Pakistan J. Zool., vol. 48(6), pp. 1825-1830, 2016.

Decline and Range Contraction of Black-Billed Capercaillie (*Tetrao urogalloides*) in Northeast China from 1950 to 2010 Based on Local Historical Documents

Yueheng Ren, Li Yang, Rui Zhang, Jiang Lv, Mujiao Huang and Xiaofeng Luan*
School of Nature Conservation, Beijing Forestry University, NO.35 Tsinghua East Road Haidian District, Beijing, P. R. China, Beijing, 100083, P. R. China,

Yueheng Ren, Li Yang, Rui Zhang contributed equally.

ABSTRACT

The black-billed capercaillie (*Tetrao urogalloides*) is a large capercaillie which is considered an endangered species that has undergone a dramatic decline throughout the late 20th century. This species is now rare or absent in Northeast China and needs immediate protection. Effective conservation and management could be hampered by insufficient understanding of the population decline and range contraction; however, any historical information, whilst being crucial, is rare. In this paper, we present local historical documents as one problem-solving resource for large-scale analysis of this endangered species in order to reveal the historical population trend in Northeast China from 1950 to 2010. Our results show that the population was widely distributed with a large population in Northeast China before the 1980s. Because of increasing habitat destruction in Northeast China since the 1970s, population numbers appeared to have significantly declined in eastern and southern Northeast China. Southeastern populations in the Changbai Mountains may have disappeared locally in the late 1990s. The population of the black-billed capercaillie appears to have suffered a decline of more than 50% (based on occurrence points) in the decade from 2000 in Northeast China compared to their distribution figures in the 1950s. The remaining population has become concentrated in the Greater Khingan Mountains and several nature reserves in the Lesser Khingan Mountains. We suggest that reforestation and national nature reserve management should be strengthened, and maybe a systematic conservation plan launched for the Greater Khingan Mountains population. More generally, our research demonstrates that recovering information from local historical documents can be a useful and reliable way to surpass the limits caused by lack of data.

Article Information
Received 21 August 2015
Revised 14 March 2016
Accepted 19 May 2016
Available online 25 September 2016

Authors' Contribution
YR, LY and XL conceived and designed the study. LY, YR, JL and MH were involved in data collection. YR, LY and RZ were involved in data processing. YR and RZ prepared distribution map. LY and YR analyzed the data. YR, LY and XL prepared Chinese manuscript. LY and RZ then translated it into English with the help of JL, MH, LY, YR and XL.

Key words
Black-billed Capercaillie, Historical distribution, Local historical documents, Population ecology.

INTRODUCTION

The black-billed capercaillie (*Tetrao urogalloides*) is a large forest-dependent species associated with conifer-dominated forests, and considered as an important species for boreal and montane forests (He *et al*., 2004; Mlikovsky, 2012; Suter *et al*., 2002; Yin *et al*., 2009; Zawadzki *et al*., 1999). *Tetrao urogalloides urogalloides* is one of three subspecies and is mainly distributed in Northeast Asia, and Northeast China is the southernmost distribution of this species (Andreev, 1991; Song, 1991; Gao, 1998; Zhu and Liu, 1989). In Northeast China, where the loss of woodland habitats has been experienced from the 1950s, the conservation status of the black-billed capercaillie has deteriorated significantly (Gao *et al*., 1982).

Knowledge of the distribution, including new data and historical information, is fundamental for effective conservation and management. Compared with the new data, historical information mainly coming from species programs or previous research is rare, especially for endangered species (Almeida *et al*., 2002; Khan *et al*., 2010; Moss *et al*., 2000; Vandel and Stahl, 2005; Zawadzki *et al*., 1999). However, historical information is an important complementarity for field investigation and is crucial to conservation assessment (Zohmann *et al*., 2014), predicting species distribution (Braunisch and Suchant, 2010; Guisan *et al*., 2013), and the in-situ and ex-situ conservation programs (Prigioni *et al*., 2007; Sands and Pope, 2010). In the case of the black-billed capercaillie, little information is available from publications. Such is the case for Heilongjiang Province from the 1980s (Song, 1991; Zhao, 1999, 2001), Jilin Province from the 1980s (Song, 1991). One dataset was collected in the Greater Khingan Mountains from 1963 to 1999 (1963, 1976-1979, 1980, 1983-1988 and 1996-1999) (Gao *et al*., 1982, 1988; He *et al*., 2004; Song, 1991; Zhao, 1999; Zhu and Liu, 1989) and another from 2004 to 2006 was collected in Northeast China (Yin *et al*., 2009). Such studies reveal the population status of the black-billed capercaillie in several places or at specific

