

First photographic record of endemic brown eared-pheasant *Crossoptilon mantchuricum* by camera-trapping at Jinguashan-Henglingzi Hemaji Nature Reserve, China

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ABSTRACT

We deployed passive camera-traps at Hebei Jinguashan-Henglingzi Hemaji Nature Reserve (JHNR), Hebei Province, China for 18 months during 2013-2014 to survey cryptic wildlife species. Over the 18-month period from March 2013 through December 2014, 799 camera-trap-days were recorded, yielding a total of 198 photographs of wild fauna (25 wildlife photographs per 100 trap-days). In total, 15 wildlife species were photographed, five mammals and ten birds. The most frequently photographed mammal species were wild boar (*Sus scrofa*), roe deer (*Capreolus pygargus*), and leopard cat (*Prionailurus bengalensis*, China Red List Vulnerable, CITES App. I). Most frequently photographed birds were large-billed crow (*Corvus macrorhynchus*) and blue whistling thrush (*Myophonus caeruleus*). Leopard cat was the only recorded representative of the Felidae. Domestic goat was photographed once. Infrequent injuries to goats were attributed by villagers to attacks by Leopard (*Panthera pardus*), a species not recorded by camera-traps. A notable record was the first photograph at JHNR of the endemic brown eared-pheasant *Crossoptilon mantchuricum*. Brown eared-pheasant is classified by IUCN Red List as globally Vulnerable, is listed in Appendix I of CITES, is classified as Vulnerable by China's Red List, is protected in China at National Level I, and is one of four species of eared-pheasant in China, three of which, including brown eared-pheasant, are endemic to China.

Keywords: brown eared-pheasant, China, camera-trap, Taihang Mountains

INTRODUCTION

Presence of brown eared-pheasant (*Crossoptilon mantchuricum*) at Hebei Jinguashan-Henglingzi Hemaji Nature Reserve (JHNR) was one factor in support of gazettal of the 33,940 ha nature reserve in 2003 (Fig. 1). Brown eared-pheasant was classified in 2013 by the IUCN Red List of globally threatened species as Vulnerable (IUCN 2016), meaning that the species is “facing a high risk of extinction in the wild in the medium-term future” (IUCN 2012). Presence of brown eared-pheasant also justified inclusion of JHNR in the “Integrated Ecosystem Restoration and Biodiversity Conservation of the Baiyangdian Catchment” project jointly supported by Asian Development Bank (ADB) and the Global Environment Facility (GEF) of the World Bank. This project was implemented by ADB beginning in 2010 and was completed in 2017. The ADB-GEF project called for establishment of a long-term biodiversity monitoring program at JHNR, of which camera-trapping was one component and was intended to monitor presence of cryptic species.

Camera-trap monitoring is useful for biodiversity survey because it is often effective at recording the presence of cryptic species (Carbone et al 2001). Installing camera-traps at sites used by wildlife can lead to development of detailed databases documenting species presence, frequencies, and numbers over long periods of time (*ibid.*). The advent of digital photography and

advances in battery and data storage technologies have enabled operation of camera-traps during daylight and dark for periods longer than six months without need for disturbance by researchers. This increases the probability that cryptic species are detected by camera-traps compared to their probability of detection by conventional observation surveys (*ibid.*).

Camera-traps have widely been used in protected areas in China to confirm presence or absence of species and/or for biodiversity survey. Presence of phasianids in China's protected areas was reported from camera-trap studies by Mingxia Zhang *et al* (2014), Zhishu Xiao *et al* (2014), Dahmer *et al* (2014), Wenhua Xie *et al* (2014), Tancheng Dong *et al* (2014), Guohai Wang *et al* (2014), Lijia Wen *et al* (2014), Yuanchao Liu *et al* (2014), Zhishu Xiao *et al* (2014), Fang Liu *et al* (2014), Wenliang Zhou *et al* (2014), and Jianpu Wu *et al* (2016). Although camera-trap survey coverage of China's nature reserves is increasing, China's northern Taihang mountain range, the location of JHNR, had not been surveyed for mammal or bird biodiversity by camera-trapping.

