

The importance of Vu Quang Nature Reserve, Vietnam, for bird conservation, in the context of the Annamese Lowlands Endemic Bird Area

J.C. EAMES, R. EVE and A.W. TORDOFF

Summary

Vu Quang Nature Reserve, Vietnam, was brought to the attention of the world scientific community following the discovery of two previously undescribed large mammal species in the early 1990s. In light of the identification of other sites of high biodiversity value in the Annamite mountains of Vietnam and Laos, the relative importance for biodiversity conservation of Vu Quang needs to be reassessed. In this paper we evaluate the importance of the site for bird conservation, in relation to 13 other protected areas in the Annamese Lowlands Endemic Bird Area (EBA) and present species lists for all 14 sites. Whilst Vu Quang supports one of the highest numbers of recorded bird species of all 14 protected areas, a complementarity analysis revealed that Vu Quang does not fall within the critical subset of sites necessary to conserve 95% of the avifaunal diversity of the EBA. The site should not, therefore, be considered a regional bird conservation priority. Furthermore, of the nine restricted-range species known from the Annamese Lowlands EBA, only three are known from Vu Quang, which is not, therefore, a priority site for the conservation of endemic bird species. We also evaluate the conservation status of the avifauna of Vu Quang, and propose potential conservation measures to enhance its importance for bird conservation.

Introduction

In 1992, the attention of the world scientific community was focused on Vu Quang Nature Reserve, Ha Tinh province, Vietnam following the discovery of a previously undescribed large mammal species, *Saola Pseudoryx nghetinhensis* (Vu Van Dung *et al.* 1993). This discovery, together with that of Giant Muntjac *Megamuntiacus vuquangensis* in 1994 (Do Tuoc *et al.* 1994), led to the creation of Vu Quang Nature Reserve, and a global publicity campaign that succeeded in mystifying the site (Eve *et al.* 1998). The idea of Vu Quang as a “lost world” and a high conservation priority was seared in the consciousness of the conservation community.

Since the discoveries at Vu Quang, biodiversity surveys have been conducted at a number of other sites in the Annamite mountains of Vietnam and Laos, many of which have also proven to be rich in biodiversity (Eve *et al.* 1998). In the light of these recent survey results, there is a need to re-evaluate the relative importance of Vu Quang for the conservation of biodiversity. The purpose of

this paper is to evaluate the importance of Vu Quang for bird conservation, in the context of the Annamese Lowlands Endemic Bird Area (EBA).

Study area

Biogeographical setting

Vu Quang Nature Reserve lies in North Annam, subunit 05c of the Indo-Malayan biogeographical realm, comprising the northern Annamite mountains of Vietnam and Laos and the coastal plain of Vietnam between the Hai Van pass and the Red River (MacKinnon 1997). The classification developed by MacKinnon (1997) was based on that of Udvardy (1975), who subdivided the Indo-Malayan Realm into 27 units and included Vu Quang in unit 4.5.1 (Indochinese Rainforest).

Vu Quang is situated in the Annamese Lowlands EBA, one of three EBAs in Vietnam (Stattersfield *et al.* 1998). Nine restricted-range species occur within the EBA, of which five are confined to it (Stattersfield *et al.* 1998) (Table 1).

Geographical setting

Vu Quang Nature Reserve (18°09'–18°27'N, 105°16'–105°35'E) covers 54,000 ha, including a strict protection area of 39,000 ha, and a forest rehabilitation area of 15,000 ha. The eastern boundary lies on the coastal plain, some 50 km from the South China Sea, while the northern, western and southern boundaries are loc-

Table 1. Status and habitat of restricted-range bird species in the Annamese Lowlands Endemic Bird Area (EBA)

Species	Global status (BirdLife International 2001)	Occurrence in other EBAs	Altitude range (m asl)	Habitat
Annam Partridge <i>Arborophila merlini</i>	Not evaluated	0	0–600	Lowland evergreen forest
Imperial Pheasant <i>Lophura imperialis</i>	Data deficient	0	0–200	Lowland evergreen forest
Edwards's Pheasant <i>Lophura edwardsi</i>	Endangered	0	0–600	Lowland evergreen forest
Vietnamese Pheasant <i>Lophura hatinhensis</i>	Endangered	0	0–200	Lowland evergreen forest
Crested Argus <i>Rheinardia ocellata</i>	Vulnerable	2	0–1,500	Lowland and montane evergreen forest
White-cheeked Laughingthrush <i>Garrulax vassali</i>	Least concern	1	600–900	Evergreen forest edge and secondary habitats
Short-tailed Scimitar Babbler <i>Jabouilleia danjoui</i>	Near threatened	1	50–900	Evergreen forest
Sooty Babbler <i>Stachyris herberti</i>	Near threatened	0	c.200	Lowland evergreen forest on limestone karst
Grey-faced Tit Babbler <i>Macronous kelleyi</i>	Least concern	1	50–700	Lowland evergreen forest

ated in the Annamite mountains, the latter following the international border with Laos. The nature reserve is located in Huong Son and Huong Khe districts of Ha Tinh province, and covers 9% of the land area of the province (Eve 2000).

Vu Quang incorporates lowlands and mountains and is ecologically diverse. The landscape can be broadly divided into three sections: river valleys, hills and mountains. The main river valleys are those of the Nam Truoi, Rao No and Khe Tre rivers, whose headwaters rise in the nature reserve. The topography of the north-east is characterized by plains and hills, from 30 to 600 m, while the south and west of the nature reserve is mountainous. The highest point is Mount Rao Co at 2,286 m (Eve 2000).

At low altitudes, the landscape is largely anthropogenic, including human habitation, irrigated and non-irrigated agricultural land (including tree crop plantations), bare land, grassland and scrub. Patches of natural forest remain on steep and inaccessible slopes, and isolated stands of trees and bamboo along rivers and streams. At medium altitudes, deeper within the nature reserve, the landscape consists of open secondary forest, and other seral forest formations. Between 100 and 500 m, much of the forest has been selectively logged. Above 500 m, the slopes are covered by primary forest (Eve 2000).

Vegetation

There are five major forest types at Vu Quang (Eve 2000). Lowland evergreen forest (100–300 m), which formerly covered much of the nature reserve, is found in the north and north-east. Lower montane evergreen forest (300–1,000 m) covers the centre of the nature reserve, with small patches in the north and north-east. Medium montane evergreen forest (1,000–1,400 m) occupies a narrow strip, stretching from the west to the south-east. Upper montane evergreen forest (1,400–1,900 m) is found on steep slopes and ridges, in the south-west and south. In the southernmost part of the nature reserve, between 1,900 and 2,200 m, there are patches of elfin forest. The remainder is covered by a range of secondary vegetation types.

Rainfall

Average annual rainfall is 2,418 mm in Huong Khe district and 2,390 mm in Huong Son district. The highest rainfall occurs in September and October, but the number of rainy days per month is remarkably regular over the year, ranging from 11 to 18 days in Huong Son, and from 10 to 18 days in Huong Khe (Eve 2000).

Methods

Field surveys

A bird species list for Vu Quang Nature Reserve was compiled from the results of several field surveys. The first multidisciplinary biodiversity survey was in May 1992 (MacKinnon and Vu Van Dung 1992). Although no specific localities are mentioned, the montane species included on the bird list suggest the survey

team traversed a wide altitudinal gradient. MacKinnon and Vu Van Dung (1992) used direct observation and identification of calls to record most species, and used 20-species lists in order to generate curves showing the cumulative number of bird species recorded against the number of lists made (MacKinnon and Phillips 1993). They also interviewed hunters and examined trophies in their possession.

The first specific ornithological survey was undertaken in June 1994 by staff from BirdLife International, in collaboration with the Species Survival Commission of IUCN (Eames *et al.* 1994, Lambert *et al.* 1994). Since the aim of this survey was to identify areas supporting populations of endemic *Lophura* pheasants, only lowland forest south of Kim Quang village was surveyed. Pre-existing trails were walked, particularly from dawn until late morning (*c.* 11h00) and from *c.* 14h00 until dusk, and birds were identified using direct observation assisted by playback of species' calls. In addition, local hunters were interviewed by showing them illustrations of species, and they were encouraged to present feathers and skins of birds they had trapped or shot. Local hunters were also employed to set non-lethal trap lines, composed of up to 50 snares across the forest floor, and blood samples were collected from trapped galliformes (Lambert *et al.* 1994).

From July to September 1997, a joint expedition by staff from the Vietnam–Russia Tropical Centre (VRTC) and the Institute of Ecology and Biological Resources (IEBR) collected bird specimens using mist-nets and identified species by direct observation while slowly walking trails or from fixed points. The survey team visited four sites: primary and secondary montane forest between 1,200 and 1,400 m; primary lower montane forest between 600 and 800 m; seral forest formations along the Con River between 200 and 300 m; and anthropogenic habitats around Huong Dai village between 100 and 150 m (Kalyakin and Korzun 1997).

As part of the WWF Indochina Programme-Vu Quang Conservation Project, a joint BirdLife/WWF mission surveyed montane forest between 1,000 and 2,200 m on the border with Laos, between 2 and 15 July 1999, using direct observations, assisted by playback of species' calls (Eames and Eve 1999). Observations were made while walking pre-existing trails and while surveying the canopy from an exposed hill-top. Observer effort was concentrated at higher elevations in the upper montane and elfin forest zones.

During 1998 and 1999, additional species were added to the list of the nature reserve opportunistically in the anthropogenic habitats around the nature reserve headquarters (Eve unpubl. data).