* Corresponding author: luanxiaofeng@bjfu.edu.cn
0030-9923/2016/0006-1825 $ 8.00/0

times but fails to describe the historical trend since the 1950s. In light of this situation, data available on black-billed capercaillie distribution and population status in Northeast China was insufficient to meet the needs for their conservation assessment.

Due to data shortage, it is essential to find alternative and effective approaches to obtain the necessary historical data. Wildlife information in China may be dispersed in local historical documents. Local historical documents, also known as local gazetteers or difangzhi, includes: chronicles, annals, chorography and regional geographical publications containing objective information about local species (Looney, 2008; Turvey *et al.*, 2015). These documents collected their data from local field surveys, local archives, historical documents and market records. Such records could be considered as hard facts or as long-term monitoring for conservation programs. In this paper, we present local historical documents as a problem-solving resource for the large-scale analysis of endangered species. We then applied historical records within a geographic information system (GIS) and addressed the following questions related to historical trends for the black-billed capercaillie in Northeast China.

MATERIALS AND METHODS

Area

Our study area (Fig 1A) comprises the Heilongjiang Province, Jilin Province and the northeast of Inner Mongolia covered by temperate forest and boreal forest (N40°5′~53°17′, E115°30′~135°06′, about 938000 km^2). The climate is a continental monsoon climate with a negative water balance. The annual precipitation is 400-1000mm, and the annual average temperature is 1-4°C, with the north - south temperature gradient of 25°C. Coniferous forest is mainly located in the Greater Khingan Mountains and is characterized by *Larix gmelinii*. The area of broad-leaved mixed forest encompasses the Lesser Khingan Mountains, Changbai Mountains and Wanda Mountains dominated by *Larix gmelinii*, *Pinus koraiensis*, *Quercus mongolica*, *Tilia amurensis* and *Betula platyphylla* (Cheng and Yan, 2008). Forest ecosystems in Northeast China support a number of forest-dependent species, for example, the black-billed capercaillie and its potential predators -- red fox (*Vulpes vulpes*), sable (*Martes zebellina*), and goshawk (*Accipiter gentilis*).

Data collection

We obtained historical records on the black-billed capercaillie in the following five ways:

1. Fauna: Records came from 10 faunal records (Appendix 2).
2. Nature reserve scientific surveys: The relevant data was collected from the National Nature Reserve survey reports conducted in Northeast China (D. Li, personal communication; X. Luan, personally collected) (Appendix 2).
3. Databases: The keyword “black-billed capercaillie”, “*Tetrao urogalloides*” and “*Tetrao parvirostris*” (Mlikovsky, 2012) were used to search several online databases such as the China National Knowledge Internet, Wanfang Database, Duxiu Search Engine, Google scholar and Biodiversity Heritage Library (http://www.biodiversitylibrary.org/).
4. Bird records: Reliable records with photographs were collected from the “China Bird Report” (http://birdtalker.net/report/ index.asp).
5. Local historical documents: Local gazetteers or difangzhi, including: chronicles, annals, regional geography and chorography were obtained from the National Library of China and the Wanfang database. Relevant information was found using the search terms black-billed capercaillie, *Tetrao urogalloides* and *Tetrao parvirostris* (Appendix 1).

Data analysis

Historical records were sifted for further analysis because they may contains potential errors or uncertainty. Records from four data sources (1-4 mentioned in “Data” above) were integrated into a dataset with brief information on the area of occupancy and then this is compared with the gazetteer records. Records that conflicted with the dataset without any hard facts, including relevant or detailed description, were excluded from analysis.

