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ASSESSMENT OF AVIFAUNA IN CORRELATION WITH ALTERATION-HYDROLOGY OF MANGLA WETLAND, AZAD KASHMIR, PAKISTAN

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Abstract

Avifauna population estimation and hydrological analysis of surface water of Mangla dam Wetland was carried out for two consecutive years by conducting bird census in the months of January. The birds are counted by Point Count Method from a fixed point and for the fix time period in such a way that the Sun is always at the back. A total of 37,082 birds belong to 37 species visited the wetland in 2010 whereas 28 with population of 21,302 birds in 2011. Twenty one bird species were common at the study site for both years. The most abundant bird species were Black Headed Gull and Great Cormorant for both years 2010 and 2011. The census index (139.93 / km²) was higher in 2010 rather than (80.38 / km²) in 2011. The level of Co+2, Cu+2, Fe+2, Mg+2, Mn+2 and Zn+2 were found to be within the permissible limits in surface water analysis. However, the levels of Cr+2, Pb+2 and Cd+2 were high from safe limits. The study emphasized on extensive monitoring of the lake and catchment area in order to address the threats posed by heavy metals.

Key words: *avifauna, birds, Mangla dam, Pakistan.*

INTRODUCTION

Wetlands are the dynamic ecosystem consists of 6% of earth habitats (Maltby and Turner, 1983). These are considered as biodiversity hotspots due to presence of wide range of flora and fauna (Mitsch and Gosselink, 1986). The habitat of wetlands is important for most of the birds for feeding, nesting and roosting behavior (Stewart, 2001). Geographically, Pakistan is present in north western part of southern Asia and consists of wetlands of an area of 9.7% ranging from coastal mangroves to glacial lakes of Himalaya. Out of 48 wetlands of Pakistan, 19 are included as Ramsar sites (Scott, 1989). Pakistan wetlands are especially important for their distinctive and diverse habitat (Garstang et al., 2003). Mangla dam is 12th largest dam of the world and it is located in Mirpur, Azad Kashmir, with subtropical climate of average rainfall of 150mm, between latitude and longitude of 32 to 36 and 73 to 75 respectively.
The water body was constructed in 1967 and consists in an area of 26599 ha which receives influx from Jhelum River. Mangla wetland have vegetated area which provides habitat for more than 30,000 water birds such as grebes, gulls, cormorants, coots, waders and geese (Ali, 2005). A total of 347 birds species were identified which included as 176 non passerine while 171 passerine (Roberts, 1991, 1992). Another study on the avian fauna of wetland indicated that 336 species were present in 2001 which included as 115 winter visitors, 153 resident, 39 passage migrants, 15 summer visitors and 14 were traced species (Grimmett et al., 2001). The biodiversity, in general, and avian fauna, in specific, have severe threats due to anthropogenic activities (Ali, 2005). The avifauna of Pakistan consists of 668 species belonging to 85 families with large number of winter visitors (Roberts, 1991, 1992). It has been reported that 85% of the migratory fauna of Pakistan consists of ducks and waders which is higher than resident and summer breeder bird population (Alfred et al., 2001).
The ratio of long distance migrant birds is higher than regular winter visitors while 43%

birds come in Pakistan for breeding only (http://www.wwfpak.org/species_birds.php).

Water is known as medium of life. It is used for different purposes which include agriculture, recreational, domestic and industries (Dara, 1993). Fresh water is a source for the development of civilizations but due to pollution there is severe threat to natural fresh water reservoir (Benjamin et al., 1996). In developing countries, the increase in production in industrial and agricultural sectors due to population growth has resulted in the contamination of water reservoirs (Canpolat and Calta, 2001). Due to anthropogenic activities seasonal variations occurs in the water bodies which disturb the biodiversity (Odum, 1971). These variations such as temperature, transparency, pH, electrical conductivity, total hardness, nitrates and phosphates determine the quantity of planktonic biomass in the freshwater bodies (Mahboob and Sheri, 2001).

Water pollution is severe threat for biodiversity globally. The major cause of water pollution is industrial effluents, sewage waste and acid rain which deposits heavy metals into water bodies (Obasohan et al., 2008). Big cities of Pakistan produce average sewage of 11650 million gallons per day which is used to irrigate 32,000 hectares. However, this sewage contains high pH, temperature, chemical oxygen demand, nitrates and nitrites, and cations like calcium, sodium, potassium, and magnesium (Ghandour et al., 1985). Besides of these, a large amount of heavy metals i.e. zinc, nickel, iron, lead, chromium, arsenic, copper, cadmium and cobalt are also present in sewage which may accumulate in soil and transferred to vegetables and crops indirectly. The other sources for the contamination of wetlands are the substances released from industrial effluents, pesticides and nitrogenous fertilizers (Ali et al., 1996).

