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Original article

Spatio-temporal responses of male Reeves's pheasants *Syrmaticus reevesii* to forest edges in the Dabie Mountains, central China

Ji-Liang Xu, Zheng-Wang Zhang, Yong Wang & John W. Connelly

We evaluated the response of male Reeves's pheasants *Syrmaticus reevesii* to different forest edges in a fragmented forest landscape in central China using radio-telemetry. Our fieldwork was carried out from April 2000 to August 2003 in the Dongzhai National Nature Reserve within the Dabie Mountains, China. We identified four major types of forest edges: shrub, farmland, road and residential edge. The association of male Reeves's pheasants with these edges was non-random and varied by season, suggesting that land-cover and land-use patterns surrounding forest fragments could have variable effects on habitat use of Reeves's pheasants. Shrub edges were preferred by males in all seasons and male Reeves's pheasant seldom moved > 200 m from this type of edge. Pheasants tended to avoid farmland edges in summer, stayed within 100 m of the nearest road edges in spring and moved farther from residential edges with season shifts. Furthermore, edge use by male Reeves's pheasants also differed between winter and the other three seasons. Our data demonstrated the relationships between edge effects and the spatial distribution patterns of Reeves's pheasants, and suggested that landscape configuration, including juxtaposition of forest and shrubby vegetation, should be incorporated into management and conservation for addressing edge effects at landscape scales. We suggest monitoring the spatial responses of this species to different forest edges over a longer term and at a larger landscape scale.

Key words: China, forest edge, habitat, Reeves's pheasant, spatio-temporal responses, Syrmaticus reevesii

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China once supported large areas of old-growth forest (Zhang et al. 2000) but has experienced a relatively large loss of forest, especially since the mid-1950s (Ministry of Forestry 1997), leading to loss and fragmentation of wildlife habitat (Zhang et al. 2000). Forest fragmentation, often the result of urbanisation and agricultural activities, can threaten native wildlife populations by eliminating blocks of continuous habitat or degrading the quality of remaining habitat for species sensitive to an increase in the amount of forest edge with non-forested habitats (Sekercioglu & Sodhi 2007). Since Gates & Gysel (1978) suggested that forest edges can act as an 'ecological trap', the ecological effects of forest edges have received considerable attention (e.g. Andrén 1995, Rochelle et al. 1999, Manolis et al.

2002, Harper et al. 2005), whereas current knowledge of ecological factors responsible for edge-use or avoidance by birds has been largely based on presence/absence data (Fletcher & Koford 2003, Wilson et al. 2007). Therefore, radio-telemetry was suggested as an appropriate technique to measure spatial responses of birds to forest edges (Norris et al. 2000, Mazerolle & Hobson 2003).

The Chinese government implemented measures to prevent wildlife habitat loss in recent years (Zhang et al. 2000, Liu et al. 2003). Nevertheless, wildlife responses to forest edges have yet to be measured (Jiang et al. 2007, Cong & Zheng 2008). Assessing responses of wildlife to edges is critical to developing effective conservation and management strategies in fragmented landscapes as edges are key components of how landscape changes influence habitat quality (Norris et al. 2008). Populations of many pheasant species have declined as a result of habitat loss and fragmentation (Zhang et al. 2003). Thus, understanding responses of pheasants to forest edges will provide an opportunity to reduce or even reverse the habitat degradation suffered by many pheasant species.

The Reeves's pheasant *Syrmaticus reevesii* is a typical forest bird, inhabiting broadleaf habitats dominated by oaks *Quercus* spp. in subtropical forests with a dense canopy and sparse undergrowth between 200 and 2,600 m asl. (Xu et al. 1991, Wu et al. 1994). This species was widely distributed and relatively common in central China (Cheng et al. 1978), but is now classified as a vulnerable species by the IUCN's Red List (IUCN 2010) and a nationally second-level protected species in China, because of illegal hunting and habitat degradation and loss (Zheng & Wang 1998). Considerable information is available on the species' incubation behaviour (Zhang et al. 2004), habitat use (Wu et al. 1994, Fang & Ding 1997, Sun et al. 2001, 2002, Xu et al. 2005, 2007a), home range (Sun et al. 2003, Xu et al. 2005, 2009), daily movement patterns and site fidelity (Xu et al. 2009), but the influence of forest edges on Reeves's pheasant is still unknown.

