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Camera trapping rare and threatened avifauna in west-central Sumatra

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Summary

Tropical forests are becoming increasingly degraded and fragmented by logging, which can affect the survival of forest bird species in different ways. In this study, we present avifauna data collected from a monitoring programme in west-central Sumatra that set camera traps in three study areas with different habitat types, levels of degradation and protection status. From 5,990 camera trap-nights, 248 independent bird photographs were recorded, comprising four orders and nine species, including three endemic species. The Great Argus Pheasant (*Argusianus argus*) was recorded in all study areas and most frequently (n = 202 photographs), followed by the threatened Salvadori's Pheasant (*Lophura inornata*). The greatest diversity of bird species (five) and abundance index (1.44 bird photographs/100 trap-nights) was recorded from a primary hill-submontane forest site located inside Kerinci Seblat National Park (KSNP) bordering degraded forest in a former logging concession recently repatriated into KSNP. However, inside a primary-selectively logged hill-submontane forest site spread over KSNP and an ex-logging concession, a Sumatran Ground Cuckoo (*Carpococcyx viridis*) was photographed. This species is noteworthy because prior to this study it had only been documented once since 1916. It is therefore crucial to use the camera trap results to increase the protection status for the ground cuckoo area. This has already happened in the other two study areas, where camera trap data have been used to reclassify the areas as Core Zones, the highest level of protection inside KSNP. This study illustrates how routine monitoring can have wider benefits through recording, and conserving, threatened and endemic non-target species in unexpected habitats that might not otherwise have been surveyed.

Introduction

Tropical forests are becoming increasingly degraded, fragmented and isolated by commercial logging, illegal logging and agricultural expansion. Clearance of forests typically occurs in lowland areas first, because this forest is more accessible and contains high-quality timber trees. Whilst lowland forests contain some of the highest levels of global biodiversity, many tropical forest protected areas (PAs) have been created in higher elevation forests that have less commercial value. Consequently, many important areas of biodiversity remain outside PAs, although they may remain connected to forest patches inside PAs. In Asia, the majority of lowland forest has already been degraded through commercial logging operations. Whilst intact forest may be preferable from a conservation perspective, selectively logged and disturbed forest can still contain important components of avian biodiversity that warrant its protection (BirdLife International 2004). The question then is how to determine the conservation value of such areas.

Biodiversity surveys have been shown to be a cost-effective use of conservation funds (Balmford and Gaston 1999). However, most tropical countries often lack financial and human resources even to systematically or regularly survey large PAs, let alone areas outside PAs. Even when resources are available, surveying may be difficult due to terrain and the difficulty in detecting focal species which may be cryptic and live at low densities (Linkie *et al.* 2006, McDonald 2004). Therefore, incidental records from surveys conducted for other purposes may be of great value. A case in point is Kerinci Seblat National Park (KSNP) in west-central Sumatra.

The *c.* 13,300 km^2 KSNP is recognized as an Important Bird Area due to its vast size and extensive altitudinal range (200–3,805 m) that encompasses lowland, hill, submontane and montane forest types (BirdLife International 2005). The avian diversity in KSNP and adjacent areas comprises over 380 species, which include 17 of the 20 Sumatran endemics (Holden 2002). Seven of these endemics are known from photographs taken by automatically triggered camera traps set in the forest (Holden 2002), illustrating the potential for using camera traps to record terrestrial bird species. In this study, we present the avifauna data collected from camera trapping conducted within a tiger and prey monitoring programme that focused on three habitat types with different levels of degradation and protection status.

Methods

Over 2 years, camera traps were placed in three study areas:

Study Area 1: Primary submontane forest inside KSNP with an altitudinal range of 947–1,941 m a.s.l. (mean 1,194 m). Twenty-six cameras were active from 3 September to 30 November 2004.

Study Area 2: Primary hill/submontane forest bordering an ex-logging concession inside KSNP with an altitudinal range of 694–1,254 m a.s.l. (mean 901 m). Twenty-eight cameras were active from 3 January to 29 March 2005.

Study Area 3: Primary-secondary hill forest site spread over an ex-logging concession and KSNP with an altitudinal range of 363–1,745 m a.s.l. (mean 829 m). A total of 36 cameras were placed over two adjoining sites within this single study area, of which nine were inside KSNP. Twenty-one camera placements were active from 16 April to 15 July 2006 and then 15 new camera placements were active from 9 August to 23 November 2006.

