

# Rapid decline of the largest remaining population of Bengal Florican *Houbaropsis bengalensis* and recommendations for its conservation

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## Summary

A census of the Critically Endangered Bengal Florican *Houbaropsis bengalensis* was conducted between March and May 2012 on and surrounding the Tonle Sap floodplain in Cambodia, which supports the last extant population of the Indochinese subspecies *blandini*. We found a decline in the number of displaying males of 44–64% since a comparable estimate from the same sites in 2005 to 2007. The estimated population, including five individuals at one previously unsurveyed site, is now 216 (95% CI 156–275) displaying males, plus potential non-displaying males and an unknown number of females. If numbers continue to be lost at a similar rate, it is possible that *blandini* would become extinct within 10 years. Although the population faces multiple threats, this critical situation has primarily been caused by the recent, rapid conversion of the florican's grassland habitat to intensive, industrial-scale, irrigated rice cultivation. To protect the Bengal Florican from extinction in South East Asia, existing Bengal Florican Conservation Areas (BFCAs) need expansion and improvements, including strengthened legal status by prime ministerial sub-decree and better demarcation, patrolling and management. As priorities, both irrigated rice and scrub encroachment within the BFCAs needs to be reversed, local communities better supported, and land outside the BFCAs monitored and strategically managed for florican conservation. Where possible, further BFCAs need to be established. Land purchase may also be an effective conservation measure; leasing land earmarked for cultivation would be cheaper, but less secure.

## Introduction

Bengal Florican *Houbaropsis bengalensis* is a 'Critically Endangered' bustard confined to the terai grasslands of India and Nepal (nominotypical *bengalensis*) and to the seasonally inundated grasslands of southern Indochina (subspecies *blandini*) (Collar 1996, Collar *et al.* 2001). *H. b. bengalensis* is almost entirely confined to protected areas which are both highly disjunct, with possibly little or no genetic interchange between many of them, and inappropriately managed for the species; surveys of these areas in years between 1990 and 2007 yielded a total of 280–401 individuals for this taxon (Donald *et al.* 2010). The species is judged to be extinct in the Mekong Delta of Vietnam and southern Cambodia (Buckton and Safford 2004, J. C. Eames and J. D. Pilgrim *in litt.* 2009), so during the breeding season the population of the subspecies *blandini* is now confined to the floodplain grasslands in and around the Tonle Sap Lake of Cambodia (Donald *et al.* 2010). These grasslands have been created and maintained by a combination of scrub removal during agricultural expansion, abandonment or fallowing after episodes of low-intensity rice cultivation, burning and extensive

livestock-grazing, which probably mimic or substitute ecosystem functions once provided by now extirpated or scarce wild herbivores (Wright *et al.* 2012, Packman *et al.* 2013), and natural fires. Much of this grassland was surveyed during 2005 to 2007; multiplying observed densities of displaying males by aerial photo-derived extent of suitable habitat in 2005, a population of 376 (293–462) displaying males was estimated at accessible sites (Gray *et al.* 2009a). Assuming a similar density, there could also have been around 30 additional displaying males at inaccessible sites; however, available habitat data were already ten years out of date at that stage, so that fewer birds may have been present by 2005. Assuming an equal sex ratio, Cambodia may have held approximately two-thirds of the global population of Bengal Florican.

Early surveys documented a wide range of threats to the floricans, notably hunting, egg collection and changes in agricultural practices (expansion in some areas and abandonment leading to scrub encroachment in others), and conservation actions began in 2000, initially focusing on surveys and community engagement to reduce hunting (Davidson 2004). However, around the time of the 2005 to 2007 census, a major additional threat to the grassland habitat around the Tonle Sap emerged: industrial-scale dry-season rice production for the benefit of large investors, involving allocation of concessions (public land designated for the use of a private entity, for the duration of the agreement) and the construction of large channels, dams and reservoirs in order to catch receding flood waters at the end of the wet season and provide irrigation throughout the dry season (December–June) (Gray *et al.* 2009a, Packman *et al.* 2013).