Therefore, we used radio-telemetry to assess the spatial and temporal responses of male Reeves's pheasant to forest edges. Our main objectives were to: 1) assess spatial responses of the pheasant to different types of forest edges and 2) investigate seasonal variations in spatial responses of the pheasant to forest edges.

Methods

Study site

Our fieldwork was carried out during April 2000 - August 2003 in the Dongzhai National Nature Reserve (31°40'N/114°24'E), located on the northern slopes of the Dabie Mountain range in the Henan Province of central China. The area comprises the major portion of the eastern distribution of Reeves's pheasant in China (Zheng & Wang 1998, Xu et al. 2007a). A 400-ha portion of the core area at Baiyun was selected as the study area (Xu et al. 2007a, 2009). The natural vegetation of this reserve is characterised by mature forests dominated by oaks *Quercus* spp., masson pine *Pinus massoniana*, dyetree *Platycarya strobilacea,* beautiful sweetgum *Liquidambar formosana* and Hupeh rosewood *Dalbergia hupeana* (Song & Qu 1996, Xu et al. 2007a, 2009). The study area suffered from serious habitat loss in the past, and presently the remaining forest fragments are surrounded by agricultural land and human infrastructure (Song & Qu 1996).

Capture and radio-tracking

We captured 17 male Reeves's pheasants during territorial establishment in April and May using a live decoy surrounded by about 30-foot hold traps (Xu et al. 2009). Each captured bird was then fitted with a coloured plastic leg band and a necklace radio-transmitter (Biotrack Ltd, UK) with frequencies between 216.00 and 217.00 MHz. The transmitter mass (16 grams) was $< 2\%$ of average pheasant body mass (Xu et al. 2009).

Radio-tagged pheasants were located using a portable TR-4 receiver (Biotrack Ltd, UK) and a Telonics hand-held three-element Yagi antenna (Biotrack Ltd, UK). We obtained bird locations once or twice each day by triangulation from permanent reference points within a randomly selected two-hour segment, between 05:00 and 19:30 or by direct observation. In most instances ($> 95\%$) the distance from the observer to the pheasant was < 200 m. The time between consecutive radio-locations averaged 12 hours (range: 8-16 hours), normally resulting in two observations/day (Xu et al. 2009). Bird relocations were also divided into the four seasons (Xu et al. 2007a, 2009): spring (March-May), summer (June-August), autumn (September-November) and winter (December-February).

Determination of forest edges

We created digital habitat maps of the study area with a scale of 1:10,000 based on remote sensing images from September 1999 (Xu et al. 2006) and a 1:10,000 digital vegetation map of Baiyun (Xu et al. 2007a). We pooled the conifer-broadleaf mixed forest, naturally occurring broadleaf forest, mature pine plantation and mature Chinese fir plantation (Xu et al. 2007a) as woodlands. We defined forest edge types by resolution power of the images, existing plant species and their coverage and possible effects of the habitat on Reeves's pheasants based on the literature. As a result, the edge types in our study included shrubby vegetation, farmlands, unpaved roads and residential areas:

1) Shrub edges, where forests abut shrubby vegetation. Shrubby vegetation, including young Chinese fir plantations, was dominated by young oaks, young Chinese firs *Cunninghamia lanceolata*, glaucous allspice *Lindera glauca,* and tea *Camellia* spp. gardens, which were < 3 m in height and < 5 cm in stem diameter.

2) Farmland edges, where forests abut farmlands. Farmland was used to produce vegetables, wheat and rice.

3) Road edges, where forests abut unpaved roads. The width of these roads was > 4 m. The roads in the reserve were used to regularly monitor wildlife and were rarely used by cars or trucks.

4) Residential edges, where the forests abut residential areas. This reserve has $>$ 30,000 residents (Surveyed by State Forestry Administration of PRC in 2008, unpubl. data), and their residential areas accounted for 8.5% at the study site and $< 0.1\%$ at the study area.