Our objectives in this study were: (i) to establish a long-term monitoring program at JHNR for cryptic species; (ii) to more completely document bird and mammal biodiversity at JHNR; and (iii) to photographically document the presence of brown eared-pheasant at JHNR. Based on the widely reported successful use of camera-trapping in China and the absence of camera-

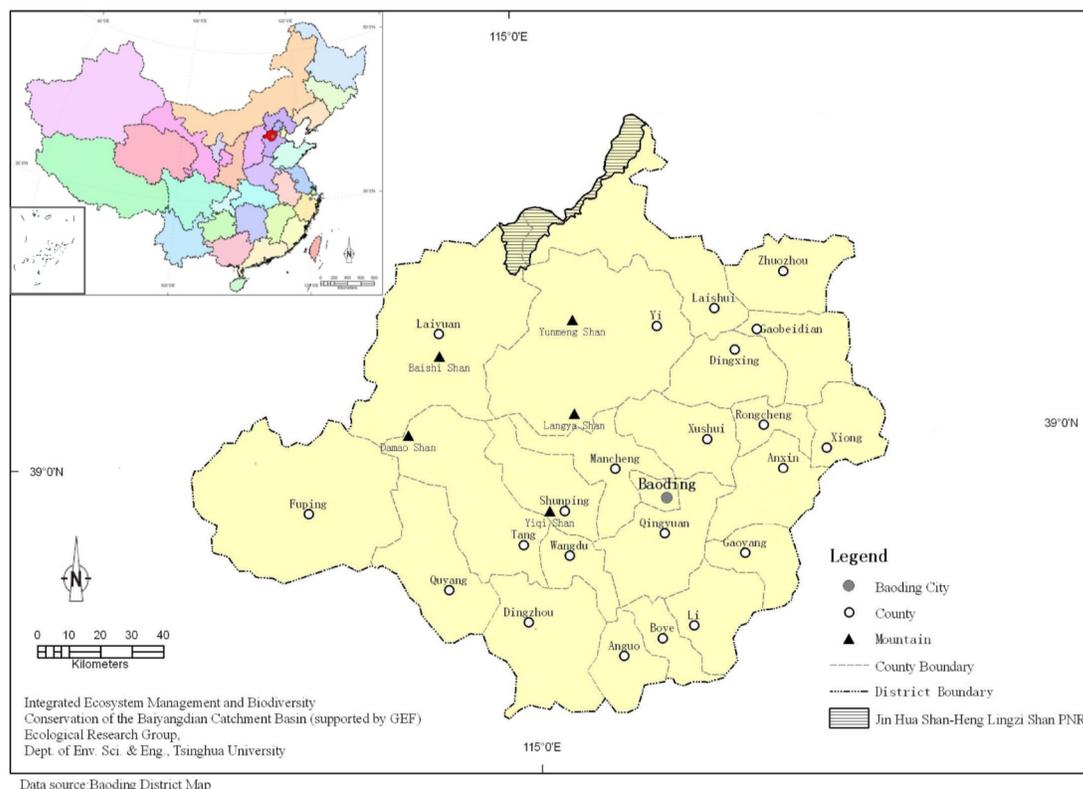


Figure 1. Location of Hebei Jinhua Shan-Henglingzi Hemaji Nature Reserve in Baoding municipality, Hebei Province

trap data for JHNR, we selected camera-trapping as the primary technology for monitoring species presence of mammals and pheasants. JHNR personnel installed and monitored camera-traps at three locations in JHNR over an 18-month period covering March-September 2013 and January-December 2014. We report here the results of the camera-trap surveys through December 2014.

MATERIALS AND METHODS

Study Area

JHNR, the study area, is located in central Hebei province at 39.74°N and 115.28°E (Fig. 1) in the Palearctic terrestrial biome. The nature reserve covers 33,940 ha of rugged terrain at elevations of 400-1,711 masl. The highest elevation in the reserve is 1,711 masl at Jinhua Shan peak. JHNR is located within Laishui and Laiyuan counties in northeastern Baoding municipality of Hebei province. JHNR lies at the western edge of the Baiyangdian Lake catchment, which covers 31,500 km² on the north China plain and drains to the Bohai Sea.