Grassland conversion was so rapid that in just 27 months between 2005 and 2007 the species may have lost 28% of its 2005 breeding habitat. In response, in 2007 some 349 km<sup>2</sup> of floodplain grassland were set aside for biodiversity and livelihood conservation, in the form of six 'Integrated Farming and Biodiversity Areas' (IFBAs) under declarations from the respective governors of the provinces of Siem Reap, Kompong Thom and Kompong Chhnang (Gray *et al.* 2009a). In 2010 these were changed to 'Bengal Florican Conservation Areas' (BFCAs) under a declaration from the Ministry of Agriculture, Forestry and Fisheries. This increased the level of legal protection, but the boundaries of the protected areas were redrawn to cover only 173 km<sup>2</sup> of three floodplain grassland sites, while extending protection to 138 km<sup>2</sup> of open forest non-breeding habitat. Meanwhile, however, conversion of floodplain grasslands accelerated, and the area of dry-season rice in the south-eastern part of the floodplain (2,407 km<sup>2</sup>), containing all BFCAs and 80% of the florican population (Gray *et al.* 2009a), increased from 50 km<sup>2</sup> in 2005 to 383 km<sup>2</sup> in 2009 (Packman *et al.* 2013) and continues to expand, both outside and inside the conservation areas. This resulted in a net loss of 19% (from 923 km<sup>2</sup> to 751 km<sup>2</sup>) of the grassland habitat in this area between 2005 and 2009 (Packman *et al.* 2013), with losses continuing since.

Between March and May 2012, a new census was conducted to provide an up-to-date assessment of the status of Bengal Florican in Cambodia. In November 2012, a workshop was held in Phnom Penh, Cambodia, to consider the results of this census and to evaluate the most appropriate conservation responses; the key conclusions of this meeting are outlined in the Discussion.

## Methods

Being vulnerable to both aerial and terrestrial predators, bustards are generally cryptic, wary birds, and it is only during the breeding season that males become conspicuous (and therefore countable) through their displays and boldly patterned plumages; at this time, in particular, male birds tend to occupy more open, treeless terrain, presumably in order both to render their displays visible over a larger area and to minimise the risk of ambush by predators (Collar 1996). Bengal Floricans in Cambodia show a seasonal pattern of movement, migrating to open deciduous dipterocarp forest beyond the floodplain when the Tonle Sap expands during the monsoonal rains (generally May–November) (Packman 2011). They move back to breed in grasslands in and around the floodplain as these dry out, with greatest display intensity of males from mid-March to early May (Gray *et al.* 2007). Like many bustard species, the Bengal Florican has an 'exploded lek' breeding system (Gray *et al.* 2007).

In 2005 a total of 28 grassland sites larger than 10 km<sup>2</sup> (considered sufficient to support an exploded lek of > 4 males) were identified from January 2005 aerial photos (for floodplain sites) and 1996 landcover maps derived from aerial photos and, for sites beyond the floodplain, satellite images (JICA 2000). Nineteen of these were surveyed during 2005 to 2007, while the other nine were inaccessible for security or logistical reasons (Gray *et al.* 2009a). In 2012 we resurveyed these 19 sites (as delineated by the 2005 habitat maps) and added one site (Ang Trapeang Thmor, to the far north of the floodplain) where small numbers of floricans have been recorded since at least 2001 (see Table 1 and Figure 1). The nine blocks unvisited during 2005 to 2007 were not surveyed formally in 2012, but we judge their current florican population to be close to zero; six remained off limits but were considered unlikely (based on satellite imagery) to retain grassland, while three were visited, but contained either no remaining suitable habitat (Prasat Bakong and Kandeak, both in Siem Reap province) or limited areas of heavily disturbed grassland (Krakor, in Pursat province).

