

Is Edwards's Pheasant *Lophura edwardsi* extinct in the wild?

JONATHAN C. EAMES & SIMON P. MAHOOD

Edwards's Pheasant *Lophura edwardsi*, endemic to the lowland forests of central Vietnam, is considered Critically Endangered. There has been no confirmed record of the species since 2009 and it may be extinct in the wild. All available evidence indicates that Edwards's Pheasant has a restricted geographic range and is an extreme lowland forest specialist. Remaining native forest in the range of Edwards's Pheasant is almost entirely to be found above 300 m, on very steep slopes and/or on karst outcrops, and therefore unsuitable for the species. Forest fragmentation and logging may cause changes to the habitat and make it more suitable for Edwards's Pheasant's congeners, leading to increasing likelihood of hybridisation and thus further contributing to the species's decline. Trapping is the major anthropogenic threat to the species. Camera-trapping is the most cost-effective way of detecting the species. The protected areas established for the species are all recommended for re-survey. The possible extinction of Edwards's Pheasant in the wild is a stark warning of potential galliform extinctions where habitat is highly fragmented and snaring prevalent.

INTRODUCTION

Edwards's Pheasant *Lophura edwardsi*, endemic to the lowland forests of central Vietnam, is classified as Critically Endangered (BirdLife International 2017). There has been no confirmed record of the species since 2009 and it may be extinct in the wild. The paucity of data, both historical and recent, concerning its distribution, status and habitat requirements hinders conservation planning. Recent research has at least clarified its taxonomic status. We present the most comprehensive published list of records to date and re-examine the data to clarify the species's historical distribution and its preferred habitat. We compare the microhabitat in which it appears to have been found with habitats in which two sympatric congeners were found and conclude that virtually all suitable habitat has been lost, and that intense hunting within its limited range could have already extirpated it from the wild. We suggest the locations where the species might continue to survive and therefore where future searches, which could help avert its extinction or support a re-introduction, should be focused.

BirdLife International (2001) included comprehensive summaries of the published records of Edwards's Pheasant and Vietnamese Pheasant *L. hatinhensis*, both classified as Endangered at that time, when the taxonomic relationship between them and Imperial Pheasant *L. imperialis*, then classified as Data Deficient, had not been clarified. Combining and tabulating these BirdLife International (2001) data by re-checking the original sources and adding recent data (Appendix 1) provides an updated comprehensive listing of all the known records of these three forms. A summary of key elements of these data follows in the species accounts.

SPECIES ACCOUNTS

Edwards's Pheasant *L. edwardsi*

Edwards's Pheasant was described by Oustalet (1896) and historically recorded from Vinh Linh, Quang Tri province, south to the Hai Van pass, Thua Thien Hue province, a north–south distance of about 150 km and an east–west distance of as little as 54 km. From 1935, there were no records of the species for 61 years until a record in August 1996 in what later became Phong Dien Nature Reserve, Thua Thien Hue province. Subsequent records to the end of 1998 are well documented. There was a record in May 2000 but no more until late 2009, when a Vietnamese newspaper reported a captive male with a deformed bill, apparently found near Bac Huong Hoa Nature Reserve, Quang Tri province (Dan Tri 2009a). Also in late 2009 a female, possibly of this species, was confiscated from a hunter

on the Hai Van pass near Hue, Quang Tri province (Dan Tri 2009b). BirdLife International field survey effort in central Vietnam was reduced after 2000 and the next dedicated survey—3,552 camera-trap days at two sites—did not take place until 2011; this failed to find the species (Grainger 2011) and subsequent camera-trap surveys have also failed (M. Grainger pers. comm. 2016).

Imperial Pheasant *L. imperialis*

Imperial Pheasant *L. imperialis* was described in 1924 from a live pair obtained from missionaries, reportedly having been captured either on the northern boundary of Quang Tri province or at Dong Hoi in Quang Binh province, near the Quang Tri border, slightly north of the known range of Edwards's Pheasant (Delacour & Jabouille 1924, 1925); consequently, the provenance of these birds is not clear. Today Dong Hoi is the capital of Quang Binh province; however, contemporary evidence suggested that this location might not be accurate (Eames & Ericson 1996). At the time of its discovery, the Imperial Pheasant was described as local and scarce and was considered to replace Edwards's Pheasant in northern parts of Annam, central Vietnam (Delacour & Jabouille 1925). There are only three other field records of Imperial Pheasant (Appendix 1). Hennache *et al.* (2003) showed it to be a hybrid of Edwards's Pheasant and Silver Pheasant *L. nycthemera*. This *in situ* hybridisation between two sympatric and congeneric species suggests the overall rarity of Edwards's Pheasant even in the 1920s; as the species became increasingly rare, individuals unable to locate a conspecific mate looked elsewhere. Equally, these hybrids might have originated from areas at the edge of Edwards's Pheasant's geographic range (although the recent records did not), where hybridisation opportunities might be expected to be greater.