The nearby Laishui County seat has a continental, monsoon-influenced, semi-arid climate characterised by hot, humid summers due to the East Asian monsoon, and generally cold, windy, dry winters. Annual precipitation averages 487 mm and about 60% of it falls as rain during June-August. Rainfall is variable and unreliable. The monthly 24-hour average temperature ranges from -3.2 °C in January to 26.8 °C in July, with an annual mean of 13 °C. There are 2,853 hours of sunshine annually, and the frost-free period lasts 217 days.

The dominant mountain range is the Taihang range, which was identified as a biodiversity conservation priority for Hebei province by Wang Hongmei *et al* (2007). JHNR vegetation has not been well studied even though the reserve lies at the northern end of this biodiverse region. JHNR is reported to support 696 species of higher plants (JHNR 2016). Suriguga *et al* (2010, in Zhang *et al* 2013) recognized six vegetation types in the Taihang range, *viz.* warm-temperate broad-leaved deciduous forest, warm-temperate coniferous forest, cold-temperate coniferous forest, warm-temperate broadleaved deciduous shrubland, cold mountain shrubland, and mountain meadow. Vegetation in the adjacent Baihuashan National Nature Reserve was categorized into twelve plant communities by Zhang *et al* (2013, Table 1). Eight of these correspond to vegetation communities at JHNR where elevations are lower. Zhang *et al* (*ibid.*) noted that most of these communities “consisted of secondary vegetation, following destruction of the original warm-temperate broad-leaved deciduous forests and cold-temperate coniferous forests (Xiang 2009), with some plantations in the 1950s (He *et al* 1992)”. The forests at JHNR were also subject to excessive harvest during previous decades and now are also recovering secondary forests.

JHNR secondary forests have increased in area in recent decades due in part to natural recovery during the post-1998 era of the National Forest Protection Program, a nation-wide logging ban in natural forests. JHNR includes parts of two state forest farms, Sangyuanjian and Zhaogezhuang. Plantation technologies

Table 1. Vegetation communities below 1800 masl at Baihuashan National Nature Reserve, which lies adjacent to JHNR on the north (adapted from Zhang et al 2013).

<i>Quercus wutaishanica</i> . A secondary forest community at 1350-1700 m in hills on shady, semi-shady, or semi-sunny slopes of 25–40° and brown forest soil
<i>Populus davidiana</i> + <i>Larix principis-rupprechtii</i> . A mixed community of secondary and planted forest at 1250-1600 m on hills with shady, semi-shady, or semi-sunny slopes of 20–40° and brown forest soil
<i>Pinus tabuliformis</i> . A planted forest community at 1200-1400 m on hills with sunny or semi-sunny slopes of 20–25° and brown forest soil
<i>Juglans mandshurica</i> . A mixed community of secondary and planted forest at 1250-1400 m on hills with sunny or semi-sunny slopes of around 20–25° and brown forest soil
<i>Hippophae rhamnoides</i> + <i>Spiraea trilobata</i> . A secondary shrubland community at 1100-1200 m on hills with semi-sunny slopes of 10–20° and brown or mountain cinnamon soil
<i>Prunus armeniaca</i> . A secondary shrubland community distributed from 900 to 1150 m on hills with semi-sunny slopes of 10–35° and mountain cinnamon soil
<i>Vitex negundo</i> var. <i>heterophylla</i> . A secondary shrubland community distributed from 750 to 900 m on hills with sunny or semi-sunny slopes of around 20–35° and mountain cinnamon or cinnamon soil
<i>Carex lanceolata</i> + <i>Sanguisorba officinalis</i> + <i>Polygonum viviparum</i> . A mountain meadow community distributed around 1800 m on hills with sunny or semi-sunny slopes of 10° and mountain meadow soil

developed at these farms have been applied to reforestation of deforested sites in the nature reserve. This complied with Hebei province government directives to close forests to logging and to re-plant deforested lands (HPG 2004).