Comparison with other protected areas in the Annamese Lowlands EBA

The bird species list for Vu Quang was compared with species lists from 13 other protected areas within the Annamese Lowlands EBA. These comprise Bach Ma, Ben En and Cuc Phuong National Parks; Dakrong, Ke Go, Phong Dien, Phong Nha, Pu Huong, Pu Hoat, Pu Mat and Xuan Lien Nature Reserves in Vietnam; and Him Namno and Nakai Nam Theun National Biodiversity Conservation Areas (NBCAs) in Laos (Figure 1). It should be noted, however, that observer effort was not constant across these sites; Nakai Nam Theun NBCA, and Vu

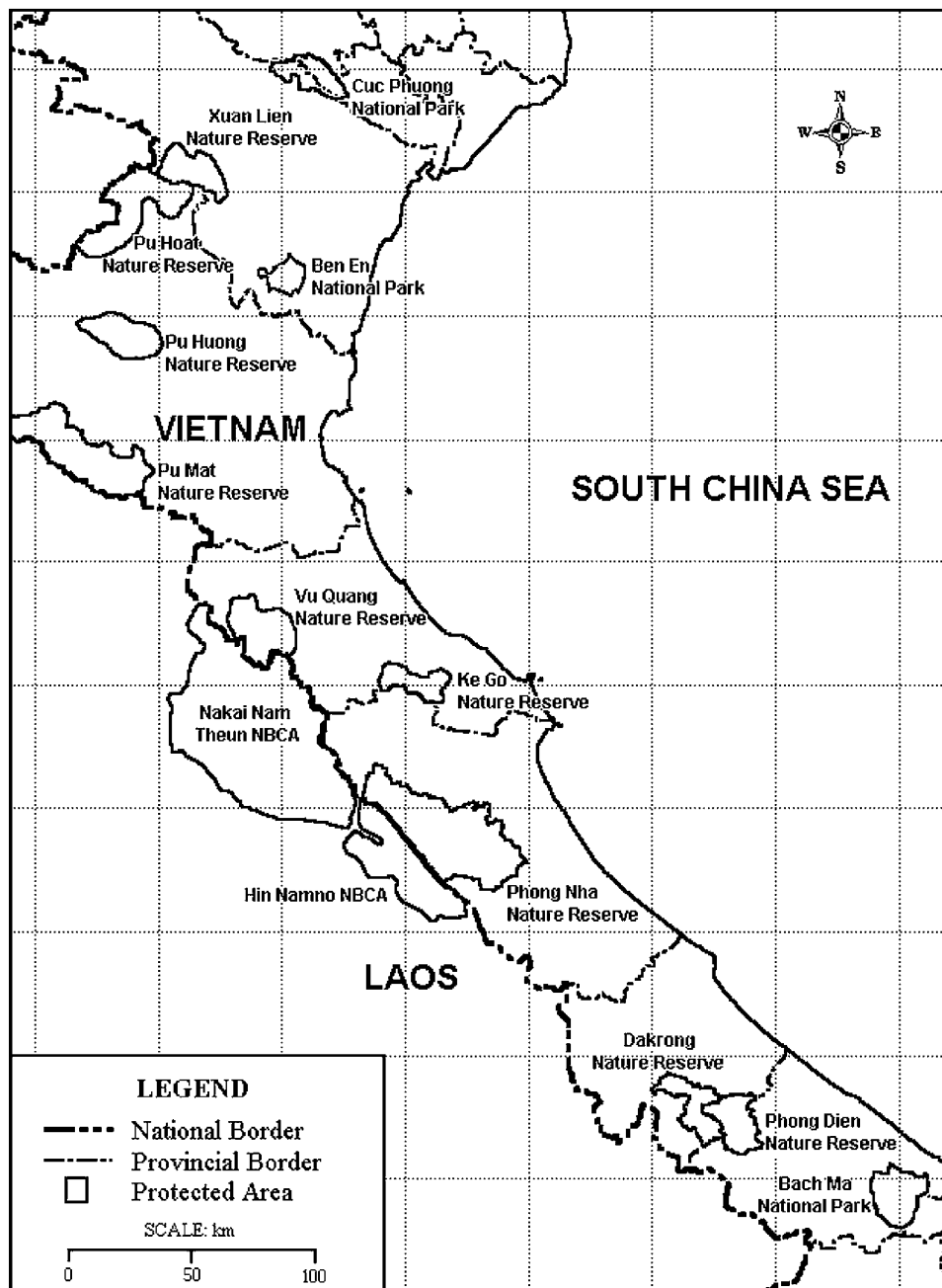


Figure 1. Location of protected areas mentioned in the text.

Quang, Ke Go and Pu Mat Nature Reserves in particular have received a disproportionately high amount of survey effort compared with other sites.

Complementarity

To evaluate the importance of Vu Quang Nature Reserve for bird conservation at regional and national levels, complementarity analyses were undertaken for all protected areas within the Annamese Lowlands EBA, all protected areas within biogeographical subunit 05c, all Vietnamese protected areas within the Annamese Lowlands EBA, and all Vietnamese protected areas within biogeographical subunit 05c. In complementarity analysis, the site with the largest number of species is first selected from any given set of sites. Sites which add the greatest number of further species are then included in a stepwise fashion, until 95% of all species known from the set are incorporated. This exercise enables conservation planners to select an optimum subset of critical sites.

Similarity

The degree of similarity between the bird species composition of Vu Quang Nature Reserve and those of the 13 other protected areas was measured using Sorenson's Similarity Index (Magurran 1988). This index is given by the formula:

$$C_s = \frac{2j}{(a+b)}$$

Where: j is the number of shared species between two areas; a is the number of species in area A; and b is the number of species in area B.

Results

Avifauna

The 1992 survey recorded a total of 211 bird species, including 13 that were not observed or heard but only reported by villagers (MacKinnon and Vu Van Dung 1992). The 1994 BirdLife/IUCN survey generated a list of 125 taxa (123 species) seen or heard (Eames *et al.* 1994, Lambert *et al.* 1994). The VRTC/IEBR expedition collected 138 specimens and, in total, recorded 170 taxa, of which 169 were identified to species level (Kalyakin and Korzun 1997). Finally, the 1999 BirdLife/WWF survey identified 110 taxa (107 species; Eames and Eve 1999). Taking all previous research into account, 274 bird species are currently known from Vu Quang Nature Reserve, including 13 known only from anecdotal reports. Of these, 214 (78%) are forest dependent. The remaining 60 are species of open country and wetlands, although some species within this category are tree nesting. Of the 214 forest-dependent species, 196 are residents and 18 are migrants, whereas of the 60 open country/wetland species, only 24 are residents, and 36 are Palearctic migrants.

Notes on selected species

This section includes all known records of the 12 species confirmed to occur at Vu Quang Nature Reserve that are considered to be restricted-range species

(Stattersfield *et al.* 1998) and/or globally threatened or near threatened (BirdLife International 2001). Additionally, an account is included for Green Peafowl *Pavo muticus*, the occurrence of which at Vu Quang has yet to be confirmed.

Chestnut-necklaced Partridge *Arborophila charltonii* Near Threatened
During 1994, this species was observed and heard on several occasions in low-land forest south of Kim Quang village: a pair were heard on 3 June; a single bird was trapped and prepared as a cabinet skin on 5 June; three or four pairs were also heard on 5 June; a single bird was heard on 6 June; and one bird was trapped on 14 June (Eames unpubl. data, Eames *et al.* 1994, Lambert *et al.* 1994).

Siamese Fireback *Lophura diardi* Near Threatened
This species was reported by hunters in 1992 (MacKinnon and Vu Van Dung 1992) and reported with uncertainty by hunters at Kim Quang village on 2 June 1994 (Eames unpubl. data). A male was seen in secondary scrub along the road north of Sao La camp on 21 August 1997 (Kalyakin and Korzun 1997).

Crested Argus *Rheinardia ocellata* Vulnerable; Restricted Range
During the 1992 survey, this species was heard calling regularly and a male was observed on a display ground from which leaves had been cleared from an estimated 25%. The authors also reported that this species was subject to hunting and was shy and difficult to observe (MacKinnon and Vu Van Dung 1992). Feathers were observed in hunters' houses during June 1994 (Eames *et al.* 1994), and calls heard on 3 and 5 June 1994 (Eames unpubl. data). The species was heard calling from slopes and ridges in valley systems south of Kim Quang village but the incidence of calling was low, involving only a few individuals; all calling appeared to be at altitudes above 300 m (Lambert *et al.* 1994). Kalyakin and Korzun (1997) reported it to be relatively common at all altitudes where secondary or primary forest remained, and heard 10–14 males between July and September 1997 in four forest plots with a total area of 15 km². The species was also heard on 4 July 1999 (Eames and Eve 1999).

[Green Peafowl *Pavo muticus* Vulnerable
During the 1994 survey, this species was recognized by hunters, with a vague report that one had been shot in the district in 1972 (Eames unpubl. data, Eames *et al.* 1994, Lambert *et al.* 1994). There is, therefore, no confirmed record from Vu Quang Nature Reserve.]

Red-collared Woodpecker *Picus rabieri* Near Threatened
During the 1994 survey, two males were recorded on 5 June, a single male on 8 June and a pair on 13 June (Eames unpubl. data, Eames *et al.* 1994, Lambert *et al.* 1994). A male was mist-netted at c. 700 m on 28 August, and single birds were seen on 30 August and 2 September 1997 (Kalyakin and Korzun 1997).

Great Hornbill *Buceros bicornis* Near Threatened
During the 1992 survey, this species was reported to be rare, seemingly as a result of high hunting pressure (MacKinnon and Vu Van Dung 1992). The species was also recorded on the 1994 survey (Eames *et al.* 1994).

Brown Hornbill *Anorrhinus tickelli* Near Threatened
In 1992 this species was included on the bird list on the basis of anecdotal

information (MacKinnon and Vu Van Dung 1992). One or two birds were heard on 3 June 1994 (Eames unpubl., Eames *et al.* 1994, Lambert *et al.* 1994). Four flocks of between 5 and 30 birds and two additional flocks were heard at elevations between 450 and 800 m between 28 August and 5 September 1997 (Kalyakin and Korzun 1997). The species was heard on 3 July and 25 birds were seen on 14 July 1999, south of Kim Quang village (Eames and Eve 1999).