Vietnamese Pheasant *L. hatinhensis*

In 1964 the third similar form was discovered and was named Vietnamese Pheasant *L. hatinhensis* by Vo Quy (1975). It might appear curious that it was not discovered earlier, when there was extensive collection in central Vietnam in the 1920s and 1930s (e.g. Delacour & Jabouille 1924, 1931, Eames & Ericson 1996), although there was little collecting activity in that period in what is today Ha Tinh province, where most Vietnamese Pheasants were recorded. After its discovery, there were few records until 1987–1995 (Appendix 1), when several were found during focused searches; since then there have been very few, the last being in 1999 (BirdLife International 2001). All but one of the records of Vietnamese Pheasant are from north of the range of Edwards's Pheasant. The exception was a male found in 1999 near the Huong River, 15 km south of Hue, Thua Thien Hue province, almost at

the southern limit of the range of Edwards's Pheasant *sensu lato* (BirdLife International 2001, Hennache *et al.* 2012). This single record throws serious doubt on the validity of the taxon, which has been variously viewed as a full species, a subspecies of Edwards's Pheasant, or an unknown taxon. Hennache *et al.* (2012) proposed that it is a result of inbreeding in Edwards's Pheasant because the highly inbred captive population of Edwards's Pheasant occasionally produces individuals with white tail- or wing-feathers phenotypically classifiable as Vietnamese Pheasant. Records of wild Vietnamese Pheasant could therefore reflect severe inbreeding resulting from the isolation of tiny relict subpopulations of Edwards's Pheasant (Hennache & Ottaviani 2005), which is consistent with observed habitat loss and fragmentation throughout the species's range.

DISTRIBUTION AND STATUS

Edwards's Pheasant ranged from southern Quang Binh province south to Hai Van pass, Thua Thien Hue province (see above). Delacour & Jabouille (1925) saw a male Edwards's Pheasant fly over the road at 480 m at the top of Hai Van pass. This record requires further consideration because seeing a *Lophura* pheasant in flight is in itself an exceptional event as running to dense cover, rather than flying, is the default escape strategy. The validity of this sight record is therefore questionable. This record is the most southerly of all but surely, if the location is accurate, cannot mark the southernmost limit of its range as apparently suitable habitat extends on the south-facing slopes of the pass. All other records that include altitudinal data are from below 300 m in broadleaf evergreen forest (BirdLife International 2001). The upper altitudinal limit was revised by Delacour (1977) to 900 from 600 m (Delacour & Jabouille 1931) for unknown reasons, and there is no evidence that the species occurs at these higher altitudes (Eames *et al.* 1992, 1994). The absence of records or credible reports of Edwards's Pheasant from higher altitudes makes it unlikely that the species occurred above 300 m.

The historical status of Edwards's Pheasant is difficult to assess because of the small number of records and because most historical opinions are contradictory and compromised by their reliance on second-hand reports of unknown reliability or by the possibility that searches were made in unsuitable habitat. Edwards's Pheasant was collected in at least eight localities. As stated in BirdLife International (2001), 10 skins and 22 live specimens were collected by trapping during Delacour's first expedition to Vietnam in 1923 (Delacour & Jabouille 1925). Delacour first described Edwards's Pheasant as 'rare' (Delacour & Jabouille 1925) but later described the species as 'not common' [= uncommon] in its limited range in central Annam [= central Vietnam] (Delacour *et al.* 1928), and lastly as 'fairly common' around Hue and Tourane (Da Nang) [= central Vietnam] (Delacour 1977). He qualified this as follows: '...we have seen wild Edwards's Pheasant on only two occasions during several months collecting; these were in localities where dozens of birds were trapped in nooses placed at openings in low brushwood fences, built by the natives across the slopes to catch ground birds...' (Delacour 1977), which we feel indicates that it was locally common.

Between 1990 and 1995 the Vietnamese Pheasant was found to be locally common in Ke Go Nature Reserve, Ha Tinh province (Eames *et al.* 1994); in contrast, extensive searches around that time elsewhere in central Vietnam failed to find it or locate very much lowland forest (Robson *et al.* 1989, Eames *et al.* 1992, 1994).