Maps of Northeast China (1:1,000,000) were acquired from the National Geographic Information Bureau, and spatial coordinates of all observation records were assigned using Google Earth and the determination of place names was made using the Global Gazetteer version 2.2. Multiple occurrences at matching sites, such as repetitions of the same record or when the distance between locations was less than 5 km were excluded. Valid records were assigned with coordinates from public resources such as Google Earth v 7.1.2 and classified into different decades (1950s-1970s, 1980s, 1990s and 2000s).

Black-billed capercaillie occurrence positions were then uploaded into ArcGIS 10.2, and overlaid with layers representing vegetation, the borders of administrative regions and nature reserves (Hou, 2001). Through the analysis of the distribution, number and intensity of record points, it was possible to evaluate the changing trend in different decades of the black-billed capercaillie

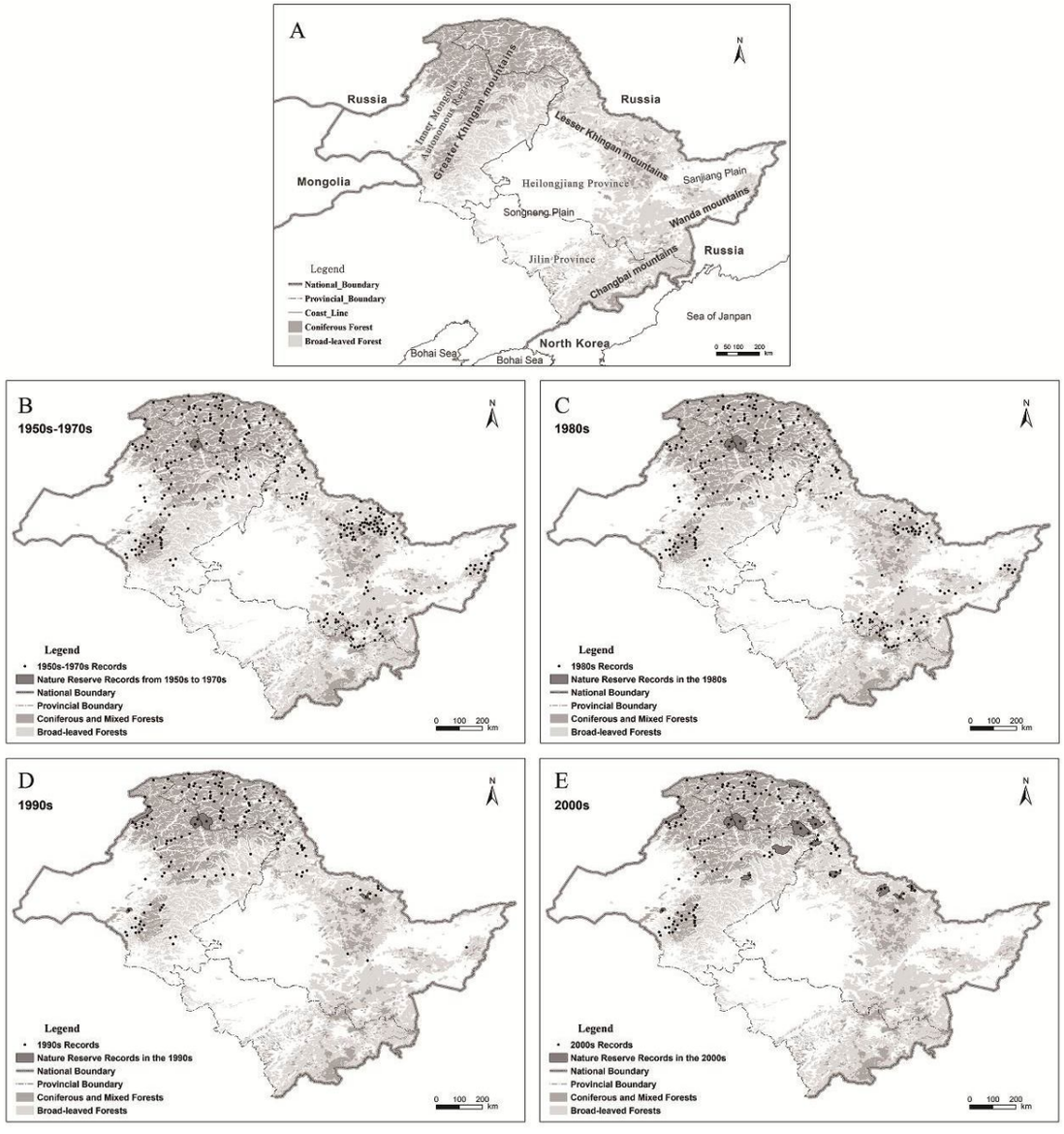

Fig. 1. The distribution of black-billed capercaillie in Northeast China (A) in the 1950s -1970s (B), 1980s (C), 1990s (D), and 2000s (E).

population and its distribution to finally assess its conservation status.

RESULTS

Data collection

A total of 76 documents of the 2235 examined presented information on black-billed capercaillie. These provided evidence regarding 296 black-billed capercaillie records, while another 62 black-billed capercaillie records were retrieved from the other four sources (as mentioned in the data sources section, giving a total of 358 black-billed capercaillie records). Some records were excluded (as mentioned in the methods section) and finally 319 black-billed capercaillie records were mapped and used for further analysis (Table I).

Table I.- Data resource in different period.

Data resource	1950s-1970s	1980s	1990s	2000s
Fauna	8	8	0	0
Manuscript (scientific research)	15	15	102	133
Nature reserve scientific surveys	0	2	18	24
Bird records	0	0	0	4
Local historical document	296	248	66	0
Exclude records (repeat records)	0	2	8	12
Total	319	271	178	149