Photoscout™ camera units that contained a heat and motion sensor, activated by a warm-blooded animal moving past, were used during this study. Cameras were set to record medium- to large-bodied mammals and were placed approximately 1 m off the ground and 2–2.5 m from the focal area of interest, thereby allowing a sufficient distance to also record small animals, such as mouse deer and small rodents. From these surveys, existing animal trails and areas where natural channelling of animal movements occur were chosen and camera traps set. Across the study area, camera traps were placed with a spacing $\geq$1,500 m and visited every 2 weeks to replace their film and check their maintenance. For each study area, we calculated the number of days that each camera trap was operational in the field, which produced the number of trap-nights. Next, for each camera, the number of independent records for each bird species was calculated. We defined ''independent'' as any individual species that was not photographed twice within 30 minutes at the same camera placement. For each study area, the encounter rates of bird species, individually and in combination, at each camera placement were calculated as the number of photographs per 100 trap-nights.

For bird species with a sufficient number of records (i.e. $n > 20$), Kruskal-Wallis tests were performed using SPSS v.13 software (SPSS, Chicago, IL, USA) to investigate whether their encounter rates at each camera trap placement significantly differed across the three study areas and, if so, Mann-Whitney *U*-tests were performed to determine which study areas differed from each other.

Finally, the mean elevation and range values were extracted for each species record using ArcView v3.2 geographic information system software (ESRI, Redlands, CA, USA). The digital elevation data were obtained from the Shuttle Radar Topography Mission (Rabus *et al.* 2003), which were converted into a raster format within ArcView and geo-referenced using the UTM 47s coordinate system within the WGS84 datum.

Results

The total numbers of trap-nights recorded from study areas 1, 2 and 3 were 1,560, 1,680 and 2,750, respectively. From the combined 5,990 camera trap-nights, 248 independent bird photographs, comprising four orders and nine species, including three endemic species, were recorded (Table 1). The greatest number of bird species (five) and abundance index (1.44 bird photographs/100 trap-nights) was recorded in study area 2. The Great Argus Pheasant was recorded most frequently (n = 202 photographs) and in all study areas, followed by the threatened Salvadori's Pheasant that was recorded in all three study areas (n = 31). In study areas 1, 2 and 3, Great Argus Pheasant represented 23%, 89% and 87% of all bird species records, respectively.

There was no significance difference in encounter rates for Salvadori's Pheasant among study areas ($n = 90$, $\chi_2^2 = 0.274$, $P = 0.87$). For Great Argus Pheasant, encounter rates were significantly different between study areas ($n = 90$, df = 2, $\chi_2^2 = 11.02$, $P = 0.004$), with lower encounter rates in study area 1 relative to study area 2 ($n = 54$, Mann_Whitney $U = 201.5$, $Z = -3.36$, $P = 0.001$) and study area 3 ($n = 62$, Mann_Whitney $U = 353.0$, $Z = -2.18$, $P = 0.029$), There were no differences between areas 2 and 3 ($n = 64$, Mann_Whitney $U = 412.0$, $Z = -1.39$, $P = 0.166$).

The Great Argus Pheasant and Salvadori's Pheasant were recorded over the greatest altitudinal range, and both Salvadori's Pheasant and Blue Whistling Thrush were recorded at the highest elevation (1,451 m a.s.l.; Table 2).

Table 1. Photographic bird records (no.) and encounter rates (ER; photographs/100 trap-nights) from three study areas in and around Kerinci Seblat National Park, west-central Sumatra.

Species	Order	IUCN Red List status	Records	Study area 1		Study area 2		Study area 3	
				No.	ER	No.	ER	No.	ER
Great Argus Pheasant *Argusianus argus*	Galliformes	Near Threatened	202	6	0.38	108	6.43	88	3.20
Salvadori's Pheasant *Lophura inornata*[a]	Galliformes	Vulnerable	31	17	1.09	9	0.54	5	0.18
Blue Whistling Thrush *Myophonus caeruleus*	Passeriformes	Least Concern	1	1	0.06	0	0.00	0	0.00
Bronze-tailed Peacock-Pheasant *Polyplectron chalcurum*[a]	Galliformes	Least Concern	8	2	0.13	0	0.00	6	0.22
Ferruginous Partridge *Caloperdix oculeus*	Galliformes	Near Threatened	1	0	0.00	1	0.06	0	0.00
Crested Partridge *Rollulus rouloul*	Galliformes	Near Threatened	1	0	0.00	1	0.06	0	0.00
Rhinoceros Hornbill *Buceros rhinoceros*	Coraciiformes	Near Threatened	2	0	0.00	2	0.12	0	0.00
Rufous-collared Kingfisher *Actenoides concretus*	Coraciiformes	Near Threatened	1	0	0.00	0	0.00	1	0.04
Sumatran Ground Cuckoo *Carpococcyx viridis*[a]	Cuculiformes	Critically Endangered	1	0	0.00	0	0.00	1	0.04
All recorded species	–	–	248	26	1.67	121	7.20	101	3.67

