ELSEVIER

Biological Conservation 108 (2002) 273–279

BIOLOGICAL CONSERVATION

www.elsevier.com/locate/biocon

Effects of human activities on migratory waterbirds at Lashihai Lake, China

Rui-Chang Quan, Xianji Wen*, Xiaojun Yang

Kunming Institute of Zoology, Chinese Academy of Sciences, Kunming, Yunnan 650223, PR China

Received 28 September 2001; received in revised form 31 January 2002; accepted 15 March 2002

Abstract

Surveys on migratory waterbirds and their habitats at Lashihai Lake, China, were conducted from October 1999 to April 2000. Five fixed points, representing different degrees of habitat disturbance and quality, were selected around the lake. We used counts ($n = 30$) to compare diversity and abundance of waterbirds at each point and evaluate the effects of habitat disturbance. The distribution of waterbirds was affected by disturbance, with more than one-third of the total species and nearly half of the total individuals occurring at the least disturbed point. Species richness was weakly and abundance was strongly correlated to habitat disturbance, but not to habitat quality. Habitat destruction and use of canoes were prominent at the lake. Naxi ethnic fishermen ($n = 37$) were interviewed. They caught 570 waterbirds between October 1999 and March 2000 in fishing nets. An estimation of the total number of waterbirds been trapped on the lake is 6164. Diving species were most susceptible. Conservation measures that should implement immediately include the cessation of habitat destruction, better plan for the development of tourism, a reduction in the number of canoes and zoning of the non-fishing area.

Keywords: Distribution pattern; Habitat disturbance; Habitat quality; Fishing net; Lashihai Lake; Migratory waterbirds; Trapping

1. Introduction

Habitat loss is the major threat to biodiversity and habitat protection is the most important means of conserving biodiversity (Primack, 1995). Bird's habitats are increasingly affected as human population expands (Terborgh, 1989). This is particularly true for wetlands. Wetlands are in retreat nearly everywhere they are found (UNEP, 1992). Up to 50% of the wetlands which once existed may have been destroyed or degraded, and many local communities that depend upon wetlands have been forced to overuse them in face of rapid population growth and extreme poverty (Munro and Holdgate, 1991). They are often filled in or drained for development, or altered by channelization of watercourses, dams, and chemical pollution (Primack, 1995).

China has the largest wetlands areas throughout Asia (Chen, 1998), harboring rich biodiversity (Zhao, 1995). However, with dense human population, most of them are also the center for local economic development. The threats to wetlands in China include water pollution, ill-planned development of tourism, over-harvest of aquatic bio-resources (e.g. fish, aquatic plant and waterbirds), and conversion of the wetland to other land uses for local inhabitants (Chen, 1998; Zhang, 1998; Zhao, 1995).

Lashihai Lake is an important wintering site for migratory waterbirds in the Trans-Himalayas of Yunnan (Fig. 1). It was gazetted a nature reserve with another lake and two reservoirs in 1998 to protect migratory waterbirds and the vulnerable plateau's wetland ecosystem. The number of waterbirds has increased steadily in recent years (Li et al., 2000). Many local people still mainly depend on fishing in the lake for their income. The Nature Conservancy and Yunnan Provincial Government are helping local communities to develop conservation and eco-tourism in the reserve. The tension between exploitation of resources and ecological sustainability remains. This study was designed to show the effects of fishing activities on wintering waterbirds and the effects of other human disturbances on the distribution pattern of waterbirds at Lashihai Lake.

* Corresponding author. Tel.: +86-871-5192023; fax: +86-871-5191823.

E-mail address: wenxj@mail.kiz.ac.cn (X. Wen).

0006-3207/02/$ - see front matter
PII: S0006-3207(02)00125-8

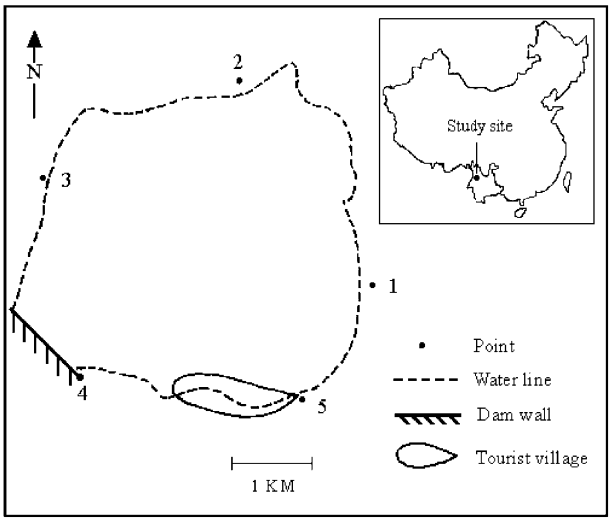

Fig. 1. Location of Lashihai Lake in the Yunnan Province of China and the five fixed survey points.