A few heavy metals are important micronutrient in low concentration like manganese, cobalt, zinc, nickel, lead and copper but their higher level poses risk for biodiversity (Nürnberg, 1982). These metals are released in industrial effluents in a higher concentration level that contaminate the water reservoir and ultimately toxic for aquatic life (Ibok et al., 1989). As these trace metals viz. nickel, copper, lead and zinc have great affinity for bio-magnification, ultimately entering into the food chain and can cause the severe health problems by effecting the liver, kidney, muscles and tissues (Dallinger et al., 1987). Metals like arsenic, cadmium, lead and chromium possess severe threat to biodiversity (Din et al., 1997, 2008). The current research work was undertaken to assess the physico-chemical parameters and concentration levels of various heavy metals in surface water of Mangla Wetland. Avifauna census was carried out to take into account the number of species and their population at the lake. The impact of anthropogenic activities and climate change (weathering process) was assessed by exploring diversity, abundance and species richness and evenness of avifauna visiting this water body. The study emphasized on working out major factors contributing in declining trend of bird species at this Ramsar site.

MATERIALS AND METHODS

The study was executed at Mangla wetland, situated in Mirpur, Azad Jammu & Kashmir (33.12 N, 73.39 E) with an elevation of 630 m and comprise of an area about 26500 ha. It is the 12th largest dam of the world which was constructed in 1967 at the southeast corner 100 km away from the Islamabad. This water body is of special concern because it provides wintering habitat for water birds.

Bird census was carried out for two consecutive years 2010 and 2011 in the months of January and February because a large number of migratory birds visit the lake. The area of the reservoir is divided into five observation points. The birds are counted by point count method from a fixed point or for the fix time period in such a way that Sun is always at the back. Relative abundance of each bird species is estimated by this method (Sutherland, 1996). The assessment of food habits of bird species was followed by as suggested in the study of Roberts (1991, 1992). The preference for the food by different groups of birds was documented. Photographs were taken by using field binocular and birds' species were subjected to identification by using keys (Ali and Ripley, 1987; Roberts, 1991, 1992). The relative abundance was calculated for each bird so as to determine the

most abundant bird species by using the terms described by Bull (1964) and McCaskie (1970). Biodiversity Index was calculated (Shannon and Wiener, 1963).

The samples were collected from the five different sites of the Mangla Dam in the study period from October 2010 to September 2011. The sampling purpose was to determine the quality of water and variation within different months of the year. A total of 12 samples were collected by using plastic bottles in such a way that bottles were disinfected, washed, dried followed by soaking in 5% nitric acid for 24 hrs. To restrict adsorption of heavy metals onto wall of sampling bottles 5 ml nitric acid was immediately added after collecting the samples (Ademoroti, 1996) and then safely transferred to laboratory. For the digestion of samples, the procedure proposed by Kar et al., 2008 was followed with little modifications. Digested samples were placed in pre-washed polythene bottle. Analytical grade reagents were used throughout the processing period. Various standards of heavy metals were prepared from certified standard stock solution (ppm) by using double distilled water. These standards were used to obtain calibration curve on Atomic Absorption Spectrophotometer. Water samples were analyzed for heavy metals (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn) in Shimadzu (AA-6300) Atomic Absorption Spectrophotometer. One way ANOVA was applied to summarize results and analyzes the variation (Steel and Torrie, 1980).

RESULTS AND DISCUSSIONS

Mangla dam consists of an area of 26,500 ha and is (33.12 N, 73.39 E) located in Mirpur, Azad Kashmir, Pakistan. In the current study, five points were marked for the observation of bird diversity named as Pounch, Khund, Jarrikus, Jarricus and Mangla. The counting of avifauna was carried out from 2010 and 2011. In the study period, number and diversity of bird species varied. A total of 37,082 birds were observed belong to 37 species in 2010 whereas declining trend in the number of species was observed in 2011 viz. 28 species and their total number were 21,302 (Table 1).