Blyth's Kingfisher *Alcedo hercules*

Near Threatened

This species was recorded twice by MacKinnon and Vu Van Dung (1992), in both primary and secondary habitats. During the 1994 survey, up to two birds were recorded on 3 June and single birds on 4 and 5 June (Eames unpubl. data, Eames *et al.* 1994, Lambert *et al.* 1994). Two specimens were mist-netted above the Con River, 2.5 km east of Sao La camp, on 30 July and 1 August, and a single bird was observed on rocks in this river, 5.5 km from Sao La camp on 31 July 1997 (Kalyakin and Korzun 1997).

Lesser Fish Eagle *Ichthyophaga humilis*

Near Threatened

One was observed near Kim Quang village on 9 June 1994 (Eames unpubl. data, Eames *et al.* 1994, Lambert *et al.* 1994), and two birds seen on 14 July 1999 (Eames and Eve 1999).

Grey-headed Fish Eagle *Ichthyophaga ichthyaetus*

Near Threatened

This species was included on the bird list on the basis of anecdotal information (MacKinnon and Vu Van Dung 1992). There are no other records of this species from Vu Quang Nature Reserve.

Spot-billed Pelican *Pelecanus philippensis*

Vulnerable

An upper mandible from this species was examined in a hunter's house in Kim Quang village in 1992 (MacKinnon and Vu Van Dung 1992), and the same specimen was examined again two years later (Lambert *et al.* 1994). This bird was reportedly shot from a flock of six seen perched in a tree around 1988 (Eames unpubl. data).

Short-tailed Scimitar Babbler *Jabouilleia danjoui* Near Threatened; Restricted Range

This species was recorded with uncertainty during 1994 (Eames *et al.* 1994, Lambert *et al.* 1994), but between July and September 1997, it was commonly recorded between 600 and 1,200 m (Kalyakin and Korzun 1997). It was also recorded on 3 July and, at 1,900 m, on 8 July 1999 (Eames unpubl. data).

Grey-faced Tit Babbler *Macronous kelleyi*

Restricted Range

Heard on 3 June 1994 (Eames unpublished data), and recorded during 1994 (Eames *et al.* 1994, Lambert *et al.* 1994). Fledged young were seen with a flock of Mountain Fulvettas *Alcippe peracensis* near Sao La camp at 300 m on 30 July 1997 (Kalyakin and Korzun 1997).

Species number

In terms of overall bird species number, Nakai Nam Theun NBCA is ranked first among the 14 protected areas within the Annamese Lowlands EBA, with 439 species. It is followed by Pu Mat Nature Reserve (283 species), Vu Quang Nature Reserve (274 species), Ke Go Nature Reserve (270 species) and Bach Ma National

Park (249 species). Ten of the sites (Bach Ma and Cuc Phuong National Parks, Dakrong, Ke Go, Phong Dien, Pu Mat, Phong Nha and Vu Quang Nature Reserves, and Nakai Nam Theun and Hin Namno NBCAs) lie within biogeographical subunit 05c, North Annam, of the Indo-Malayan Realm (MacKinnon 1997). Among these sites, Vu Quang Nature Reserve is also ranked third but, when the two protected areas in Laos are excluded, Vu Quang occupies second position behind Pu Mat Nature Reserve.

Complementarity

Complementarity analyses revealed that Vu Quang fell within the critical subset of sites only when the analysis excluded non-Vietnamese sites. For the 14 sites within the Annamese Lowlands EBA (supporting 534 species), Nakai Nam Theun (439 species) NBCA incorporates 82.2% of these species, Bach Ma National Park adds 37 species (89.1%), Ke Go Nature Reserve a further 19 species (92.7%), Ben En National Park a further eight species (94.2%) and Hin Namno NCBA a further seven species, thereby reaching the 95% threshold. Vu Quang Nature Reserve is placed in ninth position, adding only four species to include 98.7% of all species.

For the 10 sites within biogeographical subunit 05c (supporting 522 species), the 95% threshold is reached with the inclusion (in descending order of additional species contributed) of Nakai Nam Theun NCBA (439 species, 84.1%), Bach Ma National Park (37 species, 91.2%), Ke Go Nature Reserve (19 species, 94.8%) and Hin Namno NCBA (seven species, 96.2%). Vu Quang Nature Reserve is placed in eighth position, adding only four species to include 99.4% of all species.

For the eight Vietnamese protected areas within biogeographical subunit 05c (Bach Ma and Cuc Phuong National Parks, and Dakrong, Ke Go, Phong Dien, Phong Nha, Pu Mat and Vu Quang Nature Reserves), supporting 452 species, the 95% threshold is reached with the inclusion of Pu Mat Nature Reserve (283 species, 62.6%), Ke Go Nature Reserve (87 species, 81.9%), Bach Ma National Park (38 species, 90.3%), Vu Quang Nature Reserve (21 species, 94.9%) and Cuc Phuong National Park (11 species, 97.3%).

Finally, for the 12 Vietnamese protected areas within the Annamese Lowlands EBA, (supporting 471 species), the first four sites in the previous analysis retain their ranking but the 95% threshold is reached with the addition of Ben En National Park (15 species, 94.3%) and Phong Nha Nature Reserve (10 species, 96.4%). Cuc Phuong National Park is relegated to seventh position (seven species, 97.9%).

In all four complementarity analyses, at least seven of the nine restricted-range species were always included within the critical subset of sites. Eight out of nine were included in the analysis on all 14 protected areas in the Annamese Lowlands EBA, on the 10 sites within biogeographical subunit 05c, and the set of Vietnamese protected areas within the Annamese Lowlands EBA. Seven of the nine restricted-range species were included within the critical subset of sites in the analysis of all Vietnamese protected areas within biogeographical subunit 05c. Note that Ben En National Park is not known to support any restricted-range species. The species that consistently falls outside the critical subset of sites is White-cheeked Laughingthrush *Garrulax vassali*, which occurs at Phong Dien

Nature Reserve. This species also occurs in the Da Lat Plateau EBA and has only marginal occurrence within the Annamese Lowlands EBA (Stattersfield *et al.* 1998).

Similarity

High Sorenson's Similarity Index values indicate a high degree of similarity between the species assemblages at a pair of sites. The comparison revealed that the bird species composition of Vu Quang is most similar to those of Pu Mat Nature Reserve (0.758), Nakai Nam Theun NCBA (0.701) and Ke Go Nature Reserve (0.699), and least similar to those of Dakrong Nature Reserve (0.452), Pu Hoat Nature Reserve (0.537) and Pu Huong Nature Reserve (0.557) (Figure 2). This indicates that the avifauna of Vu Quang is most similar to those of protected areas with the closest geographical proximity and least similar to those furthest away.

Discussion

Avifauna

The avifauna of Vu Quang is typically Indo-Malayan. Genera typical of, but not confined to, this faunal region that occur here include *Polyplectron*, *Pavo*, *Megalaima*, *Treron*, *Pitta*, *Pericrocotus*, *Dicrurus*, *Cochoa* and *Dicaeum*. MacKinnon (1997) subdivided the region and, in common with other authors, defined the Indo-Chinese peninsula as a distinct subunit. Typical Indo-Chinese species occurring at Vu Quang include Siamese Fireback, Red-collared Woodpecker, Red-vented Barbet *Megalaima lagrandieri*, Coral-billed Ground Cuckoo *Carpococcyx renauldi*, Indo-Chinese Green Magpie *Cissa hypoleuca* and Ratchet-tailed Treepie *Temnurus temnurus*. Indo-Chinese faunal elements predominate in the lowlands, whereas Sino-Himalayan faunal elements predominate in the highlands. Notably, there is a high diversity of babblers (Timaliini) in the montane avifauna, including three *Minla* species, *Heterophasia*, *Paradoxornis* and *Yuhina*. Vu Quang Nature Reserve also supports a very few typically Sundaic species, such as Scaly-crowned Babbler *Malacopteron cinereum*.

There are few species typically associated with lowland evergreen forest (100–300 m) at the nature reserve, and fewer still that are confined to it. One of the few extreme lowland forest specialists found here is Siamese Fireback. The ranges of several other lowland species, including Chestnut-necklaced Partridge, Barbellied Pitta *Pitta elliotii* and Racket-tailed Treepie *Crypsirina temia*, extend to higher altitudes, until they are either replaced by a congener or are restricted by some environmental parameter. For example, Chestnut-necklaced Partridge is replaced at higher elevations by Bar-backed Partridge *Arborophila brunneopectus*.

