Short Communication

Attracting white-shouldered ibises to safe roosting sites in Siem Pang Kang Lech Wildlife Sanctuary, Cambodia

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We assessed the roosting preferences of the Critically Endangered white-shouldered ibis *Pseudibis davisoni* and used decoys and played calls to attract the species to novel roost trees in Siem Pang Kang Lech Wildlife Sanctuary, north-eastern Cambodia. In roost assessments, the ibis showed a preference for particular tree species, notably *Dipterocarpus intricatus*. Roost trees were taller, in a more advanced stage of decay and their crowns touched other trees less compared to a matched control sample. Roost trees were also closer to villages than expected by chance. Two trees of differing species were selected that had not previously been used by the ibis, but which met its identified roosting preferences. Ten wooden decoys of white-shouldered ibis were deployed in the crowns of these trees and call playback was used to attract the birds to them. One tree (*D. obtusifolius*) attracted nine white-shouldered ibises over the four months of the experiment, with visits increasing towards the end of the study (September & October, 2016). Subsequently, the species was recorded during opportunistic visits to the same tree in 2018 which retained some of our wooden decoys. We suggest that decoys with or without call playback may be used to attract the white-shouldered ibis, although several months may be required before results are observed.

The global population of the Critically Endangered white-shouldered ibis is estimated at 1,000 individuals, 95% of which are located in northern Cambodia (BirdLife International, 2018). Wright *et al.* (2012a) showed that 74% of the Cambodian population roosted at sites outside of existing protected areas. The white-shouldered ibis roosts communally in large numbers which makes it vulnerable to hunting and protection of communal roosts is central to conserving the species.

Siem Pang Kang Lech Wildlife Sanctuary (SPKLWS) was designated by the Royal Government of Cambodia in May 2016 (Fig. 1). The wildlife sanctuary encompasses a large portion of the Western Siem Pang Important Bird Area (centred on 14°17′ N, 106°27′ E) and suitable deciduous dipterocarp habitat for the white-shouldered ibis. As such, the sanctuary provides an opportunity to protect key roost sites of the species, although at the time of its creation only two of the 22 roost sites known were located within SPKLWS. To address this challenge, we conducted an experiment using decoys and call playback to attract the white-shouldered ibises to suitable roosting sites within SPKLWS where the risk of hunting and disturbance are lower (Kress, 1983; Crozier *et al.*, 2003).

To identify suitable trees for the experiment, we first assessed the characteristics of known roost trees used by the white-shouldered ibis. We recorded their species, height, diameter at breast height, percentage of crown touching another tree and decay stage. Decay stage was characterised using a six-factor level categorical variable modified from Cline *et al.* (1980) and Vonhof & Barclay (1996) (Table 1). To compare roost trees with other trees in the surrounding area which were available but not used, control trees were selected by walking 200 m from each roost tree on a sequential compass bearing of 0, 90,

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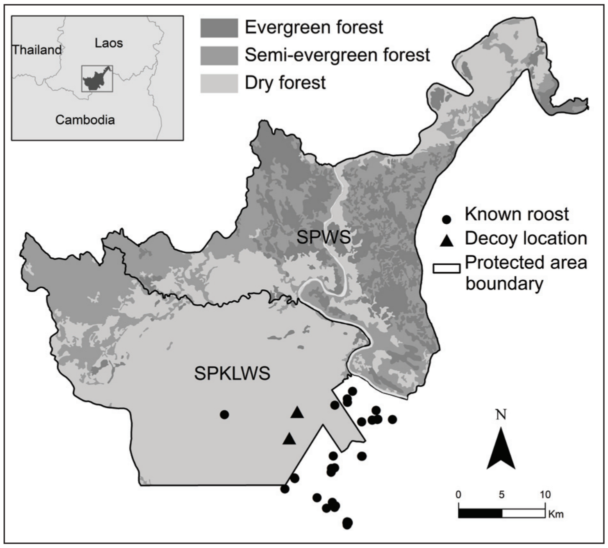

Fig. 1 Siem Pang Kang Lech Wildlife Sanctuary (SPKLWS) and adjoining Siem Pang Wildlife Sanctuary (SPWS), north-eastern Cambodia.

Table 1 Tree decay stages recognized in this study (adapted from Cline *et al.* 1980 and Vonhof & Barclay, 1996).

Factor level	Description
1	Live, healthy; no decay; no obvious defects.
2	Live, usually unhealthy; obvious defects such as broken top, cracks, or hollows present.
3	Recently dead; dead leaves still present, very little decay; heartwood hard.
4	Dead; no leaves, few twigs; top often broken; <50% of branches lost; bark loose; heartwood hard; sapwood spongy.
5	Dead; most branches and bark lost; top broken; heartwood spongy; sapwood soft.
6	Dead; no branches or bark; broken off along mid-trunk; sapwood sloughing from upper bole; heartwood soft.