Data analyses

We used the Euclidean distances approach (Conner & Plowman 2001) to assess edge-use by Reeves's pheasant in the four seasons. We generated 100 random locations for the study area using ArcView 3.2. We obtained distances from radio-locations of each individual and the random locations in the study area to different types of forest edges in each season, which were considered vectors of (u_i) and (r_i), respectively. We defined distance to a forest edge type as the distance of radio-locations or random points to the nearest forest edge of this type. When a radio-location or random location was located within a forest edge, we defined the distance as being zero. We created a vector of ratios (d_i) for each animal in each season by dividing each element in u_i by the corresponding element in r_i within each season. The expected value of each element in d_i is 1.0 under the null hypothesis of no edge selection. We calculated the mean of the d_i in each season as a vector of ρ.

We used MANOVA to determine if ρ, differed from a vector of 1 (Conner et al. 2003), and we considered non-random edge-use to have occurred if ρ differed from a vector of 1. We determined the significance levels for winter by randomisation tests because of small sample size (Edgington 1995). To determine which edge types were used disproportionately, we tested each element within ρ to determine if it differed from 1 using a pair-wise t-test. If an element in ρ was < 1, then the corresponding edge type was preferred; if an element in ρ was > 1, then the corresponding forest edge type was avoided. Moreover, the elements in ρ provide ranking of different types of forest edge use. The edge with the lowest value was preferred the most, whereas the element with the largest value was used least. Additionally, we also used pair-wise comparisons to compare relative use among edge types.

We also used the Neu et al. (1974) method, including a χ^2-test of goodness-of-fit and a Bonferroni Z-statistic to test whether there were differences of the proportions between the radio-locations in an interval of distance from an edge (hereafter used proportions) and the area in the corresponding distance interval (hereafter available proportions) in each season. We considered the proportion of radio-locations within a given distance interval as used, and the proportion of the area in the corresponding distance interval as available. We arbitrarily classified the distances to the forest edges into seven intervals: 0-50 m (including 0 m, and the same to the following), 50-100 m, 100-150 m, 150-200 m, 200-250 m, 250-300 m and $\geq$ 300 m. We selected the 50-m interval because it has commonly been used in similar studies (Ortega & Capen 2002, Jensen & Finck 2004).

For all statistical tests, we used a probability of ≤ 0.05 as the significance level. We executed a randomisation test using psychStats (available at: http://www.lcsdg.com/psychStats) online in 2006, and we carried out other statistical procedures using SPSS 10.0.1 for Windows (SPSS Inc. 1999).

Table 1. Forest edge[1] rankings based on Euclidean distances approach for male Reeves's pheasant in relation to seasons in central China. The ranking of numbers 1, 2, 3 and 4 indicate the ranking of the corresponding forest edges; the smaller the number, the greater the preference. Forest edges with the same superscript letter do not differ in relative preference (t-test: $P > 0.05$) within each row. The numbers in parentheses are the ratios of the mean distance between relocations and edges to the mean distance between random locations and edges.

Season	Sample size (N)	Ranking of forest edges (ρ)			
		1	2	3	4
Spring	17	SHRUB (0.60)[a]	RESIDENT (0.71)[a,b]	ROAD (0.83)[b,c]	FARMLAND (0.93)[b,c]
Summer	12	SHRUB (0.64)[a]	RESIDENT (0.74)[a,b,c]	ROAD (0.87)[a,b,c]	FARMLAND (0.99)[b,c]
Autumn	6	SHRUB (0.50)[a]	RESIDENT (0.84)[a,b,c]	ROAD (0.89)[a,b,c]	FARMLAND (0.92)[a,b,c]
Winter	5	SHRUB (0.46)[a]	ROAD (0.69)[a,b,c]	FARMLAND (0.82)[a,b,c]	RESIDENT (0.96)[a,b,c]

[1] SHRUB, RESIDENT, ROAD and FARMLAND represent shrub edges, residential edges, road edges and farmland edges, respectively.