The altitude ranges of most bird species occurring at Vu Quang include the zone between 300 and 1,400 m, which supports lower montane and medium montane evergreen forest. Examples of species with wide altitudinal ranges that include this zone are Bay Woodpecker *Blythipicus pyrrhotis* (up to 2,745 m), Red-headed Trogon *Harpactes erythrocephalus* (between 305 and 2,590 m), and Scarlet Minivet *Pericrocotus flammeus* (up to 1,700 m; Robson 2000). This zone encompasses the transition from the lowland to montane avifauna. In the Indo-Chinese

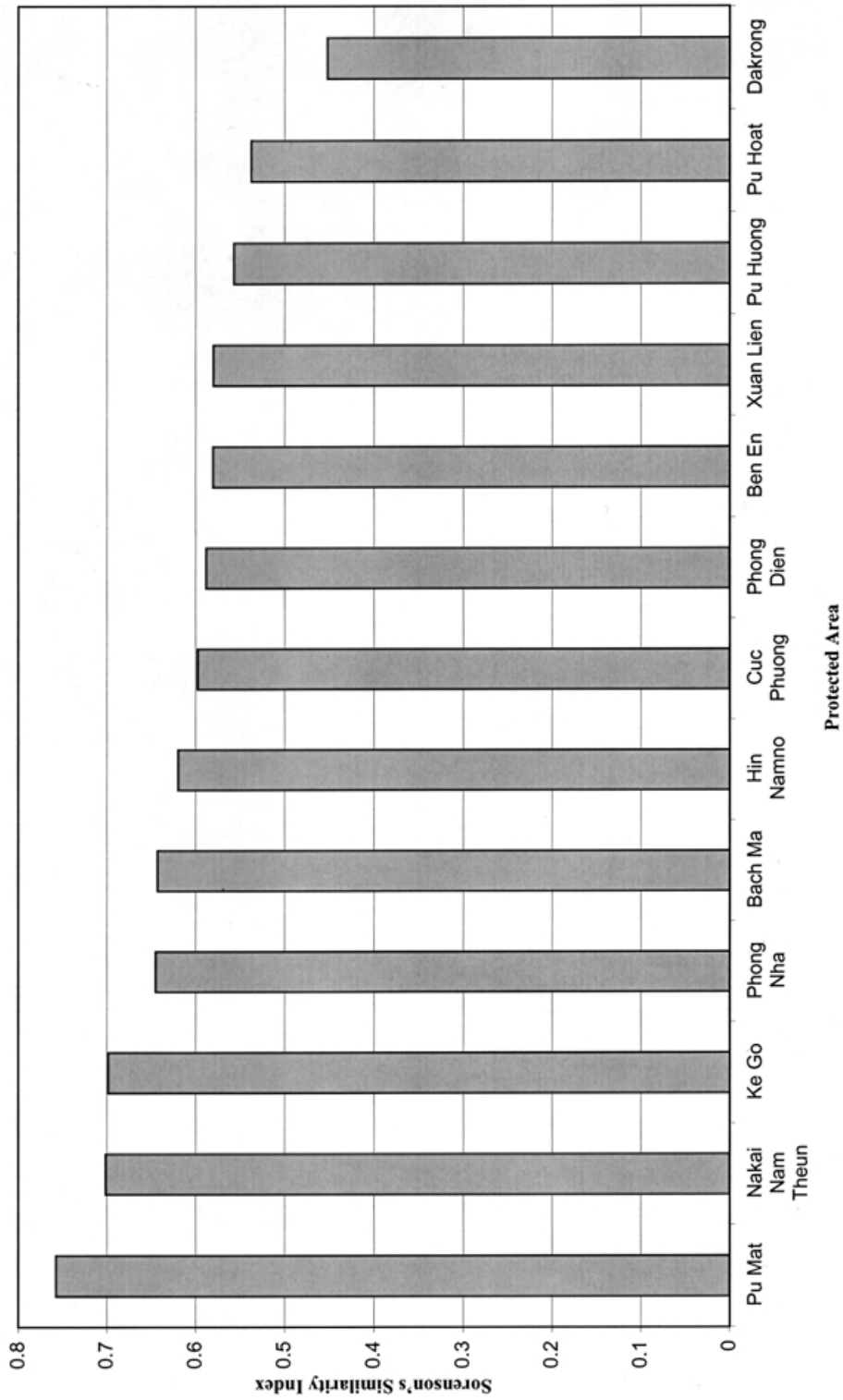


Figure 2. Sorenson's Similarity Index comparing bird species composition at Vu Quang Nature Reserve, Vietnam with those at 13 other protected areas in the Annamese Lowlands EBA.

subregion, this transition occurs at around 500 m, but is further dependent on latitude and aspect. Typical of the lower montane avifauna are Long-tailed Broadbill *Psarisomus dalhousiae* and Green Cochoa *Cochoa viridis*. Both these species are known, however, to have broad altitudinal ranges, from 500 to 2,000 m and from 700 to 2,565 m respectively (Robson 2000), but are probably more abundant between 500 and 1,000 m.

The two higher-altitude forest types at Vu Quang are distributed from 1,400 to 2,200 m. Within this zone, bird diversity decreases with increasing altitude. Typical of the montane avifauna are Golden-throated Barbet *Megalaima franklinii*, Orange-bellied Leafbird *Chloropsis hardwickii*, Lesser Shortwing *Brachypteryx leucophrys*, White-tailed Robin *Myiomela leucura* and Red-tailed Laughingthrush *Garrulax milnei*. Characteristic species of the depauperate elfin forest avifauna include Spectacled Fulvetta *Alcippe ruficapilla*, Chestnut-tailed Minla *Minla strigula* and Green-tailed Sunbird *Aethopyga nipalensis*.

Species number

Vu Quang Nature Reserve supports one of the highest recorded numbers of species of any protected area within the Annamese Lowlands EBA and biogeographical subunit 05c. However, as observer effort varied among sites, this may not accurately reflect the true species number, although the high number at Nakai Nam Theun NBCA is likely to be due to its significantly larger area and wider range of habitat types than any of the other protected areas in the EBA (Thewlis *et al.* 1998). It is not therefore possible to draw any firm conclusions about overall number of species at Vu Quang relative to other sites.

Complementarity

When considering priority clusters of protected areas at the regional level, Vu Quang Nature Reserve does not fall within the critical sub-set of sites required to support 95% of the species of either the Annamese Lowlands EBA or biogeographical subunit 05c. Vu Quang should not, therefore, be considered a regional conservation priority. However, at the national level, Vu Quang Nature Reserve is included within the critical subset of sites for both the Annamese Lowlands EBA and biogeographical subunit 05c. It should, therefore, be considered a priority site for conserving bird species diversity at the national level.

Similarity

Vu Quang Nature Reserve performs relatively poorly in the complementarity analyses because of the high degree of similarity it shares with other sites, particularly Nakai Nam Theun NBCA. This explains why the importance of Vu Quang for the conservation of bird diversity is greater at the national level than at the regional level.

Endemism

Of the nine restricted-range species known from the Annamese Lowlands EBA, only three are known from Vu Quang: Crested Argus, Short-tailed Scimitar Bab-

bler and Grey-faced Tit Babbler. All three occur in at least one other EBA. Among the 14 protected areas in the Annamese Lowlands EBA, Crested Argus and Short-tailed Scimitar Babbler are each known from nine, while Grey-faced Tit Babbler is known from four. Vu Quang Nature Reserve is not known to support any of the five restricted-range species that are believed to be confined to the Annamese Lowlands EBA: Annam Partridge *Arborophila merlini*, Edwards's Pheasant *Lophura edwardsi*, Vietnamese Pheasant *L. hatinhensis*, Imperial Pheasant *L. imperialis* and Sooty Babbler *Stachyris herberti*. We can, therefore, conclude that Vu Quang Nature Reserve is not a priority site for the conservation of endemic bird species.

Changes to avifaunal composition among species of conservation concern

Globally threatened species that may have been extirpated from Vu Quang as breeding species in recent times include Green Peafowl, Vietnamese Pheasant, White-winged Duck *Cairina scutulata*, Rufous-necked Hornbill *Aceros nipalensis* and Masked Finfoot *Heliopais personata*. All six are resident species, and, with the exception of Rufous-necked Hornbill, all are associated with lowland forest formations.

Globally threatened and near-threatened resident forest species that may become extinct here during the next 50 years include Siamese Fireback, Great Hornbill, Lesser Fish Eagle and Grey-headed Fish Eagle. To this list may be added a keystone species (i.e. a species that is believed to play a major role in maintaining ecosystem function and stability): Wreathed Hornbill *Aceros undulatus*. The pheasant and the two raptors are lowland forest specialists, while the two hornbills depend on lowland forests but may forage or disperse through montane forests. They are vulnerable to extirpation for a number of reasons. They all occur at low densities and have small population sizes. The two fish eagles occur at Vu Quang in riverine habitats and are, therefore, dependent on narrow ecotones, which are of limited extent within the nature reserve. The large hornbills are particularly vulnerable to hunting pressure because they congregate at fruiting trees, where they may easily be shot. Siamese Fireback, like all galliformes, is highly vulnerable to hunting pressure because it may be easily snared. It should also be noted that, irrespective of anthropogenic pressures such as hunting and habitat loss, it is not known whether Vu Quang Nature Reserve is large enough to support viable populations of these species. The continued existence of large hornbill and raptor populations is likely to be dependent on immigration of birds dispersing from adjacent forest areas.

Globally threatened and near-threatened species that may yet be added to the avifauna during the next 50 years because their global ranges encompass Vu Quang and suitable habitats are present include Vietnamese Pheasant, White-winged Duck, Pale-capped Pigeon *Columba punicea*, Greater Spotted Eagle, *Aquila clanga*, Imperial Eagle *A. heliaca*, Fairy Pitta *Pitta nympha* and Japanese Paradise Flycatcher *Terpsiphone atrocaudata*. This group comprises three resident species and four migrants, all of which are forest-dependent. With the possible exception of Vietnamese Pheasant, all are likely to be added to the list as a result of increased levels of observer coverage rather than as a result of colonization following changes in habitat structure.

Lack of evidence from Vu Quang suggests that Vietnamese Pheasant may either have never occurred or, if it once did, be now very rare or, as noted earlier, extirpated due to loss of lowland forest. If the species occurred previously, it could only recolonize Vu Quang if the lowland forest area was rehabilitated, if hunting pressure was reduced, and if contiguous lowland forest areas support populations of the species. It is unlikely that sufficient undisturbed tracts of lowland riverine habitat remain to support a population of White-winged Duck but the species could occur as a straggler.

Avifaunal composition and climate change

The avifaunal composition of Vu Quang is likely to alter as a result of global climatic change and local climatic events. The latter have probably already occurred as a result of the reduction in forest cover documented in the region (Wege *et al.* 1999). As Vu Quang experiences year-round high levels of precipitation and a lack of any pronounced seasonal fluctuations in precipitation and temperature, its avifauna lacks some faunal elements found on the drier, western flanks of the Annamite mountains in Laos, and to the north and south within Vietnam. Here, the climate is more seasonal, reflected by the presence of semi-deciduous or more open forests. Examples of species inhabiting such forests include Common Flameback *Dinopium javanense*, Great Slaty Woodpecker *Mulleripicus pulverulentus*, Lineated Barbet *Megalaima lineata*, Blue Pitta *Pitta cyanea*, Banded Broadbill *Eurylaimus javanicus*, Eurasian Jay *Garrulus glandarius*, Rufous Treepie *Dendrocitta vagabunda* and Common Woodshrike *Terphodornis pondicerianus*. However, the failure to detect these species in Vu Quang may simply reflect observer effort. If, as a result of climate change, there was a shift towards a more seasonal climate, one could reasonably expect some of these species to colonize Vu Quang. One could also reasonably expect to observe changes in population size and altitude range of some resident species, although it is difficult to speculate as to which species might be affected.

