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Research Paper

The impact of disturbance from photographers on the Blue-crowned Laughingthrush (*Garrulax courtoisi*)

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ABSTRACT. Human disturbance may cause significant declines in animal populations. The Blue-crowned Laughingthrush (*Garrulax courtoisi*) is critically endangered and restricted to a small area in Wuyuan, Jiangxi Province, China. Disturbance from photographers in the main breeding sites were severe in the past few years. We studied nest-site selection in nine breeding colonies in relation to disturbance by bird photographers. We compared the nest tree species and nest height above ground in Shimen (SM), the largest and most disturbed site, with the other eight sites. Birds in SM were more selective in nest tree species than in the other sites, they also nested much further from the nearest village building. Nest height above ground at SM was greater than at the other sites and itself in 2004 when there were almost no visitors. These results suggest that disturbance from birding visitors may exacerbate the endangered status of this bird. Management of bird visitors in a small breeding area of endangered species should be considered.

Impact des perturbations par les photographes sur le Garrulaxe de Courtois (*Garrulax courtoisi*)

RÉSUMÉ. Les perturbations humaines peuvent causer un déclin significatif chez les populations animales. Le Garrulaxe de Courtois (*Garrulax courtoisi*) est une espèce en voie de disparition et restreinte à une petite région du Wuyuan, province de Jiangxi, en Chine. Les perturbations par des photographes sur les principaux sites de reproductions ont été sévères au cours des dernières années. Nous avons étudié la sélection de sites de nidification dans neuf colonies en relation avec les perturbations par des photographes. Nous avons comparé les espèces arboricoles utilisées ainsi que la hauteur des nids au-dessus du sol au Shimen (SM), le site le plus grand et le plus perturbé, avec les huit autres sites. Les individus au SM furent plus sélectifs quand au choix des espèces arboricoles que dans les autres sites, et firent leur nid à une plus grande distance du bâtiment le plus près du village. La hauteur au-dessus du sol des nids au SM était plus élevée que dans les autres sites, ainsi qu'au même site en 2004, au moment où les visiteurs étaient quasi absents. Ces résultats suggèrent que les perturbations par les visiteurs peuvent exacerber le statut d'en voie de disparition de cet oiseau. La gérance des visites pour des raisons ornithologiques dans des sites de reproduction restreint d'espèces en voie de disparition devrait être considérée.

Key Words: *bird photographer; breeding success; habitat management; human disturbance; nest-site selection*

INTRODUCTION

Wildlife responses to human disturbance may be detected at several levels, such as changes in sensory detection, physiology, behaviour, fitness, space use, and population growth rate (Tablado and Jenni 2017). Both comparative and experimental approaches have been used to assess individual behavioral, distributional, demographic, and population responses to human disturbance (Gill 2007, Kerbiriou et al. 2009). If animals respond behaviorally or physiologically to human disturbance, their fitness (reproductive output and survival as proxies) and habitat use may be compromised, even by single events (Bowles 1995, Knight and Gutzwiller 1995, Wingfield et al. 1997, Frid and Dill 2002, Buckley 2011 in Tablado and Jenni 2017). The decline of many species has been directly or indirectly linked to human disturbance (Reijnen et al. 1996, Brawn et al. 2001, Beebee and Griffiths 2005, Reed and Merenlender 2011). Indeed, human activities in an area can appear to be neutral or even benign in their effect on wildlife, but may ultimately cause populations to decline over time (Lowe et al. 2014).

Animals may perceive visitors as potential predators and respond to disturbance accordingly, whether from a noisy, low-flying helicopter or from a quiet wildlife photographer (Frid and Dill 2002). Many authors have investigated the responses of breeding birds to human disturbance, such as the energy costs of earlier flight initiation and vigilance (e.g., González et al. 2006, Poudel et al. 2015), changes in habitat use (e.g., Lafferty 2001, Fernández-Juricic et al. 2002, Markovchick-Nicholls et al. 2008, Lowe et al. 2014), reduced parental care (e.g., Burger 1994, Verhulst et al. 2001, Bautista et al. 2004, Yasué and Dearden 2006), and decreased reproductive success (Safina and Burger 1983, Bailly et al. 2016). Behavioral responses to human disturbance vary among species (Blumstein et al. 2005), with, e.g., group-living species more likely to suffer from injuries during panic behavior (Carney and Sydeman 1999).