Although livestock grazing is not permitted in nature reserves in China (Article 26, Regulations of P.R.China on Nature Reserves, 1 December 1994), some goat producers occupied and grazed their goats on lands that were only recently gazetted as JHNR. Goat production declined during the last 10 years in JHNR and on state forest farm lands within and adjacent to JHNR (Liu Xiugang, Manager, Zhaogezhuang State Forest Farm, pers. comm., June 2016).

JHNR is reported to support 32 species of mammals and 102 birds (JHNR 2016). One mammal (leopard *Panthera pardus*) and four birds (brown eared-pheasant, black stork *Ciconia nigra*, and golden *Aquila chrysaetos* and imperial *A. heliaca* eagles) are first-class protected species in China. As of this writing JHNR supported populations of three globally threatened animal species, Chinese (or grey) goral *Naemorhedus griseus*, brown eared-pheasant *Crossoptilon mantchuricum*, and grey-sided thrush *Turdus feae*, all designated as Vulnerable in the Red List of Threatened Species (IUCN 2016).

The nature reserve was home to around 6,700 persons living in 12 villages in 2016, a substantial reduction from over 19,000 residents in 34 villages in 2003 at the time of gazettal. The reduction resulted from realignment of the reserve boundary and voluntary abandonment of some properties. To regulate human use the reserve is zoned into core (11,850 ha or 34.9%), buffer (11,290 ha or 33.3%), and experimental (10,800 ha or 31.8%) zones.

Camera-trapping

JHNR deployed camera-traps beginning in 2013 to survey the presence of cryptic bird and mammal species,

and to photographically document the presence of brown eared-pheasant, the species for which the nature reserve was established. All camera-traps were passive units from Scoutgard® (Queensland, AU). Two camera-traps were deployed in the western core zone (Figure 2) of JHNR at Qizhongkou in April 2013 but only one trap functioned and accounted for 145 camera-trap days. Two camera-traps were deployed in the eastern core zone (Fig. 2) at Lingnantai at end-October 2013 through end-March 2014, accounting for 298 camera-trap days in total. Two camera-traps were deployed in the western core zone at Nankuan at end-June 2014 through end-December 2014, accounting for 356 camera-trap days. This resulted in a total survey effort of 799 camera trap-days.

Camera-traps were installed in ravines, preferably those with open water in small streams or pools. The core zones were selected for sampling because they supported fewer villagers and livestock than did other zones. The Jinhuaashan or eastern core zone also abutted the neighboring Xiaowutaishan (in Hebei province) and Baihuashan (in Beijing municipality) National Nature Reserves, which buffer JHNR from human activities to the west and north, respectively (Figure 2).

Batteries were replaced and digital images were periodically downloaded by authors LZM and DK. Cameras were set to imprint both date and time on each photograph and no delay was set between photographs. An Excel® database was developed in June 2016 to record the camera-trapping results by photograph.

A camera trap-day was defined as a sensor-camera unit that functioned without failure for a 24-hour period. The number of active camera trap-days prior to failure of a unit (generally due to battery failure or ice/water damage) was calculated by counting days from deployment or last service to the date of the last photograph.

Mammal identification and taxonomy in this report follow Smith and Xie (2008). Bird identification and taxonomy follow MacKinnon and Phillipps (2000).