The lack of records of Edwards's Pheasant from 1935 to 1996 (Appendix 1) coincided with a period of no published survey effort. Later records, including those of Vietnamese Pheasant, indicate that since its discovery the distribution of Edwards's Pheasant contracted only slightly, if at all, in the south and has been extended (through improved knowledge) to Ha Tinh province in the north (BirdLife International 2001). However, all recent confirmed records away

from the contiguous Phong Dien and Dakrong Nature Reserves, located either side of the Thua Thien Hue–Quang Tri provincial border, have been of Vietnamese Pheasant.

Since the late 1990s, the only three records from outside this core area are the male Vietnamese Pheasant captured 15 km south of Hue, near the Huong river, Huong Thuy district, Thua Thien Hue province, in 1999, and two birds of uncertain identity (Appendix 1). One of these was captured in May 1998 in secondary forest just north of Bach Ma National Park (Huynh Van Keo 2000); however, neither the sex nor the age of the bird appears to have been recorded, making the assessment of this record difficult. The other, a juvenile male caught in Bao Ninh district, Quang Binh province, in 1998 or 1999 (JCE pers. obs.), cannot be assigned to a taxon because the white tail-feathers defining the Vietnamese Pheasant typically appear only after the first or even second adult moult (Hennache *et al.* 2012).

The decline in the number of records of Edwards's Pheasant during the 1990s and 2000s correlates with a decline in survey effort. Survey effort increased after 2011, although the species has not been found (Grainger *et al.* 2011, M. Grainger pers. comm. 2015).

Edwards's Pheasant, a humid lowland forest specialist?

The level lowland forest of the coastal plain of central Vietnam has been entirely converted to irrigated rice cultivation. This happened as part of the historic southward movement of the Vietnamese people, a process referred to as Nam Tiến (Advancing South) (Brown 1991). Although ongoing for several centuries, this landscape-level conversion was nearing completion when Delacour first visited the region in 1923. Delacour wrote, '...along the sea the plain is generally sandy with low vegetation, then come rich paddy-fields, and beyond low thick bush which is cut down nearly every year. This is all that remains of the primeval forest...' (Delacour & Jabouille 1925). He also noted that forest still remained close to the sea at Vinh Linh, from where the species was collected (Delacour & Jabouille 1925). Today the landscape at this location consists entirely of paddyfields (JCE pers. obs.). Remaining native forest in the range of Edwards's Pheasant is almost entirely above 300 m, on very steep slopes and/or on karst outcrops. One obvious possibility that the paucity of recent records raises is that Edwards's Pheasant has very specific habitat requirements, which were most commonly found in the now deforested foothills and adjacent level or slightly undulating lowlands; this is consistent with the documented altitudinal records.

Central Vietnam is unique in the Indo-Burma region in supporting three sympatric species of *Lophura*, all inhabiting broadleaved evergreen forest. Edwards's Pheasant, for example, was said to inhabit the exceedingly damp forests of the mountains at low and moderate altitudes on the eastern slopes of the Chaine Annamitique (Delacour & Jabouille 1925). It is possible that the distribution of all three extant *Lophura* species is governed by topography, humidity and rainfall, and forest structure. The habitat use of the two widespread species, Silver Pheasant and Siamese Fireback *L. diardi*, is fairly well known. Madge & McGowan (2002) give the altitudinal range of Silver Pheasant as up to 2,200 m, and in Laos, Vietnam and Cambodia down to 300 m in places. Away from the coastal plain, much of central Vietnam is mountainous, and Silver Pheasant is by far the most frequently and widely recorded *Lophura* species there (JCE pers. obs.). Siamese Fireback inhabits drier monsoon forests than Silver Pheasant, up to about 800 m (Madge & McGowan 2002), and is therefore common in parts of Laos and Thailand (Round 1988, Thewlis *et al.* 1998) which have seasonally lower rainfall and a marked dry season, but it is scarce and perhaps localised in Vietnam east of the Annamite Mountains. In Khao Yai National Park, Thailand, Siamese Fireback has extended during recent years into submontane areas where Silver Pheasant formerly predominated, coinciding with increasing temperatures and decreasing rainfall (and therefore decreasing humidity) there,

perhaps caused by global warming (Round & Gale 2008, Sukumal *et al.* 2010). This suggests that humidity (presumably through effects on vegetation, soil and leaf-litter) defines the fine-scale distribution of these two species.

The restricted distribution of Edwards's Pheasant coincides with a region of generally high year-round humidity and very high rainfall. This pattern was noted by Delacour & Jabouille (1925) who wrote, 'There is no dry season, but rain is much more abundant in September, October and November.' Much of the forest east of the Annamite Mountains is humid throughout the year, whereas most forest west of the watershed has a pronounced dry season with lower rainfall, another fact noted by Delacour & Jabouille (1925). It is the 'ever-wet forest' which provides the additional niche that allows this area to support the third sympatric *Lophura* species, Edwards's Pheasant. Consistent with this, Hennache (2001) considered that Edwards's Pheasant was the only pheasant species in captivity that seemed to like rain, and Delacour (1977) reported that the species inhabited 'exceedingly damp forests'.