Local historical documents were an important resource before the 1990s. Historical documents accounted for 92.8% and 91.5% of observation records from the 1950s - 1970s and 1980s, respectively. With the improvement in the level of scientific research, conservation and management, several programs and surveys were launched in the 1990s. Over the 1990s and 2000s, scientific research becomes a much more important source to obtain distribution data; 53.4% and 81.9% of the observation records came from scientific research manuscripts in the 1990s and 2000s, respectively.

Historical population trend

Historically black-billed capercaillie were widely distributed and presented abundant populations throughout the mountains of Northeast China. Before 1980, the black-billed capercaillie occurrence points didn't present obvious change (Fig. 1B), but there was a considerable reduction in southern and eastern areas from the 1980s, especially in the Lesser Khingan Mountains where forest cover was subject to a severe decline from the 1950s. Compared with the distribution in the 1950s, there was a reduction of almost 14% of observation records in the 1980s (Fig. 1C). From the 1980s onwards black-billed capercaillie became limited to the core area of the Greater Khingan Mountains, Lesser Khingan Mountains, Wanda Mountains and Changbai Mountains. After the 1980s, the observation records became rare in spite of the additional data available from provincial and nature reserve surveys (School of Nature Conservation, Beijing Forestry University, unpublished data). The situation deteriorated in the 1990s: zero occurrences in the records in the Changbai mountains and Wanda Mountains, and a decline of about 66% in the observation records in the Lesser Khingan Mountains. In the 1990s, there was a significant reduction of nearly 44% over all observation records compared with the distribution records from the 1950s (Fig. 1D). The distribution became concentrated in the Greater Khingan Mountains in the 2000s. In the 2000s, there appears to have been a decline in the observation records of about 53% compared with the distribution in the 1950s (Fig. 1E).

