Journal of King Saud University – Science (2013) **25**, 267–270

King Saud University
Journal of King Saud University – Science
www.ksu.edu.sa
www.sciencedirect.com

ORIGINAL ARTICLE

Habitat association of Little Grebe (*Tachybaptus ruficollis*) at Kallar Kahar Lake, Pakistan

Sadia Bilal, Muhammad Rais *, Maqsood Anwar, Iftikhar Hussain, Madiha Sharif, Bilal Kabeer

Wildlife Management, PMAS-Arid Agriculture University, Rawalpindi, Pakistan

Received 29 December 2012; accepted 12 March 2013
Available online 21 March 2013

KEYWORDS
Little Grebe;
Kallar Kahar Lake;
Habitat preference;
Hydrophytes;
Eutrophication;
Birds of Pakistan

Abstract Understanding of species–habitat relationship is fundamental to effective conservation planning and management. We studied the association of Little Grebe abundance with habitat parameters at Kallar Kahar Lake, District Chakwal, Punjab, Pakistan, from September 2010 to July 2011. Bird population density data, vegetation and physico-chemical parameters were collected along three strips from different areas of the lake based on habitat variability. The association of Little Grebe abundance with physico-chemical parameters of water was determined using simple linear regression. The physico-chemical parameters differed significantly ($P < 0.05$) among the three strips. Water temperature and turbidity were negatively related while pH and depth were positively related with grebe population. We concluded that the species more frequently occurred in shallow water habitats with preponderance of reed vegetation, slightly high alkalinity, low water temperature and low turbidity. The reed vegetation such as *Phragmites* and *Typha* provided shelter and nesting sites while open water had abundant planktons and crustaceans, algae such as *Spirogyra* spp. and submerged vegetation such as *Chara* spp. provided foraging sites. Threats to the species included eutrophication, fluctuation in the water level and littering by visitors which need to be addressed through appropriate management interventions.

1. Introduction

Habitat resources such as food, refuge and water are the basic needs of an animal species required for its survival and successful reproduction in a particular area (Leopold, 1933; Thomas, 1979). Habitat selection is a hierarchical process related with a series of innate and learned behavioral decisions made by an animal about what kind of a habitat it would select at different scales of the environment (Hutto, 1985). The Little Grebe (*Tachybaptus ruficollis*) or Dabchick (Order Podicipediformes; Family Podicipedidae) is one of the smallest grebes with body length of 25–29 cm and having a buoyant rounded body. The

* Corresponding author. Address: Environment Resource Center, Department of Biology, Indiana-Purdue University, Fort Wayne, Indiana, USA. Tel.: +1 92 332 5442050.
E-mail address: sahil@uaar.edu.pk (M. Rais).
Peer review under responsibility of King Saud University.

ELSEVIER Production and hosting by Elsevier

1018-3647 © 2013 Production and hosting by Elsevier B.V. on behalf of King Saud University.
http://dx.doi.org/10.1016/j.jksus.2013.03.001

global conservation status of Little Grebe is of Least Concern (IUCN, 2009). Little grebe is widely distributed all over the world. It occurs in Europe, central and southern Asia and sub-Saharan Africa, Pacific islands and southern Africa except in Kalahari (Hockey et al., 2005). In Pakistan, Little Grebe is widespread in distribution. It is resident to large lakes, but very rarely seen in the flowing rivers and occasionally visits the estuaries and salt water bodies along the seacoast. In Punjab province, the species occurs in Salt Range lakes including Khabbeki, Nammal and Ucchali (Roberts, 1991) and Kallar Kahar Lake (Ali, 2007; Azam et al., 2009). Human activities and environmental changes are prime factors of decline in most of the waterfowl populations. Consequently, essential conservation efforts need to be taken. It is also important to have high quality baseline information on species habitat preferences and breeding biology to construct guidelines for the preservation and improvement of waterfowl habitat (Bruce et al., 1992). The data regarding biology and ecology of Little Grebe are deficient in Pakistan. Present study was, therefore, conducted to study the association of Little Grebe abundance (population density) with habitat parameters at Kallar Kahar Lake, Chakwal, Punjab.