The limited data available suggest that the three *Lophura* species in central Vietnam do not naturally occur in the same microhabitats, although they can occupy the same forest block. At Son Tung, Ha Tinh province, Siamese Fireback was found in degraded scrubby woodland whereas Edwards's Pheasant was only recorded in secondary forest (Robson *et al.* 1989); Siamese Fireback was not found in the part of Khe Net, Quang Binh province, where Edwards's Pheasant was found (Eames *et al.* 1994). This suggests that Siamese Fireback has greater ecological plasticity and is able to tolerate very degraded forests in a way that Edwards's Pheasant cannot. The larger-bodied fireback might also be displacing (or have displaced) Edwards's Pheasant in recently degraded forests. At higher altitudes Silver Pheasant is widespread, with many records from very degraded habitats; increasing forest degradation and fragmentation might allow it to expand its range downslope and displace Edwards's Pheasant or hybridise with it.

The restriction of Edwards's Pheasant to lowlands has probably hindered its crossing the Annamite passes at altitudes of 500 m and above into Laos, but in any case wet evergreen forest below 500 m is very rare in Laos; the only area found and visited so far forms a mosaic with seasonally dry forest (Duckworth *et al.* 2010). Even in places which have a marked dry season, forest in areas where the cloud-base is at a moderate altitude tend to have a much less severe dry season (approaching the ever-wet forest in humidity). Surveys in both Laos and Vietnam in the Annamites at the latitudinal range of Edwards's Pheasant have been extensive enough to make it reasonably certain that it does not inhabit such areas. This is consistent with the suggestion above that the core habitat of Edwards's Pheasant was the lowlands, which, before deforestation, was an extensive area of habitat to which it was the best adapted of the three congeners.

Edwards's Pheasant has the smallest known distribution of the species that define the Annamese Lowlands EBA, presumably owing to its habitat preferences, discussed above. There are no Edwards's Pheasant records from south of the Hai Van pass. Historically, bird collecting effort south of this pass was very small in low-altitude forest there, and few modern bird surveys have been carried out. In principle, Edwards's Pheasant might be found south of its known range, but south of the pass low-altitude forest is generally drier, so if the above reasoning is correct, the species is unlikely to occur. It is equally unlikely to occur much to the north of its known range, where most remaining broadleaved evergreen forest is on karst. There is no evidence that it inhabits forest on limestone, and some karst areas close to the known range of Edwards's Pheasant (e.g. Phong Nha Ke Bang National Park) have been relatively well surveyed, indicating that it is absent from such areas.

All available evidence, albeit fragmentary, suggests that Edwards's Pheasant only ever occurred in level lowland forest below 300 m in central Vietnam.

THREATS

Habitat modification and loss

The largest forest tracts now remaining within Edwards's Pheasant's range are in northern Quang Tri and the adjacent Quang Binh provinces, the source of most specimens; some forest survives at locations where birds were not collected historically, even below 300 m. However, even if forest formerly occupied by the species survives, it may no longer be suitable. Patches of very humid forest in a matrix of less humid forest may retain high humidity only when that matrix is large. Forest fragmentation and structural alteration caused by the use of defoliants in the Vietnam War and widespread subsequent logging, expansion of tree plantations, agricultural intensification and human population growth in the hills above the now deforested coastal plain, have overwhelmed this part of Vietnam (BirdLife International 2001). Moreover, the forest matrix around patches suitable for Edwards's Pheasant will contain Silver Pheasants which, given the small numbers of Edwards's Pheasants, may result in hybrid 'Imperial Pheasants'. Thus, although other species of *Lophura* evidently do not require large habitat blocks, some at least persisting in naturally small patches of less than 10 km² (Brickle *et al.* 2008), it is unsafe to assume that the same is true for Edwards's Pheasant. Similarly, although many of its congeners persist in degraded habitat, and there are even records of Edwards's Pheasant from such habitat (Eames *et al.* 1994), there is no reason to assume that it can survive in such forest in the long term. If correct, the above speculations make the extent of remaining superficially suitable lowland forest in Edwards's Pheasant's range deceptively optimistic.