Twenty one (21) bird species i.e. great cormorant, great egret, common teal, bar-headed goose, mallard, common coot, northern pintail, grey heron, red-wattled lapwing, little cormorant, indian pound heron, black-winged stilt, black-headed gull, eurasian wigeon, ruddy shelduck, northern shoveler, great crested grebe, common pochard, common sandpiper, slender billed gill and red shank were observed both in 2010 and 2011 years (Figure 1).

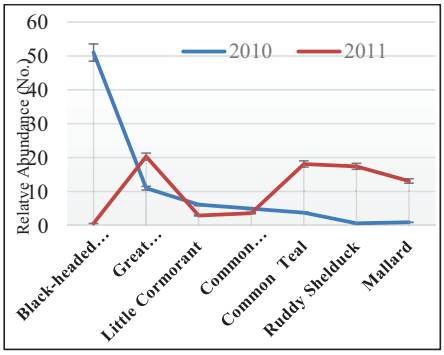

Figure 1. Comparison of dominant species in Mangla wetland, Azad Kashmir, Pakistan during 2010 and 2011

The relative abundance for each bird species was calculated in the current study (Tables 2 and 3). Black headed gull was the most abundant species in 2010 while great cormorant, in 2011. At the Mangla dam in 2010, the dominant and subdominant bird species were black headed gull (51.00 %) and great cormorant (10.99 %) (Table 3). However, the dominant and subdominant bird species in 2011 were great cormorant (20.31%) and common teal (18.11%) respectively (Table 2).

Table 1. Summary of different analysis in 2010 and 2011 years, in Mangla wetland, Azad Kashmir, Pakistan

Specifications	Year	
Parameters	2010	2011
Area Surveyed (ha)	26,500 ha	26,500 ha
Total Population	37,082	21,302
Number of Species	37	28
Census Index	139.93 /km²	80.38/km²
Dominant Species	Black Headed Gull (51.00; relative abundance)	Great Cormorant (20.31; relative abundance)
Sub-Dominant Species	Great Cormorant (10.99; relative abundance)	Common Teal (18.11; relative abundance)

Table 2. Dominant and sub-dominant index of avifauna observed during 2010 year in Mangla wetland, Azad Kashmir, Pakistan

S#	Common name	Khund	Mangla	Jarrikus	Jarrikus	Pounch	Total Population	Relative Abundance	Density hectare
1	Black-headed Gull	8772	7835	38	38	2230	18913	51.00	71.37
2	Great Cormorant	765	2265	238	104	702	4074	10.99	15.37
3	Little Cormorant	0	996	16	16	1242	2270	6.12	8.57
4	Common Pochard	307	33	698	698	94	1830	4.94	6.91
5	Common Teal	153	64	442	409	326	1394	3.76	5.26
6	Great Crested Grebe	85	66	232	237	264	884	2.38	3.34
7	Little Stint	0	0	5	0	862	867	2.34	3.27
8	Great Egret	23	575		0	193	791	2.13	2.98
9	Grey Heron	167	353	3	18	126	667	1.80	2.52
10	Tufted Duck	314	0	61	61	161	597	1.61	2.25
11	Whiskered Tern	11	6	0	0	554	571	1.53	2.15
13	Little Egret	19	153	146	24	223	565	1.60	2.13
14	Black Wing Stilt	0	221	0	0	322	543	1.46	2.04
15	Northern Pintail	132	81	17	24	231	485	1.30	1.83
16	Mallard	0	27	150	159	0	336	0.91	1.27
17	Greenshank	36	71	4	4	213	328	0.88	1.24
18	Common Coot	46	65	36	55	47	249	0.67	0.94
19	Ruddy Shelduck	178	0	0	0	43	221	0.60	0.83
20	Little Grebe	37	27	19	29	92	204	0.55	0.77
21	Slender Billed Gull	0	0	0	0	187	187	0.50	0.71
22	Bar-headed Goose	161	0	0	0	0	161	0.43	0.61
23	Ferruginous Duck	98	16	0	48	0	161	0.43	0.61
23	Indian River Tern	28	101	0	0	21	150	0.40	0.57
24	Redshunk	0	0	0	0	121	121	0.33	0.46
25	Northern Lapwing	21	0	17	17	62	117	0.32	0.44
26	Eurasion Wigeon	0	0	9	9	69	87	0.23	0.33
27	Black Stork	0	0	1	1	82	84	0.23	0.32
28	Indian Pond Heron	26	32	0	0	12	70	0.19	0.26
29	Common Sandpiper	13	6	25	25	0	69	0.19	0.26
30	Pied Kingfisher	12	32	0	4	18	66	0.18	0.25
31	Common Shelduck	0	0	0	0	4	4	0.01	0.02
32	Gosander	0	0	2	2	0	4	0.01	0.02
33	Red-wattled Lapwing	5	16	1	1	4	27	0.07	0.10
34	Pallasis Gull	3	3	0	0	4	10	0.03	0.04
35	Caspian Tern	2	0	0	0	0	2	0.005	0.01
36	White-breasted Kingfisher	2	0	0	0	0	2	0.005	0.01
37	Northren Shoveler	0	0	0	2	0	2	0.005	0.01