2. Materials and methods

2.1. Study area

Kallar Kahar Lake (32 46 30.31 North of latitude; 72 42 23.80 East of longitude) is an Inland permanent saline/brackish lake. It is located in District Chakwal, Punjab, Pakistan. The lake is situated at an altitude of about 457 m above the sea level, and covers an area of 133.50 hectares (Rais et al., 2011). The lake lies in a tropical region. Weather is hot in summer and dry and cold in winter. Kallar Kahar is fed by numerous freshwater springs at the base of hills in the catchment area. An area of 164 hectares has been enclosed within a constructed bund. The volume of water, however, keeps on changing based on the seasons and amount of rainfall received, and may reduce to even almost 50 hectares during the dry season and swell again after the rains especially in the monsoon (Rais et al., 2011).

2.2. Study design

The study site was surveyed twice a month during morning and evening hours from September, 2010 to July, 2011. For habitat assessment, vegetation analysis and physico-chemical characteristics of water (i.e. water depth, temperature, turbidity and pH) were studied. Two strips (each 600 m long and 100 m wide; area 6 hectares) were laid out along the edge of the lake to record Little Grebe population and to sample habitat features along the shoreline (Lichvar and Campbell, 1997) while one strip (400 m long and 100 m wide; area 4 hectares) was laid out in open water. The number of Little Grebes was noted and vegetation and water samples were collected from 30 quadrates along ten sampling points at an interval of 40 m along each strip. A simple garden rake with long handle and double head was used for submerged aquatic vegetation (Kenow et al., 2007). The rake was dragged in substrate up to 1.5 m depth and the collected samples were stored in polythene bags along with water. Later, slides for each sample were prepared. The number of each plant species and its percentage cover within each quadrate was noted. The following calculations were made: Density (D) = total number of plant species/total area of sampling points; Relative density (RD) = total number of individuals of a species/total number of individuals of all species; Relative Frequency (RF) = Frequency value of a species/total frequency value of all species × 100; Relative cover (RC) = total cover of a species/total cover of all species × 100 and Importance value of each species (IVI) = Relative density + relative frequency + relative dominance (Coroi et al., 2004). The depth of water was determined using a marked steel rod. The water temperature was recorded using a thermometer while pH was recorded with a pH meter (pH range – 1.0–15.0 pH). Water turbidity was measured with the help of Secchi disk. The number of individuals of Little Grebes in each quadrate was noted. The population of Little Grebes was calculated by dividing the number of Little Grebes with the area (Area = Length × Width) of the strip.

The means of physico-chemical parameters of water were compared using single factor ANOVA at $\alpha = 0.05$. The relationship of population of Little Grebe with physico-chemical parameters of water was determined using simple linear regression at $\alpha = 0.05$.

