

ASSESSMENT OF WATERFOWL DIVERSITY OF RIVER CHENAB, PAKISTAN

M. Altaf^{1*}, A. Javid¹, A. M. Khan², M. Umair³, Irfan¹, S. Ashraf¹, M. Idnan¹, M.S. Haider⁴ and Z. Ali²

¹Department of Wildlife and Ecology, University of the Veterinary and Animal Sciences, Lahore, Pakistan

²Environmental Health and Wildlife, Department of Zoology, University of the Punjab, Lahore, Pakistan

³Department of Plant Sciences, Quaid-i-Azam University, Islamabad, Pakistan

⁴Department of Fisheries and Aquaculture, University of the Veterinary and Animal Sciences, Lahore, Pakistan

*Corresponding Author's Email: altaf_mughal450@yahoo.com

ABSTRACT

River Chenab is an important wetland of Punjab province and the tree plantations around the river are the part of tropical thorn forest. But as a consequence of deforestation much of the natural forested areas have been turned to agricultural land. The main objective of study was to explore the avifaunal diversity with special focus on endangered avian species *Sterna acuticauda* of river Chenab. This one year study extending from May, 2013 through April, 2014 was conducted along a 90 km long belt of the river Chenab. The study was focused at three heads of the river namely head Marala (district Sialkot), head Khanki (district Gujrat) and head Qadirabad (district Gujranwala). Surveys were made during dawn (5:00 am to 8:00 am) and dusk (4:00 pm to 7:00 pm) hours and a total of 51 waterbird species belonging to 33 genera, 16 families and 8 orders were recorded from the study area. Throughout the year a total of 2531 birds from recorded from head Marala, 2026 from the head Khanki and 2230 from head Qadirabad. Diversity indices were analyzed through statistical software PAST version 2.17 C. Shannon-Weiner diversity index at head Marala was 2.62, at head Khanki it was 2.64 while at head Qadirabad it was 2.78. It can be concluded from the present study that the river Chenab is waterfowl rich and should be declared as protected site for waterfowls.

Key words: Evenness, Margalef, Wetland, Richness, Qadirabad.

INTRODUCTION

Wetlands provide habitat to a variety of organisms and are important sites for genetic diversity, and evolution of both the terrestrial and aquatic organisms. Wetlands are categorized on the basis of age, chemical composition, origin and size (Gorham and Janssens, 1992).

Wetlands are the transitional zones between the aquatic and terrestrial environments and therefore are of immense importance for the organisms inhabiting water and the terrestrial medium. In addition these are the most productive sites hence provide food source to almost all the water birds. Anthropogenic impacts like pollution, industrialization, agriculture intensification and urbanization are adversely affecting the life in these areas (Ali, 2005; Altaf *et al.*, 2013). Pakistan has many climatic and vegetation zones within a relatively small area. Various climatic regimes in the country result in a variety of wetland systems ranging from high-altitude cold wetlands to hot and humid wetlands in coastal areas. There are more than 225 wetlands in Pakistan while 19 have international importance. Wetlands in Pakistan cover an area of 780,000 hectares, comprising 9.7 percent of the total surface area of the country with 74% freshwater and 26% of coastal wetland areas (IUCN, 1989; Altaf *et al.* 2014).

The birds on the globe are described by 9042 species (Sibley and Monroe, 1990), while 2700 avian

species have been reported from Asia (Collar *et al.* 2001). Similarly, 668 bird species have been recorded within territorial limits of Pakistan (Mirza and Wasiq, 2007).

The diversity patterns are difficult to map and monitor along a large geographical area while there is dire need to conserve 12% of the world's threatened birds, 25% mammals, 40% amphibians and 20% invertebrates (Vié *et al.* 2009). The diversity extinction will keep rising (McKee *et al.* 2004) until, besides directly biodiversity monitoring, the information regarding habitat variables that may influence species diversity are not considered while conserving the species (Cody, 1981). A common field-measured habitat metric used by ornithologists (Pidgeon *et al.*, 2001), and to a lesser extent, mammalogists (August, 1983) and entomologists (MacArthur and MacArthur, 1961).