The least abundant bird species were Northern shoveler white-breasted kingfisher and Caspian tern, whose relative abundance was even less than 0.01. The total area of the lake was 26,500 ha and noted by using GIS techniques. It was done for the calculation of density of each bird species which were observed at the lake in 2010 and 2011. The density of birds at the site was higher for 2010 (139.93/km²) than to 2011 (80.38/km²). In the current study, 45 bird species were noted which include 27 winter visitors, 13 resident, 2 double passage migrants, 1 summer breeders and 2 irregular year round visitors (Figure 2).

Furthermore, among 37 bird species that were observed of which are include 14 abundant, 11 very common, 5 very abundant, 5 rare, 1 common and 1 fairly common in 2010. However, 27 bird species were recorded in 2011 which were 4 very abundant, 9 abundant, 9 very common and 5 common (Figure 3). Birds feeding preferences was also determined. The highest count of birds were carnivorous (68.88%; insects, molluscs, crustaceans, fish, and frog) followed by omnivores (24.44%; leaves, shoots, seeds, submerged vegetation, insects, insect larvae, small beetles and worms)

and herbivorous (6.66%; shoots of plants and vegetation in water) birds (Figure 5).

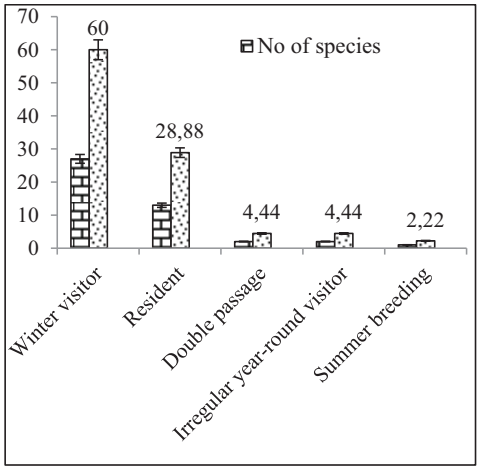

Figure 2. Relative abundance of migratory, breeding and resident avifauna in Mangla wetland, Azad Kashmir, Pakistan, during 2010 and 2011 years

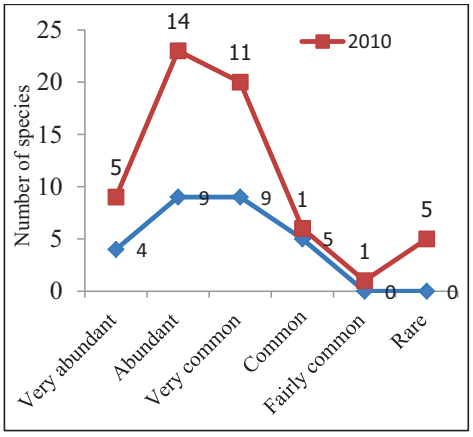

Figure 3. Species status and their relative abundance, during 2010 and 2011 years, in Mangla wetland, Azad Kashmir, Pakistan

In 2010, the number of bird species observed at selected sites were in the order of (30) Pounch, (26) Khund, Mangla (23), (23) Jarrikus (2) and (22) Jarrikus (1). However, a different pattern was observed in 2011 for these sites.

The concentration level of heavy metals in the water samples from Mangla Lake followed the decreasing trend: Cr>Fe>Co>Zn>Pb>Ni>Cu>Cd>Mn for both sites (Figure 4).

Minimum values for Cr, and Cd was recorded in September. However, maximum level for Co, Mn, Ni and Cu was found in August, Aril, October and June respectively. At both sampling sites, monthly variation for metals found to be significant at $p<0.05$ (Table 3).