Hunting and trapping

Trap density in central Vietnam's forests is markedly higher than the regional average. For example, a camera-trap survey in Bac Huong Hoa Nature Reserve, Quang Tri province, was hampered because each apparently suitable camera-trap location already held a wire snare (BirdLife in Indochina 2008). Elsewhere in Indochina, blocks of habitat exceeding about 500 km² may hold a central area requiring so much time and effort to reach that hunting pressure is lower than in more accessible areas (authors' observations in many areas). But within Edwards's Pheasant's range, forest blocks are now so small that access to their centre is easy and the largely non-selective techniques used are still employed as long as any marketable ground fauna survive. Because Edwards's Pheasant overlaps in distribution and habitat preferences with more hunting-tolerant species such as Red Junglefowl *Gallus gallus*, Leopard Cat *Prionailurus bengalensis* and Lesser Chevrotain *Tragulus kanchil*, it is implausible that snaring will be abandoned as insufficiently rewarding while any Edwards's Pheasants survive (BirdLife International 2001).

CONSERVATION PRIORITIES

Survey area selection

The most pressing conservation priority for Edwards's Pheasant is an intensive search for a wild population. The Khe Net area, Quang Binh province, and adjacent to Ke Go Nature Reserve, Ha Tinh province, might seem a priority survey area because it held a population of the Vietnamese Pheasant in the mid-1990s. However, this area has suffered from extremely heavy hunting, uncontrolled logging and forest loss despite being the subject of a conservation project (Willcox *et al.* 2015). All the Edwards's Pheasants recorded there in the 1990s appear to have been in an area of less than 1 km², despite the surveying of a greater area of forest at that site; nothing particularly special about the habitat in the specific area where the birds were found was noted (Eames *et al.* 1994). Even if inbreeding depression, or continuation of the factors that isolated the population in the first place, have not doomed this population, densities of other terrestrial avian species

have declined dramatically. In 1994 the survey team set 55 snares which in one week (385 trap-days) caught one Vietnamese Pheasant, two Grey-capped Emerald Dove *Chalcophaps indica*, one Coral-billed Ground Cuckoo *Carpococcyx renauldi*, four partridges *Arborophila* sp. and three pittas *Pitta* sp. (Eames *et al.* 1994). In contrast, a camera-trap survey targeting small carnivores carried out in a similar area of the same forest over 1,343 trap-days between 2006 and 2010 recorded only eight individual birds: one Red-collared Woodpecker *Picus rabieri*, one Red Junglefowl, two Grey-capped Emerald Doves and three Orange-headed Thrushes *Geokichla citrina* (Willcox *et al.* 2015). It should be noted that, with the exception of Red Junglefowl, none of the bird species recorded are predominantly terrestrial and are therefore less vulnerable to snaring. The site has evidently lost almost all large- and medium-bodied terrestrial birds during the last 20 years.

With time now running out to find a population, a method of prioritising remaining forest patches likely to hold Edwards's Pheasant for survey is needed. One option is interview surveys, but these face difficulties of ensuring that discussion is about Edwards's Pheasant, not the various similar species that inhabit the same general area (Thewlis *et al.* 1998, N. Wilkinson pers. comm.). The subspecies *beli* of Silver Pheasant in much of central Vietnam, as well as Siamese Fireback and Coral-billed Ground Cuckoo, are all dark-plumaged and are therefore likely to be confusing species for interviewees. Grainger *et al.* (2017) have prioritised survey areas with historical records based on their present-day habitat characteristics and identified the Khe Net and Khe Go Nature Reserves as the areas of greatest priority for survey.

Survey methods

Designing a suitable survey for Edwards's Pheasant is a major challenge. Many galliform species are surveyed using vocalisations but, as is typical of *Lophura* species, Edwards's Pheasant is not known to vocalise loudly. An alarm call similar to other *Lophura* species is known and displaying males advertise by wing-whirring, only audible at close range. There are limited reports of other sounds from captive birds, e.g. in Hanoi Zoo at the start of the breeding season, during February and March '...two males sometimes produced special calls [unfortunately not described], informing the other of their territory...' (Dang 1997). A. Hennache (pers. comm. 2012) also describes a high-pitched vocalisation by Edwards's Pheasant: 'the male screams shortly and often prior to breeding and at the beginning when the hen is laying, usually with rapid wing flapping', and notes that 'sometimes the male walks around the female clucking, almost like calling but much softer'. Obtaining good recordings of this call, so that surveyors (a) at least have the advantage of knowing what it sounds like, and (b) can try to broadcast it in the hope that it might trigger audible responses, is a priority. The lack of a known far-carrying and species-diagnostic vocalisation may have greatly reduced the chances of detecting the species during the 1990s surveys; detections relied on opportunistic sightings, snaring birds or material held by hunters.