The avian diversity in Pakistan is facing substantial threats due to loss of natural habitat, illegal hunting and leasing of land for cultivation. These activities seriously degrade the natural habitat of wild birds (He and Hubbell, 2011; Umair, 2012; Altaf *et al.* 2013). Eutrophication also leads to increased sedimentation and oxygen deficiency hence adversely affecting the diversity directly and indirectly. *Sterna acuticauda* is a wetland and resident birds of Pakistan. The population of this species in Pakistan is decreasing day by day. The main reason is that the habitat of this bird is almost lost e.g. sands pits are converted into the agriculture land, while threats are also present like

predation, dams, over fishing, pollution and water extraction. The present study was therefore conducted to explore the avifaunal diversity with a special focus on endangered avian species *Sterna acuticauda* of river Chenab.

MATERIALS AND METHODS

Study area: River Chenab starts from Kangra and Kulu districts of Himachal Pradesh in India and enters Pakistan near Diawara village, district Sialkot. Total length of the river is 960 km (Siddiqi and Tahir-Kheli, 2004). This one year study extending from May 2013 through April 2014 was conducted along a 90 km long belt of river Chenab

from district Sialkot to district Gujranwala. The forest vegetation at head Marala (Sub-area i.e. SA-1), head Khanki (SA-2) and head Qadirabad (SA-3) (table1); and associated cultivated areas at each head were surveyed during dawn and dusk hours and data on ecology and population status of fluvial avian diversity was collected (figure 1).

Climate: The climate of the study area is sub-tropical with average temperature variations of 5°C during winter to 45°C during summer. The pH of riverine water is slightly basic ranging from 7.9 to 8.1 (Irrigation and Power Department Punjab, 2007).

Table 1. Coordinates of river Chenab.

Study Area	Types of habitat	Coordinate	Elevation (ft)
Study area-1 (SA-1)			
Head Marala (Sialkot)	Forest habitat	32°39'59 N, 74°28'05 E	811
Baholpur			
Study area-2 (SA-2)	Agri-Rural Forest habitat	32°34'55 N, 74°25'41 E	840
Head Khanki (Gujrat)	Forest habitat	32°24'32 N, 73°58'39 E	712
Ghazi Chak			
Study area-3 (SA-3)	Agri-Rural Forest habitat	32°30'00 N, 73°05'39 E	739
Head Qadirabad(Gujranwala)	Forest habitat	32°19'06 N, 73°41'36 E	683
Kot Hara	Agri-Rural Forest habitat	32°16'06 N, 73°42'22 E	695