The national nature reserve records emphasized that national nature reserves are vital to the black-billed capercaillie conservation. There were two national nature reserves recording black-billed capercaillie with a total area of 1254.48km^2 in the 1970s. In the 1980s there were three national nature reserves located in the Greater Khingan Mountains and Lesser Khingan Mountains, protecting about 2929.61 km^2. Without the protection of national nature reserves, distribution in the Changbai Mountains and Wanda Mountains showed a considerable reduction. Compared with the 1980s, the protected area in the black-billed capercaillie distribution has increased by 64% in the 1990s and by 459% in the 2000s respectively. Nature reserves were required to produce records in the 2000s, for example the records kept by the nature reserve in the Lesser Khingan Mountains. Furthermore, nature reserves have maintained this species population in the nature reserve and surrounding area, even though there has occurred a dramatic decrease in the population throughout Northeast China from the 1970s to 1990s.

DISCUSSION

Effective data collection

Generally, biodiversity-oriented regional management was hampered by data shortage, but problems abounded in data collection. In this paper we suggest that local historical documents (called local gazetteers or difangzhi) can lessen the restrictions found in historical data from previous research, such as accessibility, spatially and temporally variable and non-standardized sampling (Turvey *et al*., 2015). Because local historical documents follow a specific scientific natural history tradition, it makes it easy to identify the species records. In addition, compilation of local historical documents is systematic and provides a geographical coverage across most of China, therefore, local historical documents have the potential to add valuable information that could lengthen and extend research which otherwise would not be possible if this valuable source of information was discounted. Therefore, it could be considered as a key factor to ensure that the data are sufficient. The black-billed capercaillie, for example, has only 3 effective records from faunal reports and only 14 records from scientific research for rare species distribution. In contrast with the above methods, 160 data points were extracted from 76 local historical documents. The numbers of effective records from local historical documents were considerable from

the 1950s to 1990s (Table I). Such an approach would be useful to provide greater opportunities for conservationists and environmental planners to improve the system conservation planning.

Threat and regional extinction

Habitat destruction is considered a significant threat to the black-billed capercaillie population (He *et al*., 2004; Song, 1991; Yin *et al*., 2009). As a coniferous forest-dependent species associated with the climax community, the black-billed capercaillie is sensitive to the reduction of coniferous forest and mixed broadleaf-conifer forest (Andreev, 1991; Gao *et al*., 1982; Yin *et al*., 2009). Therefore, deforestation that has occurred throughout Northeast China since the 1950s would lead to the distribution shrinking. For example, *Larix gmelinii* and Betula forest is vital to the black-billed capercaillie in the Greater Khingan Mountains (Song, 1991). *Larix gmelinii* forest stock decreased by 34.5% between 1950 and 1982 in the Greater Khingan Mountains, especially in 1970s (1965 vs. 1976, -40%); Betula forest stock decreased by 59.4% between 1950 and 1982 in the Greater Khingan mountains, especially in 1970s (1965 vs. 1976, -49%) (Wu, 1994). In addition, hunting would be another important threat to black-billed capercaillie. For instance, a hunting group killed 53 black-billed capercaillie during March to April in the 1980s in the Greater Khingan Mountains (Song, 1991).

The disappearance of the black-billed capercaillie population in the Changbai and Wanda Mountains draws our attention. Only the map quoted by Song (1991) shows that black-billed capercaillie are distributed in the Changbai Mountains. According to the field surveys in 1979-1984 and 1987-1990, Song (1991) neither mentions the distribution nor claims its extinction in the Changbai Mountains and no record was found from the nature reserve scientific surveys, birding and fauna records in Changbai Mountains after 1980 (X. Luan, personal collection; Zhao, 1985). However, we suggest that this species existed in Changbai Mountains in the early 1980s, but was restricted to the Northeastern Changbai Mountains in the late 1980s and after that, the population may have disappeared from the area by the late 1990s. Regional extinction may be the response to deforestation: about 90% of virgin forest has been lost in the period from1949 to 1985 in the Changbai Mountains (Zhang, 2000); consumption of timber was two times higher than the increment of the natural forest between the 1970s and the 1980s in some forestry farms, such as Linkou (Jiang *et al*., 2000).