Results

Responses to different types of forest edges and seasonal variations

Male Reeves's pheasant (N = 17) used shrub edges, farmland edges, road edges and residential edges non-randomly in all four seasons ($P < 0.01$ in spring, summer and autumn, and $P < 0.05$ in winter). In spring and summer, male Reeves's pheasants associated with shrub and residential edges more than expected ($P < 0.01$) and used farmland edges and road edges in proportion to their availability. Pheasants used shrub edges more than expected in autumn and winter ($P < 0.01$), preferred farmland edges in winter ($P < 0.05$) and used the other two forest edges proportional to their availability in autumn and winter. Pair-wise comparisons indicated that shrub edges were preferred over farmland and road edges ($P < 0.05$), but were similar in preference to residential edges in spring.

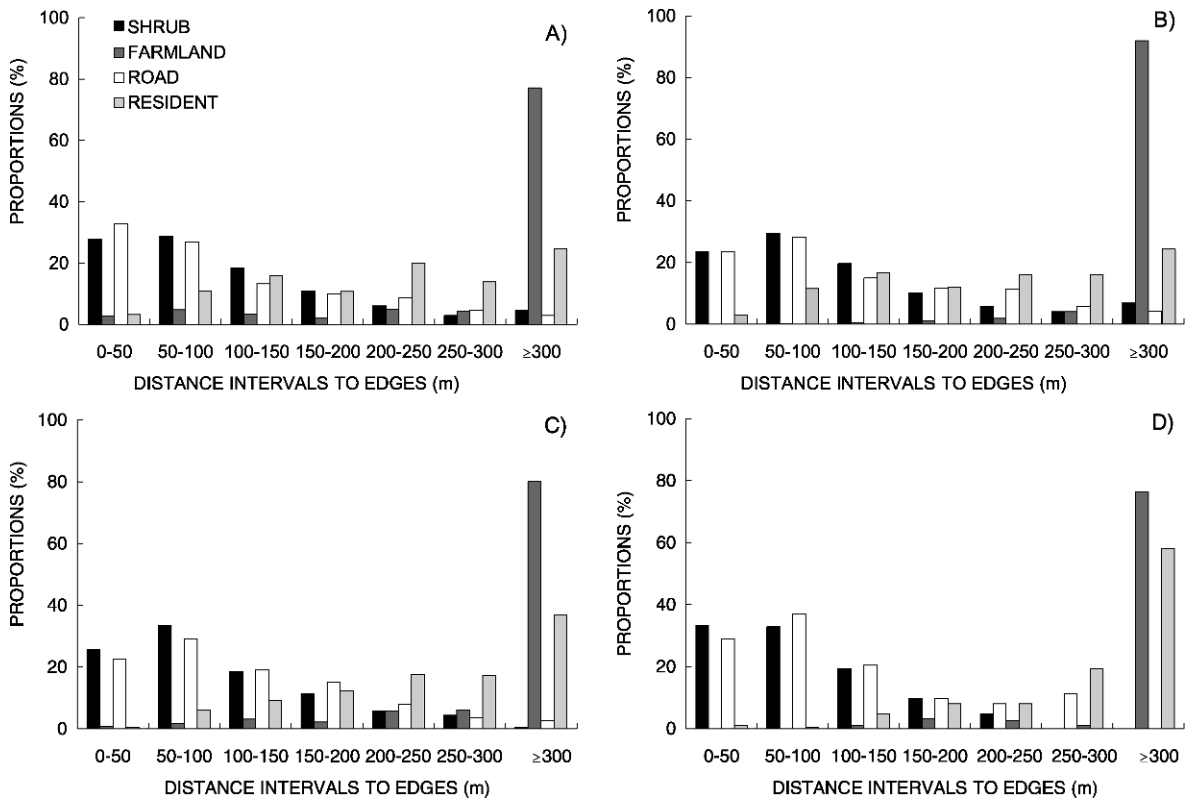

Figure 1. Proportions of male Reeves's pheasants' relocations in response to edge distance and edge types in the seasons spring (A), summer (B), autumn (C) and winter (D). SHRUB indicates shrub edges, RESIDENT indicates residential edges, ROAD indicates road edges and FARMLAND indicates farmland edges; the symbols in B), C) and D) are the same as in A).