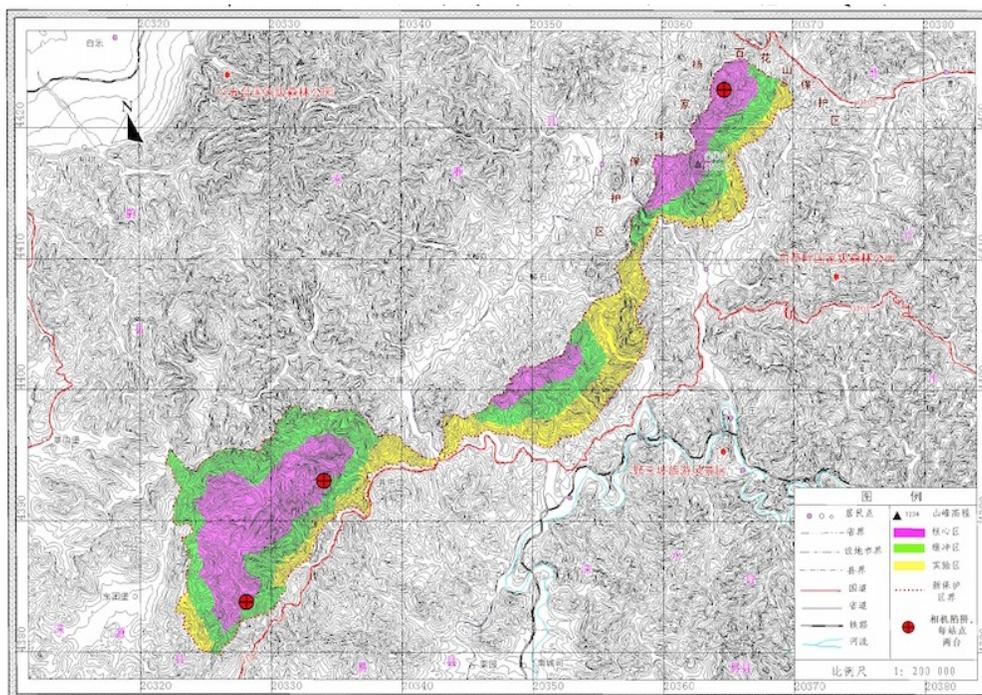


Figure 2. Management zones and camera-trap locations in Hebei Jinhua Mountain-Henglingzi Hemaji Nature Reserve (red dot with cross indicates camera-trap site; yellow shading = experimental zone; green = buffer zone; pink = core zone)

Table 2. Photographed species at Jinhua Mountain-Henglingzi Hemaji Nature Reserve from March 2013 through December 2014

Species		Number of Photos	China IUCN Red List Status*	IUCN Red List Status**
large-billed crow	<i>Corvus macrorhynchus</i>	77		
wild boar	<i>Sus scrofa</i>	54		
blue whistling-thrush	<i>Myophonus caeruleus</i>	26		
red-billed blue magpie	<i>Urocissa erythrorhyncha</i>	14		
unidentified squirrel	<i>Callosciurus</i> sp.	6		
leopard cat	<i>Prionailurus bengalensis</i>	4		LC
roe deer	<i>Capreolus pygargus</i>	3		LC
Koklass pheasant	<i>Pucrasia macrolopha</i>	3	II	LC
hog badger	<i>Arctonyx collaris</i>	3		NT
grey-headed woodpecker	<i>Picus canus</i>	2		
domestic goat	<i>Capra aegagrus hircus</i>	1		
brown eared-pheasant	<i>Crossoptilon mantchuricum</i>	1	I	V
tawny Owl***	<i>Strix aluco</i>	1	II	LC
Oriental turtle dove	<i>Streptopelia orientalis</i>	1		
spangled drongo	<i>Dicrurus hottentotus</i>	1		
Eurasian sparrowhawk	<i>Accipiter nisus</i>	1		LC

*I = First-Class National Protection; II = Second-Class National Protection, List of endangered and protected species of China

**V = Vulnerable; NT = Near Threatened; LC = Least Concern

***Species not previously reported at JHNR; Tawny Owl identification to be confirmed

RESULTS

Photography

Over the 18-month period from 23 April 2013 through 20 December 2014 the sampling effort totaled 799 trap-days. This yielded 198 photographs of wildlife (Table 2) or 25 photographs per 100 trap-days. This compares favorably to the 17 photographs of wildlife per 100 trap-days reported by Dahmer *et al* (2014) over 8,307 trap-days and 9 reported by Tilson *et al* (2004) over 123 trap-days. In total, 15 wildlife species were photographed, all but one of which was reported earlier by Baoding Municipality *et al* (2003).



Figure 3. Brown eared-pheasant photographed by camera-trap near Nankuan village in southwestern JHNR on 13 Dec 2014 at 15:49 hrs.