Wildlife observers and photographers actively seek and approach wildlife, unlike other recreationists who mostly encounter wildlife accidentally (Speight 1973). This nonconsumptive recreation activity may effect birds because of their more frequent and longer

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duration (Boyle and Samson 1985). However, few studies have addressed the influence birdwatchers and photographers may exert on a species when it is the target of their concerted interest.

The Blue-crowned Laughingthrush *Garrulax courtoisi*, a group-living species, is listed as Critically Endangered (CR) by IUCN, with a total known population size of around 240 mature individuals (BirdLife International 2016). It is confined to an extremely small breeding range in Jiangxi Province, China, where its breeding sites are distributed in stands of broad-leaved trees beside a number of villages near the tributaries of the LeAn River. Disturbance from villagers' daily activities cannot be avoided, but the birds appear to be accustomed to them. Each year, they arrive at the breeding sites in mid-late April, breed colonially and cooperatively without territory. Three or four eggs are laid in each clutch. Although resident in Wuyuan, however, they leave the breeding ground a few days after the young have fledged and wander throughout the nonbreeding season.

The species was treated as a subspecies of Yellow-throated Laughingthrush *Garrulax galbanus* for many years (see Collar 2006), but its sudden appearance in trade around 1990, with birds being acquired by several western institutions, led conservationists to note its distinctiveness (Long et al. 1994). However, the provenance of these traded birds was unclear, and indeed the whereabouts of any wild population was unknown until searches through the 1990s were finally rewarded with the 'rediscovery' of the species in 2000 in a small cluster of villages in the region of Wuyuan in Jiangxi Province (Hong et al. 2003). Since then, this rare and beautiful bird has attracted the attention of many birdwatchers and photographers from all over the world.

Of the Laughingthrush breeding sites, Shimen village is the best known to bird photographers because the large size (more than 50 breeding individuals each year) and stability (it can be found in the same area from April to July every year) of this subpopulation make the species easy to find and be photographed. During our studies, we observed many visitors pursuing birds from dawn to dusk to take photographs, frequently involving flashing lights and mechanical camera sounds. Birds in Shimen have been disturbed by visitors ever since the rediscovery of the species, and from our observations, the subpopulation over the site has suffered far longer and stronger disturbance from birdwatchers and photographers than those at the other sites. Consequently, aware that disturbance can induce changes in nest position (Morán-López et al. 2006, Chen et al. 2011) and that such changes might be disadvantageous to the species, we investigated the effects of visitors on nest-site selection of the Laughingthrush.

STUDY AREA

Wuyuan is known as "China's most beautiful landscape," with rich bird diversity (He et al. 2014), therefore the area attracts a large number of tourists, birdwatchers, and photographers every year. It is a part of the Huangshan Mountains, with 83% mountainous area and a 100–150 m average altitude. The villages were built along the main river, the LeAn River, which is a branch of the Raohe River, and its tributaries. Fengshui forests, mainly composed of broad-leaved trees, are the main breeding area of the Blue-crowned Laughingthrush in the villages. These forests are small in area and isolated from each other and other forests.

METHODS

Field study

From 2012 to 2016 we conducted field investigations in nine breeding sites of the Blue-crowned Laughingthrush in Wuyuan, named Shimen (here after SM), Jinpan (JP), Hexi (HX), Taibai (TB), Haikou (HA), Hokou (HO), Caomen (CM), Zhongyun (ZY), and Linhe (LH). All of them are villages bordering rivers with adjacent broad-leaved woodland or stands of broad-leaved old trees, but the sizes of the breeding subpopulations they host vary considerably. SM and JP are only a few hundred meters apart, on opposite sides of the same river, and they host the same flock of Laughingthrushes that gather there when the birds arrive from their (as yet unknown) wintering area; however, when breeding begins, the flock separates into two breeding subpopulations; we therefore treated them as separate breeding sites.