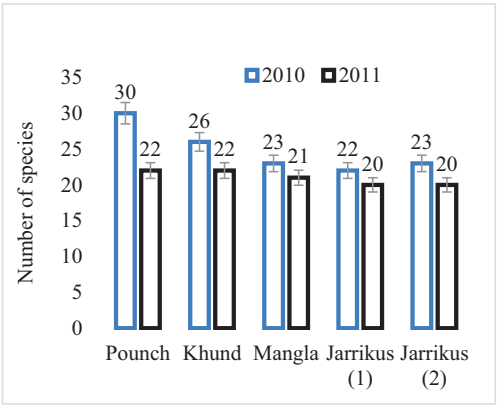

Figure 4. Number of bird species in different sites of Mangla wetland, Azad Kashmir, Pakistan during 2010 and 2011 years

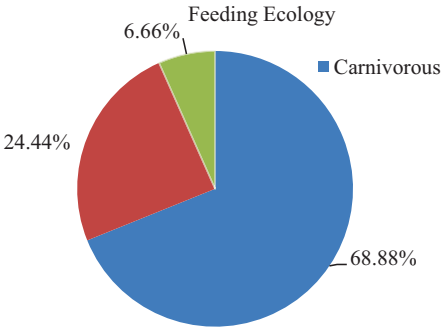

Figure 5. Feeding ecology of birds in Mangla wetland, Azad Kashmir, Pakistan

However, temporal variation between sampling stations was non-significant ($p>0.05$). Bird migration is a litmus test for environment quality and healthy bird population indicate healthy habitats; declining bird populations indicate ill or degraded habitats. One third of the bird endangered species choose their habitat near or in wetland areas. It is too much alarming situation that 42% populations of the migratory water birds are declining in the flyways (Ali et al., 2011). In 1992 has reported 347 bird species at the lake area out of which 176 were non passerines. 336 bird species were reported by Grimmett et al., (2001) whereas 141 species were observed at the reservoir in 2006 by Ali et al.

Mangla dam provides staging and wintering area for various water bird species (Robert, 1991). According to Chaudhary (2009), there were 102 bird species were present at the study site. However, in our study a total of 45 species of birds were recorded. The reason for such a difference in number of species visiting this wetland may be owed to the fact that lakes have suffered degradations (anthropogenic activities) secondly partial or local migration of birds. Khan (1992) studied that population trends of waterfowl species declined due to increase in human and livestock activities. Water birds used different types of habitats in different times of their lifecycle. But it is difficult to assess the factors responsible for the decrease trend of change of population (Chaudhary, 2009).

Table 3. Dominant and sub-dominant index of avifauna observed during 2011 year in Mangla wetland, Azad Kashmir, Pakistan

S #	Common Name	Khund	Mangla	Jarrikuss 1	Jarrikuss 2	Pounch	Total Population	Relative Abundance	Density/ Hectare
1	Great Cormorant	801	2432	248	117	729	4327	20.31	16.33
2	Common Teal	659	602	978	821	798	3858	18.11	14.56
3	Ruddy Shelduck	1332	542	439	455	942	3710	17.42	14.00
4	Mallard	159	570	910	987	162	2788	13.09	10.52
5	Common Pochard	207	129	287	383	164	1170	5.49	4.41
6	Northern Pintail	223	101	67	83	234	1108	5.20	4.18
7	Bar-headed Goose	495	0	0	0	589	1084	5.09	4.09
8	Little Cormorant	0	76	2	74	470	622	2.92	2.35
9	Gadwall	168	88	54	61	149	520	2.44	1.96
10	Slender Billed Gull	86	97	0	0	104	287	1.35	1.08
11	Northren Shoveler	0	0	142	128	0	270	1.27	1.02
12	Great Crested Grebe	30	26	55	60	63	234	1.10	0.88
13	Redshank	25	15	0	0	164	204	0.96	0.77
14	Eurasion Wigeon	0	0	80	100	0	180	0.84	0.68
15	Indian Pond Heron	52	64	0	0	24	140	0.66	0.53
16	Black-headed Gull	55	49	0	0	20	124	0.58	0.47
17	Common Tern	46	31	0	0	28	105	0.49	0.40
18	Common Coot	9	46	2	25	14	96	0.45	0.36
19	Grey Heron	17	33	6	9	13	78	0.37	0.29
20	Intermediate Egret	30	25	11	0	12	78	0.37	0.29
21	Tufted Duck	45	0	14	11	0	70	0.33	0.26
22	Red-wattled Lapwing	11	26	6	6	10	59	0.28	0.22
23	Common Sandiper	0	0	23	30	0	53	0.25	0.20
24	Great Egret	7	20	0	0	10	37	0.17	0.14
25	Black Wing Stilt	0	9	0	0	20	29	0.14	0.11
26	White Eyed Pochard	15	0	6	4	0	25	0.12	0.09
27	Red Crested Pochard	0	0	12	13	0	25	0.12	0.09
28	Gull Billed Tern	0	0	10	11	0	21	0.10	0.08

Due to fragile ecosystem and vulnerability to degradation, Lakes are the most affected ecosystem in the world in which contaminants are deposited and take a time to flush out than rivers. They need more careful management than streams and rivers (McCalla, 1995).