Populations of males within sites were sampled using replicate 1 km<sup>2</sup> squares (reflecting the approximate minimum distance between adjacent territories within an exploded lek: Gray *et al.* 2007, 2009a), without consideration of current habitat distribution, to provide a mean density for that site. At each site a 1-km<sup>2</sup> grid was overlaid and a sample of squares proportional to site area was selected, aiming to achieve 20% coverage for sites < 100 km<sup>2</sup> (with an enforced minimum of eight

Table 1. Survey sites, their province, area and number of survey squares designated, also showing the area declared as Integrated Farming and Biodiversity Areas (IFBAs) in 2007 and still given protection as Bengal Florican Conservation Areas (BFCAs) by 2012.

Site code	Site name	Province	Site area (km <sup>2</sup> ) <sup>1</sup>	No. of 2012 survey squares	IFBA 2006-2009 (km <sup>2</sup> )	BFCA 2010-2012 (km <sup>2</sup> )
a	Puok Lvea	Siem Reap	43	8		
b	Stoung-Chikraeng	Kompong Thom/Siem Reap	71	18	69 <sup>2</sup>	75 <sup>3</sup>
c	San Kor	Kompong Thom	158	24		
d	Veal Srangai	Kompong Thom	32	19	57	-
e	Kruos Kraom <sup>4</sup>	Kompong Thom	46	9		
f	Kouk Preah Beung Trea	Kompong Thom/ Kompong Chhnang	216	24	105	-
g	Chong Doung	Kompong Thom	34	8	26	26
h	Baray	Kompong Thom	258	44	92	73
i	Kandieng	Pursat	17	8		
j	Bakan	Pursat	22	8		
k	Koas Kroala	Battambang	400	24		
l	Moung Russei	Battambang	12	8		
m	Sangkae-Kompong Pring	Battambang	14	8		
n	Bavel	Battambang	152	23		
o	Aek Phnum	Battambang	18	8		
p	Aek Phnum-Preak	Battambang	27	8		
q	Thmor Kol	Battambang	39	8		
r	Mongkol Borei	Banteay Meanchey	266	24		
s	Preah Net Preah	Banteay Meanchey	75	14		
t	Ang Trapeang Thmor <sup>5</sup>	Banteay Meanchey	61	12		

<sup>1</sup>As determined by Gray *et al.* (2009a) from 2005 aerial photographs

<sup>2</sup>Comprising two adjacent IFBAs: Stoung (Kompong Thom) 28 km<sup>2</sup>, Chikraeng (Siem Reap) 41 km<sup>2</sup>

<sup>3</sup>Comprising two BFCAs: Stoung 28 km<sup>2</sup>, Chikraeng 46 km<sup>2</sup>