Table 2. Effects of edge distance on male Reeves's pheasants in relation to edge types and seasons in central China. '+' indicates that the proportion of radio-locations within a given distance interval was larger than the proportion of the area in the corresponding distance interval, and '-' indicates that the proportion of radio-locations within a given distance interval was smaller than the proportion of the area in the corresponding distance interval.

Type of edge	Distance intervals	Availability (A[1])	Spring		Summer		Autumn		Winter	
			U[2]	U vs A[3]	U	U vs A	U	U vs A	U	U vs A
Shrub	0 - 50 m	0.155	0.238 ~ 0.318	+	0.192 ~ 0.280	+	0.178 ~ 0.335	+	0.240 ~ 0.426	+
	50 - 100 m	0.167	0.248 ~ 0.330	+	0.249 ~ 0.344	+	0.252 ~ 0.421	+	0.235 ~ 0.421	+
	100 - 150 m	0.151	0.150 ~ 0.220		0.155 ~ 0.238	+	0.116 ~ 0.255		0.116 ~ 0.271	
	150 - 200 m	0.123	0.083 ~ 0.139		0.070 ~ 0.133		0.058 ~ 0.172		0.038 ~ 0.155	
	200 - 250 m	0.096	0.039 ~ 0.082	-	0.034 ~ 0.084	-	0.016 ~ 0.099		0.006 ~ 0.091	-
	250 - 300 m	0.062	0.015 ~ 0.045	-	0.020 ~ 0.061	-	0.007 ~ 0.081		0	-
	≥ 300 m	0.246	0.028 ~ 0.065	-	0.043 ~ 0.096	-	-0.007 ~ 0.016	-	0	-
Farmland	0 - 50 m	0.035	0.014 ~ 0.044	NS[4]	0	-	-0.008 ~ 0.026	NS	0	NS
	50 - 100 m	0.042	0.029 ~ 0.068		-0.003 ~ 0.006	-	-0.006 ~ 0.041		0	
	100 - 150 m	0.046	0.019 ~ 0.052		-0.002 ~ 0.017	-	0.000 ~ 0.062		-0.010 ~ 0.031	
	150 - 200 m	0.041	0.008 ~ 0.034		0.001 ~ 0.024	-	-0.004 ~ 0.048		-0.003 ~ 0.067	
	200 - 250 m	0.039	0.031 ~ 0.071		0.005 ~ 0.034	-	0.016 ~ 0.099		0.027 ~ 0.134	
	250 - 300 m	0.038	0.025 ~ 0.061		0.020 ~ 0.062		0.019 ~ 0.105		0.050 ~ 0.175	
	≥ 300 m	0.76	0.734 ~ 0.809		0.891 ~ 0.948	+	0.729 ~ 0.872		0.680 ~ 0.847	
Road	0 - 50 m	0.207	0.288 ~ 0.372	+	0.190 ~ 0.279	NS	0.151 ~ 0.300	NS	0.201 ~ 0.380	NS
	50 - 100 m	0.185	0.229 ~ 0.309	+	0.234 ~ 0.328		0.211 ~ 0.373		0.276 ~ 0.466	
	100 - 150 m	0.167	0.104 ~ 0.164	-	0.112 ~ 0.187		0.120 ~ 0.260		0.125 ~ 0.284	
	150 - 200 m	0.136	0.074 ~ 0.128	-	0.084 ~ 0.152		0.086 ~ 0.214		0.038 ~ 0.155	
	200 - 250 m	0.103	0.063 ~ 0.114		0.082 ~ 0.148		0.031 ~ 0.128		-0.005 ~ 0.059	
	250 - 300 m	0.083	0.029 ~ 0.067	-	0.033 ~ 0.082		0.002 ~ 0.068		-0.010 ~ 0.031	
	≥ 300 m	0.119	0.015 ~ 0.045	-	0.022 ~ 0.065		-0.002 ~ 0.055		0	
Residential	0 - 50 m	0.015	0.017 ~ 0.049	+	0.012 ~ 0.048		-0.007 ~ 0.016		-0.010 ~ 0.031	NS
	50 - 100 m	0.036	0.082 ~ 0.138	+	0.083 ~ 0.150	+	0.019 ~ 0.105		-0.009 ~ 0.020	
	100 - 150 m	0.056	0.128 ~ 0.193	+	0.127 ~ 0.205	+	0.041 ~ 0.145		0.006 ~ 0.091	
	150 - 200 m	0.077	0.081 ~ 0.136	+	0.087 ~ 0.155	+	0.065 ~ 0.183		0.027 ~ 0.134	
	200 - 250 m	0.098	0.166 ~ 0.237	+	0.122 ~ 0.199	+	0.109 ~ 0.245	+	0.027 ~ 0.134	
	250 - 300 m	0.109	0.109 ~ 0.171		0.123 ~ 0.200	+	0.105 ~ 0.240		0.116 ~ 0.271	
	≥ 300 m	0.609	0.208 ~ 0.286	-	0.199 ~ 0.288	-	0.281 ~ 0.454	-	0.483 ~ 0.678	