The food chain and food network have important relation with birds. As most of the birds feed on insects so, they also participate to control the insects population within the ecosystem. Previous study of the lake shows that 56.87% birds were insectivorous (Chaudhary, 2009). Similar results trend was observed in our study as 68.88% birds were carnivorous followed by 24.44% omnivorous and 6.66% herbivorous at the site. Black headed gull and common pochard have high relative abundance in our study in two consecutive years 2010 and 2011 respectively. However, low relative abundance was calculated for ruddy shelduck in 2010 and mallard in 2011. Similarly, little grebe, common teal and black headed gull have low relative abundance at Uchhali lake in 2010 as compare to 2011 by Mehmood (2011). The reason of decline at Mangla wetland in 2011 could be the restoration of actual habitat at Uchhali. As these birds were shifted their place

due to low water level from Uchhali to Mangla. In our study, birds such as common pochard, great cormorant, black headed gull, mallard, common teal, little cormorant, and ruddy shelduck have most frequent population.

However, least abundant bird species were Caspian tern, white breasted kingfisher and Northern shoveler. Similar trend was observed by Ali et al. (2006) where Northern shoveler was most frequent species but in our study its population decreased at the lake as 2 and 270 individuals observed in 2010 and 2011 respectively. The decrease population of this bird could be due to occupation of the habitat at the Mangla Lake by other bird species which may migrate from other wetlands.

The feeding habit of great cormorant was carnivorous and winter visitor in Pakistan (Robert, 1991). It was very abundant bird at Taunsa and Mangla lakes (Ali et al., 2006). Similarly, great cormorant also possess very abundant bird status in the current study at the site. Black headed gull is a winter visitor's bird with a population status of most common and abundant found at major water bodies in Pakistan (Roberts, 1991). There were 144 individuals of black headed gull present at Taunsa Barriage (Mahboob and Nisa, 2009). The population status of black headed gull was abundant in Jiwani and rare in Taunsa reservoir (Ali et al., 2011). However, it was very abundant and very common bird at Mangla dam in 2010 and 2011 respectively. Common teal (*Anas crecca*) is most common and abundant bird that is winter visitors at major wetlands of Pakistan.

It is also game bird widely hunted due to its abundance, wing versatility and palatability. It lives in small groups and flocks of about 200 birds. Its favorite habitat was the shallow pools along the sides of water bodies (Grimmett et al., 2008).

In our study, largest population consists of 3,858 birds of common teal were counted at Mangla dam in 2011 which was lower in 2010. However, a very small population as only 45 individuals of this bird was reported by Ali et al. (2006) at the same wetland. Common pochard is a diving duck and forms large flock on water bodies which is also winter visitor bird species (Grimmett et al., 2008). It was reported that common pochard was most dominated bird species at Mangla wetlands (Ali, 2005). Similarly, it is also noted to be most abundant bird species in current study.

Mallard (*Anas platyrhynchos*) is the most abundant species widely distributed from Canada to Alaska and Russia to Western Europe (Roberts, 1991). It is a winter visitor water bird least encountered in Sindh (Grimmett et al., 2008). The maximum number up to 600 individual of this bird was present at Drigh Lake (Gabol et al., 2005). Due to readily adaptable and high tolerance for disturbance, it adjusts in variety of breeding and wintering habitats (Ali, 2005). Its population range in between 336-2,788 individuals at the reservoir in current study. However, 729 individuals were reported at Uchhali complex by Ali (2005). Furthermore, it was noticed that the population of Mallard was also reduced in last three years as only few individuals of this bird were observed in Muzaffarabad (Awan and Saleem, 2007). Same decline trend was observed at Rasool Barrage where population number had reduced 200 from 1996 to 2005. The reason of population decline is uncontrolled hunting (Akbar et al., 2009). Northern shoveler (*Anas clypeata*) is also winter visitor bird at Mangla dam (Ali et al., 2006). It prefers the stagnant and muddy water. They are not liked by hunters because their bodies have musky smell (Roberts, 1991).