Almost all photographs of the Blue-crowned Laughingthrush published online or in print were taken in SM. We counted the online posts of photographs of this species in Birdnet (http://www.birdnet.cn/portal.php), the main web site for bird photo sharing in China, as a measure of the degree of disturbance from photographers in SM. The SM site was the best known breeding site for the Laughingthrush, and it was also the only site with convenient room and board accommodations for bird visitors before 2015. However, photographers did not indicate where their photos were taken when they uploaded these pictures so we cannot be sure that all the pictures were taken in SM. Even if some of them were taken in the other sites, the ratio was too small to largely influence the overall trend of the amount of Laughingthrush's pictures taken in SM.

We searched villages with suitable habitats and recorded the number of nests in each breeding site since 2012 (Table 1). We also measured the nest height above ground (NHAG), tree height (TH), and diameter at breast height (DBH) of the trees used for breeding, and compared clutch size and brood size in each nest in SM with the other sites for comparison. We chose an area without Laughingthrush nests in the same forest as a control area without breeding nest of the Laughingthrush in SM, recorded the species, and measured the TH value of all trees in this area for comparison with the nest area. Because the NHAG value may increase with tree height, which varies with tree species and age, we excluded the data from bamboo (n = 4), plum trees (n = 1), pear trees (n = 2), and osmanthus (n = 13) when comparing the NHAG value because these species cannot reach as high as the other trees.

Because all Laughingthrush breeding sites were in or near villages, they all fell within an area encompassing the villagers' daily activities. We therefore tried to assess this basic level of villager disturbance by one parameter, DB, i.e., nest distance to human buildings (house, road, and bridge).

Because nest inspections by researchers may affect incubation and food-provisioning schedules, we climbed trees to check the eggs only once, and in as brief a time as possible (a few minutes) when the parents were both absent. Though we found many nests, we were only able to examine the clutch size of nine nests directly because they were built at the end of thin branches, quite high to observe and climb. However, because the nest structure stretched somewhat after the eggs hatched and the nest bottom was thin

Table 1. Numbers of nests in nine breeding sites of the Blue-crowned Laughingthrush (*Garrulax courtoisi*) in Wuyuan, Jiangxi, 2012–2016.

Year	Nest amount									
	SM	JP	HX	CM	HA	HO	TB	ZY	LH	Total
2012	17	0	1		--		2	0	--	20
2013	15	4	2		--		0	1	3	25
2014	21	0	0	3	11+	3	0	0	0	38+
2015	8	10	0	8	8+	2	3	0	1	40+
2016	21	0	0	7	13	3	2	0	0	46
Total	82	14	3	18	32+	8	7	1	4	169+
Average	16.4	2.8	0.6	5.6	10.7	2.7	1.4	0.2	1.0	

Note: "--" means unclear, "+" means more than, gap means no data, "0" means no nests were found.
Please see Methods in main text for expansion of study site abbreviations.

and transparent, and the nestlings would stick their heads out the nest when they beg for food, we were able to count nestlings by monocular telescope. Although most of the nest bottom became thin enough to see the nestlings, it still required a long observation, thus counting was easier when the adults fed the young.

Data analysis

Nine breeding sites, five of them previously undisclosed, have been recorded since 2012 (see Birdlife international 2016). Because SM was almost the only site known and disturbed by bird photographers before 2015, we used data from the other eight sites for comparison, to assess the impact of disturbance on the Laughingthrush.

We checked clutch and brood sizes of the Laughingthrush in SM and other sites. However, nests checked for eggs were not always the same as those checked for nestlings. So we assumed that no individual differences occurred in hatching ability, and the breeding success ratio was calculated as the ratio of the number of nestlings and clutch size in SM.