Three photographed species are listed as nationally protected in China, brown eared-pheasant at Level I, and Koklass pheasant and tawny owl at Level II. One photographed species, brown eared-pheasant, is listed as globally Vulnerable in the IUCN Red List of Threatened Species (IUCN 2016) and by China's Red List of Protected Species (Fig. 3). Two of these three species are seldom recorded at JHNR because of low population numbers and cryptic behavior (pheasants) or low population numbers and nocturnal lifestyle (tawny owl).

Because camera-traps were placed near water sources in otherwise dry forest habitats, the frequency of photographs of wildlife was higher than might be expected in areas lacking water. In addition, birds not only drank from but also bathed in open pools or small streams, increasing the frequency of repeat photographs from a visit by single individual. The four most frequently photographed species were often recorded in more than one photograph during a given visit. Large-billed crow, wild boar, and red-billed blue magpie often visited the trap sites in groups.

Anecdotal Evidence of Carnivore Presence

Villagers infrequently reported injury to domestic goats that grazed in the nature reserve. Villagers attributed

these injuries to attacks by leopard. Presence of leopard was not confirmed by camera-trapping, by anyone working in forest or wildlife administration during the course of this study, or by others during the most recent decade. The nearest verified occurrence of leopard in recent years was reported by Song Dazhao *et al* (2014). They reported results of a multi-year camera-trap study of a population of 14 leopards in forests of Shanxi province, some 330 km SSW of JHNR.

DISCUSSION

Initial efforts at camera-trapping at JHNR yielded high numbers of wildlife photographs per 100 trap-days in spite of this being the first effort at camera-trapping at JHNR. This probably resulted from camera-trap installation near water sources on an otherwise xeric shrub-woodland landscape.

One photographed and tentatively identified species was new to the species list for the nature reserve (tawny owl *Strix aluco*). Because the single photograph was of poor quality (night photo, black & white, poor exposure), additional evidence is required before identification can be confirmed, possibly by aural survey at night.

While visual records of brown eared-pheasant at JHNR have been reported and Zhang (2006) earlier confirmed the presence of brown eared-pheasant at JHNR, the first known photographic record was made during this study. The brown eared-pheasant population at JHNR is said by livestock grazers, state forest farm workers, and nature reserve personnel to be increasing. Given the declines in populations of humans and domestic goats in the reserve, and the progressive recovery of forest habitats at elevations above 1000 masl, reported increases in numbers of brown eared-pheasant (and other wildlife) might be valid.

JHNR is located in the Taihang mountain range in close proximity to six state-level protected areas (Table 3). The total protected land area exceeds 775 km² and provides large, continuous tracts of habitat that are occupied and exploited by progressively fewer humans and livestock. Both the area and quality of forest cover over this large protected landscape are said to be increasing in response to a long-term decline in logging (since 1998), effective control of wildfire, and tree planting by state forest farms (Laishui Forestry Bureau, unpubl. data). Our initial efforts at camera-trapping reported here were limited in scope but resulted in the potential addition of one species to the nature reserve species list. In view of its steadily improving conservation environment, prospects are good at JHNR for further increases in documented biodiversity.

CONCLUSIONS

Camera-trapping proved an effective technique for biodiversity survey and for photographic documentation of the presence of brown eared-pheasant at JHNR. Initial efforts at camera-trapping indicated potential for expanded application of the technology in future biodiversity survey at JHNR.

Table 3. Five protected areas that lie adjacent to or overlap JHNR in the northern Taihang mountain range

Protected area name	Area (ha)	Province	County
Baihuashan National Nature Reserve	21,743	Beijing	Qingshuizhen
Xiaowutaishan National Nature Reserve	21,833	Hebei	Zhangjiakou
Jinhuashan-Henglingzi Hemaji Nature Reserve	33,940	Hebei	Laishui-Laiyuan
Baicaopan National Forest Park	*	Hebei	Laishui
Sangyuanjian State Forest Farm	**5,000	Hebei	Laishui
Zhaogezhuang State Forest Farm	**6,700	Hebei	Laishui
Dianziliang State Forest Farm	**2,771	Hebei	Laiyuan
Total***	77,516		