Conservation

Large-scale reforestation, banning deforestation and hunting have taken place in Northeast China since the late 1980s, especially in national nature reserves. Along with the investment policy to wildlife conservation and nature reserves, 17 national nature reserves located in the black-billed capercaillie distribution were created in 2015 (protecting about 16680 km^2). In this case, habitat restoration may have led to the population increasing between 1999 and 2006 on the eastern slopes of the Greater Khingan Mountains (Yin *et al*., 2009). However, deforestation and anthropogenic impact still exists in Northeast China, which may have led to the population decreasing by 30% on the western slopes in the same time (Yin *et al*., 2009). Therefore, in conclusion we suggest that: (1) field surveys should be launched in the center and southwestern Greater Khingan Mountains in order to reveal the conservation status of black-billed capercaillie; (2) conservation strategies should be applied and strengthened in the main distribution areas, according to the field surveys; (3) systemic conservation planning for black-billed capercaillie should be taken in Northeast China, and this will simultaneously benefit other species in the same community.

CONCLUSIONS

According to the historical data, the range of black-billed capercaillie in Northeast China contracted since the 1950s, and the population in Wanda Mountains and Changbai Mountains may disappeared in 1990s. We suggest that local historical documents can be an effective source to reveal species distribution changes with large time scale.

ACKNOWLEDGMENTS

We thank S. Wu (South China Normal University, School of Life Science) and D. Li (Chinese Academy of Forestry) for providing valuable advice. We are grateful to X. Rong, F. Luo (both from Beijing Forestry University, School of Nature Conservation), P. Shi (Detao Shanghai Centre), and M. Shahid (College of Veterinary Medicines, China Agriculture University) for reviewing and editing earlier versions of this manuscript. We are also grateful to G. Pearce for revising the final version of this manuscript.

Funding statement

This study was supported by a grant from Ministry of Science and Technology of the People's Republic of China (Research and application of key techniques on endangered species conservation and prediction of forest fire and pests in response to climate change, 2013BAC09B00), Zhejiang Dapanshan National Nature

Reserve (Intelligent management system based on 3S for nature reserve, contract NO.: 2014-HXFUBHQ-LXF-003), and Beijing Songshan National Nature Reserve (Forest management plan in Beijing Songshan National Nature Reserve, contract NO.: 2014-HXFUBHQ-LXF-002).

Statement of conflict of interest

Authors have declared no conflict of interest.

REFERENCES

Almeida, D., Copp, G.H., Masson, L., Miranda, R., Murai, M. and Sayer, C.D., 2012. Changes in the diet of a recovering Eurasian otter population between the 1970s and 2010. *Aquat. Conserv. Mar. Freshw. Ecosyst.*, **22**: 26–35.

Andreev, A.V., 1991. Winter habitat segregation in the sexually dimorphic Black-Billed Capercaillie *Tetrao urogalloides*. *Orins Scand.*, **22**: 287–291.

Braunisch, V. and Suchant, R., 2010. Predicting species distributions based on incomplete survey data: the trade-off between precision and scale. *Ecography*, **33**: 826–840.

Cheng, X. and Yan, X., 2008. Effects of climate change on typical forest in the northeast of China. *Acta Ecol. Sin.*, **28**: 0534–0543.

Gao, W., 1998. *Tetrao parvirostris. In: China red data book of endangered animals* (ed. S. Wang), Science Press, Beijing.

Gao, W., Xiang, G., Zhang, Song, F.Y. and Gao, Z., 1988. The Breeding Habitat of Black–Billed Capercaillie. *Acta zool. Sin.*, **34**: 194–195.

Gao, Z., Liu, G. and Zhao, Y., 1982. Ecology of *Tetrao parvirostris*. *Chinese Wlidl.*, **3**: 29–32.

Guisan, A., Tingley, R., Baumgartner, J.B., Naujokaitis-Lewis, I., Sutcliffe, P.R. and Tulloch, A.I., 2013. Predicting species distributions for conservation decisions. *Ecol. Let.*, **16**: 1424-1435.

He, F., Wan, J., Tian, J. and Ge, D., 2004. Tetraonidae in Greater Khingan Mountains. *Forest By–product Special China*, **5**: 42–43.