In our study, Northern shoveler was least abundant bird species at the site. Similar status of this bird was noted by Ali et al. (2006) at the Mangla dam. However, highest population of Northern shoveler up to 3,500 was reported at Drigh Lake in 2,000 (Gabol et al., 2005). In addition, it was also most abundant bird up to 546 individuals at Kallar Kahar Lake (Reis et al., 2010).

Kingfisher is the bird species linked to water bodies for their feeding (Roberts, 1991). It was noted that kingfisher was resident bird species in Muzaffarabad (Awan et al, 2004). White breasted kingfisher occupied the status of common bird at the Trimmu dam (Ali et al., 2011). Previous studies showed that this bird was fairly common at Mangla Dam (Ali et al., 2011). However, white breasted kingfisher was found to be rare in our study at the Lake. The trend of decline of avifauna at Jiwani wetland Pakistan was noted as 120 bird species by

Robert (1991, 1992), 101 bird species by Grimmett et al. (1998) and 84 bird species by Mirza and Wasiq (2007) respectively. Similar trend of decline of birds were observed at Taunsa Barrage by Robert (1991); Grimmett et al., (1998); Mirza and Wasiq (2007); Mehboob and Nisa (2009). Similarly, a trend of decline of avifauna was observed at Mangla reservoir. A total of 347 bird species were reported by Roberts (1991, 1992) while 336 bird species were noted by Grimmett et al., (2001). According to Ali et al. (2006), 141 bird species were present at the reservoir. Whereas, a total of 102 bird species were present at Mangla wetland (Chaudhary, 2009). However, in the current study period, the observed number of bird species was 37 and 28 in 2010 and 2011 respectively.

The decline of bird species could be due to the disturbance of water quality which occurs by the excessive use of fertilizers, agrochemical and ill planned management of municipal waste. The municipal waste contains heavy metals like Pb, Cr and Cd were in higher concentration than WHO permissible limit. The other cause of decline of avifauna may be due the degradation of habitat by anthropogenic activities, use of some species as game birds and illegal hunting. Physical, chemical and biological processes occur permanently in the water bodies and should be considered to explain the inorganic elements and heavy metals concentrations (Narayanan and Vijayan, 2007).

Anthropogenic activities also affect the behavior and concentration level of heavy metals and inorganic elements (Baeyens et al., 1998). The seasonal variation in the water modifies the population density of both animal and plant species (Odum, 1971). The productivity of fresh water ecosystem in the form of planktonic biomass is regulated by factors such as temperature, pH, transparency, total hardness, etc. (Mahboob and Sheri, 2001). Various metals are essential micronutrient at low concentration but their higher level is toxic for biodiversity. Higher level of these metal ions creates turbidity and discoloration of lake water (Trivedi and Gurdeep, 1992).

In the current study, the order of higher concentration of heavy and trace metals in the water of Mangla Lake were Cr>Fe>Co>Zn>Pb>Ni>Cu>Cd and Mn. Except Cr, Pb and Cd all other metal were within safe limit (Table 4).

Table 4. Analytical values of heavy metals in Mangla dam during 2010-2011

Specifications	Metals								
Sampling Period	Cr	Co	Mn	Ni	Cu	Zn	Pb	Fe	Cd
Oct	0.1100	0.0620	0.0032	0.0222	0.0112	0.0288	0.0199	0.0709	0.0103
Nov	0.1518	0.0510	0.0045	0.0210	0.0118	0.0320	0.0181	0.0953	0.0111
Dec	0.1629	0.0672	0.0048	0.0204	0.0101	0.0381	0.0186	0.1029	0.0119
Jan	0.1642	0.0560	0.0051	0.0124	0.0142	0.0260	0.0210	0.0910	0.0108
Feb	0.1272	0.0671	0.0048	0.0135	0.0155	0.0281	0.0221	0.1017	0.0113
March	0.1250	0.0512	0.0053	0.0133	0.0155	0.0406	0.0216	0.1081	0.0115
April	0.1315	0.0501	0.0056	0.0139	0.0154	0.0502	0.0223	0.1100	0.0129
May	0.1312	0.0274	0.0037	0.0141	0.0176	0.0601	0.0221	0.0599	0.0140
June	0.1283	0.0294	0.0028	0.0150	0.0183	0.0605	0.0201	0.0460	0.0176
July	0.1290	0.0940	0.0023	0.0139	0.0102	0.0583	0.0199	0.0440	0.0129
Aug	0.1209	0.0990	0.0022	0.0107	0.0038	0.0670	0.0212	0.0321	0.0112
Sep	0.1092	0.0419	0.0033	0.0101	0.0031	0.0681	0.0182	0.0652	0.0041
Mean	**0.1326**	**0.0580**	**0.0039**	**0.0150**	**0.0122**	**0.0464**	**0.0204**	**0.0772**	**0.0116**
SD	0.01809	0.0220	0.0011	0.0039	0.0049	0.0159	0.0015	0.0276	0.0030
Min	0.1092	0.0274	0.0022	0.0101	0.0031	0.0260	0.0181	0.0321	0.0041
Max	0.1642	0.0990	0.0056	0.0222	0.0183	0.0681	0.0223	0.1100	0.0176
WHO Limit	**0.05**	**1.0**	**0.05**	**0.05**	**0.05**	**0.10**	**0.01**	**1.0**	**0.005**