<sup>4</sup>Part included within contiguous Kouk Preah Beung Trea IFBA

<sup>5</sup>Additional site for 2012 survey

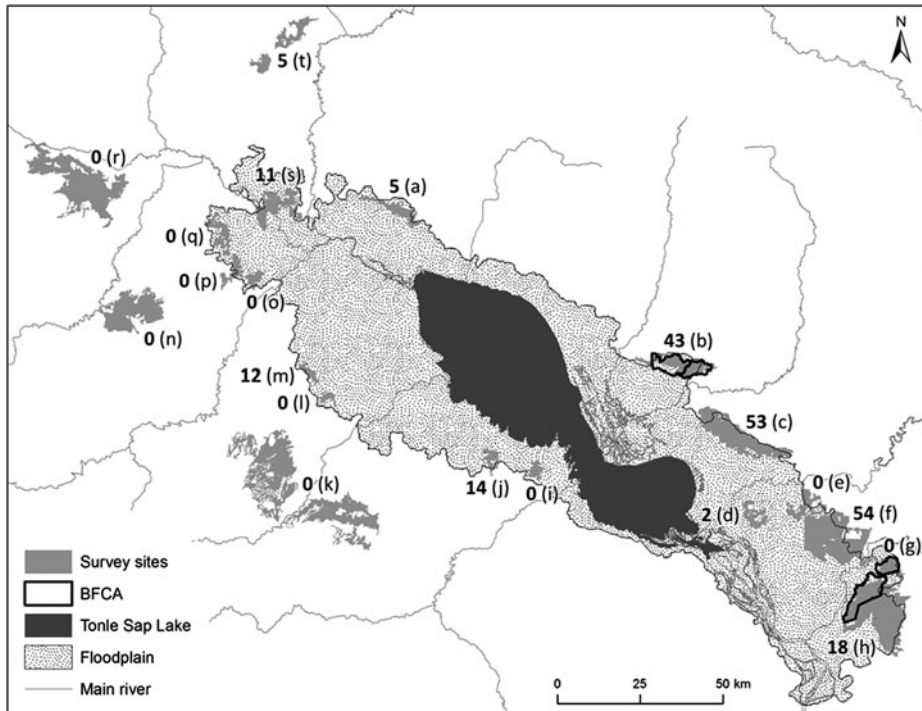


Figure 1. Map showing estimates of numbers of displaying males at survey sites in 2012. Sites are coded with a letter (see Table 1).

squares per site for the smallest sites to ensure sufficient replicates for site-specific estimates) and 15% coverage for sites > 100 km<sup>2</sup>, with a maximum cap of 24 squares per site (Table 1). Squares were surveyed 7 March–5 May 2012, at times of daily peak male display activity in the early morning and late afternoon (06h00–08h30 and 16h00–18h30) (Gray *et al.* 2009a). An observer would remain in the centre of the square for one hour, recording any displaying males observed. A total of 307 squares were identified for sampling. Of these 17 were inaccessible, due to dense scrub or extensive open water (from rice irrigation), and were therefore assumed to hold no floricans (with a zero recorded for the survey). The remaining 290 squares were each surveyed twice and subsequent analysis of density considers the higher of the two counts. This contrasts with the methodology of Gray *et al.* (2009a), who visited each of 268 survey squares just once (but with two observers, for one hour).

For each site, the total number of displaying males was estimated by multiplying mean density (maximum count per surveyed 1-km<sup>2</sup> square) by the site area. In calculating the overall population estimate, to account for unequal survey effort among sites, density estimates from each site were weighted both by survey effort (i.e. proportion of site surveyed) and by the relative contribution of each site to the total study area, following Greenwood and Robinson (2006) and Gray *et al.* (2009a). We estimated detectability in 2012, comparing the numbers of floricans located during just the first or just the second round of visits to the maximum count recorded across both visits. To allow direct comparison with the 2005 to 2007 survey, we adjusted the total estimated population by the detectability achieved in a single visit.

## Results

The total estimate for displaying male floricans in Cambodia (and thus for Indochina and the subspecies *blandini* as a whole) for 2012 was calculated as 216 (156–275). Assuming an equal sex

ratio suggests a total population estimate of 432 (312–550) individuals; however, this should be considered with caution, as populations of declining species are often male-biased (Donald 2007).

A comparison of the 19 accessible sites surveyed by Gray *et al.* (2009a), holding the vast majority of the estimated population both then and now, reveals a 44% decline in the estimated number of displaying male floricans, from 376 (293–462) during 2005 to 2007 to 211 (152–279) in 2012. In the 2012 survey, single visits detected 64.4% of the maximum numbers of displaying males detected over two visits. We therefore reduced the 2012 population estimate by 35.6%, to allow direct comparison with numbers estimated for the same sites from single visits during the 2005 to 2007 survey; this suggested that the population may have declined by 64%, assuming that detectability was similar between the two surveys. However, repeat visits to 10 squares containing territorial males during 2002–2003 suggested that detectability was consistently high at that time (Davidson 2004), a finding which formed the basis for the assumption that detectability approached 100% during the 2005 to 2007 survey. It is possible that fewer males displayed consistently by 2012 owing to reduced extent of habitat and greater disturbance from agricultural activities. If detectability was better during 2005 to 2007 than in 2012, then the magnitude of population decline may lie between 44% and 64%.