180 or 270 degrees and selecting the closest mature tree to that location. One matched control tree was selected for each roost tree and assessed in the same way.

We assessed the roost preference of the white-shouldered ibis for different trees using non-parametric methods. A *G* test (Crawley, 2007) was used to compare roost and control trees. More specifically, we compared whether the frequencies of tree species used by the ibis differed significantly from the frequencies of tree species in the random control group (Table 2). Tree height, crown size and decay stage were compared using a Wilcoxon signed ranks test (R Core Team, 2016). The location of each roost tree in suitable habitat was also assessed. The distance of roost sites to villages was calculated in ArcGIS (ESRI, 2011). To determine the mean distance to villages for the forest as a whole (the control group), a regular grid of points with 100 m spacing was created for deciduous dipterocarp habitat within the study area and the distance of each point to the nearest village calculated. Due to the large difference in sample sizes between the roost treatment and control treatment, we used a permutation test with 2,000 Monte Carlo replications to compare the means of the two treatments using the *perm* package in R (Fay & Shaw, 2010; R Core Team, 2016).

We located 43 roost trees regularly used by the white-shouldered ibis at 22 separate sites. Numbers of roost trees per site ranged between one and 12. The species showed a significant preference for roosting in particular dipterocarp species (Table 2), especially *D. intricatus* (Log likelihood ratio statistic $G = 98.2$, $df = 6$, $p = <0.001$). The median height of roost trees was 17.5 m, compared with a median height of 12 m for matched control trees. This difference in tree height was significant ($V = 818.5$, $p = < 0.001$, $n = 43$). The median decay stage for roost trees was 4 and 1 for control trees. This difference in decay stage was also significant ($V = 595$, $p = < 0.001$, $n = 43$). The branches of 38 roost trees were entirely isolated from other trees (e.g., 0% of the tree crown touched other trees). The same was only true for 18 of the matched control trees (which had a median value of 10% of crown touching

Table 2 Tree species used for roosting by the white-shouldered ibis, compared with control tree species.

Species	No. roost trees	No. control trees
Dipterocarpus intricatus	38	9
Dipterocarpus obtusifolius	3	7
Dipterocarpus tuberculatus	0	6
Shorea obtusa	1	11
Catunaregam tomentosa	0	2
Syzygium cumini	1	2
Terminalia chebula	0	6
Total	43	43

Table 3 Characteristics of decoy trees selected and numbers of white-shouldered ibis (WSI) observed at these during the trial.

	Species	Height	Decay stage	% of crown touching	Distance to villages (km)	No. decoys	Sampling occasions	WSI
1	*Dipterocarpus intricatus*	16	2	0	6.9	4	37	0
2	*Dipterocarpus obtusifolius*	20	2	0	4.8	6	38	9

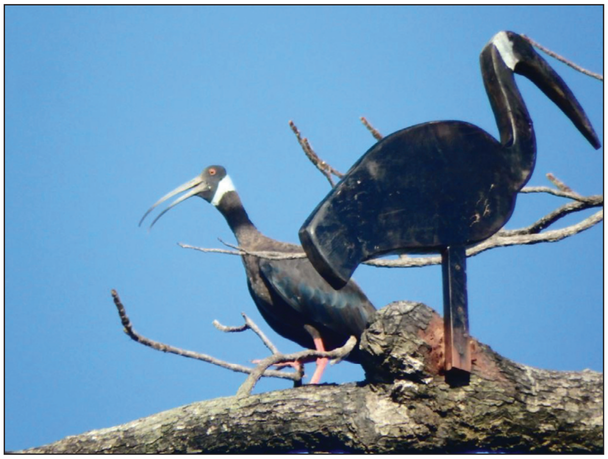

Fig. 2 White-shouldered ibis next to a wooden decoy on the second experimental roost tree, 7 July 2016 (© BirdLife International Cambodia Programme).

Fig. 3 Up to 30 white-shouldered ibis roosting on the second experimental roost tree, 2 July 2018 (© Jonathan Eames).

other trees). Differences between roost and control trees in the percentage of tree crown touching other trees were consequently significant ($V = 39$, $p = < 0.001$, $n = 43$). The mean distance of the 22 independent roost sites to villages was 3.33 km, compared to 9.14 km for the entire area of deciduous dipterocarp forest we surveyed. This difference was also significant ($p = 0.002$).