Some 1990s searches for Edwards's Pheasant successfully used wire snares (Eames *et al.* 1994), but these have not been employed subsequently. The 2011 Edwards's Pheasant survey used camera-traps; in 3,552 trap-days no images of Edwards's Pheasant were obtained. Camera-trapping was set up in two areas, Dakrong Nature Reserve, Quang Tri province, and Khe Nuoc Trong Watershed Protection Forest, Quang Binh province, below 400 m, avoiding steep slopes, with trap-sites separated by up to 500 m (based on assumptions about home-range size); cameras were left in place for a minimum of 40 nights (Grainger 2011). Camera-trapping is known to be an effective method for detecting both Silver Pheasant and Siamese Fireback, and therefore it is likely to be effective for detecting Edwards's Pheasant. A lack of Edwards's Pheasant records from a camera-trap site can safely be assumed to indicate that the species is either absent or present at an extremely low density.

Camera-trap surveys for Edwards's Pheasant should be set up in 'ever-wet forest' in level lowlands below 300 m. Locations where other *Lophura* species, especially Siamese Fireback, have been recorded with certainty should be avoided, because this species occupies a totally different niche. Pheasants can be baited to specific sites; grain soaked in aniseed oil is used by gamekeepers to attract pheasants to feeders, whilst mealworms are used by photographers to attract pheasants in Malaysia; their efficacy at increasing detections of pheasants at camera-traps should be evaluated. Because Edwards's Pheasant's microhabitat-use is unknown, camera-traps should be placed in a wide variety of locations using, if practicable, local trappers whose claims to have experience of trapping Edwards's Pheasant appear plausible. Indeed, finding a population of Edwards's Pheasant is so important that the possibility of joining teams of (illegal) professional hunters using snares should be considered.

Edwards's Pheasant might be located more efficiently by using dogs trained to find nests or even incubating adults. Dogs have been trained to find birds' eggs or adult birds such as kiwis *Apteryx* (Robertson & Fraser 2009). At all pheasant nests located using dogs, feather samples could be taken for DNA analysis to confirm the identification, and a camera-trap could be placed to record the outcome of the nest.

Conservation measures

Conservation action during the 1990s resulted in the establishment of three new protected areas for Edwards's Pheasant, at sites from which the species had been confirmed: Ke Go, Dakrong and Phong Dien Nature Reserves (Le Trong Trai *et al.* 1999a,b). Later a protected area was established at a fourth site, Bac Huong Hoa Nature Reserve, from where it has been reported (BirdLife in Indochina 2008). Recently it has been recommended that Ke Go Nature Reserve together with Bach Ma National Park should be re-surveyed (Grainger *et al.* 2017). We propose that all these sites are now re-surveyed.

An action plan for Edwards's Pheasant was recently developed which recommended conservation management of the captive population and hinted at reintroduction (Pham & Le 2015). Reintroduction of Edwards's Pheasant is an option, because there is a captive population of up to 1,000 birds (M. Grainger *in litt.* 2017). Eames (1996) stated that reintroduction was at that time inappropriate, because the principal cause of decline (deforestation) remained. Twenty years later the rates of forest loss have declined and the landscape has stabilised. A reintroduction project has begun in Khe Nuoc Truong Watershed Protection Forest which also involves a novel forest lease dimension. However, Edwards's Pheasant has not been confirmed from the site. Camera-traps have confirmed that Silver Pheasant and Siamese Fireback do occur there (Le Trong Trai pers. comm.).

Snaring remains a major issue in Vietnam and how to address this, even within a privately leased forest concession, is unclear as the mandate for law enforcement remains with state bodies. Preventing the extinction or decline of endemic and threatened species in state-managed protected areas has proved difficult in Vietnam (Brook *et al.* 2012). In the interim, optimal management of the captive stock of Edwards's Pheasant, which is already inbred, is vital (Hennache *et al.* 2012); these may be the only remaining birds.

CONCLUSIONS

Edwards's Pheasant may be extinct in the wild, although the 2009 record provides hope that it remains extant. Any remaining population is likely to be small, highly fragmented and at risk of inbreeding depression, owing to an almost complete loss of suitable habitat.

Although it was not found on very recent surveys, these may have targeted the wrong locations, as evidenced by the presence of

Siamese Fireback in areas that were camera-trapped. It is possible that areas of suitable habitat in its historical range have not been surveyed recently or even evaluated for suitability. All the protected areas where the species was recorded historically should be re-surveyed. If feasible, playback of calls and the use of dogs may represent the best chances of locating wild Edwards's Pheasant, but would be relatively expensive, time-consuming and logistically complex. Therefore, lower-cost methods such as camera-trapping should be used. The possible extinction of Edwards's Pheasant from the wild is a stark warning of the potential for galliform extinctions where habitat is highly fragmented and snaring prevalent.