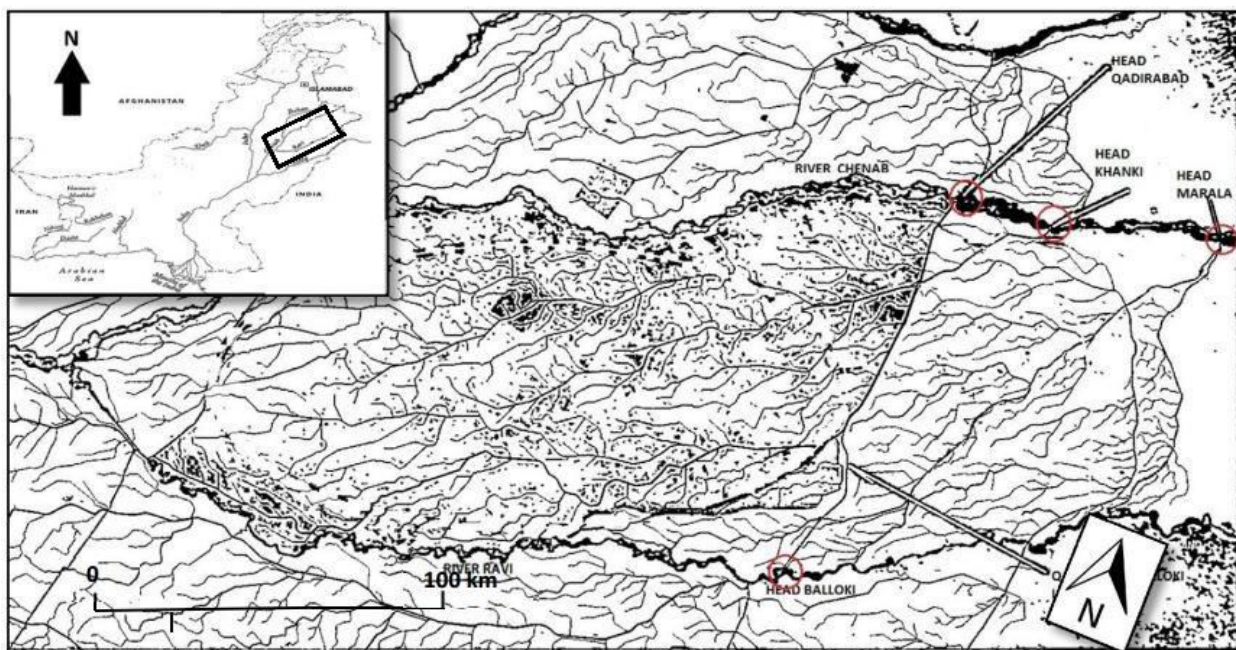


Figure 1. The Map of river Chenab along with three study sites i.e. head Marala, Khanki, and Qadirabad

Methodology: The waterfowl diversity of study area was estimated through linear count survey method and both, the direct (direct observations and voices) and indirect (nests, carcasses and group questionnaire survey)

methods were used. To correctly identify the waterfowl species of the study area Roberts (1991), Mirza and Wasiq (2007), and Grimmett *et al.* (2008) were consulted.

Statistical Analysis: The collected data was interpreted through computer-based software PAST version 2.17C and Dominance (D), Shannon-Wiener diversity index (H'), Simpson Index (S), Margalef (R) and Evenness (E) were recorded following (Hammert, 2001). Census Index was computed using following formula;

Census Index = n/area

Where

n = numbers of birds

RESULTS AND DISCUSSION

During present survey, a total of 51 waterfowl species representing 33 genera, 16 families and 8 orders were recorded from the study area. During the study period a total of 2531 water birds representing 51 species, 33 genera, 16 families and 8 orders were recorded from head Marala. Dominance, Census Index, Shannon-Wiener diversity index, Simpson Index, Margalef Index and Evenness were recorded as 0.138, 2.531, 2.62, 0.86, 6.38 and 0.27, respectively (Table 3).

Similarly, 2026 waterfowls belonging to 50 species, 32 genera, 16 families and 8 orders were recorded from head Khanki. Dominance, Census Index, Shannon-Wiener diversity index, Simpson Index, Margalef Index and Evenness were 0.129, 2.023, 2.64, 0.87, 6.57 and 0.27 respectively at head Khanki. At head Qadirabad, a total of 2230 water birds representing 51 species, 33 genera, 16 families and 8 orders were recorded during entire study period. The Dominance at head Qadirabad was 0.115, Census Index 2.23, Shannon-

Wiener diversity index 2.78, Simpson Index 0.88, Margalef Index 6.48 while Evenness was 0.32. The results revealed that 51 waterfowl species representing 33 genera, 16 families and 8 orders were recorded from the study area. While other studies shows that 43 waterfowl species representing 27 genera, 10 families and 6 orders from Rasool barrage; district Jhelum (Akbar *et al.* 2010) while 32 species waterfowl species belonging to 17 families and 6 orders during their survey to river Ravi (Iqbal *et al.* 2011).