Hou, X., 2001. *Vegetation atlas of China*, Science Press, Beijing.

Jiang, C., Wang, H., Zhu, X. and Xu, G., 2000. *Linkou Forestry Bureau Chorography (1925-1998)*. Linkou Forestry Bureau, Linkou.

Khan, W. A., Qasim, M., Ahmad, E., Chaudhry, A.A., Bhaagat, H. B. and Akhtar, M., 2010. Status of smooth coated otter (*Lutrogale perspicillata sindica*) in Pakistan. *Pakistan J. Zool.*, **42**: 817-824.

Looney, K.E., 2008. Village Gazetteers: A new source in the China field. *China J.*, **60**: 135–147.

Milkovsky, J., 2012. The correct name for the Siberian Black–billed Capercaillie is *Tetrao urogalloides* (Aves: Tetraonidae). *Zootaxa*, **3452**: 66–68.

Moss, R., Picozzi, N., Summers, R.W. and Baines, D., 2000. Capercaillie *Tetrao urogallus* in Scotland –demography of a declining population. *Ibis*, **142**: 259–267.

Prigioni, C., Balestrieri, A. and Remonti, L., 2007. Decline and recovery in otter *Lutra lutra* populations in Italy. *Mammal Rev.*, **37**: 71–79.

Sands, J.P. and Pope, M.D., 2010. A survey of galliform monitoring programs and methods in the United States and Canada. *Wildl. Biol.*, **16**: 342–356.

Song, Y., 1991. *Tetrao parvirostris (Bonaparte). In: Rare and endangered Gallinacean in China* (ed. T. Lu). Fujian Science & Technology Publish House, Fuzhou.

Suter, W., Graf, R.F. and Hess, R., 2002. Capercaillie (*Tetrao urogallus*) and avian biodiversity: Testing the key–species concept. *Conserv. Biol.*, **16**: 778–788.

Turvey, S.T., Crees, J.J. and Di Fonzo, M.M.I., 2015. Historical data as a baseline for conservation: reconstructing long-term faunal extinction dynamics in late imperial–modern China. *Proc. R. Soc.*, **282**: 1–9.

Vandel, J.M. and Stahl, P., 2005. Distribution trend of the Eurasian lynx *Lynx lynx* populations in France. *Mammalia*, **69**: 145–158.

Wu, C., 1994. *Forestry in the greater Khingan mountains*. Huangshan Publishing House, Hefei.

Yin, Y., Ge, D., Guan, X., Sun, H. and Li, Z., 2009. Population and habitat status of black–billed capercaillie in the Northeast of China. *Territ. Nat. Resour. Stud.*, **2**: 90–91.

Zawadzki, J., Sudnik, W. and Zawadzka, D., 1999. Changes in distribution and numbers of capercaillie, *Tetrao urogallus* L., in the Puszcza Augustowska forest and a proposal for an active protection of the species. *Sylwan*, **143**: 69–78.

Zhang, P., 2000. *Special topic discussion on natural forest protection program—Northern China.* Forestry Publishing House, Beijing.

Zhao, Z., 1985. *The avifauna of Changbai mountain.* Jilin Science & Technology Press, Changchun.

Zhao, Z., 1999. *Tetrao parvirostris*. In: *Zoography of rare and endangered species in Northeast China* (ed. Z. Zhao). China Forestry Publishing House, Beijing.

Zhao, Z., 2001. *A handbook of the birds of China – Volume I: Non–passerines*, Jilin Science and Technology Press, Changchun.

Zhu, Z. and Liu, H., 1989. *Ecology of Tetraonidae.* In: *Wildlife in greater Khingan mountains* (ed. Y. Ma). Northeast Forestry University Press, Harbin.

Zohmann, M., Immitzer, M., Wöss, M., Gossow, H. and Nopp-Mayr, U., 2014. Modelling habitat use of *Tetrao urogallus* L. in Austria for conservation issues. *J. Nature Conserv.*, **22**: 223–234.