All statistical tests were performed using SPSS 17.0. The statistical significance level was set at $p < 0.05$. ANOVA analysis was done to check the differences of DB, DBH, NHAG, clutch size, and brood size values between SM and other sites. T-test statistic, degrees of freedom (df) and P-values from these models are presented. Additionally, means are presented as back-transformed parameter estimates, with the upper and lower 95% confidence limits. GLM methods and correlation tests were undertaken to determine the relationship between these parameters.

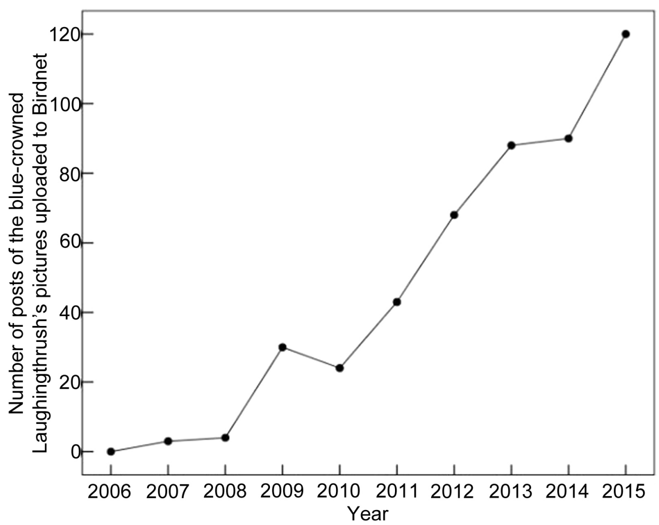
RESULTS

From 2012 to 2016, 169 nests were found in the nine breeding sites but only 144 were used because of accessibility. SM was the largest subpopulation with most breeding pairs. The other subpopulations held fewer breeding individuals and were less stable than SM, and in some years some sites were entirely unoccupied (Table 1).

Disturbance levels in SM

In the years following its rediscovery, the Blue-crowned Laughingthrush became increasingly well known. Photographs of it appeared on Birdnet from 2007 onward, and rose dramatically after 2010 (Fig. 1), reflecting a major increase in the number of photographers and the levels of disturbance they created.

Fig. 1. Numbers of posts of the Blue-crowned Laughingthrush's (*Garrulax courtoisi*) pictures uploaded to Birdnet since 2006.



Nests in SM averaged 119.2 ± 7.1 m from buildings, a much father distance than at the other sites where they averaged only 13.4 ± 2.9 m from buildings ($F_{1,93} = 104.2$, $p < 0.001$).

Nesting trees

All nests were built in broad-leaved (but not fruit) trees in SM, while bamboo, fruit trees, and conifers were also used for nesting at other sites (including JP, across the river from SM). Hackberry *Celtis sinensis*, Chinese ash *Pterocarya stenoptera*, and Chinese sweet gum *Liquidambar formosana* were selected most in SM (Fig. 2). Camphor trees were used the most for nesting at all other sites (Fig. 2). Nest trees in SM were similar in height but higher in crown density compared with nest trees in all other sites.

Table 2. Linear-regression analysis of the tree height (TH) and nest height above ground (NAGH) from 2012 to 2016 in Shimen (SM).

	p-value	F-value	TH (m) mean ± se	NHAG (m) mean ± se	average ratio of NHAG / TH (%) mean ± se
2012	0.001	15.2	21.4 ± 1.1	15.1 ± 0.9	80.8 ± 2.3
2013	< 0.001	23.9	23.0 ± 1.3	17.0 ± 1.1	75.0 ± 2.9
2014	0.023	6.2	22.8 ± 1.0	15.8 ± 1.1	67.4 ± 4.9
2015	0.002	26.8	21.4 ± 1.0	17.1 ± 0.7	80.9 ± 2.5
2016	< 0.001	4.7	20.9 ± 1.2	17.0 ± 0.5	76.2 ± 1.7

Fig. 2. Nesting trees in Shimen (SM). White represents the number of nesting trees in SM, black represents the number in other sites. The cumulative of white and black is the number of trees chosen for nesting.