The avifauna diversity of various waterfowl species along with their feeding habitats (i.e. 2 Herbivore, 10 omnivore, 4 Insectivore, 12 carnivore, and 22 Piscivore) and distribution (i.e. 11 resident bird, 2 summer breeder, 31 winter visitor and 7 year round visitors) is summarized in Table 2. The IUCN (2015) red list results showed that the diversity of river Chenab has one avian species (Black-bellied Tern) endangered, one species (Indian Skimmer) as Vulnerable, 3 species (Darter/Snake Bird, Painted Stork, Indian River Tern) as near threatened and 46 species as least count. Intermediate egret ($n=1577$), large egret ($n=1303$), little egret ($n=971$), purple heron ($n=244$), grey heron ($n=220$), black-winged stilt ($n=218$), Indian pond heron ($n=214$), cattle egret ($n=145$), night heron ($n=145$) and Indian river tern ($n=140$) were more common while the numbers of garganey ($n=5$), pied avocet ($n=5$) and little stint ($n=5$), Eurasian coot ($n=4$) and Temminck's stint ($n=3$) were lowest in the study area (figure 2 and Table 2).

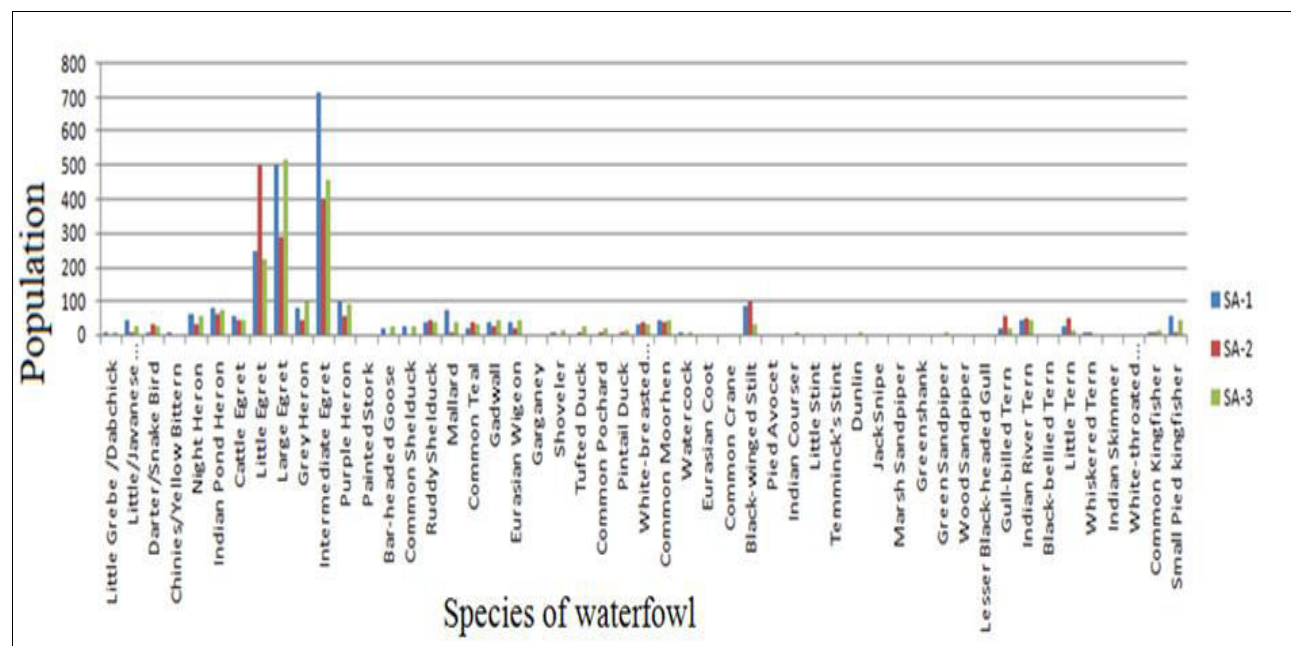


Figure 2. Diversity of the birds at the river Chenab

Table 2. Waterfowl diversity of the study area

Scientific name	Common name	Family	Order	FH	Dist.	SA-1	SA-2	SA-3	Total	IUCN
<i>Tachybaptus ruficollis</i>	Little Grebe /Dabchick	Podicipedidae	Podicipediformes	Piscivore	R	5	4	7	16	LC
<i>Phalacrocorax niger</i>	Little/Japanese Cormorant	Phalacrocoracidae	Suliformes	Piscivore	Y	45	9	25	79	LC
<i>Anhinga melanogaster</i>	Darter/Snake Bird	Anhingidae	Suliformes	Piscivore	Y	5	34	24	63	NT
<i>Ixobrychus sinensis</i>	Chinese/Yellow Bittern	Ardeidae	Pelecaniformes	Piscivore	Y	5	3	2	10	LC
<i>Nycticorax nycticorax</i>	Night Heron	Ardeidae	Pelecaniformes	Piscivore	S	60	29	56	145	LC
<i>Ardeola grayii</i>	Indian Pond Heron	Ardeidae	Pelecaniformes	Piscivore	R	79	60	75	214	LC
<i>Bubulcus ibis</i>	Cattle Egret	Ardeidae	Pelecaniformes	Piscivore	R	55	45	45	145	LC
<i>Egretta garzetta</i>	Little Egret	Ardeidae	Pelecaniformes	Piscivore	Y	250	500	221	971	LC
<i>Egretta alba</i>	Large Egret	Ardeidae	Pelecaniformes	Piscivore	R	498	290	515	1303	LC
<i>Ardea cinerea</i>	Grey Heron	Ardeidae	Pelecaniformes	Piscivore	W	80	45	95	220	LC
<i>Egretta intermedia</i>	Intermediate Egret	Ardeidae	Pelecaniformes	Piscivore	Y	717	400	460	1577	LC
