The Status and Distribution of Green Peafowl *Pavo muticus* in Dak Lak Province, Vietnam

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Funded by
Danida

This report constitutes the technical annex to the project entitled: Institutional Strengthening of the Institute of Ecology and Biological Resources including field training in conservation assessment techniques.

Hanoi, 1998

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Green Peafowl from Beebe (1922)

Citation:

Brickle, N. W., Nguyen Cu, Ha Quy Quynh, Nguyen Thai Tu Cuong and Hoang Van San (1998) *The Status and Distribution of Green Peafowl* Pavo muticus *in Dak Lak Province, Vietnam*. BirdLife International - Vietnam Programme, Hanoi, Vietnam

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i Summary

- This report presents the results of a survey of Green Peafowl in Dak Lak Province, conducted between 2 February and 4 May 1998.

- The Green Peafowl has undergone a massive decline across its former range. In Vietnam Green Peafowl has gone from being widespread across the country at the turn of the century to being known only from two provinces: Dak Lak and Dong Nai.

- Green Peafowl are typically found in open forest near water. They are threatened by habitat destruction and hunting by humans, for food, eggs, feathers and the wild bird trade.

- Dak Lak still contains large areas of forest, particularly open dry deciduous forest. The province is however targeted for massive industrial and agricultural development and has the highest immigration rate of any province in Vietnam.

- This project aimed to survey Green Peafowl in Dak Lak, to determine their status and distribution, and to investigate their habitat use. A methodology based on two-hour morning and evening point counts was employed.

- 26 sites were visited and Green Peafowl were recorded at 13 of them. A minimum of 187 birds was found. The majority of records were from the north-west of Dak Lak, comprising the districts of Ea Sup, Ea H'Leo, Buon Don, Cu Jut, Dak Mil and Cu M'Gar.

- Analysis of habitat use showed that Green Peafowl were recorded in the largest numbers in dry deciduous forest, followed by mixed and then evergreen forest. Green Peafowl numbers were positively related to the presence of permanent water within 2 km and negatively related to the presence of human settlement within 2 km.

- Based on analysis of habitat-use a prediction for the distribution of Green Peafowl in the whole of Dak Lak was made. This predicted that although dry deciduous forest within 2 km of water and greater than 2 km from people only occupied around 3% of the land area, it was predicted to hold nearly 40 % of the Green Peafowl in Dak Lak.

- The results conclude that large, undisturbed areas of dry deciduous forest with access to permanent water are essential for Green Peafowl. This habitat is of major importance to large mammal species, including wild cattle, as well as several endangered large waterbirds and raptors.

- The conservation of Green Peafowl, and by consequence the conservation of several other threatened large mammal and bird species, will involve protection of large, continuous blocks of dry deciduous forest with undisturbed access to permanent water.

- The most important areas of Dak Lak for suitable Green Peafowl habitat are found in the districts of Ea Sup, Ea H'Leo, Buon Don, Cu M'Gar, Cu Jut, Dak Mil and Ea Kar. Of vital importance are the presently undisturbed permanent forest rivers and streams within these districts including the Ea H'Leo, Ea Khal, Ea Wy, Ya Lop, Dak Dam, Dak Rue, Ea Rok and the Serepok.

ii Summary of Recommendations

Recommendations made by this survey are divided into high priority issues and medium term (lower priority) issues. The full text of the recommendations is found in the report text Sections 9 and 10.

ii.i High priority issues

ii.i.i Protected areas - Expansion of Yok Don National Park

The expansion scheme proposed by Yok Don National Park authority (1998) as well as three further expansion schemes are detailed, and it is recommended that all be immediately implemented.

Plan A, B

Northwards extension through Ea Sup to the Gia Lai provincial border, enclosing a large area of dry deciduous forest and completely enclosing large sections of the Serepok, Dak Rue, Ea H'Leo and Ya Lop rivers. This extension is predicted to increase the number of Green Peafowl protected by Yok Don National Park from 11% to 34% of the provincial total, while providing an excellent refuge for large mammal species.