Can the importance of Vu Quang Nature Reserve for bird conservation be enhanced?

Detailed spatial planning for conservation at Vu Quang Nature Reserve at the commune, nature reserve and regional levels is provided in Eve (2000). Of the forest types that occur at Vu Quang, lowland forest has suffered the greatest loss in overall extent and quality. This is because the direction of human immigration to the Vu Quang area has been from east to west. Humans have shown, and continue to show, a preference for clearing forests of the level lowlands along major permanent water courses for agriculture. In addition, they continue to degrade adjacent lowland forest to meet their demands for timber (for commercial and local use) and other forest products. It is predominantly lowland species that have become extinct to date and, if current trends continue, are prone to future extinction. As species become extinct, the conservation importance of the nature reserve will decrease.

The lowland forest avifauna is the most threatened, but its conservation would be enhanced by a programme that prevents further forest clearance and rehabilitates degraded lowland forest. The success of any such programme would depend

on the capacity of the nature reserve authority, the level of resources available to them, the political will to implement nature reserve regulations, and the cooperation of local communities. Conservation actions to maintain bird diversity must be realistic, which, under the prevailing socioeconomic conditions, means highly targeted.

Given the importance of lowland riverine habitats for globally threatened and near-threatened bird species, conservation effort should focus on preventing their further disturbance, degradation and clearance. Any programme to promote the rehabilitation of lowland forest should, as part of its strategy, focus on major permanent water courses. The programme should promote regrowth along the cline of degradation from the strict protection area outwards, first along the water course and then outwards from it. Rivers should be selected on the basis of their importance for bird species of conservation concern, and the current level and trend of degradation. The distance between rivers and the opportunities for connecting any intervening forest patches should also be taken into account, and full use should be made of the processes of natural regeneration and recolonization. The nature reserve management authority should take full advantage of any opportunities presented under government directive 661, the Five Million Hectares Reforestation Programme, implementation of which has recently begun.

The conservation status of species of conservation concern and keystone species would be enhanced by stricter enforcement of nature reserve regulations on hunting, amnesties for illegally held firearms, and awareness-raising activities.

The five species identified earlier as being in particular danger of going extinct at Vu Quang within the next 50 years are all good indicators of lowland forest quality. Since all are large, conspicuous species that can easily be surveyed for, they should be the focus of monitoring programmes.

At the Annamite mountains level, the suggestion has been made of placing the forest between Pu Mat and Vu Quang Nature Reserves under some form of protection. While we support this idea in principle it should be noted that, within Vietnam, the North-East Indo-China Montane Forests Ecoregion, as defined by Wikramanayake *et al.* (1997), currently enjoys 24% coverage in the protected areas network, compared with 4% coverage for Vietnam as a whole. This ecoregion should, therefore, be considered a low priority for further protection (Wege *et al.* 1999). The conservation of a forest corridor could also be assured without expanding the Vietnamese protected areas system, if, for instance, the intervening forest was designated as watershed protection forest (which confers a similar level of protection) or if intervening forest on the Laotian side of the Annamite mountains was protected. Indeed, a proposal exists to establish Nam Theun Extension NBCA in Laos, which would provide such a link (Duckworth *et al.* 1999).

To the west, Nakai Nam Theun NBCA is contiguous with Vu Quang Nature Reserve (Duckworth *et al.* 1999), and its presence significantly enhances the conservation importance of Vu Quang, particularly if the potential for transboundary cooperation in protected area management is fully realized.

According to Wikramanayake *et al.* (1997), Vu Quang is situated in both the North-East Indo-China Montane Forest Ecoregion and the Annamite Range Moist Forests Ecoregion. The latter ecoregion, although enjoying 52% forest coverage, has a conservation coverage of only 17% (Wege *et al.* 1999). Any regional

approach should, therefore, explore ways in which Vu Quang could be linked to remaining areas of lowland forest within this ecoregion. This is particularly relevant when one considers that it is this ecoregion that supports Vietnamese Pheasant, a species that may recolonize Vu Quang if lowland forest rehabilitation is successful. Linking Vu Quang in this way would, thereby, increase its conservation importance. It is very unfortunate, therefore, that almost all of the intervening lowland forest between Vu Quang and Ke Go Nature Reserve (the nearest protected area in this ecoregion and one which is known to support this globally endangered species) has been cleared and settled by humans.

Acknowledgments

This paper was commissioned by the WWF Indo-China Programme and comprises an output of the WWF Indo-China-Vu Quang Conservation Project funded by the Royal Netherlands Government. The authors would like to thank Dr Nguyen Cu and Nguyen Duc Tu at the BirdLife International Vietnam Programme for their contributions to this paper.

Appendix: Continued.

Species	Scientific Name	Nakai													Total no. of Sites	
		Nam Theun	Hin Namno	Phong Dien	Phong Dakrong	Go	Ke Xuan Lien	Huong Pu	Ben En	Phong Nha	Pu Mat	Pu Hoat	Cuc Phuong	Bach Ma		Vu Quang
Grey-capped Pygmy Woodpecker	<i>Dendrocopos canicapillus</i>	1				1	1	1	1	1	1	1	1	1	1	11
Fulvous-breasted Woodpecker	<i>D. macei</i>		1													1
Stripe-breasted Woodpecker	<i>D. atratus</i>	1					1									2
Great Spotted Woodpecker	<i>D. major</i>												1			1
Rufous Woodpecker	<i>Celeus brachyurus</i>	1	1			1	1	1	1	1	1	1	1	1	1	8
Lesser Yellownape	<i>Picus chlorolophus</i>	1	1	1		1	1	1	1	1	1	1	1	1	1	11
Greater Yellownape	<i>P. flavinucha</i>	1	1	1		1	1	1	1	1	1	1	1	1	1	13
Laced Woodpecker	<i>P. vittatus</i>	1	1	1		1	1	1	1	1	1	1	1	1	1	7
Red-collared Woodpecker	<i>P. rabieri</i>	1	1	1		1	1	1	1	1	1	1	1	1	1	9
Grey-headed Woodpecker	<i>P. canus</i>	1														1
Common Flameback	<i>Dinopium javanense</i>	1	1						1							4
Greater Flameback	<i>Chrysocolaptes lucidus</i>	1	1			1	1	1		1		1				6
Pale-headed Woodpecker	<i>Cecinulus grantia</i>	1				1	1	1		1				1	1	6
Bay Woodpecker	<i>Blythipicus pyrrhotis</i>	1	1	1		1	1	1	1	1	1	1	1	1	1	14
Black-and-buff Woodpecker	<i>Meiglyptes jugularis</i>	1														1
Heart-spotted Woodpecker	<i>Hemicircus canente</i>	1	1													2
Great Slaty Woodpecker	<i>Mulleripicus pulverulentus</i>	1	1			1										3
Great Barbet	<i>Megalaima virens</i>	1													1	2
Red-vented Barbet	<i>M. lagrandieri</i>	1	1	1		1	1	1	1	1	1	1	1	1	1	14
Lineated Barbet	<i>M. lineata</i>	1	1													2
Green-eared Barbet	<i>M. faiostrica</i>	1	1	1		1	1	1	1	1	1	1	1	1	1	13

Appendix: Continued.

Species	Scientific Name	Nakai											Total no. of Sites			
		Nam Theun	Hin Namno	Phong Dien	Phong Dakrong	Ke Xuan Go	Pu Lien Huong	Ben En	Phong Nha	Pu Mat	Pu Hoat	Cuc Phuong		Bach Ma	Vu Quang	
Golden-throated Barbet	<i>M. franklinii</i>	1					1								1	6
Black-browed Barbet	<i>M. oorti</i>													1		1
Blue-throated Barbet	<i>M. asiatica</i>	1														1
Moustached Barbet	<i>M. incognita</i>	1	1				1									4
Blue-eared Barbet	<i>M. australis</i>	1	1						1							3
Coppersmith Barbet	<i>M. laemaecephala</i>	1	1				1							1		4
Oriental Pied Hornbill	<i>Anthracceros albirostris</i>	1	1				1		1					1		10
Great Hornbill	<i>Buceros bicornis</i>	1	1	1												10
Brown Hornbill	<i>Anorrhinus tickelli</i>	1	1	1			1		1					1		14
Rufous-necked Hornbill	<i>Aceros nipalensis</i>	1	1							1						3
Wreathed Hornbill	<i>A. undulatus</i>	1	1				1		1							6
Common Hoopoe	<i>Upupa epops</i>						1		1							5
Orange-breasted Trogon	<i>Harpactes oreskios</i>	1	1	1			1		1							6
Red-headed Trogon	<i>H. erythrocephalus</i>	1	1	1			1		1					1		14
Indian Roller	<i>Coracias benghalensis</i>	1	1							1						5
Dollarbird	<i>Eurystomus orientalis</i>	1	1	1			1		1					1		12
Blyth's Kingfisher	<i>Alcedo hercules</i>	1	1	1			1		1					1		9
Common Kingfisher	<i>A. atthis</i>	1	1	1			1		1					1		14
Blue-eared Kingfisher	<i>A. meninting</i>	1	1	1			1		1							3
Oriental Dwarf Kingfisher	<i>Ceyx erithacus</i>						1		1							6
Banded Kingfisher	<i>Lacedo pulchella</i>	1	1	1										1		5
Stork-billed Kingfisher	<i>Halcyon capensis</i>	1	1	1										1		3
Ruddy Kingfisher	<i>H. coromanda</i>	1	1	1			1							1		5
White-throated Kingfisher	<i>H. smyrnensis</i>	1	1	1			1		1					1		14
Black-capped Kingfisher	<i>H. pileata</i>	1	1											1		6
Crested Kingfisher	<i>Megaceryle lugubris</i>	1	1	1			1							1		8
Pied Kingfisher	<i>Ceryle rudis</i>						1		1					1		5
Blue-bearded Bee-eater	<i>Nyctornis athertoni</i>	1	1	1			1		1					1		9

Appendix: Continued.