<i>Ardea cinerea</i>	Purple Heron	Ardeidae	Pelecaniformes	Piscivore	R	99	55	90	244	LC
<i>Mycteria leucocephala</i>	Painted Stork	Ciconiidae	Ciconiiformes	Piscivore	W	2	3	3	8	NT
<i>Anser indicus</i>	Bar-headed Goose	Anserinae	Anseriformes	Herbivore	W	22	4	24	50	LC
<i>Tadorna ferruginea</i>	Common Shelduck	Anatidae	Anseriformes	Carnivore	W	24	4	25	53	LC
<i>Tadorna tadorna</i>	Ruddy Shelduck	Anatidae	Anseriformes	Carnivore	W	35	45	36	116	LC
<i>Anas platyrhynchos</i>	Mallard	Anatidae	Anseriformes	Omnivore	W	74	8	35	117	LC
<i>Anas crecca</i>	Common Teal	Anatidae	Anseriformes	Carnivore	W	18	35	34	87	LC
<i>Anas strepera</i>	Gadwall	Anatidae	Anseriformes	Insectivore	W	35	25	41	101	LC
<i>Anas Penelope</i>	Eurasian Wigeon	Anatidae	Anseriformes	Grainivore	W	35	17	43	95	LC
<i>Anas querquedula</i>	Garganey	Anatidae	Anseriformes	Omnivore	W	2	2	1	5	LC
<i>Anas clypeata</i>	Shoveler	Anatidae	Anseriformes	Carnivore	W	7	3	16	26	LC
<i>Aythya fuligula</i>	Tufted Duck	Anatidae	Anseriformes	Omnivore	W	4	6	23	33	LC
<i>Aythya ferina</i>	Common Pochard	Anatidae	Anseriformes	Omnivore	W	4	5	21	30	LC
<i>Anas acuta</i>	Pintail Duck	Anatidae	Anseriformes	Herbivore	W	3	6	12	21	LC
<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	Rallidae	Gruiformes	Omnivore	R	33	35	32	100	LC
<i>Gallinula chloropus</i>	Common Moorhen	Rallidae	Gruiformes	Omnivore	R	45	40	45	130	LC
<i>Gallinula cinerea</i>	Watercock	Rallidae	Gruiformes	Omnivore	W	5	2	5	12	LC
<i>Fulica atra</i>	Eurasian Coot	Rallidae	Gruiformes	Omnivore	W	3	0	1	4	LC
<i>Grus grus</i>	Common Crane	Gruidae	Gruiformes	Omnivore	W	3	4	2	9	LC
<i>Himantopus himantopus</i>	Black-winged Stilt	Recurvirostridae	Charadriiformes	Carnivore	R	85	99	34	218	LC
<i>Recurvirostra avosetta</i>	Pied Avocet	Recurvirostridae	Charadriiformes	Carnivore	W	2	1	2	5	LC
<i>Cursorius coromandelicus</i>	Indian Courser	Glareolidae	Charadriiformes	Insectivore	W	4	3	8	15	LC
<i>Calidris minuta</i>	Little Stint	Scolopacidae	Charadriiformes	Insectivore	W	2	1	2	5	LC
<i>Calidris temminckii</i>	Temminck's Stint	Scolopacidae	Charadriiformes	Insectivore	W	1	1	1	3	LC
<i>Calidris alpina</i>	Dunlin	Scolopacidae	Charadriiformes	Carnivore	W	2	2	5	9	LC
<i>Lymnocyrtus minimus</i>	Jack Snipe	Scolopacidae	Charadriiformes	Omnivore	W	2	2	4	8	LC
<i>Tringas tagmatilis</i>	Marsh Sandpiper	Scolopacidae	Charadriiformes	Carnivore	W	2	2	3	7	LC