[a]Endemic.

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Table 2. Elevation records for avifauna from three study areas in and around Kerinci Seblat National Park, west-central Sumatra.

Species	Elevation (m) Mean (range)
Great Argus Pheasant	808 (523–1,030)
Salvadori's Pheasant[a]	1250 (969–1,451)
Blue Whistling Thrush	1,451
Bronze-tailed Peacock-Pheasant[a]	1,164 (1,127–1,275)
Ferruginous Partridge	776
Crested Partridge	979
Rhinoceros Hornbill	969
Rufous-collared Kingfisher	553
Sumatran Ground Cuckoo[a]	1,119

[a]Endemic.

A noteworthy record from this study was a Sumatran Ground Cuckoo (*Carpococcyx viridis*) photographed at 1,119m a.s.l. in study area 3 (Table 2). Two photographs, obtained within 2 minutes of each other, were taken of this Critically Endangered Sumatran endemic (Figure 1).

Discussion

This study has shown the benefits of routine monitoring for collecting location data on some difficult to detect, rare and threatened bird species, from habitats where they might not have been expected or otherwise surveyed. Despite cameras being set for tigers and their prey, we still recorded some interesting bird species, such as the Sumatran Ground Cuckoo and Salvadori's

Figure 1. Sumatran ground cuckoo, *Carpococcyx viridis*, recorded on 18 May 2006 in degraded forest adjacent to the Kerinci Seblat National Park border, west-central Sumatra.

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Pheasant. The camera trap method applied in this study could be used as part of a wider bird survey to assess priority areas for conservation across Indonesia, especially if complemented with camera trap data from other studies.

Camera trapping as a tool for assessing avifauna

Great Argus Pheasant was the most commonly photographed bird species in our study. In KSNP, the call of this species is also one of the most commonly heard bird calls and, so, camera trapping would not need to be used as a primary survey method for this species. However, Salvadori's Pheasant was the second most photographed species in our study and, like the Ferruginous Partridge that was also recorded, is not easy to detect from calls. For certain bird species, camera trapping can produce useful data and does hold the potential as a bird survey technique. Holden (2002) photo-trapped two bird species that were previously unknown from KSNP: the Giant Pitta (*Pitta caerulea*) that, hitherto, had not been reliably recorded from Sumatra; and the Sunda Thrush (*Zoothera andromedae*), which is a very difficult bird to survey, either by sight or by call.

In our study, three unexpected species were recorded: Rhinoceros Hornbill; Rufous-Collared Kingfisher; and the Sumatran Ground Cuckoo. Two other species that we expected to record but did not were Schneider's Pitta (*Pitta schneideri*) and Banded Pitta (*Pitta guajana*). The absence of these species may be a result of cameras being set for tigers and not specifically for pittas, i.e. not focusing more on the undergrowth. The nature of our camera placements, predominantly on main ridge and animal trails, would probably limit any inferences made about species composition from each study area. However, comparing species abundance indices across study areas would be possible because all placements were made in a similar way, i.e. along ridge and animal trials. Thus, any biases in camera placement that existed within one study area would have existed in the other study areas.

An assumption made in this study was that our trapping rate index related to absolute bird abundance (Williams *et al.* 2002). To calibrate this functional relationship would require the collection of independent measures of bird densities, which we did not have. This is a possible limitation of this study, so caution is needed if trying to interpret the results in a wider context than our study areas. However, from camera trap data collected in southern Sumatra, O'Brien *et al.* (2003) found a relationship between the abundance index (species photographs/100 trap-nights) for medium- to large-bodied animals, which included Great Argus Pheasant, and respective absolute abundances (species/km^2).