Species	Scientific Name	Nakai													Total no. of Sites
		Nam Theun	Hin Namno	Phong Dien	Phong Dakrong	Go	Ke Xuan Lien	Pu Huong	Ben En	Phong Nha	Pu Mat	Pu Hoat	Cuc Phuong	Bach Ma	
Oriental Turtle Dove	<i>Streptopelia orientalis</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	8
Spotted Dove	<i>S. chinensis</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	14
Red Collared Dove	<i>S. tranquebarica</i>			1	1	1	1	1	1	1	1	1	1	1	8
Barred Cuckoo Dove	<i>Macropygia unchall</i>	1	1				1	1	1	1	1	1	1	1	8
Little Cuckoo Dove	<i>M. ruficeps</i>									1					1
Emerald Dove	<i>Chalcophaps indica</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	13
Pink-necked Green Pigeon	<i>Treron vernans</i>												1	1	1
Orange-breasted Green Pigeon	<i>T. bincincta</i>					1							1		2
Thick-billed Green Pigeon	<i>T. curvirostra</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	11
Pin-tailed Green Pigeon	<i>T. apicauda</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	8
Yellow-vented Green Pigeon	<i>T. seimundi</i>	1	1	1	1				1	1	1	1	1	1	7
Wedge-tailed Green Pigeon	<i>T. sphenura</i>	1							1				1	1	3
White-bellied Green Pigeon	<i>T. sciboldii</i>	1											1	1	2
Green Imperial Pigeon	<i>Ducula aenea</i>	1		1	1	1	1	1	1	1	1	1	1	1	4
Mountain Imperial Pigeon	<i>D. badia</i>	1		1	1	1	1	1	1	1	1	1	1	1	12
Slaty-legged Crane	<i>Rallina eurizonoides</i>												1	1	1
Slaty-breasted Rail	<i>Gallinulus striatulus</i>					1	1	1	1	1	1	1	1	1	3
White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	10
Ruddy-breasted Crane	<i>Porzana fusca</i>	1											1	1	2
Common Moorhen	<i>Gallinula chloropus</i>	1	1							1			1	1	4
Eurasian Woodcock	<i>Scolopax rusticola</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	7
Wood Snipe	<i>Gallinago nemoricola</i>	1												1	1
Pintail Snipe	<i>G. stenura</i>	1							1				1	1	3

Appendix: Continued.

Species	Scientific Name	Nakai													Total no. of Sites	
		Nam Theun	Hin Namno	Phong Dien	Phong Dakrong	Go Lien	Xuan Huong	Pu Huong	Ben En	Phong Nha	Pu Mat	Hoat Phuong	Cuc Ma	Bach Ma		Vu Quang
Tiger Shrike	<i>Lanius tigrinus</i>					1		1				1				4
Brown Shrike	<i>L. cristatus</i>	1	1			1		1			1			1		10
Burmese Shrike	<i>L. collurioideus</i>	1						1			1			1		4
Long-tailed Shrike	<i>L. schach</i>	1	1	1		1		1			1			1		14
Grey-backed Shrike	<i>L. teptironotus</i>	1				1		1			1			1		7
Eurasian Jay	<i>Garrulus glandarius</i>	1	1													2
Red-billed Blue Magpie	<i>Urocissa erythrorhyncha</i>	1				1		1			1			1		6
White-winged Magpie	<i>U. whiteheadi</i>	1	1	1		1		1			1			1		11
Common Green Magpie	<i>Cissa chinensis</i>	1	1			1		1			1			1		7
Indochinese Green Magpie	<i>C. hypoleuca</i>	1	1	1		1		1			1			1		11
Rufous Treepie	<i>Dendrocitta vagabunda</i>					1		1								2
Grey Treepie	<i>D. formosae</i>	1				1		1			1					5
Racket-tailed Treepie	<i>Crypsirina temia</i>	1	1	1		1		1			1			1		14
Ratchet-tailed Treepie	<i>Temnurus temnurus</i>	1	1	1		1		1			1			1		14
Large-billed Crow	<i>Corvus macrorhynchos</i>	1	1	1		1		1			1			1		14
Collared Crow	<i>C. torquatus</i>															1
Ashy Woodswallow	<i>Artamus fuscus</i>	1	1	1		1		1			1			1		10
Black-naped Oriole	<i>Oriolus chinensis</i>	1				1								1		3
Black-hooded Oriole	<i>O. xanthornus</i>	1	1							1						3
Maroon Oriole	<i>O. traillii</i>	1	1	1		1		1			1			1		7
Large Cuckooshrike	<i>Coractna maciei</i>	1	1	1		1		1			1			1		13
Indochinese Cuckooshrike	<i>C. polioptera</i>	1														1
Black-winged Cuckooshrike	<i>C. melaschistos</i>	1	1	1		1		1			1			1		9
Swinhoe's Minivet	<i>Pericrocotus cantoniensis</i>	1														1
Ashy Minivet	<i>P. divaricatus</i>	1	1													4
Small Minivet	<i>P. cinnamomeus</i>	1				1		1			1					3

Appendix: Continued.

Species	Scientific Name	Nakai													Total no. of Sites		
		Nam Theun	Hin Namno	Phong Dien	Phong Dakrong	Go Lien	Xuan Huong	Pu Huong	Ben En	Phong Nha	Pu Mat	Hoat Phuong	Cuc Ma	Bach Ma		Vu Quang	
Grey-chinned Minivet	<i>P. solaris</i>	1								1	1				1	1	5
Long-tailed Minivet	<i>P. ethologus</i>										1					1	2
Short-billed Minivet	<i>P. brevirostris</i>	1															1
Scarlet Minivet	<i>P. flammeus</i>	1	1	1						1	1	1			1	1	13
Bar-winged Flycatcher-shrike	<i>Hemipus picatus</i>	1	1	1						1	1	1			1	1	11
White-throated Fantail	<i>Rhipidura albicollis</i>	1	1	1						1	1				1	1	10
Black Drongo	<i>Dicurus macrocercus</i>	1	1	1						1	1	1			1	1	12
Ashy Drongo	<i>D. leucophaeus</i>	1	1	1						1	1	1			1	1	13
Crow-billed Drongo	<i>D. annectans</i>	1	1	1						1	1	1			1	1	11
Bronzed Drongo	<i>D. aeneus</i>	1	1	1						1	1	1			1	1	14
Lesser Racket-tailed Drongo	<i>D. remifer</i>	1	1	1						1	1	1			1	1	8
Spangled Drongo	<i>D. hotentottus</i>	1	1	1						1	1	1			1	1	12
Greater Racket-tailed Drongo	<i>D. paradisus</i>	1	1	1						1	1	1			1	1	14
Black-naped Monarch Asian	<i>Hypothymis azurea</i>	1	1	1						1	1	1			1	1	14
Paradise-flycatcher Japanese	<i>Terpsiphone paradisi</i>	1	1	1						1	1	1			1	1	13
Paradise-flycatcher Japanese	<i>T. atrocaudata</i>	1															1
Common Iora	<i>Aegithina tiphia</i>	1								1	1				1	1	7
Great Iora	<i>A. lafresnayei</i>	1	1	1						1	1	1			1	1	12
Large Woodshrike	<i>Tephrodornis gularis</i>	1	1	1						1	1	1			1	1	12
Common Woodshrike	<i>T. pondicerianus</i>	1	1	1													2
Brown Dipper	<i>Cinclus pallasi</i>	1								1						1	4
White-throated Rock Thrush	<i>Monticola gularis</i>	1													1		3
Blue Rock Thrush	<i>M. solitarius</i>	1	1	1						1	1				1	1	8
Blue Whistling Thrush	<i>Myophonus caeruleus</i>	1	1	1						1	1	1			1	1	12
Orange-headed Thrush	<i>Zosterops citrina</i>	1													1	1	6

Appendix: Continued.