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- Jonathan C. EAMES**, BirdLife International Cambodia Programme, PO Box 2686, Phnom Penh, Cambodia.
Email: jceames@birdlife.org
- Simon P. MAHOOD**, Wildlife Conservation Society Cambodia Program, PO Box 1620, Phnom Penh, Cambodia.
Email: smahood@wcs.org

Appendix 1.

A summary of the records of Edwards's, Vietnamese and Imperial Pheasants in chronological order.

Where data similar to that in BirdLife International (2001) is concerned, we refer to the source material which predates that publication.

Key: EP = Edwards's Pheasant; IP = Imperial Pheasant; VP = Vietnamese Pheasant; M = male; F = female; U = unknown; Juv = juvenile; C = confirmed (records with a specimen, image or first-hand report); N = unconfirmed (second-hand reports without supporting data). AMNH = American Museum of Natural History, New York; BMNH = British Natural History Museum (now known as NHMUK); FMNH = Field Museum of Natural History, Chicago; MCZ = Museum of Comparative Zoology, Boston Mass.; MNHN = Museum National d'Histoire Naturelle, Paris; IEBR = Institute of Ecology and Biological Resource, Hanoi; BLI 2001 = BirdLife International (2001).

Note that individuals in Hanoi Zoo (mostly *L. hatinhensis*) without date or locality data are excluded.

Date	Form	Number	Location (with altitude where known)	Data	C/N	Source
1895	EP	U several	About 30 km north of Hue, Quang Tri province	Collected	C	Oustalet (1896)
1895	EP	U several	About 50 km north-west of Hue, Quang Tri province	Collected	C	Delacour (1977)
1922	EP	2U	Hai Lang, Quang Tri province	Unknown	N	P. Jabouille's notebook, in Ciarpaglini & Hennache (1997)
1922	EP	1M	Vinh Linh, Quang Tri province	Unknown	N	P. Jabouille's notebook, in Ciarpaglini & Hennache (1997)
November 1923	EP	1M	Huong Hoa district, Quang Tri province	Collected	C	Specimen in BMNH (BLI 2001)
December 1923	EP	1M	Cam Lo, Quang Tri province	Collected	C	Specimen in BMNH (BLI 2001)
February 1924	EP	1M	Huong Hoa district, Quang Tri province	Collected	C	Specimen in MNHN (BLI 2001)
March 1924	EP	1F	Cam Lo, Quang Tri province	Collected	C	Specimen in BMNH (BLI 2001)
May 1924	EP	2M	Mai Lanh (Hai Lang?), Quang Tri province	Collected	C	Specimens in MNHN (BLI 2001)
1924	EP	1M	Hai Van pass, Thua Thien Hue province (480 m)	Seen in flight over road	C	Delacour & Jabouille (1925)
1924	IP	1M, 1F	Probably Quang Tri province, near Quang Binh provincial border	Obtained from missionaries, sent to France	C	Delacour & Jabouille (1924)
January 1925	EP	1M	About 30 km north of Hue, Quang Tri province	Collected	C	Specimen in BMNH (BLI 2001)
April 1925/26	EP	1M	About 30 km north of Hue, Quang Tri province	Collected	C	Specimen in MNHN (BLI 2001)
July 1925/29	EP	1M	Mai Lanh (Hai Lang?), Quang Tri province	Collected	C	Specimen in MNHN (BLI 2001)
November 1925	EP	1M	Lang Khoai village, Quang Tri province	Collected	C	Specimen in AMNH (BLI 2001)
December 1925	EP	1M	About 30 km north of Hue, Quang Tri province	Collected	C	Specimen in MCZ (BLI 2001)
December 1927	EP	1M	About 30 km north of Hue, Quang Tri province	Collected	C	Specimen in MNHN (BLI 2001)
May 1928	EP	1M	About 30 km north of Hue, Quang Tri province	Collected	C	Specimen in FMNH (BLI 2001)
November 1929	EP	2M	Lang Khoai village, Quang Tri province	Collected	C	Specimens in BMNH (BLI 2001)
1929	EP	1F	Unknown	Collected	C	Specimen in AMNH (BLI 2001)
1935	EP	1F	Unknown	Collected	C	Specimen in BMNH (BLI 2001)
1964	VP	1M	Son Tung, Ky Son commune, Ky Anh district, Ha Tinh province	Collected	C	Vo Quy (1975)
April 1974	VP	1M	Ky Thuong commune, Ky Anh district, Ha Tinh province	Collected	C	Dang Huy Huynh <i>et al.</i> (1974)
December 1987	VP	2M	Ky Thuong commune, Ky Anh district, Ha Tinh province	Hunted remains found	C	Robson <i>et al.</i> (1989, 1991)
January–February 1990	VP*	11M, 2F	Ke Go NR c.12 km west of Cat Bin, Ha Tinh province	Snared by hunter	C	Robson <i>et al.</i> (1993)
February 1990	IP	1M	Ke Go NR c.12 km west of Cat Bin, Ha Tinh province (50–100 m)	Captured, died, specimen retained	C	Specimen in IEBR Robson <i>et al.</i> (1991, 1993)
April 1990	VP	2M, 2F	Minh Hoa district, Quang Binh province	Captured, sent to Hanoi Zoo	C	Rozendaal (1991)
1991	IP	1M, 1F	Khe Map Reng, Ky Anh district, Ha Tinh province	Snared by hunter	N	Nguyen Cu & Eames (1993)
April 1992	VP	1F, 1 chick	Bau Mon, Ky Thuong district, Ha Tinh province	Trapped	N	Nguyen Cu & Eames (1993)
May 1992	VP	1M	Gat Che Me valley floor, Ky Thuong district, Ha Tinh province	Trapped, photographed	C	Nguyen Cu & Eames (1993)
June–July 1994	VP	2–3M, 1F, 4–5 Juv	Khe Net watershed, Quang Binh province (200–300 m)	Seen/caught	C	Eames <i>et al.</i> (1994)
April 1995	VP	1M	Ke Go NR c.12 km west of Cat Bin, Ha Tinh province	Seen	C	P. Alström, U. Olsson & D. Zetterström in litt. (2000)

