan and Ali, 2015). Fishing mal practices is the major threats to avifauna. Such as Mangla Dam mainly used for fishing. Many ducks particularly diving ducks are killed in fishing nets (Ali *et al.*, 2011). Estimated avian diversity at Mangla Dam AJK reported 188 bird species of which 13% summer breeders, 64% winter migrants and 29% were passage migrants during 2011-2014 (Khan and Ali, 2015).

Invasive Species

The invasive species affect biodiversity negatively and need to be assessed before introduction into a new habitat. Invasive species are linked with the modification of habitat by human beings (Lim *et al.*, 2003). The population of little egret and Night herone was reduced by the introduction of invasive species such as common myna and house crow at the Mangla Dam (Khan and Ali, 2015).

Human Activity

Birds are the significant indicator of healthy environment and habitat. Habitat destruction and human intervention has been resulting in the decline of birds' diversity (BirdLife International, 2012). Over exploitation, hunting and developments works are some of the main threats for the declining trend of birds. The diversity ofbirds linked with the water bodies of District Sanghar, Sindh, Pakistan (Rais, 2008). In Hingol National Park, a total of 204 bird species were reported in 2005-2007, out of which 14 bird species were declared as near threatened. The key threats to these birds are anthropogenic activities such as human population pressure and development activities (Ghalib *et al.*, 2008). WWF-Pakistan asserts the need to create awareness involving all stakeholders, including community, government organizations, NGOs, academia and students to conserve wetlands to curb illegal trade and ruthless hunting. Anthropogenic activities can have negative impact on bird migration, especially the disappearance of wetlands and degradation of bird habitats.

Conclusions

Pakistan is a favorable wintering and breeding site for a great majority of migratory birds' species. Natural ecosystem provides plenty of trees, plantation and grasses that fulfill significant feeding and space requirements

for these migratory birds. But anthropogenic activities like over hunting of Dalmatian Pelican, Black-headed Ibis, Painted Stork, gees, coot and ducks resulted in marked reduction of their number in given locality. Other activities like excessive cutting of trees, over grazing and fires that resulted in diminished grasses and exploited wood sources that serve as habitat for migratory birds results in habitat destruction making environment less favorable for many migratory birds *i.e.* Greater painted snipe, Buzzard, Band tailed fish eagle, Common tawny eagle, Black stork and Water pipit. Further ecological concerns of migratory birds are eutrophication, heavy metals and ago-chemical contamination due to which the population of migratory birds is decline and on threats. As the excessive use of pesticides severely affects the population of gulls, eagles, terns, geese, ducks and cormorants. Hence it is concluded that all the above stated problems *i.e.* over hunting, over grazing, excessive use of pesticides, habitat loss and eutrophication are the major threats to the wildlife and need to be addressed in order to conserve bird species.

Recommendation

To ensure the protection and conservation of migratory birds it is the utmost need of the hour to take some challenging steps for their habitat protection. Government and different wildlife protection and conservation agencies should work in collaboration to ensure the survival of migratory bird's populations under natural environments.

Following steps should be immediately implemented for migratory bird's conservation: 1) Proper monitoring of diversity and population dynamics of migratory birds, 2) Aquatic avifauna details monitoring about water quality and water loss through evaporation, 3) Periodic assessment of levels of pollutants and salts affecting water quality making it inhospitable for migratory birds, 4) Local public entrance should be prohibited in some localized enclosed areas to avoid human intervention, 5) Inclusion of fresh water reservoirs in the list of Ramsar Sites and initiating research projects addressing mentioned ecological concerns could be helpful in promoting the migration of birds and 6) It is indispensable for the government to manage the people awareness program for the importance of birds and their conservation and also require discouraging the illegal hunting.

Conflicts of interest

The authors declare no conflicts of interest.

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