Using the identified characteristics of roost trees, we selected two trees previously unused by the white-shouldered ibis in SPKLWS. The trees selected were as similar as possible to known roost trees (Table 3). The only limiting factor was that whereas the ibis prefers dead and decaying trees for roosting, we selected trees in a less advanced stage of decay to ensure that their upper reaches could be safely reached by climbers. This being assured, we made 10 decoys of the white-shouldered ibis from wood, painted these to resemble the plumage of the species and attached them to the upper branches of the trees to provide a visual cue to encourage the species to roost there (Feare *et al*., 2015; Fig. 2). The white-shouldered ibis roosts communally, vocalising frequently at dawn and dusk as it leaves and returns to roost sites. To encourage the species to use our two decoy trees, we played call recordings of the ibis (obtained from www.xeno-canto.org/) through a loudspeaker concealed near the base of each tree (Kress, 1983). Playback and monitoring was undertaken at each tree twice a week between 1700 and 1830 hrs from 14 June 2016 to 28 October 2016 to coincide with the period of communal roosting. The call recordings could be heard from 300 to 500 m away.

White-shouldered ibises were subsequently recorded at the second decoy tree (*D. obtusifolius*) (Fig. 2) on six separate occasions. Singletons were observed on three of these occasions, whereas two birds were observed on the remaining occasions. The frequency of visits increased towards the end of the experiment with five visits occurring during the third study month (September). Almost two years later, white-shouldered ibises were recorded during opportunistic visits to the same tree as follows: up to 30 birds on 2 and 3 July 2018 and 18 birds on 4 July 2018 (Fig. 3). Because we ceased call playback in October 2016, the birds observed in 2018 must have relied upon visual cues or memory to return to the roost tree.

We found that the characteristics of known roost trees differed from our matched control trees, but did not attempt to infer which characteristics are most influential in roost tree selection. We simply document that white-shouldered ibises tend to select roost trees which are significantly taller than most trees in the landscape of SPKLWS and that they select *D. intricatus* at a greater frequency than would be expected by chance. They also appear to select roosts closer to villages than would be predicted by chance. It has been hypothesized that the white-shouldered ibis has an association with domestic buffalo because it feeds on invertebrates which are disturbed by the grazing and wallowing behaviour of the latter (Wright *et al.,* 2010; 2012b). Domestic livestock occur in greater density closer to villages and this might explain why roosting sites are located close to villages. Equally, ibises could prefer habitats with intermediate levels of disturbance a short distance from villages. However, we cannot exclude the possibility that our knowledge of roost trees may be spatially biased. Put simply, roost sites closer to villages are more likely to be known because these areas are more intensively used by people.

Our comparisons are limited because we were only able to employ decoys and call playback at two trees. We also acknowledge our lack of data for random control trees with similar characteristics to our experimental trees. White-shouldered ibises were not recorded at our first experimental tree which represented its preferred roost species (*D. intricatus*), but were recorded at the second tree which was larger, closer to human habitation and a different species (*D. obtusifolius*). Because optimal roost trees have likely declined in the landscape due to selective logging, it is possible that roost trees now used by the species represent the most favoured trees out of those that remain. Notwithstanding this, our partial success in attracting white-shouldered ibis to novel roost trees suggests that decoys and call playback have some utility in this respect. The increased frequency of visits towards the end of our experiment also suggests that these may need to be employed for significant periods before birds visit a desired location. However, it should be noted the effective distance from which it may be possible to divert birds using call playback will depend to some extent on the volume of the loudspeaker employed. We also acknowledge that we took a risk in conducting the study because our methods could be observed and copied by local hunters.

We are aware that decoys and call playback have been used to encourage breeding in the Critically Endangered Chinese crested tern *Sterna bernsteini* on the Mazu Islands of Taiwan (BirdLife International, 2013), and that acoustic enrichment techniques employed at the Bronx Zoo, New York, increased breeding success in a captive colony of the Critically Endangered northern bald ibis *Geronticus eremita* (Clark *et al.,* 2012). To our knowledge however, our study is the first attempt to use decoys and call playback to encourage modified roosting behaviour in the Critically Endangered white-shouldered ibis.

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Robin Loveridge was a technical advisor for the BirdLife International Cambodia Programme between 2014–2016 and holds a BSc (Hons) in Biology from the University of Bristol and a Master of Research in Ecology, Evolution and Conservation from Imperial College, London. He is currently studying a PhD at the University of York (UK) on barriers to achieving development and conservation in tropical forest management in Tanzania.

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Jonathan Eames has worked for BirdLife International in Southeast Asia for over 25 years, establishing conservation programmes in Vietnam, Cambodia and Myanmar and creating 10 new protected areas in Vietnam and three in Cambodia. He currently works as senior technical advisor for the BirdLife International Cambodia Programme and leads conservation activities at Siem Pang Wildlife Sanctuary and Siem Pang Kang Lech Wildlife Sanctuary. Jonathan holds a BA (Hons.) in Development Studies from the University of East Anglia (UK) and was appointed as an Officer of the Order of the British Empire for his services to biodiversity conservation in 2011.