<i>Tringa nebularia</i>	Greenshank	Scolopacidae	Charadriiformes	Carnivore	W	3	2	4	9	LC
<i>Tringa ochropus</i>	Green Sandpiper	Scolopacidae	Charadriiformes	Carnivore	W	2	2	5	9	LC
<i>Tringa glareola</i>	Wood Sandpiper	Scolopacidae	Charadriiformes	Carnivore	W	2	2	3	7	LC
<i>Larus fuscus</i>	Lesser Black-headed Gull	Laridae	Charadriiformes	Carnivore	W	2	2	2	6	LC
<i>Gelochelidon nilotica</i>	Gull-billed Tern	Sternidae	Charadriiformes	Piscivore	W	22	55	17	94	LC
<i>Sterna aurantia</i>	Indian River Tern	Sternidae	Charadriiformes	Piscivore	W	45	50	45	140	NT
<i>Sterna acuticauda</i>	Black-bellied Tern	Sternidae	Charadriiformes	Piscivore	W	3	2	2	7	EN
<i>Sterna albifrons</i>	Little Tern	Sternidae	Charadriiformes	Piscivore	S	27	50	14	91	LC
<i>Chlidonias hybridus</i>	Whiskered Tern	Sternidae	Charadriiformes	Piscivore	Y	5	8	3	16	LC
<i>Rynchops albicollis</i>	Indian Skimmer	Rynchopidae	Charadriiformes	Piscivore	Y	2	2	1	5	VU
<i>Halcyon smyrnensis</i>	White-throated Kingfisher	Alcedinidae	Coraciiformes	Piscivore	R	3	3	2	8	LC
<i>Alcedo atthis</i>	Common Kingfisher	Alcedinidae	Coraciiformes	Piscivore	R	8	7	13	28	LC
<i>Ceryle rudis</i>	Small Pied kingfisher	Alcedinidae	Coraciiformes	Piscivore	R	55	9	46	110	LC

Note: FH (Feeding Habit), Distribution (Dist.), Least Count (LC), Vulnerable (VU), Near threatened (NT) and Endangered (EN)