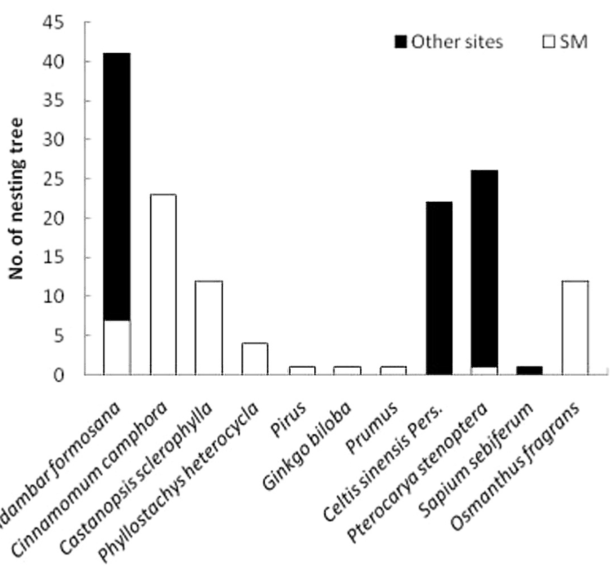
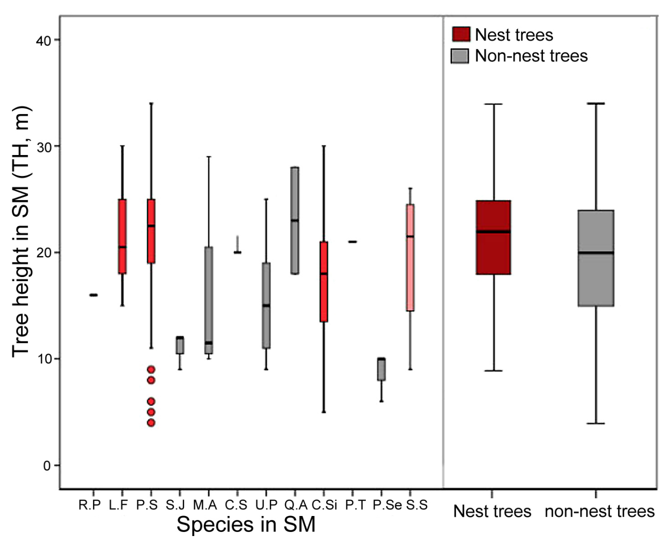


Fig. 3. Comparison of tree height of nest trees and non-nest trees in Shimen (SM). Note: Red bars indicate nesting trees, gray bars indicate non-nest trees, and the error bars indicate standard error. R.P = *Robinia pseudoacacia* Linn., L.F = *Liquidambar formosana*, P.S = *Pterocarya stenoptera*, S.J = *Sophora japonica* Linn., M.A = Melia azedarach Linn., C.S = Castanopsis sclerophylla, U.P = Ulmus parvifolia Jacq., Q.A = *Quercus acutissima* Carruth., C.Si = *Celtis sinensis* Pers., P.T = *Pteroceltis tatarinowii* Maxim., P.Se = *Pyrus serotina*, S.S = *Sapium sebiferum*. The tree height of nesting trees and non-nest trees are significantly different (F1,224 = 12.4, p = 0.001).



Tree height was similar in all sites (Fig. 3; $F_{2,129} = 0.0$, $p = 0.934$). However, DBH was smaller in SM (43.7 ± 2.2 cm) than at the other sites (98.7 ± 7.3 cm; $F_{1,129} = 80.9$, $p < 0.001$).

In SM, the height of nesting trees was higher (19.1 ± 0.5 m, n = 144) than the height of non-nesting trees ($F_{1,224} = 12.4$, $p = 0.001$). Also, in SM the tree species chosen for nesting tended to be the highest species there (Fig. 3).