1.1. Study site

Lashihai Lake (26°44′–27°00′N and 100°05′-100°13′E) is the largest (1000 ha) of two lakes and two reservoirs in the Reserve, at 2400 m above sea level. It was a natural, seasonal lake before a dam wall was built across the southwestern side to stop water flowing toward an underground outlet in 1993 (Fig. 1). A tunnel was built in 1994 to take the water from the lake to Lijiang urban area. So, now the lake's water level is controlled. Annual precipitation in this area is 900–1000 mm, with most occurring between June and September. Annual average temperature is 11.8 °C, and lowest average monthly temperature in January is 3.9 °C.

About 7500 Naxi ethnic people live in four villages around the lake and include 1206 persons that mainly rely on fishing in the lake. Others are farmers who grow wheat, maize, potato, and rape in farmland surrounding the lake. During past decades, Naxi people have changed their use of the lake. Local people, especially people who now rely on fishing, used to grow their crops in part of lake's bottom after the water level decreased, but the dam wall raised the water level stopping this practice. Aquatic plants in the lake are unsustainably harvested as food for pigs, cattle, and people. Thus, aquatic vegetation (*Ceratophyllum demersum, Myriphyllum spicatum, Hydrilla verticillata, Ottelia acuminata, Potamogeton crispus, Potamogeton malaianus* and *Potamogeton pectinatus*) that once dominated the entire lake (Dali Branch of Yunnan Forestry Survey and Planning Institute, 1998) is now restricted to the north of the lake. *O. acuminata*, an endangered aquatic plant species and endemic to the plateau wetland of Yunnan, is collected for food and also sold. The high price commanded by the species results in over-exploitation.

Migratory waterbirds begin to arrive at Northwest Yunnan after early October every year and leave before late April of the next year (Yang et al., 1995). Waterbirds used to be an important protein resource and income, but now waterbirds is an important resource for eco-tourism. Lashihai Lake supports the majority of migratory waterbirds in the reserve.

2. Methods

Data on species and number of waterbirds trapped by fishing nets were collected by interviewing 37 fishermen in villages with the aid of Naxi-speaking assistants in the end of March 2000. Naxi fishermen were shown with pictures (Sonobe and Usui, 1993) and asked (1) the species and number trapped by fishing nets in the past 6 months, (2) the mesh size, length and how many pieces of fishing net used in the lake, and (3) how captured waterbirds were disposed, sold or eaten by fishermen. All the birds caught by fisherman in fishing nets are drowned. According to the report from staff of the reserve, there are over 400 canoes in total on the lake and about 400 canoes are used for fishing. Each fisherman owns a canoe, so the numbers of each species caught equals to that the average number of each species caught per fisherman times 400.

Regular observations were made at five fixed points at the edge of the lake (Fig. 1). The census radius at each point was 1000 m except at overlapping area between point 1 and point 5, where some trees acted as the boundary to avoid double counting. The habitats of waterbirds within 1000 m radius were categorized as deep water area, shallow water area, mudflat, grassland and farmland (Quan et al., 2001). The sizes of each habitat changed with season and were measured by a GPS receiver (GARMIN 12) in early (October–December), mid (January–February) and late winter (March–April).

During the survey, we used direct count (Spindler et al., 1981) with binoculars of 10× and a Nikon ED 78 mm field scope (25–56× zoom). The regular counts at each point at the edge of the lake were recorded on tape recorder once a week from 1 October 1999 to 29 April 2000 during daytime, and 30 counts (a count is defined as a survey of all five points in a week) were made in total. Generally, all birds were identified in relation to the habitats. Each point was counted on a different day in a week. The order of counting the points was regularly rotated to minimize possible order bias on the birds' distribution and abundance at each point. Counting was not done on days with fog, rain, or strong wind to reduce the bias caused by the effect of extreme weather (Verner, 1985).