The numbers of displaying males estimated for each site in 2012 are shown in Figure 1, and numbers by site during 2005 to 2007 (from Gray *et al.* 2009a) and 2012 are compared in Table 2. Sampling intensity was designed to allow an overall population estimate, so caution is required when interpreting trends within individual sites. However, of the 19 sites surveyed during both censuses, seven held no floricans in either survey and three appear to have lost their florican population between the two surveys (Mongkol Borei, Kruos Kraom and Chong Doung). In contrast, some sites appear to have maintained numbers (e.g. Stoung–Chikraeng, Sangkae–Kompong Pring, and Kouk Preah Beung Trea).

Kouk Preah Beung Trea, San Kor and Stoung–Chikraeng (all located predominantly within Kompong Thom province) hold by far the largest numbers of floricans (combined, 69% of the total population), an estimated 54, 53 and 43 displaying males respectively, with the next largest population of only 18 at Baray. However, Sangkae–Kompong Pring has the highest density of displaying males (0.88/km<sup>2</sup>), followed by Bakan (0.63/km<sup>2</sup>) (both small sites < 25 km<sup>2</sup> in the western floodplain) and Stoung–Chikraeng (0.61/km<sup>2</sup>). Sangkae–Kompong Pring also supported the highest density in 2005 to 2007.

## Discussion

The results of the 2012 census reveal a further serious deterioration in the status of the Bengal Florican in Cambodia, to the point where its long-term survival in the country (and hence the survival of the taxon *blandini* and the entire Indochinese population) is perilous. If numbers continue to be lost at a similar rate to the estimated decline between 2005 to 2007 and 2012, it is possible that *blandini* would become extinct within 10 years.

Scrub encroachment due to agricultural abandonment accounted for 65% of the grassland loss that occurred between 1995/6 and 2005, mostly within the inner floodplain (Packman *et al.* 2013). The substantial decline in florican numbers at Veal Srangai after 2002–2003 reflects this successional loss of grassland to scrub. Since it emerged in 2004–2005 (Gray *et al.* 2009a), rapid, large-scale conversion of the Tonle Sap grasslands to intensive dry-season rice cultivation has become the most severe threat to the Bengal Florican remaining in Cambodia (Packman *et al.* 2013). Dry-season rice cultivation and associated irrigation structures were responsible for 95% of grassland losses in the south-eastern region of the Tonle Sap floodplain between 2005 and 2009 (Packman *et al.* 2013).

Conservation measures for Bengal Floricans focused initially (2000 onwards) on anti-hunting campaigns and diagnostic ecological research, leading to the establishment of protected areas to prevent habitat loss and a range of other threats. Unfortunately, these protected areas have proved extremely difficult to retain intact. IFBAs were set up at Stoung–Chikraeng, Veal Srangai, Kouk Preah Beung Trea, Chong Doung and Baray in 2006/7. IFBA protection was withdrawn at Kouk

Table 2. Estimated numbers of displaying males by site (with 95% CIs) for 2002–2003 (three sites only, from Davidson 2004), 2005 (sites b, d, e) or 2006 to 2007 (16 sites) (from Gray *et al.* 2009a) and 2012. Sites listed in descending order of population size during 2005 to 2007, % change marked in bold show no overlap in CIs.