Species	Scientific Name	Nakai											Total no. of Sites				
		Nam Theun	Hin Namno	Phong Dien	Phong Dakrong	Go Lien	Xuan Huong	Pu Huong	Ben En	Phong Nha	Phong Mat	Pu Hoat		Cuc Phuong	Bach Ma	Vu Quang	
Black-throated Tit	<i>Aegithalos concinnus</i>	1													1	1	3
Sand Martin	<i>Riparia riparia</i>	1													1		1
Dusky Crag Martin	<i>Hirundo concolor</i>										1				1		2
Barn Swallow	<i>H. rustica</i>	1	1			1						1			1	1	8
Red-rumped Swallow	<i>H. daurica</i>	1		1							1				1		6
Striated Swallow	<i>H. striolata</i>			1							1				1		3
Northern House Martin	<i>Delichon urbica</i>	1													1		1
Asian House Martin	<i>D. dasypus</i>														1		1
Striated Bulbul	<i>Pycnonotus striatus</i>	1														1	2
Black-headed Bulbul	<i>P. atriceps</i>	1	1														2
Black-crested Bulbul	<i>P. melanicterus</i>	1	1			1		1	1	1	1	1	1	1	1	1	12
Red-whiskered Bulbul	<i>P. jocosus</i>	1	1	1		1		1	1	1	1	1	1	1	1	1	14
Light-vented Bulbul	<i>P. sinensis</i>					1									1	1	5
Sooty-headed Bulbul	<i>P. aurigaster</i>	1	1	1		1		1	1	1	1	1	1	1	1	1	11
Stripe-throated Bulbul	<i>P. finlaysoni</i>	1	1	1		1		1	1	1	1	1	1	1	1	1	11
Flavescens Bulbul	<i>P. flavescens</i>	1				1		1	1	1	1	1	1	1	1	1	11
Puff-throated Bulbul	<i>Aliphloxys pallidus</i>	1	1	1		1		1	1	1	1	1	1	1	1	1	13
Ochraceous Bulbul	<i>A. ochraceus</i>								1	1	1	1	1	1	1	1	5
Grey-eyed Bulbul	<i>Iole propinqua</i>	1	1	1		1		1	1	1	1	1	1	1	1	1	11
Ashy Bulbul	<i>Hemixos flava</i>	1				1					1						5
Mountain Bulbul	<i>Hypsipetes mcclllandii</i>	1									1				1	1	4
Black Bulbul	<i>H. leucocephalus</i>	1	1	1		1		1	1	1	1	1	1	1	1	1	10
Zitting Cisticola	<i>Cisticola juncidis</i>	1				1											4
Bright-headed Cisticola	<i>C. exilis</i>															1	1
Hill Prinia	<i>Prinia atrogularis</i>	1				1									1		3
Rufescent Prinia	<i>P. rufescens</i>	1	1			1		1	1	1	1	1	1	1	1	1	8
Grey-breasted Prinia	<i>P. hodgsonii</i>	1				1					1				1		5
Yellow-bellied Prinia	<i>P. flaviventris</i>	1					1								1	1	5
Plain Prinia	<i>P. inornata</i>	1													1		4
Chestnut-flanked White-eye	<i>Zosterops erythropleurus</i>	1				1									1		1

Appendix: Continued.

Species	Scientific Name	Nakai													Total no. of Sites	
		Nam Theun	Hin Namno	Phong Dien	Phong Dakrong	Ke Xuan Go	Pu Lien Huong	Ben En	Phong Nha	Pu Mat	Pu Hoat	Cuc Phuong	Bach Ma	Vu Quang		
White-tailed Leaf Warbler	<i>P. davisoni</i>	1				1								1	1	7
Yellow-vented Warbler	<i>P. cantator</i>	1														1
Sulphur-breasted Warbler	<i>P. ricketti</i>	1				1									1	4
Golden-spectacled Warbler	<i>Seiurus burkii</i>	1		1		1							1		1	8
Grey-cheeked Warbler	<i>S. poliogenys</i>	1						1						1	1	5
Chestnut-crowned Warbler	<i>S. castaneiceps</i>	1								1					1	3
Rufous-faced Warbler	<i>Abroscopus albogularis</i>	1							1						1	4
Yellow-bellied Warbler	<i>A. superciliosus</i>	1		1		1		1					1		1	10
Striated Grassbird	<i>Megalurus palustris</i>					1				1				1		5
Masked Laughingthrush	<i>Garrulax perspicillatus</i>					1		1						1	1	7
White-crested Laughingthrush	<i>G. leucolophus</i>	1		1		1		1		1				1	1	14
Lesser Necklaced Laughingthrush	<i>G. monileger</i>	1		1		1		1		1				1	1	13
Greater Necklaced Laughingthrush	<i>G. pectoralis</i>	1		1		1									1	5
Grey Laughingthrush	<i>G. maesi</i>	1							1						1	6
Black-throated Laughingthrush	<i>G. chinensis</i>	1		1		1		1		1			1	1	1	13
White-cheeked Laughingthrush	<i>G. vassali</i>															1
Rufous-vented Laughingthrush	<i>G. gutturalis</i>														1	1
Spot-breasted Laughingthrush	<i>G. merulinus</i>														1	1
Hwamei	<i>G. canorus</i>	1				1								1	1	6

Appendix: Continued.

Species	Scientific Name	Nakai													Total no. of Sites		
		Nam Theun	Hin Namno	Phong Dien	Phong Dakrong	Go Lien	Xuan Huong	Pu En	Ben En	Phong Nha	Pu Mat	Hoat Phuong	Cuc Ma	Bach Ma		Vu Quang	
Chestnut-crowned Laughingthrush	<i>G. erythrocephalus</i>	1									1						2
Red-tailed Laughingthrush	<i>G. milnei</i>	1													1		2
Abbott's Babbler	<i>Malacocincla abbotii</i>					1										1	4
Buff-breasted Babbler	<i>Pellorneum tickelli</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	13
Spot-throated Babbler	<i>P. albicentre</i>	1		1						1							4
Puff-throated Babbler	<i>P. ruficeps</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	11
Scaly-crowned Babbler	<i>Malacopteron cinereum</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	12
Large Scimitar Babbler	<i>Pomatohinus hypoleucos</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	13
White-browed Scimitar Babbler	<i>P. schisticeps</i>	1	1	1	1	1									1		7
Streak-breasted Scimitar Babbler	<i>P. ruficollis</i>	1				1	1	1	1	1	1	1	1	1	1	1	7
Red-billed Scimitar Babbler	<i>P. ochraceps</i>	1									1				1		3
Coral-billed Scimitar Babbler	<i>P. ferruginosus</i>	1									1				1		3
Short-tailed Scimitar Babbler	<i>Jabouilleia danjoui</i>	1		1	1	1	1	1	1	1	1	1	1	1	1	1	9
Limestone Wren Babbler	<i>Napothera crispifrons</i>															1	1
Streaked Wren Babbler	<i>N. brevicaudata</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10
Eyebrowed Wren Babbler	<i>N. epilepidota</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10
Pygmy Wren Babbler	<i>Pnoepyga pusilla</i>	1														1	4
Spotted Wren Babbler	<i>Spelacornis formosus</i>	1													1		2
Rufous-fronted Babbler	<i>Stachyris rufifrons</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	6
Rufous-capped Babbler	<i>S. ruficeps</i>															1	4
Golden Babbler	<i>S. chrysaea</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	7

Importance of Vu Quang for bird conservation

Species	Scientific Name	Nakai											Total no. of Sites				
		Theum Nam	Hin Nammo	Phong Dien	Phong Dakrong	Ke Xuan Go Lien	Pu Huong	Ben En	Phong Nha	Pu Mat	Pu Hoat	Cuc Phuong		Bach Ma	Vu Quang		
Sooty Babbler	<i>S. herbeti</i>		1													1	2
Grey-throated Babbler	<i>S. nigriceps</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	11
Spot-necked Babbler	<i>S. striolata</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
Striped Tit Babbler	<i>Macronous gularis</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
Grey-faced Tit Babbler	<i>M. kelleyi</i>			1	1	1	1	1	1	1	1	1	1	1	1	1	4
Chestnut-capped Babbler	<i>Timalia pileata</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	9
Yellow-eyed Babbler	<i>Chrysomma sinense</i>	1														1	2
Silver-eared Mesia	<i>Leiothrix argenteauris</i>	1														1	3
Cutia	<i>Cutia nipalensis</i>	1														1	1
White-browed Shrike	<i>Pteruthius flaviscapris</i>	1								1						1	5
Babbler																	
Black-eared Shrike	<i>P. melanotis</i>	1														1	3
Babbler																	
Chestnut-fronted Shrike	<i>P. aenobarbus</i>	1														1	3
Babbler																	
White-hooded Babbler	<i>Gampsorhynchus rufulus</i>	1								1						1	5
Spectacled Barwing	<i>Actinodura ramsayi</i>	1															1
Blue-winged Minla	<i>Minla cyanouroptera</i>	1														1	3
Chestnut-tailed Minla	<i>M. strigula</i>	1														1	2
Red-tailed Minla	<i>M. ignotincta</i>	1														1	3
Yellow-throated Fulvetta	<i>Alcippe cinerea</i>															1	1
Rufous-winged Fulvetta	<i>A. castaneiceps</i>	1														1	3
Spectacled Fulvetta	<i>A. ruficapilla</i>	1														1	2
Rufous-throated Fulvetta	<i>A. rufogularis</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	12
Dusky Fulvetta	<i>A. brunnea</i>	1															1
Rusty-capped Fulvetta	<i>A. dubia</i>	1														1	2
Brown-cheeked Fulvetta	<i>A. poiocephala</i>															1	5
Mountain Fulvetta	<i>A. penacensis</i>															1	1
Grey-cheeked Fulvetta	<i>A. morrisonia</i>	1														1	12
																	4

Appendix: Continued.