We ranked the habitat quality (Table 2) of all points mainly based on the proportion of shallow water areas

and grassland at each point to analyze the relationship between waterbird distribution and habitat quality. Waterbird distribution was based on density at each point (see Table 2). Habitat disturbances (Table 2) at the five points were ranked mainly in terms of (1) direct habitat destruction during past 5 years, such as the construction of the tourist village, so point five is the severest disturbed one, and (2) number of canoes. The latter is the main index to determine the degree of habitat disturbance among point one, two, three, and four. We also recorded the number of tourists, fires in the farmland near the lake, and livestock in the grassland and shallow water area, which also contribute to the rank of habitat disturbance when the numbers of canoes are similar in some points, and helping to determine the ranking order among them.

3. Results

3.1. Bird trapping pressure

In total, 570 catching records of 11 waterbird species by fishing nets were reported (Table 1). All the birds caught are drowned. The number of waterbirds caught by different fisherman in a 6 month period ranged between 2 and 45. The three commonest caught species were Black Coot (*Fulica atra*) (58%), Little Grebe (*Podiceps ruficollis*) (10%), and Common Pochard (*Aythya ferina*) (11%), together accounting for 79% of the total number of the birds trapped. The average numbers of each species caught per fisherman in winter were calculated to compare trapping pressure across species (Table 1). The estimated total number of all caught species was 6164. The number of the commonest caught species, Black Coot, was more than 3500 individuals, accounting for 14.3% of the wintering population of the species (Table 1).

There were about 1600 pieces of fishing net, totalling about 80,000 m in length and encircled the lake 4–5 times. Two kinds of mesh sizes were used in fishing nets, with mesh size <1 cm and >5 cm. More than half of the fishing nets were large mesh. The small mesh only captured small fish (*Abbottina rivularis*, *Hypseleotris swinhonis*, *Misgurnus anguillicaudatus*). The large mesh captured large fish (*Cyprinus carpio haematopterus, Carassius auratus auratus*), and wintering waterbirds.

3.2. Habitat degradation and loss

The degree of disturbances at each point usually changed with season, as did habitat quality (Table 2). The severest habitat destruction in recent years was the construction of a tourist vacation village in 1997. It destroyed 60 ha of grassland and 40 ha of shallow water area (Fig. 1). Each October the water level would have inundated the area of the tourist village, an area that was a suitable habitat for large number of waterbirds such as Cranes (*Grus grus*), Bar-headed Geese (*Anser indicus*), and Ruddy Shelducks (*Tadorna ferruginea*) before. Tourists entertained disturb waterbirds, sometimes, driving them with canoes.

There are about 400 canoes in the lake, or an average density of more than 40/km^2. Thousands of domestic ducks, hundreds of pigs, cattle, and horses that grazed in the grassland and shallow water area, together with tens of shepherds also increased the habitat disturbances.

The disturbances at point five were severest in all three sub-seasons among the five points (Table 2), which mainly resulted from the construction of the tourist vacation village. The major disturbance of point three, close to Dayucun Village, was daily human activities

Table 1
Waterbirds drowned by fishing nets between October 1999 and March 2000

Common name (scientific name)	No. of birds (Mean±SD)[a]	%[b]	NSC[c]	TN[d]
Black Coot (*Fulica atra*)	8.97±8.38	14.3	3588	25,710
Common Pochard (*Aythya ferina*)	1.68±3.38	36.1	672	1860
Little Grebe (*Podiceps ruficollis*)	1.54±1.74	23.3	616	2640
Great Crested Grebe (*Podiceps cristatus*)	0.65±1.03	17.2	260	1515
Tufted Duck (*Aythya fuligula*)	0.57±1.64	12.7	228	1800
Ferruginous Duck (*Aythya nyroca*)	0.92±2.03	17.7	368	2076
Goosander (*Mergus merganser*)	0.57±0.80	9.2	228	2490
Great Cormorant (*Phalacrocorax carbo*)	0.03±0.16	1.9	12	645
Red-crested Pochard (*Netta rufina*)	0.24±0.60	1.0	96	990
Spotbill Duck (*Anas poecilorhyncha*)	0.08±0.36	1.5	32	2130
Green-winged Teal (*Anas crecca*)	0.16±0.55	0.6	64	11,340

[a] Number of birds caught by 37 fisherman in winter.
[b] Percentage of each species drowned.
[c] Numbers of each species caught = average number of birds caught per fisherman × total number of canoes (400).
[d] Total number of each species on the lake.