3. Results

We recorded two main habitat types viz. open water and marshy to swampy areas along the edges of Kallar Kahar Lake. The most dominant species of emergent hydrophytes recorded from the lake was *Phragmites karka* (Importance Index Value = IVI = 43.22) followed by *Saccharum spontaneum* (IVI = 13.86) while the most abundant submerged species was *Spirogyra* spp. (Relative Cover = RC = 30.79), *Chara* spp. (RC = 24.88) and *Hydrilla verticillata* (RC = 10.86) (Table 1). The strip I had similar dominant emergent species of hydrophytes while strip II also had *Schoenoplectus lacustris* (IV = 15.34) as important emergent species in addition to *Phragmites karka* (IV = 15.99), and *Saccharum spontaneum* (IV = 13.65) (Table 1). The strip III had only submerged and floating vegetation with *Chara* spp. (RC = 34.69), *Spirogyra* spp. (RC = 19.80) and *Cladophora* spp. (RC = 13.71) (Table 1). The mean water temperature was relatively higher at strip II (Table 2). The pH of the lake was slightly basic (above 8). The turbidity was the highest along strip II while strip III had the maximum depth (0.69 m) (Table 2). The studied physico-chemical parameters differed significantly ($F = 3.35$, $df = 27$, $P < 0.05$) among three strips. We recorded 203 individuals (N) of Little Grebes with a population density (PD) of 12.68 individuals per hectare from the lake during the study period (Table 2). The maximum number of grebes was 129, with a population density of 21.5 recorded from strip I followed by strip III ($N = 60$; PD = 15) and strip II ($N = 14$; PD = 2.33). The population density of grebe differed significantly ($P < 0.05$) among the strips. The maximum number of Little Grebe ($N = 28$) was recorded in June, 2011 while the minimum number ($N = 11$) was recorded in January, 2011 (Table 2). Temperature ($\beta = -1.343$, $t = -3.654$, $P = 0.001$) and turbidity ($\beta = -0.058$, $t = -1.888$, $P = 0.001$) were negatively related while pH ($\beta = 10.537$, $t = 3.601$, $P = 0.001$) and depth ($\beta = 0.159$, $t = 2.845$, $P = 0.008$) were positively related with the population density of Little Grebe. The temperature ranged from 21.2 to 25.6 °C at the lake during the present study. The maximum number of nests (06) was noted along strip I which

Table 1 Emergent and submerged vegetation recorded from Kallar Kahar Lake during 2010–2011.

S. No.	Botanical names	I		II		III		Mean	
		RC	IVI	RC	IVI	RC	IVI	RC	IVI
1	*Cynodon dactylon*	4.57	16.59	0.009	6.86	–	–	1.52	7.82
2	*Phragmites karka*	72.76	113.67	0.08	15.99	–	–	24.28	43.22
3	*Phyla nodiflora*	1.83	13.83	0.001	8.49	–	–	0.61	7.44
4	*Potamogeton crispus*	–	–	0.002	10.18	–	–	0.001	3.39
5	*Saccharum spontaneum*	11.88	27.92	0.01	13.65	–	–	3.963	13.86
6	*Schoenoplectus lacustris*	–	–	0.009	15.34	–	–	0.003	5.11
7	*Tamarix aphylla*	–	–	–	10.17	–	–	0.000	3.39
8	*Typha angustifolia*	2.74	6.76	0.005	6.82	–	–	0.915	4.53
9	*Vallisneria spiralis*	6.22	22.23	0.006	13.62	–	–	2.075	11.95
10	*Anabaena* spp.	8.93	–	18.59	–	2.54	–	10.02	0.00
11	*Arthrospira platensis*	–	–	–	–	3.89	–	1.29	0.00
12	*Chara* spp.	–	–	39.96	–	34.69	–	24.88	0.00
13	*Chroococcus* spp.	–	–	1.86	–	0	–	0.62	0.00
14	*Cladophora* spp.	–	–	–	–	13.71	–	4.57	0.00
15	*Gloeocapsa* spp.	–	–	8.36	–	0	–	2.78	0.00
16	*Hydrilla verticillata*	19.6	–	7.06	–	5.92	–	10.86	0.00
17	*Hydrodictyon* spp.	23.05	–	–	–	4.91	–	9.32	0.00
18	*Lyngbya* spp.	–	–	–	–	3.55	–	1.18	0.00
19	*Oedogonium* spp.	–	–	–	–	11	–	3.66	0.00
20	*Spirogyra* spp.	48.41	–	24.16	–	19.8	–	30.79	0.00

RC = Relative cover; IVI = Importance index value.

Table 2 Number of individuals, dives and nests of Little Grebe and description of habitat parameters at Kallar Kahar Lake recorded during 2010–2011.