Date	Form	Number	Location (with altitude where known)	Data	C/N	Source
August 1996	EP	1M, 1F	Khe Lau (16.500°N 107.200°E) in forest area of Phong My commune, Phong Dien district, Thua Thien Hue province (300–400 m)	Trapped by hunters, died, specimen in Bach Ma NP HQ	C	Eames (1997)
October 1996	EP	1M	Same location as August 1996 record above	Trapped by hunters, released	N	Garson (1997)
December 1996	EP	1M	Kreng village, Huong Hiep commune, Dakrong district, Quang Tri province	Trapped by hunters, sent to Hanoi Zoo	C	Dang Gia Tung (1997)
January 1997	VP	1M	Ke Go NR, at Rao Cai, Ha Tinh province	Trapped by rattan collectors	N	Le Sau in litt. (1997)
December 1997	EP	4U	Ba Long valley, Ba Long commune, Dakrong district, Quang Tri province (50–300 m)	Trapped by hunters	N	Le Trong Trai <i>et al.</i> (1999b)
1997–1998	EP	2U	Dong Che area, Dakrong district, Quang Tri province	Trapped by hunters	N	Le Trong Trai <i>et al.</i> (1999b)
1997–1998	EP	8–10U	Dong Che area, Dakrong district, Quang Tri province	Seen by hunters	N	Le Trong Trai <i>et al.</i> (1999b)
May 1998	U	1U	Loc Dien commune, near Bach Ma NP, Phu Loc district, Thua Thien Hue province	Captured	N	Huynh Van Keo (2000)
1998–1999	U**	1M (juv)	In the west of Bao Ninh district, Quang Binh province	Collected	C	JCE pers. obs.
1999	VP	1M	15 km south of Hue, near the Huong river, Huong Thuy district, Thua Thien Hue province	Trapped by rattan collectors	C	JCE pers. obs.
February 2000	IP	1M (juv)	Trieu Nguyen commune, Dakrong district, Quang Tri province	Captured	C	BLI 2001
March 2000	EP	2M, 1F, + 4 eggs	My Chanh river, Hai Lang district, Quang Tri province; one male later captive in the District Forest Protection Dept., Quang Tri province	Captive bird seen, others reported by rattan collectors	C	A. Tordoff pers. comm. (2000)
Late 2009	EP	1M	Near Bac Huong Hoa NR, Quang Tri province	Captive bird photographed	C	Dan Tri (2009a)
Late 2009	U***	1F	Hai Van pass, Thua Thien Hue province	Confiscated, photographed	N	Dan Tri (2009b)

* Partly confirmed. Of these birds, only the legs and heads of two males and several bundles of feathers were examined. See Robson *et al.* (1993), p.31.

** This individual was identified as Edwards's Pheasant. However, it was a juvenile, and in this plumage the Vietnamese Pheasant is said to be indistinguishable.

*** The identity of this bird has never been confirmed, and it was released without samples of feathers or blood being taken; some consider it to be an Edwards's Pheasant and some a Silver Pheasant.