[1] A shows the 'available proportion', i.e. the proportion of the area within a given distance interval.
[2] U shows the 'used proportion', i.e. the proportion of radio-locations in the corresponding distance interval.
[3] 'U vs A' is 'Used vs Available'.
[4] NS indicates non-significance at $P > 0.05$ based on a χ^2-test.

Shrub edges were preferred over farmland edges ($P < 0.05$), but were similar in preference to the other two types of forest edges in summer. All other habitat types were similar in preference in all seasons (Table 1).

Effects of edge distance on male Reeves's pheasants

The distributions of the relocations of males in relation to edge distance and edge types in four seasons were not uniform (Fig. 1). Male Reeves's pheasants used distance to shrub edges non-randomly in all seasons (χ^2-test: $P < 0.01$ for all). They preferred distance to shrub edges < 100 m in all seasons, and avoided distance to shrub edges > 200 m except in autumn (Table 2). Pheasants usually avoided distance to farmland edges < 250 m in summer (χ^2-test: $P < 0.05$; see Table 2), whereas they used it in proportion to its availability in the other three seasons. Moreover, males preferred a distance of < 100 m to road edges in spring (χ^2-test: $P < 0.05$) and used it proportional to its availability in the other three seasons.

The pattern was more complicated for residential edges (see Table 2). Males used distance to this kind of edge non-randomly in spring, summer and autumn (χ^2-test: $P < 0.05$ for all) and used it in

proportion to its availability in winter. Pheasants appeared to prefer distances < 250 m in spring, between 50 and 300 m in summer and between 200 and 250 m in autumn, and it seemed that males preferred sites close to residential edges in spring, and then preferred to be further away from these edges as the seasons progressed.

Discussion

Our findings comprised the first step towards a more detailed understanding of the responses of this pheasant species to forest habitat loss and fragmentation. However, our results were based on male pheasants, so inferences regarding females should be made with caution. Even though vegetation and structural characteristics of forests were not correlated with edge types (Sun et al. 2001, 2002, Xu et al. 2005, 2007a) at this study site, it is possible that some variations of edge association of the pheasants that we observed were confounded by forest composition and structure variations. However, because these variations are relatively random among edge types, we believe that our data were more representative of the effects of different edges on the habitat association of male Reeves's pheasants. A detailed examination of forest characteristics associated with different edges related to pheasant locations could provide additional insight into edge effects.

Male Reeves's pheasant inhabiting forests surrounded by agriculture and human dwellings did not show avoidance of any forest edge. These findings were consistent with those reported by previous surveys (Fang & Ding 1997) and were also similar to behaviour exhibited by golden pheasants *Chrysolophus pictus* (Liang et al. 2003), Elliot's pheasant *Syrmaticus ellioti* (Xu et al. 2007b) and Temminck's tragopan *Tragopan temminckii* (Cong & Zheng 2008). However, our results contrasted those reported for Mrs Hume's pheasant *Syrmaticus humiae* (Jiang et al. 2007). Previous reports did not consider responses to forest edges in relation to edge types, although some studies (Fletcher & Koford 2003, Jensen & Finck 2004) stated that it was very important to assess the edge effects according to the types.