Similar trend of concentration was reported by Gulfraz et al. (2001) in which Cr, Cd and Pb were in higher concentration in Mangla Lake. It may be due to the addition of untreated municipal waste from poultry forms and geological weathering taking place in these areas. Chromium is used in manufacturing of paints, pigments, glass, ceramics industry, photographic and chromo metals products. So, it enters into municipal waste and reaches into Lake Water which are the main sources of chromium pollution (Lone et al., 2003). The highest level of Cr was observed in Jan in our study. Similar result was obtained in the same water body and Rawal Lake by Gulfraz et al. (2001). Cr with higher levels in the reservoir in the January may be attributed to the low water level and metal deposition. However, low metal level was noted in September as water inflow and outflow was higher which did not allow the metal deposition. Cr concentration in higher quantity in diet decreases the muscle fat in birds and increase protein deposition (Ward et al., 1995). Feed Conversion Ratio (FCR) and body mass of bird is disturbed (Hossain et al., 1998). Lead contamination occurs by snow, rain, waste water treatment, smelting works and by anthropogenic activities (Fardous et al., 2011). It is not necessary for the metabolic activities of the animals. It enters into water bodies from dyes, mining and petroleum industry and affects aquatic life adversely (Ciftci et al., 2008).

In our study, Lead concentration was higher than permissible limits in the month of January to May. Similarly, higher concentration level of Lead was reported by Iqbal et al., (2006) and Gulfraz et al., (2001) in the water of Mangla and Kollar Kohar. The higher level could be due to snow fall and rainy season by which atmospheric Lead comes to the soil and ultimately enter into this wetland. Lead is very toxic element for the biodiversity. It causes several diseases in birds such as anemia, weight loss and green watery faeces (Redig et al., 1980). It also affects circulatory system, nervous system, kidneys, biochemical and behavioral changes in animals (Scheuhammer, 1998). In our observation, the level of Cadmium was not within safe limits. The higher value was recorded in March to June. Similar trend of values were observed by Yaha (2008), Iqbal et al., (2006) and Gulfraz et al., (2001), and in the water of Mangla, Kallar Kohar and Manchar Lake respectively. This higher level could be due to emission of Cadmium from natural resources to environment by volcanic activities, weathering of rocks and sea spray or it may be by anthropogenic activities such as burning of fossil fuels, industrial processes, municipal effluents, metal extraction, and phosphate fertilizers and also from the uncontrolled open burning of wastes. This atmospheric Cadmium comes to ground with rain and snow in winter and ultimately into lake water. As Cadmium is metal toxicant in the environment naturally and industrially, that enters into biological system via food, soil and water. It causes the reproductive toxicity in birds (Toman et al., 2002) and decline in egg production (Rahman et al., 2007). The observed values of Mn, Co, Ni, Fe, Zn and Cu indicated that these metals lie under safe limits. Similar findings were recorded in Manchar Lake by Yaha (2008).

CONCLUSIONS

Mangla wetland avifauna population estimation and hydrological analysis of surface water recorded a total of 37,082 birds belonging to 37 species visited the wetland in 2010 whereas 28 with population of 21,302 birds in 2011. In surface water analysis, the level of heavy metals (Co^{+2}, Cu^{+2}, Fe^{+2}, Mg^{+2}, Mn^{+2} and Zn^{+2}) were found to be within the permissible limits whereas levels of Cr^{+2}, Pb^{+2} and Cd^{+2} were higher than safe limits.

The research work emphasize on extensive monitoring of this Ramsar site and catchment area in order to address the threats posed by heavy metals.

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