Table 2
Richness and density of wintering waterbirds recorded at five observation points in Lashihai Lake

	Point 1	Point 2	Point 3	Point 4	Point 5
Early winter					
Habitat disturbance rank[a]	1	3	4	2	5
Habitat quality rank[b]	4	1	5	3	2
Species per ha	0.13	0.07	0.07	0.07	0.05
Individuals per ha	28	9	5	5	2
Mid winter					
Habitat disturbance rank	1	4	2	3	5
Habitat quality rank	4	1	5	2	3
Species per ha	0.17	0.1	0.1	0.08	0.06
Individuals per ha	29	12	13	6	5
Late winter					
Habitat disturbance rank	1	4	2	3	5
Habitat quality rank	3	1	5	2	4
Species per ha	0.15	0.1	0.11	0.08	0.09
Individuals per ha	19	9	12	7	5

[a] 1 is least disturbed and 5 is most disturbed. Ranking based on direct habitat destruction (e.g. construction of the village), number of canoes, tourists, fires, and livestock.

[b] 1 is best and 5 is poorest. Ranking based on the proportion of shallow water areas and grassland at the point.

along the lakeside. Inhabitants in the village expanding their residential area and farmland in the past decades had destroyed a large patch of habitat. Most people living in this village depend on fishing and about 150 canoes also disturb waterbirds at point three.

Both habitat destruction and human disturbance were relatively moderate at point two and point four, but between mid and late winter (drought), many farmers reclaimed low land areas, previously considered as marginal for crop cultivation at the lakeside, that also were important habitats for waterbirds. Little habitat destruction or disturbance occurred at point one.

3.3. Waterbird distribution

Fifty-two waterbird species were recorded (Appendix). Waterbirds were not evenly distributed among five points for both species richness ($\chi^2 = 31.102$, df = 4, $P < 0.001$) and abundance ($\chi^2 = 208.902$, df = 4, $P < 0.001$). Most waterbirds congregated at point one with more than one-third of the total species and nearly half of the total individuals in all three sub-seasons (Fig. 2). But Ruddy Shelduck and Bar-headed Geese, the only two of the common species (wintering population > 500 individuals), were more abundant at point two than at other points.

Point one was the only preferred site if comparing with average number of species per ha at point two (Mann–Whitney $U = 6.5$, $P < 0.05$), point three (U = 7.0, $P < 0.05$), point four ($U = 4.0$, $P < 0.05$), and point five