Site	Estimated number of displaying males (95% CI)			Percent change 2005–2012
	2002–2003	2005–2007	2012	
San Kor (c)		87 (54–120)	53 (22–83)	–39%
Baray (h)		65 (19–111)	18 (0–37)	–72%
Kouk Preah Beung Trea (f)		53 (20–86)	54 (16–92)	+2%
Stoung–Chikraeng (b)	36 (23–49)	49 (40–59)	43 (20–66)	–12%
Mongkol Borei (r)		38 (0–88)	0	–100%
Kruos Kraom (e)	24 (13–36)	17 (9–26)	0	<b>–100%</b>
Preah Net Preah (s)		16 (4–29)	11 (0–33)	–31%
Veal Srangai (d)	34 (17–50)	16 (4–28)	2 (0–5)	<b>–88%</b>
Sangkae–Kompong Pring (m)		12 (6–18)	12 (0–24)	0%
Chong Doung (g)		12 (0–26)	0	–100%
Puok Lvea (a)		11 (0–26)	5 (0–16)	–55%
Bakan (j)		0	14 (6–21)	n/a
Aek Phnum (o)		0	0	0%
Aek Phnum–Preak (p)		0	0	0%
Moung Ruessei (l)		0	0	0%
Thmor Kol (q)		0	0	0%
Kandieng (i)		0	0	0%
Bavel (n)		0	0	0%
Koas Kroala (k)		0	0	0%
Ang Trapeang Thmor (t)		Not surveyed	5 (0–15)	n/a

Preah Beung Trea in September 2008 and when BFCAs, recognised as conservation areas of national importance, were introduced in 2010 at Stoung–Chikraeng, Chong Doung and for part (79%) of the original Baray IFBA, 57 km<sup>2</sup> of Veal Srangai IFBA and 19 km<sup>2</sup> of Baray lost their protected status. Consequently, whilst the BFCAs now receive, in theory at least, a higher level of protection than in their previous form as IFBAs, the area of florican breeding grasslands under protection has decreased by 50% (from 349 km<sup>2</sup> in 2006/7 to 173 km<sup>2</sup> in 2010). Therefore, in 2012 only 22% of the florican population was estimated to occur within BFCAs (20% at Stoung–Chikraeng, 2% at Baray), compared to an estimated 36% within the former IFBA boundaries in 2007 (Gray *et al.* 2009a). Furthermore, the remaining BFCAs are suffering substantial encroachment, with almost 20% of their area under intensive cultivation in 2010 (Mahood *et al.* 2012).

Stoung–Chikraeng BFCA has benefited from active Community Management Committees (CMCs), who value the traditional, low-intensity livelihoods they gain from the grasslands. This strong local network helps ensure that illegal habitat conversion and hunting of floricans are reported and rapid enforcement action is taken. CMCs have now also been established at Baray and Chong Doung BFCAs. To reinforce the value of conservation to local communities, wildlife-friendly rice and community-based ecotourism that have proved successful in other parts of Cambodia (Clements *et al.* 2010) are also being piloted in BFCAs.

Marked population declines have apparently occurred within both protected (e.g. Chong Doung and Baray) and unprotected (e.g. San Kor) sites, in contrast to the population within the formerly protected Kouk Preah Beung Trea (IFBA status in 2006–2008 only), which has apparently remained stable, despite recent extensive dam construction within all four sites. A number of possibilities may contribute to differing population trends among sites. First, satellite-tracking showed that birds from Chong Doung and Baray use an entirely separate non-breeding area with little suitable habitat remaining, compared to those at more northerly floodplain sites (e.g. Stoung–Chikraeng, San Kor, Kruos Kraom), for which suitable non-breeding habitat persists (Packman 2011).



Second, dam construction does not always result in total loss of grassland: patches of grass may remain between the boundaries of concessions, or even within concessions if dams do not hold water or cultivation fails for some other reason. Third, at sites where rice crops are harvested early, it is possible that floricans may use the resulting stubbles and fallows, although this is unconfirmed. However, the persistence of adults displaying in fragmented habitat impacted by agriculture, such as at Kouk Preah Beung Trea, may be misleading. Although breeding productivity is notoriously hard to determine, these areas are likely to be suboptimal for floricans, with (a) impeded drainage that often results in unsuitable dense wet grassland vegetation (Gray *et al.* 2009b), (b) reductions in both burning and grazing that favour scrub growth, and (c) greater human disturbance. As floricans are highly site-faithful, with high survival rates once adult (Packman 2011), these sites may be experiencing a 'lag' before they lose their birds. Without knowledge of breeding productivity, such landscapes should not be accepted as an alternative to extensive intact grassland conservation, although they obviously merit further study.