Species	Scientific Name	Nakai										Total no. of Sites			
		Nam Theun	Hin Namno	Phong Dien	Phong Dakrong	Go Lien	Xuan Huong	Pu En	Ben Nha	Phong Mat	Pu Hoat		Cuc Phuong	Bach Ma	Vu Quang
Little Spiderhunter	<i>Arachnothera longirostra</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	10
Streaked Spiderhunter	<i>A. magna</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	14
Russet Sparrow	<i>Passer rutilans</i>	1													1
Plain-backed Sparrow	<i>P. flaveolus</i>	1													2
Eurasian Tree Sparrow	<i>P. montanus</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	12
Forest Wagtail	<i>Dendronanthus indicus</i>	1													5
White Wagtail	<i>Motacilla alba</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	9
Yellow Wagtail	<i>M. flava</i>	1													7
Grey Wagtail	<i>M. cinerea</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	9
Richard's Pipit	<i>Anthus richardi</i>	1													5
Paddyfield Pipit	<i>A. rufulus</i>	1													3
Olive-backed Pipit	<i>A. hodgsoni</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	9
Red-throated Pipit	<i>A. cervinus</i>	1													4
Pin-tailed Parrotfinch	<i>Erythrura prasina</i>	1													1
White-rumped Munia	<i>Lonchura striata</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	13
Scaly-breasted Munia	<i>L. punctulata</i>	1													6
Crested Bunting	<i>Melophus lathami</i>	1													2
Chestnut-eared Bunting	<i>Emberiza fucata</i>	1													1
Little Bunting	<i>E. pusilla</i>	1													1
Yellow-breasted Bunting	<i>E. aureola</i>	1													2
Chestnut Bunting	<i>E. rutila</i>	1													4
Black-faced Bunting	<i>E. spodocephala</i>	1													1
Total no. of species at site		439	220	158	102	270	133	146	191	213	283	128	171	249	274
Sorenson's similarity index with Vu Quang		0.701	0.619	0.588	0.452	0.699	0.580	0.557	0.581	0.645	0.758	0.537	0.598	0.642	n/a

Species lists were derived from a number of published and unpublished sources: for Cuc Phuong National Park, Robson *et al.* (1989), Eames *et al.* (1999) and Tordoff *et al.* (1999); for Bach Ma National Park, Eve (1996); for Ben En National Park, Tordoff *et al.* (2000); for Dakrong Nature Reserve, Le Trong Trai *et al.* (1999c); for Hin Namno NBCA, Eve *et al.* (1998); for Ke Go Nature Reserve, Le Trong Trai *et al.* (1999b); for Nakai Nam Theun NBCA, Eve *et al.* (1998); for Phong Dien Nature Reserve, Le Trong Trai *et al.* (1999c); for Phong Nha Nature Reserve, Eames *et al.* (1994), Kalyakin (1999) and Timmins *et al.* (1999); for Pu Hoat Nature Reserve, Anon. (1997); for Pu Huong Nature Reserve, Kemp and Dilger (1996); for Pu Mat Nature Reserve, Round (1999); and, for Xuan Lien Nature Reserve, Le Trong Trai *et al.* (1999a).

References

- Anon. (1997) [Investment plan for Pu Hoat Nature Reserve, Nghe An province.] Unpublished report to Nghe An Provincial People's Committee, Vinh, Vietnam. (In Vietnamese.)
- BirdLife International (2001) *Threatened birds of Asia: the BirdLife International red data book*. Cambridge, U.K.: BirdLife International.
- Do Tuoc, Vu Van Dung, Dawson, S., Arctander, P. and MacKinnon, J. (1994) *Introduction of a new large mammal species in Vietnam*. Technical Report. Hanoi, Vietnam: Ministry of Forestry. (In Vietnamese.)
- Duckworth, J. W., Salter, R. E. and Khounbolin, K. (compilers) (1999) *Wildlife in Lao PDR: 1999 status report*. Vientiane, Laos: IUCN-The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management.
- Eames, J. C. and Eve, R. (1999) Bird species recorded during the survey from 2 July to 15 July 1999 in forest unit 224. Unpublished.
- Eames, J. C., Lambert, F. R. and Nguyen Cu (1994) A survey of the Annamese Lowlands, Vietnam, and its implications for the conservation of Vietnamese and Imperial Pheasants *Lophura hatinhensis* and *Lophura imperialis*. *Bird Conserv. Internatn.* 4: 343–382.
- Eames, J. C., Tordoff, A. W. and Wege, D. C. (1999) Bird list from Cuc Phuong National Park 10 and 11 April 1999. Unpublished.
- Eve, R. (1996) *Birdlist of Bach Ma National Park, Hai Van Pass, Bana*. Hue, Vietnam: Bach Ma National Park Project WWF/EC.
- Eve, R. (2000) Spatial planning for nature conservation in Vu Quang Nature Reserve, Ha Tinh province. Unpublished report to WWF Indo-China Programme, Hanoi, Vietnam.
- Eve, R. Nguyen Viet Dung and Meijboom, M. (1998) Vu Quang Nature Reserve: a link in the Annamite chain. Vol. 2, 0: list of species: fauna and flora. Unpublished report to WWF Indo-China Programme, Hanoi, Vietnam.
- Inskipp, T., Lindsey, N. and Duckworth, W. (1996) *Annotated checklist of the birds of the Oriental Region*. Sandy, Bedfordshire, U. K.: Oriental Bird Club.
- Kalyakin, M. V. (1999) Ornithological studies in Ke Bang area, central Vietnam in March–April 1999. Unpublished report to the Vietnam–Russia Tropical Centre, Hanoi, Vietnam.
- Kalyakin, M. V. and Korzun, L. P. (1997) Ornithological studies in Vu Quang Nature Reserve, July–September 1997. Final Report. Unpublished report to the Vietnam–Russia Tropical Centre, Hanoi, Vietnam.
- Kemp, N. and Dilger, M. (1996) *Bu Huong proposed nature reserve*. London, U.K.: Society for Environmental Exploration.
- Lambert, F. R., Eames, J. C. and Nguyen Cu (1994) *Surveys for endemic Pheasants in the Annamese Lowlands of Vietnam, June–July, 1994: status and conservation recommendations for Vietnamese Pheasant *Lophura hatinhensis* and Imperial Pheasant *L. imperialis**. Gland, Switzerland and Cambridge, U.K.: IUCN Species Survival Commission.
- Le Trong Trai, Le Van Cham, Bui Dac Tuyen, Tran Hieu Minh, Tran Quang Ngoc, Nguyen Van Sang, Monastyrskii, A. L. and Eames, J. C. (1999a) *A feasibility study for the establishment of Xuan Lien Nature Reserve, Thanh Hoa province*. Hanoi, Vietnam: BirdLife International Vietnam Programme.
- Le Trong Trai, Nguyen Huy Dung, Nguyen Cu, Le Van Cham, Eames, J. C. and Chicoine, G. (1999b) *An investment plan for Ke Go Nature Reserve, Ha Tinh province, Vietnam: a contribution to the management plan*. Hanoi, Vietnam: BirdLife International Vietnam Programme.
- Le Trong Trai, Richardson, W. J., Le Van Cham, Tran Quang Ngoc, Nguyen Van Sang, Monastyrskii, A. L. and Eames, J. C. (1999c) *A feasibility study for the establishment of Phong Dien (Thua Thien Hue province) and Dakrong (Quang Tri province) Nature Reserves*. Hanoi, Vietnam: BirdLife International Vietnam Programme.

- MacKinnon, J. R. (1997) *Protected areas system review of the Indo-Malayan Realm*. Gland, Switzerland: the Asian Bureau for Conservation (ABC) and the World Conservation Monitoring Centre (WCMC).
- MacKinnon, J. R. and Phillips, K. (1993) *A field guide to the birds of Sumatra, Java and Bali*. Oxford, U.K.: Oxford University Press.
- MacKinnon, J. R. and Vu Van Dung (1992) Draft management plan for Vu Quang Nature Reserve, Huong Khe district, Ha Tinh province, Vietnam. Unpublished report to the Ministry of Forestry, Hanoi, Vietnam.
- Magurran, A. E. (1988) *Ecological diversity and its measurement*. London, U.K.: Chapman and Hall.
- Robson, C. (2000) *A field guide to the birds of Thailand and South-East Asia*. Bangkok, Thailand: Asia Books Co.
- Robson, C. R., Eames, J. C., Wolstencroft, J. A., Nguyen Cu and Truong Van La (1989) Recent records of birds from Viet Nam. *Forktail* 5: 71–97.
- Round, P. D. (1999) Avifaunal surveys of the Pu Mat Nature Reserve, Nghe An province, Vietnam 1998–1999. Unpublished report to Social Forestry and Nature Conservation in Nghe An Province, Vinh, Vietnam.
- Sibley, C. G. and Monroe, B. L. (1990) *Distribution and taxonomy of birds of the world*. New Haven, CT. and London, U.K.: Yale University Press.
- Stattersfield, A. J., Crosby, M. J., Long, A. J. and Wege, D. C. (1998) *Endemic bird areas of the world*. Cambridge, U.K.: BirdLife International.
- Thewlis, R. M., Timmins, R. J., Evans, T. D. and Duckworth, J. W. (1998) The conservation status of birds in Laos: a review of key species. *Bird Conserv. Internatn.* 8(Suppl.): 1–159.
- Timmins, R. J., Do Tuoc, Trinh Viet Cuong and Hendrichsen, D. K. (1999) *A preliminary assessment of the conservation importance and conservation priorities of the Phong Nha-Ke Bang proposed national park, Quang Binh province, Vietnam*. Hanoi, Vietnam: Fauna and Flora International Indochina Programme.
- Tordoff, A. W., Buckton, S. T. and Hughes, N. R. (1999) List of birds recorded at Cuc Phuong National Park, 4 December 1999. Unpublished.
- Tordoff, A. W., Swan, S. and Grindley, M. (2000) *Ben En National Park*. London, U.K.: Society for Environmental Exploration.
- Udvardy, M. D. F. (1975) *A classification of the biogeographical provinces of the world*. Gland, Switzerland: IUCN.
- Vu Van Dung, Pham Mong Giao, Nguyen Ngoc Chinh, Do Tuoc, Arctander, P. and MacKinnon, J. (1993) A new species of living bovid from Vietnam. *Nature* 363: 443–445.
- Wege, D. C., Long, A. J., Mai Ky Vinh, Vu Van Dung and Eames, J. C. (1999) *Expanding the protected areas network in Vietnam for the 21st century: an analysis of the current system with recommendations for equitable expansion*. Hanoi, Vietnam: BirdLife International Vietnam Programme.
- Wikramanayake, E., Dinerstein, E., Hedao, P. and Olson, D. (1997) *A conservation assessment of terrestrial ecoregions of the Indo-Pacific region*. Washington D.C.: WWF-US Conservation Science Programme.

JONATHAN C. EAMES and ANDREW W. TORDOFF

BirdLife International Vietnam Programme, 11, Lane 167, Tay Son, Dong Da, Hanoi, Vietnam.
E-mail: eames.birdlife@netnam.org.vn

ROLAND EVE

WWF Indochina Programme Office, No. 7, Yet Kieu, Hanoi, Vietnam.
E-mail: roland@wvfon.org.vn

Received 3 April 2001; revision accepted 4 July 2001