It was evident that responses of our male Reeve's pheasants to different types of forest edges vary, implying that land use pattern surrounding habitat fragments could have different effects on habitat use of Reeves's pheasants. Shrub edges were preferred by males and our data actually suggest that male Reeves's pheasants seldom moved > 200 m from this edge. Shrubby areas occupied a small amount of the home range of the male pheasants (Xu et al. 2009), whereas these areas were preferred (Xu et al. 2007a). Our results also provided evidence that larger and particularly wider, e.g. > 200 m, areas of shrub land might be harmful to this species of pheasant.

Male Reeves's pheasants did not avoid farmland edges except during the summer, but most birds were located at a distance relatively far from the farmland edge. Predation risk often increases at sites closer to farmland edge in a forest landscape (Andrén 1995). The main predators of Reeves's pheasants in this reserve, including black kite *Milvus migrans*, common buzzard *Buteo buteo* and Eurasian sparrow hawk *Accipiter nisus* (Xu et al. 2002), preferred an open habitat (e.g. areas adjacent to farmland edge).

Most relocations of male Reeves's pheasants occurred 50-100 m from the road edge and preferred habitats closer to roads in spring. These results were similar to those reported for golden pheasant (Liang Wei, unpubl. data) and Cabot's tragopan *Tragopan caboti* (Zhang Yan-Yun, unpubl. data). Road construction has been prohibited in our reserve since the 1980s as a result of nature reserve establishment, and existing roads are now used largely to monitor wildlife with minimal vehicle traffic, which should have minimal influence on the pheasant. Males preferred to display on these roads in spring (Sun Quan-Hui, unpubl. data). Outside of reserves, road construction is considered one of the most important tools for social and economic development in rural areas (Laurance et al. 2002), and it is still common. Therefore, additional research in other areas is necessary to better understand the influence of road edges on Reeves's pheasants.

Edge use by male Reeves's pheasants also varied among seasons with a difference in the use pattern between winter and the other three seasons. Such temporal variations in edge use suggest that previous studies (Fang & Ding 1997, Sun et al. 2001, 2002, Xu et al. 2005) likely underestimated the influence of habitat fragmentation on Reeves's pheasants, since they were based mainly on surveys in a single season. Factors responsible for the seasonal patterns in edge use by Reeves's pheasant are likely related to

temporal variation of habitat use (Xu et al. 2007a), site fidelity (Xu et al. 2009) and human activities at the forest edges. Habitat use of male Reeves's pheasant remained relatively stable across seasons except during winter (Xu et al. 2007a), and the species showed a high site fidelity in all seasons (Xu et al. 2009). Moreover, its home range in winter was rather small (Xu et al. 2009) and relatively far from residential and farmland edges. Additionally, effects of residential edges on male Reeves's pheasant were complex, and pheasants moved farther from this type of edge with the season shift, which might be partly attributed to human activities.

Management implications

We present the first direct evidence on the response of male Reeves's pheasants to different types of forest edges in a fragmented forest landscape in central China. Because this species of pheasant responded differently to various types of edges in relation to seasons, by using a simple assessment or management framework for assessing habitat fragmentation and restoring habitat for this pheasant, we may have overlooked key information that might improve conservation strategies. Instead, incorporating landscape patterns in management and conservation will be critical for addressing the edge effects at landscape scales (Fletcher & Koford 2003, Sekercioglu & Sodhi 2007). For instance, the proximity between shrubby areas and forests should be considered in detail (Xu et al. 2007a) and it would be better if the shrub patches were $\leq$ 200 m wide.

Our results documented the spatio-temporal responses to different forest edges at local scale for one species, but the pattern found for Reeves's pheasant in this reserve may not be unique. There are 14 protected areas containing Reeves's pheasant in the Dabie Mountains, central China, including five national nature reserves and seven provincial nature reserves (Xu et al. 2007a). The protected areas are managed under similar regulations and frameworks. Additionally, responses to forest edges by golden pheasants in some national nature reserves in Guizhou and Shaanxi, China (Liang et al. 2003) were similar to those described here. Therefore, the spatio-temporal response pattern that we demonstrate here should be applicable to the protected areas. However, because our work was confined to a single study area over a relatively short time, it is entirely reasonable to monitor spatial responses to different kinds of forest edges over a longer term and at a larger and landscape scale.

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