Strip No. (Length × Width)	Little Grebe		Physico-chemical parameters of water				Relative cover of plants spp.	Activities	
	Number	Population density/ha	Temperature °C	pH	Turbidity (NTU)	Depth (m)		Dives per min	Nests
I (600 × 100 m)	129	21.5	21.2	8.96	26.10	0.62	19.99	1.75	6
II (600 × 100 m)	14	2.33	26.6	8.52	57.10	0.4	6.67	0.5	1
III (400 × 100 m)	60	15	21.2	8.48	25.70	0.69	11.11	2.6	0
Total	203								
Mean	–	12.68	23	8.65	36.3	0.57	12.59	1.61	2.33

showed that the reed vegetation such as *Phragmites* and *Typha* was preferred as shelter and nesting sites. The maximum number of dives per minute (2.6) was recorded in strip III, which is the area located at the open water. This seems to indicate that the open areas of the lake provided foraging sites for the grebes, as it had abundant planktons and crustaceans, algae such as *Spirogyra* spp and submerged vegetation such as *Chara* spp (Table 2).

4. Discussion

Little Grebes make a differential use of the available habitat. The vegetation and water physico-chemical characteristics are the main variables that govern Little Grebe distribution. Rais et al. (2011) reported 0.15 Little Grebes per hectare during 2008–09 from Kallar Kahar Lake. Our results showed increase in the population mainly due to the restoration of the ecological condition of the lake. Water level of the lake was much reduced during 2009–2010 (Rais et al., 2010) which might had affected the population of breeding birds including Little Grebe. Further, variation in the population estimation may also be contributed to differences in the observers, time and duration of the study and different sampling sites.

It is believed that site occupancy and frequency of occurrence of water bird species are strongly correlated with the presence of submerged vegetation, vegetation along the shore and pond size. The three important factors affecting site selection are pond size (area), connectivity (distance to the nearest wetland) and habitat quality (González et al., 2010a,b). We also recorded that water depth, water quality and vegetation had strong association with Little Grebe occurrence. The trophic status and/or shallowness of water also influence water bird richness and abundance (McKnight, 1998; Colwell and Taft, 2000). Little Grebe inhabits a wide range of small and shallow wetlands usually less than 1 m depth with rich vegetation (Fjeldsa, 2004). Ceccobelli and Battisti (2010) recorded Little Grebe from wetland channels with water deeper than 0.3 m. We recorded the species from areas having different water depth levels, but usually above 0.4 m. Burton (1988) reported that Little Grebe favors 20–32 °C temperature and adjusts itself accordingly in the habitat. The population of Little Grebe increases during clear stages of water, because the visi-

bility of prey increases in low turbidity (Gregg and Rose, 1985; Kerekes, 1994). Moss and Moss (1993) reported that Little Grebe mostly preferred the habitat with reed vegetation such as *Phragmites*, *Scirpus* and *Typha* which are used in nest building. Little Grebe inhabits a variety of habitats including reclaimed waterfront. However, the species was found to prefer reed beds (Hattori and Mae, 2001). Our results are consistence with aforementioned studies. We concluded that the species used shallow water habitats with preponderance of reed vegetation, slightly high alkalinity but low water temperature and turbidity.

The lake enjoys legal protection under the provincial wildlife law. The main factors affecting the Little Grebe population at Kallar Kahar Lake are water eutrophication, fluctuation in the water level and litter deposition by the visitors. Several actions may be taken to improve the conservation of the lake. We suggest a proper management of the vegetation to maintain high-quality habitat for the species, but removing over growth so that the lake integrity may not be affected. Further, an educative program should also be taken to reduce littering in and around the lake by visitors. Finally, water entering the lake needs to pass through check dams to reduce the influx of excessive nutrients to reduce eutrophication and silting in the lake.

References

Ali, M., 2007. Studies on Population Status of CMS Species of Water Birds on Wetlands of Upper Punjab. Zoological Survey Department, Pakistan.

Azam, M.M., Ali, M., Ahmed, W., Nazar, A.Q., 2009. Midwinter Waterfowl Census 2009 at Different Wetlands of Punjab and NWFP. Zoological Survey Department, Pakistan.

Bruce, D.J.B., Alan, D.A., Michael, G.A., Ankeney, C.D., Johnson, D.H., Kadlec, J.A., Krapu, G.L., 1992. Ecology and Management of Breeding Waterfowls. University of Minnesota Press.