*Included within Sangyuanjian State Forest Farm area

**Included within Jinhuashan-Henglingzi Hemaji Nature Reserve

***Includes only Baihuashan, Xiaowutaishan, and Jinhuashan-Henglingzi protected areas

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REFERENCES

- Baoding Municipality Forestry Bureau, Baoding Municipality Forestry Survey Design Team, Laishui County Forestry Bureau, and Laiyuan County Forestry Bureau. 2003. Hebei Jinhuashan-Henglingzi Hemaji Nature Reserve Scientific Investigation Report. March 2003.
- Carbone C, Christie S, Conforti K, Coulson T, Franklin N, Ginsberg J R, Griffiths M, Holden J, Kawanisi K, Kinnaird M, Laidlaw R, Lynam A, Macdonald D W, Martyr D, McDougal C, Nath L., O’Brien T, Seidensticker J, Smith D J L, Sunquist M, Tilson R, and Wan Shahrudin W N. 2001. The use of photographic rates to estimate densities of tigers and other cryptic prey. *Animal Conservation* 4:75-79.
- Dahmer, T. D., Gui Xiaojie and Tian Shurong. 2014) Camera-trapping for South China Tiger in Hupingshan National Nature Reserve, Hunan Province. *Chinese Journal of Wildlife Yesheng Dongwu* 35(1):19-25.
- Fang Liu Xiujiang Su, Diqiang Li, Benzong Wang, Ziliang Zhang. 2014. Using camera trap to investigate animal diversity in Hunan Gaowangjie National Nature Reserve. *Biodiversity Science* 22:779-784, doi:10.3724/sp.j.1003.2014.14177.
- Guohai Wang, Zepan Shi, Xiuju Liu, Qihai Zhou, Zhishu Xiao. 2014. Camera trap survey of mammals and birds in Huaping National Nature Reserve, Guangxi. *Biodiversity Science* 22:785-787, doi:10.3724/sp.j.1003.2014.14125.
- He SY, Xing QH, and Yin ZT. (1992) *Flora of Beijing* [in Chinese]. Beijing, China: Beijing Press.
- HPG. 2004) Hebei Province Mountain Closure and Reforestation Regulations. Internal Memorandum, Hebei Province Government, October 2004, 8 p.
- IUCN. 2012. IUCN Red List Categories and Criteria. Version 3.1, edition 2. International Union for Conservation of Nature and Natural Resources, World Conservation Union, Gland, Switzerland.
- IUCN. 2016) The IUCN Red List of Threatened Species. Version 2015-4. <www.iucnredlist.org>. Downloaded on 20 June 2016.
- Jianpu Wu, Hong Luo, Xuelin Zhu, Bingzhang Li, Wulin Liu, Ping Ci. 2016. Monitoring mammals and birds with camera traps at different altitudes of Medog, Tibet. *Biodiversity Science* 24:351-354, doi:10.17520/biods.2015106.
- JHNR. 2016. Hebei Jinhuashan-Henglingzi Hemaji Nature Reserve Biodiversity Survey Report. Hebei Forestry Dept., Shijiazhuang, Hebei.
- Lijia Wen, Kun Shi, Jian Huang, Yang Song, Yumin Guo. 2014. Preliminary analysis of mammal and bird diversity monitored with camera traps in Medog, Tibet. *Biodiversity Science* 22:798-799, doi:10.3724/sp.j.1003.2014.13256.
- MacKinnon, J. and K. Phillipps. 2000. A field guide to the birds of China. Oxford Univ. Press, New York, 586 p.
- Mingxia Zhang, Lin Cao, Ruichang Quan, Zhishu Xiao, Xiaofei Yang, Wenfu Zhang, Xuezhi Wang, Xiaobao Deng. 2014. Camera trap survey of animals in Xishuangbanna Forest Dynamics Plot, Yunnan. *Biodiversity Science* 22:830-832, doi:10.3724/sp.j.1003.2014.14064.