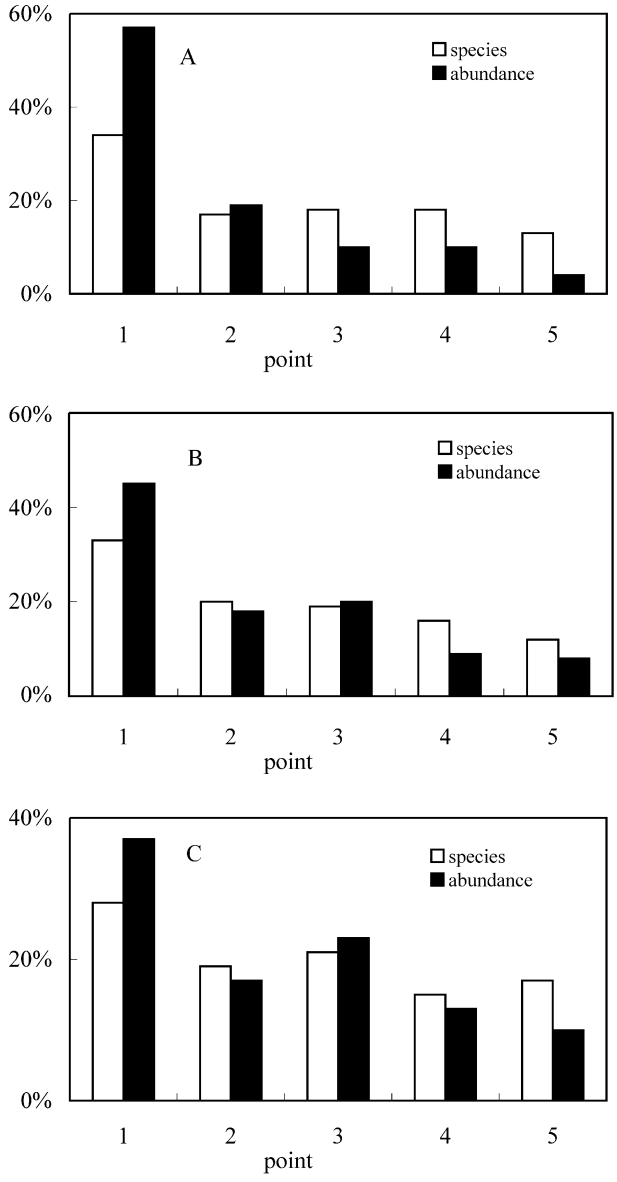

Fig. 2. The relative abundance of species and individuals at five points. (A) early winter; (B) mid winter; (C) late winter.

($U = 4.0$, $P < 0.05$) respectively. There was no significant difference among point two, three, four, and five. The distribution pattern of species richness was not related to the habitat quality in early (spearman rank $r_s = 0.10$, $P > 0.05$, $n = 5$), mid ($r_s = 0.31$, $P > 0.05$, $n = 5$), and late winter ($r_s = 0.30$, $P > 0.05$, $n = 5$) respectively. Point one also had largest number of individuals ($U = 7.5$, 8.0, 3.5, and 2.0, $P < 0.05$, 0.05, 0.05, and 0.05, compared with the average number of individuals per ha at point two, three, four, and five respectively). There were no significant differences among points two, three, and four, and among points three, four, and five, but point two was significantly selected when comparing with point five ($U = 6.5$, $P < 0.05$). The total population distribution was also not significantly related to the habitat quality in

early ($r_s = 0.45$, $P > 0.05$, $n = 5$), mid ($r_s = 0.50$, $P > 0.05$, $n = 5$), and late winter ($r_s = 0.10$, $P > 0.05$, $n = 5$).

Total population distribution pattern was strongly correlated to habitat disturbance, decreasing systematically at each point with increasing habitat disturbances in early ($r_s = -0.89$, $P < 0.05$, $n = 5$), mid ($r_s = -0.90$, $P < 0.05$, $n = 5$), and late winter ($r_s = -0.90$, $P < 0.05$, $n = 5$). The species richness at each point was not strongly correlated to habitat disturbance in early ($r_s = -0.82$, $P = 0.089$, $n = 5$), mid ($r_s = -0.82$, $P = 0.089$, $n = 5$), and late winter ($r_s = -0.70$, $P = 0.188$, $n = 5$), but it still tended to decrease with the increase of habitat disturbance.

4. Discussion

Four factors impact on migratory birds population at their stop-over sites and winter quarters: restriction of habitats, hunting and trapping, disturbance, and effects of biocides (Berthold, 1993). In Yunnan province habitat destruction and over-hunting were the major threats to the wetlands species (Wen et al., 1995). Similarity, the major threats to the waterbirds at Lashihai Lake were habitat loss, disturbance, and bird trapping.

Active protection measures at the lake, after the establishing of the reserve, have mostly prevented illegal trapping, shooting, and poison baiting, but fishing nets are widely used and catch many waterbirds. Data on bird trapping probably underestimated the harvest (Table 1) because local fishermen were suspicious of the researcher's motive. Diving waterbirds (e.g. Black Coot, Common Pochard, and Little Grebe) were more likely to be caught than waterbirds getting food on the surface (e.g. Spot-bill Duck and Green-winged Teal) (Table 1).

A particular class of movements that may be vitally important for waterbirds are within-season movements among multiple sites (Haig et al., 1998). For some species at the lake, the losses due to catching may be buffered by the immigration from other plateau lakes and reservoirs in the Yunnan Province, which is an important area for wintering waterbirds in China. But if the level of human disturbance and harvest at other sites are similar to those at Lashihai Lake, there may be significant impacts on some species.