Burton, P.J.K., 1988. Release of wild birds after treatment. Proc. Inaugural Symp. Br. Wildlife Rehabilitation Council 1, 109–114.

Ceccobelli, S., Battisti, C., 2010. On the water depth in diving sampling sites of *Tachybaptus ruficollis*. Rendiconti Lincei 21 (4), 359–364.

Colwell, M.A., Taft, O.W., 2000. Waterbird communities in managed wetlands of varying water depth. Waterbirds 23, 45–55.

Coroi, M., Skeffington, M.S., Giller, P., Smith, C., Gormally, M., O'Donovan, G., 2004. Vegetation diversity and stand structure in streamside forest in south of Ireland. Forest Ecol. Manage. 202 (1–3), 39–57.

Fjeldsa, J., 2004. The Grebes: Podicipedidae. Oxford University Press, Oxford, UK, p. 246.

González, E.S., Zapata, J.A.S., Botella, F., 2010a. Agricultural ponds as alternative habitat for waterbirds: spatial and temporal patterns of abundance and management strategies. Eur. J. Wildlife Res. 56 (1), 11–20.

González, E.S., Botella, F., Sempere, R.A., Zapata, J.A.S., 2010b. An empirical demonstration of the ideal free distribution: Little Grebes *Tachybaptus ruficollis* breeding in intensive agricultural landscapes. Ibis 152, 643–650.

Gregg, W.W., Rose, F., 1985. Influences of aquatic macrophytes on invertebrate community structure, guild structure and microdistribution in streams. Hydrobiologia 128, 45–56.

Hattori, A., Mae, S., 2001. Habitat use and diversity of waterbirds in a coastal lagoon around Lake Biwa. Jpn. Ecol. Res. 16, 543–553.

Hockey, P.A.R., Dean, W.R.J., Ryan, P.G., 2005. Roberts – Birds of Southern Africa, seventh ed. New Holland Publishers, Cape Town, p. 1296.

Hutto, R.L., 1985. Habitat Selection by Non-Breeding Migratory Land Birds. Academic Press, Orlando, pp. 455–476.

IUCN, 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Kenow, K.P., Lyon, J.E., Hines, R.K., Elfessi, A., 2007. Estimating biomass of submersed vegetation using a simple rake sampling technique. Hydrobiologia 575, 447–454.

Kerekes, J.J., 1994. Aquatic birds in the trophic web of lakes. Hydrobiologia 179 (280), 1–524.

Leopold, A., 1933. Game Management. Charles Scribner's Sons, New York, London, p. 481.

Lichvar, R., Campbell, J., 1997. Baseline Study of Vegetation at Strawberry Island, Niagara River, NY. US Army Engineer Waterways Experiment Station, p. 29.

McKnight, S.K., 1998. Effects of food abundance and environmental parameters on foraging behavior of Gadwalls and American coots in winter. Can. J. Zool. 76, 1993–1998.

Moss, D., Moss, G.M., 1993. Breeding biology of the Little Grebe *Tachybaptus ruficollis* in Britain and Ireland. Bird Study 40 (2), 107–114.

Rais, M., Kabeer, B., Anwar, M., Mahmood, T., 2010. Effect of habitat degradation on breeding water birds at Kallar Kahar Lake, district Chakwal. J. Anim. Plant Sci. 20 (4), 318–320.

Rais, M., Anwar, M., Mehmood, T., Hussain, I., 2011. Bird diversity and conservation at Kallar Kahar Lake with special reference to water birds. Pak. J. Zool. 43 (4), 673–681.

Roberts, T.J., 1991. The Birds of Pakistan. Non-Passeriformes, vol. 1. Oxford University Press, p. 598.

Thomas, J.W., 1979. Wildlife habitats in managed forests: The Blue Mountains of Oregon and Washington. United States Department of Agriculture, Forest Service Handbook, Washington, D.C. p. 553.