- Shi Zepan, Zhou Qihai, Li Xiankun, and Xiao Zhishu. 2014. Estimation of species richness of mammals and birds using camera traps in Nonggang Forest Dynamics Plot, South China. *Biodiversity Science* 22(6):826-829.
- Smith, A. T. and Yan Xie. 2008. A guide to the mammals of China. Princeton Univ. Press, Princeton and Oxfordshire, 544 p.
- Song Dazhao, Wang Buping, Jiang Jinyuan, Wan Shaoping, Cui Shiming, Wang Tianming, Feng Limin. 2014. Using camera trap to monitor a North Chinese leopard (*Panthera pardus japonensis*) population and their main ungulate prey. *Biodiversity Science* 22(6):733-736.
- Tancheng Dong, Hongjun Chu, Hongpan Wu, Yuan Wang, Yan Ge, Lan Bu. 2014. Monitoring birds and mammals through camera traps in Mount Kalamaili Ungulate Nature Reserve, Xinjiang. *Biodiversity Science* 22:804-807, doi:10.3724/sp.j.1003.2014.14178.
- Tilson, R., Hu Defu, Muntifering, J., and Nyhus P. J. 2004. Dramatic decline of wild South China tigers *Panthera tigris amoyensis*: field survey of priority tiger reserves. *Oryx* 38(1):40-47.
- Wang Hongmei, Qian Jinping, Zhang Xiulan and He Xiubin. 2007. Biodiversity sustainability assessment of principal ecosystems in Hebei, China. *Wuhan Univ. J. Nat. Sci.* 12(4):749-754.
- Wenhua Xie, Xifu Yang, Jiajie Yu, Junnian Li, Shuanglun Tao, Zhijun Lu, Xuezhi Wang, Zhishu Xiao. 2014. A survey of mammals and birds using camera traps in Badagongshan Forest Dynamics Plot, Central China. *Biodiversity Science* 22:816-818, doi:10.3724/sp.j.1003.2014.14022.
- Wenliang Zhou, Tao Pan, Bin Li, Jinyun Chen, Tao Song, Zhaojie Peng, Guochen Zhang, Faguang Pu, Baowei Zhang. 2014. Camera trapping survey of mammals and birds in Tianma National Nature Reserve, China. *Biodiversity Science* 22:776-778, doi:10.3724/sp.j.1003.2014.14068.
- Xiang CL. 2009. The Ecological Impact of Ecotourism on Vegetation in Nature Reserve: A Case in Baihua Mountain National Nature Reserve [PhD dissertation]. Beijing, China: Beijing Normal University.
- Yuanchao Liu, Howman Wong, Hongjun Chu, Dongzhi Liu, Fan Zhang, Gang Chen, Yingjie Qi. 2014. Camera trap survey of wildlife in Buergen Beaver National Nature Reserve, Xinjiang. *Biodiversity Science* 22:800-803, doi:10.3724/sp.j.1003.2014.14181.
- Zhang Jintun, Xu Bin, and Li Min. 2013. Vegetation patterns and species diversity along the elevational and disturbance gradients in the Baihua Mountain Reserve, Beijing, China. *Mountain Research & Development* 33(2):170-178. <http://dx.doi.org/10.1659/MRD-JOURNAL-D-11-00042.1>
- Zhang Zhengwang. 2006. The distribution range of brown eared-pheasant enlarged in Hebei Province. *Newsletter of China Ornithological Society* 15 (2):28-29.
- Zhishu Xiao, Linfang Wu, Linfang Tang, Xueli Lu, Zhongliang Huang, Wanhui Ye, Xiaoqun Huang. 2014. Camera trap survey of mammals and birds in Dinghushan Forest Dynamics Plot, Southern China. *Biodiversity Science* 22:823-825, doi:10.3724/sp.j.1003.2014.14027.
- Zhishu Xiao, Xuezhi Wang, Xiaoqun Huang. 2014. Mammal and bird diversity in Qingchengshan Forest Park, Southwest China: data from camera traps. *Biodiversity Science* 22:788-793, doi:10.3724/sp.j.1003.2014.14028.