Water depth strongly influences the availability of waterbird habitat (Safran et al., 2000). In Lahsihai Lake, shallow water areas and grassland had abundant food (grasses, aquatic plants, small crustaceans and shrimps) for waterbirds, but not all shallow water areas and grassland were preferred by waterbirds. Species richness and abundance were correlated to human disturbance, not to habitat quality. However, it is difficult to separate out the effects of a specific disturbance (e.g. canoe, tourist, reclamation and livestock) from this study.

5. Conclusions and recommendations

The distribution pattern of the waterbirds was influenced by human disturbance and not habitat quality. No management plans exist to completely stop disturbance or catching. The large numbers of fisherman (> 40 canoes/km^2) indicate a high level of habitat disturbance and birds trapping are unavoidable. All development projects at lakeside will destroy or fragment habitat and be followed by human disturbance. The reclamation of the seasonal grassland and shallow water areas will exacerbate the conflict between migratory waterbirds and local people. There should be (1) a designated non-fishing zone (at least one-third of the lake) that prohibited from fishing activities during winter; (2) no more reclamation of grassland or other habitats surrounding the lake; and (3) mitigation of the negative effects of the tourist vocation village, including tourist's behavior.

Acknowledgements

The fieldwork of this research was funded by Joint Project Office of Yunnan Great Rivers Conservation and Development Project, China National Science Foundation (grant No. 39730080), Yunnan Science Foundation (grant No. 1999C0082M), A Grant for Systematic and Evolutionary Biology, CAS and Yunnan Provincial Forestry Department. We thank Naxi ethnic people for their cooperation in the bird trapping survey. We also thank Professor Q.-K. Zhao for his invaluable help and comments on an early draft of the manuscript, Professor J.-G. Zhu and Professor L. Yang for comments on field methodology. We especially thank T.-F. Huang, G-H. Peng, and X.-L. Peng for field assistant, Dr. W. Xiao and L.-W. Cui for valuable discussions, Dr. T. R. New and two anonymous reviewers for many valuable suggestions for improving the manuscript.

Appendix. List of waterbirds at Lashihai Lake[a]

Common name	Scientific name	Resident[b]	Migrant[c]
Great Crested Grebe	*Podiceps cristatus*		+
Little Grebe	*Podiceps ruficollis*	*	
Great Cormorant	*Phalacrocorax carbo*		+
Great Egret	*Egretta alba*		+
Intermediate Egret	*Egretta intermedia*		#
Little Egret	*Egretta garzetta*		#
Grey Heron	*Ardea cinerea*		+
Cattle Egret	*Bubulcus ibis*		#
Pond Heron	*Ardeola bacchus*		#
Chinese'Little Bittern	*Ixobrychus sinensis*		#
Black Stork	*Ciconia nigra*		+
Bar-headed Goose	*Anser indicus*		#
Greylag Goose	*Anser anser*		+
Common Shelduck	*Tadorna tadorna*		+
Ruddy Shelduck	*Tadorna ferruginea*		+
Baikal Teal	*Anas formosa*		–
European Wigeon	*Anas penelope*		+
Falcated Teal	*Anas falcata*		+
Green-winged Teal	*Anas crecca*		+
Gadwall	*Anas strepera*		+
Pintail	*Anas acuta*		–
Shoveler	*Anas clypeata*		+
Spotbill Duck	*Anas poecilorhyncha*		+
Mallard	*Anas platythynchos*		+
Mandarin Duck	*Aix galericulata*		#
Common Goldeneye	*Bucephala clangula*		–
Goosander	*Mergus merganser*		+
Smew	*Mergus squamatus*		–
Red-crested Pochard	*Netta rufina*		+
Common Pochard	*Aythya ferina*		–
Ferruginous Duck	*Aythya nyroca*		+
Tuffed Duck	*Aythya fuligula*		+
Common Crane	*Grus grus*		–
Hooded Crane	*Grus monacha*		+
White-breasted Water Hen	*Amaurornis phoenicurus*		–
Black Coot	*Fulica atra*		+
Moorhen	*Gallinula chloropus*		+
Lapwing	*Vanellus vanellus*		+
Grey-headed Lapwing	*Vanellus cinereus*		–
Little Ringed Plover	*Chradrius dubius*		+
Lesser Golden Plover	*Pluvialis dominica*		–
Eurasian Curlew	*Numenius arquata*		+
Spotted Redshank	*Tringa erythropus*		–
Common Greenshank	*Tringa nubularia*		–
Common Redshank	*Tringa totanus*		+
Green Sandpiper	*Tringa ochropus*		–
Common Sandpiper	*Tringa hypoleucos*		+
Red-necked Phalarope	*Phalaropus lobatus*		-
Black-winged Stilt	*Himantopus himantopus*		+
Brown-headed Gull	*Larus brunnicephalus*		+
Black-headed Gull	*Larus ridibundus*		+
Great Black-headed Gull	*Larus ichthyaetus*		+

[a] The migrant status of the birds based on Mackinnon and Phillipps (2000).