Nest height above ground

Nest height above ground (NHAG) was higher at SM (15.9 ± 0.5 m; n = 59) than at other sites (10.8 ± 0.8; n = 30; excluding data from bamboo and fruit trees: n = 7; $F = 27.8$, $p < 0.001$; Fig. 4). However, at SM, NHAG differed between years, being lower in 2004 (10.9 ± 2.5 m) than in other years (Fig. 4).

NHAG increased with TH in both SM and other sites, but decreased after it reached the highest value in the other sites, not in SM. Besides this, the rise range in SM was larger than the other sites, with no obvious fall after the peak. Birds in SM seemed still to nest higher compared with other sites, even allowing for tree height (Fig. 5).

TH of nesting trees in SM from 2012 to 2016 showed no significant differences (see Fig. 5; $F_{4,77} = 0.5$, $p = 0.720$); nor did NHAG ($F_{4,77} = 0.7$, $p = 0.568$). However, ratio of NHAG and TH seemed to differ between years ($F_{4,77} = 3.2$, $p = 0.018$; Table 2; Fig. 4). This means birds at SM seemed to adjusted their nest position for some reason in different years.

Fig. 4. Comparison of nest height above ground in Shimen (SM) and other sites since 2012, and SM 2004 (mean value ± standard error).

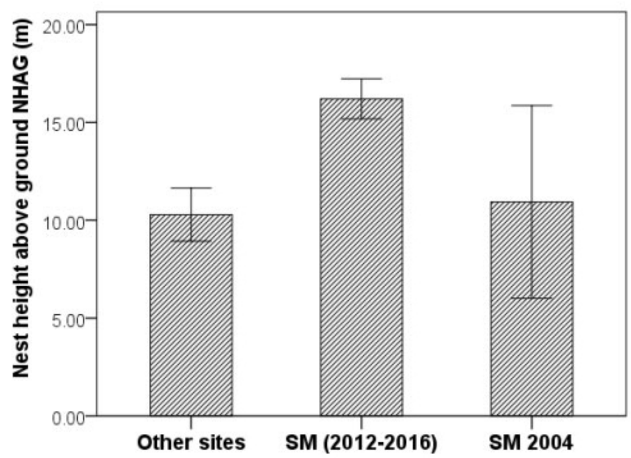
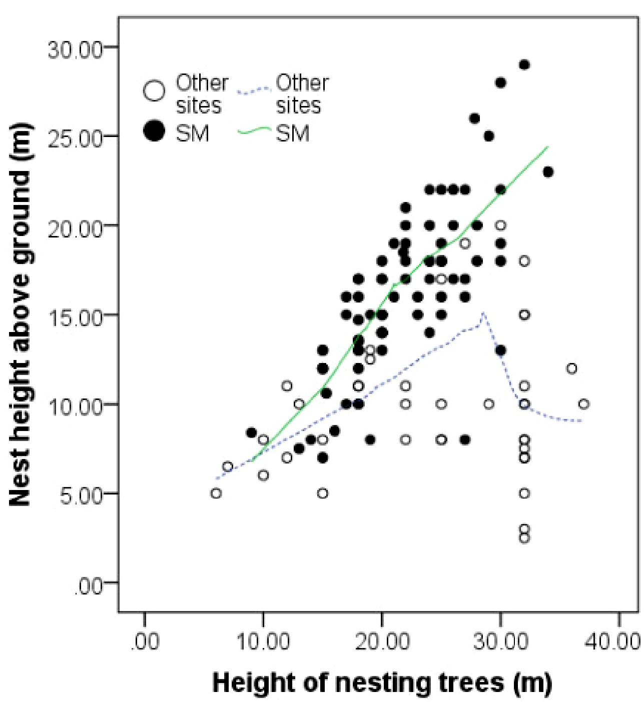


Fig. 5. Relationship of nest height above ground (NAGH) and tree height (TH) in Shimen (SM) and other sites. Note: the solid point indicates data in SM, and the hollow point indicates data in the other sites; the solid curve indicates trend of NAGH change with the TH in SM, and the dotted one indicates the same in the other sites.