Table 3.Diversity, Richness, Evenness and Density of waterfowls of study area

Study Area	Population	Dominance	Simpson	Shannon	Evenness	Margalef	Density
SR-1	2531	0.138	0.86	2.62	0.27	6.38	2.531
SR-2	2026	0.129	0.87	2.64	0.27	6.57	2.023
SR-3	2230	0.115	0.88	2.78	0.32	6.48	2.23

During present survey, little grebe, Indian pond heron, cattle egret, large egret, purple heron, white-throated kingfisher, white-breasted waterhen and Black-winged stilt were observed as resident bird species of the study area. Similarly, seven waterfowl species namely little cormorant, darter bird, yellow bittern, little egret, intermediate egret, whiskered tern and Indian skimmer were year round visitors throughout the study period. Out of them, little egret, intermediate egret and little cormorant were more common while the Indian skimmer was the least counted species. Little Tern and Night heron were observed as the summer breeders. These species were common and easily observed during the surveys.

Likewise grey heron, painted stork, bar-headed goose, common shelduck, ruddy shelduck, mallard, common teal, Eurasian Wigeon, garganey, shoveler, tufted duck, common pochard and pintail duck, watercock, Eurasian coot, common crane, pied avocet, Indian courser, little stint, Temminck's stint, dunlin, Jack snipe, marsh sandpiper, greenshank, green sandpiper, wood sandpiper, lesser black-headed gull, gull-billed tern, Indian river tern, whiskered tern and black-bellied terns were observed as the winter visitor waterfowl species..

Black-bellied terns *Sterna acuticauda* are distributed in Pakistan, China, India, Nepal, Bangladesh, Myanmar, Thailand, Laos, Cambodia and Vietnam. The species is now declining at an unprecedented rate and is extinct from many parts of South-East Asia (Thomas and Poole, 2003; Inskipp *et al.* 2013). *S. acuticauda* was categorized as Near Threatened in 2010 (IUCN, 2010) however due to rapid decrease in its population the species is now listed amongst Endangered category (IUCN, 2015).

In Pakistan, Roberts (1991) recorded *S. acuticauda* feeding along the rivers and freshwater bodies. Only 14 individuals of *Sterna acuticauda* from head Qadirabad, 4 from head Marala, 25 from river Ravi and 256 from Chashma barrage have been reported (Ali and Akhtar, 2005). The major factor of species decline is agricultural intensification (IUCN, 2015). During present survey, a total of 7 *S. acuticauda*, 3 from head Marala, 2 from head Khanki and 2 from head Qadirabad were recorded during winter season. It was further observed that even very small piece of land in the river was being utilized for the agriculture purposes. Similarly, the towns have been developed adjacent to the river banks. These may be the reasons for rapid decrease in populations of *S. acuticauda*.

Conclusion: A total of 51 water bird species belonging to 33 genera, 16 families and 8 orders were recorded from the study area during present survey and it is therefore suggested that Chenab is rich in waterfowl diversity and should be declared as protected site for waterfowls.