[b] * Resident species.

[c] +, Migratory species mainly breeding in China and countries north to China; #, migratory species mainly breeding within China; –, migratory species mainly breeding in countries north to China.

References

Berthold, P., 1993. Bird Migration: A General Survey. Oxford University Press, Oxford.

Chen, J. 1998. Wetlands and the Conservation of Waterbirds in China. In Wetlands International-China Programme (ed.) Wetland and Waterbirds Conservation: 41–44. Beijing: China Forestry Publishing House.

Dali Branch of Yunnan Forestry Survey and Planning Institute, 1998. The Comprehensive Expedition to Lijiang Lashihai Plateau's Wetland Nature Reserve of Yunnan Province. Dali Branch of Yunnan Forestry Surveying and Planning Institute. pp. 1–36.

Haig, S.M., Mehlman, D.W., Oring, L.W., 1998. Avian movements and wetland connectivity in landscape conservation. Conservation Biology 12, 749–758.

Li, C., Ling, Z.G., Cheng, Y.Q., Yang, X.J., 2000. The change of waterfowl in Lashihai Lake, Yunnan Province. Territory & Nature Resource Study 3, 58–61.

Mackinnon, J., Phillipps, K., 2000. A Field Guide to the Birds of China. Oxford University Press, New York.

Munro, D. A., Holdgate, M. W. (eds). 1991. Caring for the Earth: A Strategy for Sustainable Living. Published in partnership by IUCN, UNEP, and WWF, Gland.

Primack, R.B., 1995. A Primer of Conservation Biology. Sinauer Associates, Sunderland.

Quan, R-C., Wen, X., Yang, X., Peng, G-H., Huan, T-F., 2001. Habitat use by wintering Ruddy Shelduck at Lashihai Lake, Lijiang, China. Waterbirds 24 (3), 402–406.

Safran, R.J., Colwell, M.A., Isola, C.R., Taft, O.E., 2000. Foraging site selection by nonbreeding White-faced Ibis. The Condor 102, 211–215.

Sonobe, K., Usui, S., 1993. A Field Guide to the Waterbirds of Asia. The Wildlife Society of Japan, Tokyo.

Spindler, M.A., Murphy, S.M., Kessel, B., 1981. Ground census of waterbird population in the Upper Tanana Valley. In: Miller, F.L., Gunn, A. (Eds.), Symp. On Census and Inventory Methods for Population and Habitats. Northwest Section of Wildlife Society, Banff.Alerta, pp. 133–148.

Terborgh, J., 1989. Where Have All the Birds Gone? Princeton University Press, Princeton, NJ.

UNEP, 1992. Saving Our Planet: Challenges and Hopes. United Nations Environment Programme, Nairobi, Kenya.

Verner, J., 1985. Assessment of counting techniques. In: Johnston, R.F. (Ed.), Current Ornithology. Plenum Press, New York, pp. 247–302.

Wen, X., Yang, L., Yang, X., 1995. Status of waterbirds in wetlands of Yunnan plateau, China. In: Chen, Y. (Ed.), Study of Wetlands in China. Jilin Science Technology Press, Chang Chun, pp. 248–255.

Yang, L., Wen, X., Han, L., Yang, X., Shi, W., Wang, S., 1995. The Avifauna of Yunnan China. Yunnan Science and Technology Press, Kunming.

Zhang, G. 1998. A study on the measures of wise use of wetlands in China In Wetlands International-China Programme (ed.) Wetland and Waterbirds Conservation: 52–55. Beijing: China Forestry Publishing House.

Zhao, K., 1995. The study of wetland's biodiversity and their sustainable utilization in China. In: Chen, Y. (Ed.), Study of Wetlands in China. Jilin Science Technology Press, Chang Chun, pp. 153–158.