DISCUSSION

Wildlife tends to select more concealing habitat to counteract the influence of disturbance (Chen et al. 2011). The greater DB values in SM suggest that it is visitors rather than villagers that are the source of disturbance. The tree species selected for nesting at SM possess more crown density than at other sites, indicating a greater requirement for seclusion in birds at SM. It is generally known that DBH increases with tree age; the higher DBH value at other sites reflects the fact that the nest trees are older and therefore taller. In fact, nest trees at other sites were always isolated or more distant from each other compared with SM. Although the number of photographs posted online reveal that disturbance increased dramatically from 2012 to 2015, nest height showed no significant differences in these four years ($F_{3,56} = 1.0$, $p = 0.420$), and we infer that the Laughingthrushes had already increased the height of their nest positions as a response to visitors disturbance before our study began. Nevertheless, the ratio of TH and NHAG rose generally from 2012 to 2016, possibly responding to the enhanced disturbance pressure by photographers. However, the difference might be due to other factors such as competition for nest sites, which would weaken the effect of disturbance on nesting tree choice and then nest height.

Laughingthrushes in SM now nest higher (and previously at SM itself) and select tree species offering more cover than at other sites, and this behavior appears to be correlated with targeted disturbance by birdwatchers and photographers. Nest outcomes and reproductive success have been related to nest height above ground and concealment in many studies (Mitrus and Soćko 2008, Coppedge 2010, Endo 2012). Hatching rate of the endangered Spanish Imperial Eagle *Aquila adalberti* was affected negatively by the frequency of human activities around nest sites. Hatching success of the Blue-crowned Laughingthrush in 2004 (although n = 6) was as high as 94.7% (Liao et al. 2007), much higher than SM now. Social species are more flighty than noncooperative breeders when humans approach (Blumstein 2006). Blue-crowned Laughingthrushes are cooperative breeders and they monitor both conspecifics and predators, which make them more responsive to human disturbance.

Predation is the most important factor influencing breeding success in natural conditions (Nilsson 1984, Martin 1995, Wesolowski and Tomialojc 2005). Colonially nesting birds are more vulnerable to disturbance because breeding individuals concentrate in a small area (Buckley and Buckley 1976, Manuwal 1978). Eggs or nestlings are defenseless when adults are absent; this greater exposure to predators may increase mortality. Chinese Goshawk *Accipiter soloensis*, Besra *A. virgatus*, Japanese Sparrowhawk *Accipiter gularis*, and Black Baza *Aviceda leuphotes* (but in recent years no corvids) occur in the breeding areas and could more easily prey upon the eggs, nestlings, and even adult Laughingthrushes when high nests are more exposed. As the largest breeding group, SM should contribute most to overall population growth. Disturbance might therefore be constraining breeding success, leaving the total population size unchanged at about 200–240 individuals since the rediscovery of this species in 2000.

Whether animals under pressure shift their habitats depends on the relative costs and benefits of moving elsewhere (Frid and Dill 2002). Breeding pairs moved to JP to nest in 2013 and 2015 (see

Table 1), and this might reflect high disturbance levels for the breeding subpopulation in SM.

Only a few bird photographers knew of the other breeding sites in the past. However, they still preferred SM because of the large number of birds and convenient accommodation in the village. However, some people began to take pictures in JP in 2015, and some photographers shifted to CM in 2016 because they were rejected and forbidden by the administrative department in Wuyuan to take photos in SM. Excessive pursuit and disturbance of these birds during the breeding season may exacerbate their endangered status. If the breeding site at SM and other potential breeding areas are developed as new tourist venues, further disturbance will result. Unfortunately, the Blue-crowned Laughingthrush is still not classified as a protected animal in China, so there is no legal basis for regulating the behavior of photographers and birdwatchers in Wuyuan. Because the species ranges over a wide area in the villages it is very difficult to provide practical measures that could protect it from disturbance, and at present the only solution is to improve the photographers' awareness of the problem and appeal to their self-restraint.

Responses to this article can be read online at:
http://www.ace-eco.org/issues/responses.php/1007

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