There are further grounds for concern. Home ranges of floricans are large relative to BFCAs extent. For example, the dry season average 95% kernel is 31 km<sup>2</sup> for males and 43 km<sup>2</sup> for females (Packman 2011), which, despite considerable overlap of individuals' home ranges, suggests that the current BFCAs are too small to support a breeding population that is viable in the longer term (e.g. Stoung–Chikraeng BFCAs is 75 km<sup>2</sup>). Furthermore, dam construction along the Mekong River threatens to modify flooding regimes in the Tonle Sap basin, with reduced extent of floodplain habitats and concomitant changes in land use (Arias *et al.* 2012, Orr *et al.* 2012).

To date, BFCAs have had only partial success, although they represent an important and practical immediate response in the struggle to save the Bengal Florican in Cambodia. However, the 2012 census shows that in its current form this approach is, on its own or at least without further development, insufficient to ensure the long-term survival and recovery of the population. Lessons learned from Stoung–Chikraeng show that, for BFCAs to fulfil their function, greater support for local communities from provincial and national government is needed. Also, the current level of protection of BFCAs through ministerial decree is unlikely to be sufficient to avert the large-scale degazettements and excisions as well as the piecemeal encroachments suffered by the IFBAs, particularly in the face of continued pressure to expand rice irrigation.

### *Recommendations for Bengal Florican conservation*

BFCAs need clearer demarcation, more regular and thorough patrolling, to faster detect encroachment and illegal activities, and better means to resolve these. A key recommendation is that BFCAs should be given the highest level of protection possible under Cambodian law, in the form of a prime-ministerial sub-decree. Although politically complicated, this is legally and practically achievable, and such protection from the country's highest authority would give the best possible chance for a future for Bengal Florican in Cambodia.

To increase the amount of grassland habitat available within BFCAs, efforts should focus on reclaiming land currently under illegal intensive rice cultivation, and on the removal and burning of encroaching scrub, accompanied by research to determine breeding success of floricans and optimal habitat management techniques. If opportunities arise, particularly if farming is abandoned on areas of poorer soil, current BFCAs should be expanded and additional BFCAs should be established (e.g. at San Kor, Kouk Preah Beung Trea and Sangkae–Kompong Pring).

Although contentious, land acquisition both inside and outside existing BFCAs may also be an effective immediate conservation measure, and preliminary land price surveys and legal analyses have already been conducted in 2009 (ACCB and WCS 2009). Outright purchases will require substantial funds and are likely to be limited in size and number, with a lek of ten males commanding a land price in the low millions of dollars. However, such costs reflect the current high agricultural conversion value of florican habitats, emphasising the urgency of decisive action. Conservation concessions (i.e. cultivable land leased and managed for grassland conservation) may be cheaper, but would be less secure and less permanent than outright land purchase. Either

approach will have to be protected from fresh encroachment, requiring political support, community willingness, monitoring and enforcement as for the BFCAs.

Annual population monitoring has now been expanded to San Kor, Kruos Kraom and Kouk Prea Beung Trea, as well as the BFCAs and Veal Srangai, together encompassing 80% of the national population. This fieldwork allows surveillance of habitat conversion across these sites, but monitoring of habitat encroachment at other sites should also be repeated. Whilst 80% of the florican population is located in the south-east quarter of the Tonle Sap, the remaining small populations to the west may hold important genetic diversity and face different levels of threat, so should not be neglected. Breeding areas cannot be considered in isolation, and efforts are needed to secure breeding habitat at sites for which appropriate non-breeding habitat also persists.

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