Avifauna in west-central Sumatra

Terrestrial foraging guild birds, such as pheasants and ground cuckoos, are reported as being sensitive to selective logging (Lambert and Collar 2002), which is possibly linked to them living at naturally low densities due to their relatively large and/or heavy body sizes. Still, Great Argus Pheasants, Bronze-tailed Peacock-pheasants and a Sumatran Ground Cuckoo were all recorded in the mosaic of primary-logged hills forests from study area 3. Great Argus Pheasant abundance was significantly higher in study area 3 (3.20 photographs/100 trap-nights) than in the primary submontane forest from study area 1 (0.38 photographs/100 trap-nights). Similarly, from southern Sumatra, higher Great Argus Pheasant abundance was recorded in more human-disturbed forests (O'Brien *et al.* 2003).

Terrestrial birds tend to feed on large invertebrates and small vertebrates that live on the forest floor. Whilst the effect of selective logging on this food source is unclear, such activities will open up forest areas and cause changes in microclimate (e.g. humidity, temperature) and resources (e.g. woody debris). Selective logging in Malaysian Borneo and Uganda had no apparent effect on the composition or richness of dung beetles (Holloway *et al.* 1992, Nummelin

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and Hanski 1989), a possible pheasant or ground cuckoo food source. A possible explanation for the Sumatran Ground Cuckoo record might be that this species, like the Bornean Ground Cuckoo (*Carpococcyx radiatus*), will follow foraging wild boar, which can maintain higher densities in degraded-secondary forests, that may inadvertently disturb potential invertebrate prey (Long and Collar 2002).

The Sumatran Ground Cuckoo record

The discovery of the ground cuckoo is encouraging. With little known about the distribution and abundance of this species, its vulnerability to selective logging is also unknown. The Sumatran Ground Cuckoo record was from a 2,970 km^2 area of contiguous forest that extends into KSNP, with no impassable natural barriers. Within this forest area, 2,573 km^2 occurs within the ground cuckoo's known altitudinal range of 300–1,880 m a.s.l. (BirdLife International 2001). Our new record from 1,119 m a.s.l. is therefore consistent with previous records. This species discovery represents only the third record since 1916. A 1997 record and a 2007 record were both from southern Sumatra (Zetra *et al.* 2002, WCS 2007). The 1997 rediscovery was from primary forest 100 m from a coffee farm, which suggests that this species may be tolerant to low levels of human disturbance. However, a more pernicious factor threatening the avifauna of Indonesia is the substantial demand created by the domestic bird trade (Jepson and Ladle 2005).

Conserving avifauna in west-central Sumatra

Reports from KSNP have found that amongst hunters and bird-trappers the Sumatran Ground Cuckoo was not well known (Holden 1997), possibly because this species is rare and therefore difficult to find or because it has an unpleasant taste and is therefore not targeted (Long and Collar 2002). However, the other terrestrial bird species recorded in this study may be more vulnerable to poaching. In 2004, the forest crime most commonly encountered by the KS-Tiger Protection and Conservation Units was the poaching of song birds and ground birds, with some 41 incidents being recorded (Martyr and Nugraha 2004).

Across Sumatra, the effects of forest fragmentation, and subsequent isolation of smaller remnant patches are considered to adversely affect a greater number of bird species than the forest degradation caused by selective logging (Lambert and Collar 2002). Numerous tropical studies have documented lag times in avifauna extinctions in disturbed forests (see Sodhi *et al.* 2004 for a review).

From our study, all the terrestrial species recorded are known to be intolerant to forest conversion for agriculture. This deforestation is much higher across the Kerinci Seblat region (-396.6 km^2/yr) than inside KSNP (-85.6 km^2/yr; M. Linkie unpubl. data). These deforestation patterns create an uncertain future for the protection of the study area 3 outside KSNP, where the ground cuckoo, along with a number of other threatened or endemic mammal species, were found. Camera data collected in study areas 1 and 2 have already been used by the Indonesian Department of Forestry to officially designated these areas as Core Zones inside KSNP, affording them the highest protection status. Swift action is needed to secure an official conservation status for the section of study area 3 that lies outside of KSNP. However, for study area 3 and other PAs in Indonesia, the conservation of critically endangered and endemic species will also require strong law enforcement to mitigate both bird poaching and agricultural encroachment, and the political will to do this.

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