REFERENCES

- Akbar, M., Zaib-un-Nisa, and A. S. Janjua (2010). Waterfowl Population Estimation at Rasool Barrage, Game Reserve, Jhelum, Pakistan (1996 – 2005). Pakistan J. Life Soc Sci. 8(1): 11-15.
- Ali, Z. (2005). Ecology, distribution and conservation of migratory birds at Uchalli Wetlands Complex, Punjab, Pakistan. University of the Punjab. Thesis (unpublished). Pakistan.
- Ali, Z., and M. Akhtar (2005). Bird surveys at wetlands in Punjab, Pakistan, with special reference to the present status of White-headed Duck *Oxyura leucocephala*. Forktail. 21: 43-50.
- Altaf, M., A. Javid, Irfan, M.A. Munir, S. Ashraf, K.J. Iqbal, M. Umair, Z. Ali, and A.M. Khan (2013). Diversity, distribution and ecology of birds in summer season flathead Khanki, Punjab, Pakistan. Biologia (Pak). 59(1): 131-137.
- Altaf, M., A. Javid, Irfan, M.A. Munir, S. Ashraf, M. Umair, K.J. Iqbal, A.M. Khan and Z. Ali (2014). Diversity of wild mammalian fauna of Chenab riverine forest, Punjab, Pakistan. J. Anim. Plant. Sci. 24(5): 1342-1347.
- August, P. V. (1983). The role of habitat complexity and heterogeneity in structuring tropical mammal communities. Ecology. 64: 1495-1507.
- Cody, M. L. (1981). Habitat selection in birds: the roles of vegetation structure, competitors, and productivity. BioScience. 31(2): 107-113.
- Collar, N. J., R. Crosby, and M. Crosby (2001). Threatened birds of Asia: the BirdLife International red data book. BirdLife International Cambridge, UK.
- Gorham, E., and J. A. Janssens (1992). The paleorecord of geochemistry and hydrology in northern peatlands and its relation to global change. Suo. 43(4-5): 117-126.
- Grimmett, R., T. J. Roberts, T. Inskipp, and C. Byers. (2008). Birds of Pakistan. A&C Black, Pakistan.
- Hammert, Q., D. A. T. Harper & P. D., Ryan (2001). Past paleontological statistical software package for education and data analysis. Palaeontol. stat. 4.
- He, F., and S. P. Hubbell (2011). Species-area relationships always overestimate extinction rates from habitat loss. Nature. 473: 368-371.
- Inskipp, C., H. S. Baral, T. Inskipp, and A. Stattersfield (2013). The state of Nepal birds 2010. J. Threatened Taxa. 5(1): 3473-3503.
- Iqbal, M., I. Salem, Z. Ali, M. A. Khan, and M. Akhtar (2011). Bird Ecology from the Ravi River of Lahore: Habitat Degradation. J. Anim. Plant. Sci. 21(4): 817-821.

- IUCN. (1989). Pakistan Fact Sheet Water. Journalist Resource Centre for the Environment. IUCN Pakistan.
- IUCN. (2010). The IUCN the red list of threatened species. IUCN.
- IUCN. (2015). The IUCN the red list of threatened species. IUCN.
- MacArthur, R. H., and J. W. MacArthur (1961). On bird species diversity. *Ecology*. 42(3): 594-598.
- McKee, J. K., P. W. Sciulli, C. D. Fooce, and T. A. Waite. (2004). Forecasting global biodiversity threats associated with human population growth. *Biol. Cons.* 115(1): 161-164.
- Mirza, Z., and H. Wasiq (2007). A field guide to the birds of Pakistan. Bookland, Lahore.
- Pidgeon, A., N. Mathews, R. Benoit, and E. Nordheim (2001). Response of avian communities in the northern Chihuahuan Desert to historic habitat change. *Cons. Biol.* 15(6): 1772-1788.
- Irrigation and Power Department Punjab (2007). Surface water quality monitoring in Punjab Moghalpura, Lahore., Directorate of Land Reclamation, Punjab Canal Bank.
- Roberts, T. J. (1991). The birds of Pakistan. Oxford University Press Karachi, Pakistan.
- Sibley, C. G., and B. L. Monroe (1990). Distribution and Taxonomy of Birds of the World.
- Siddiqi, T., and S. Tahir-Kheli (2004). Water Needs in South Asia: Closing the Demand Supply Gap (Honolulu, GEE-21).
- Thomas, W., and C. Poole (2003). An annotated list of the birds of Cambodia from 1859 to 1970. *Forktail*. 18: 103-128.
- Umair, M. (2012). Distribution and Impact of *Parthenium hysterophorous* on Wetland Diversity at Head Khanki, Pakistan. University of Gujrat, Gujrat, Thesis (unpublished).
- Vié, J.C., C. Hilton-Taylor, and S. N. Stuart (2009). Wildlife in a changing world: an analysis of the 2008 IUCN Red List of threatened species. IUCN.