Plan C

Southwards extension of Yok Don National Park through Cu Jut and Dak Mil. This extension would cover much of the dry deciduous forest in the border regions south of Yok Don while enclosing much of the catchment for rivers and streams flowing north into Yok Don National Park, including Dak Dam and Dak Klau. As well as protecting Green Peafowl this extension would benefit some other important mammal and bird species recorded here including Tiger, Leopard and White-winged Duck.

Plan D

A huge expansion is proposed to extend over much of eastern Ea Sup and western Ea H'Leo. This extension would enclose large areas of dry deciduous forest as well as large areas of mixed forest and areas currently designated as watershed protection forest. This area is predicted to hold 22% of the Green Peafowl in Dak Lak.

ii.i.ii Management Recommendations

Planning issues

Strategic plans should be made and implemented to control the spread of people and agricultural areas within Dak Lak Province. Settlement of people into areas identified as important for wildlife should be prevented. Specifically with reference to this study, this includes along the rivers Ea H'Leo, Ya Lop, Serepok, Ea Wy, Ea Hiao, Dak Rue, Dak Ken, Dak Dam and Ea Khal. This land is of exceptional value for wildlife.

Forestry management

Forestry concessions within the dry deciduous forest should be recognized for their high biodiversity. Forestry compartments should be effectively policed to prevent illegal use outside of logging periods. Notably: grazing, firewood collection, illegal logging, hunting, fishing and illegal settlement. Access should be strictly controlled.

ii.i.iii Further survey work

Surveys in eastern Cambodia for Green Peafowl (and large mammals)

All the important deciduous forest areas in Dak Lak adjoin the Cambodian border and there is likely to be a free flow of animals in both directions. Surveys should be conducted in the Cambodian provinces of Mondulkiri and Ratanakiri with a view to expanding the protected area system there.

Surveys in Gai Lai and Kon Tum for Green Peafowl (and large mammals)

To investigate the suitability of habitat and the extent of Green Peafowl in Gia Lai and Kon Tum Provinces. These provinces formerly held Green Peafowl, and areas of apparently suitable deciduous forest appear to remain. The survey should be carried out during the dry season using a methodology similar to that used in this survey.

ii.ii Medium term issues

ii.ii.i Protected area development

- **Reserve establishment in Ea So, Ea Kar district**. The area is of importance for wild cattle as well as Green Peafowl.
- **Reserve development in south Gia Lai**. The deciduous forest areas of south Gia Lai that form a continuous block with areas in Dak Lak should be protected.
- **Reserve development in Cambodia**. Important areas adjoining the Vietnamese border should be included in the protected area system to form a large cross-border reserve.

ii.ii.ii Management recommendations

- **Management of border regions**. Further restriction of access and use of the border guards in forest protection.
- **Conservation awareness**. Increasing the awareness of the importance of deciduous forest and the unique fauna living in it.

ii.ii.iii Further survey work

- **Monitoring numbers**. Repeat surveys of Green Peafowl to record continuing status.
- **Wet season surveys**. To investigate the habitat requirements and distribution of Green Peafowl during the rainy season. To assess the importance of temporary water sources.

iii Acknowledgements

This report comprises the technical annex to the final report of the Danida funded project entitled "Institutional Strengthening of the Institute of Ecology and Biological Resources including field training in conservation techniques".

This project was sponsored by Danida through the Royal Danish Embassy in Hanoi. We extend our grateful thanks to them for supporting our work.

We also thank the many people and organisations that helped us during the fieldwork in Dak Lak Province and while working in Hanoi. In Dak Lak we express our gratitude to the Provincial People's Committee, the People's Committees of connected districts, the Provincial Police Department, the Border Headquarters and connected guard stations. Thanks also go to the Forest Protection Departments of the districts, and the staff of the Forest Enterprises and Sub-Enterprises where fieldwork was conducted. Special thanks are due to Mr Nguyen Huu Tri, Director of Dak Lak Department of Science, Technology and the Environment and Mr Pham Ngoc Danh, Head of the Environmental Management Section for their assistance and help throughout our time in Dak Lak.

In Hanoi, we would like to thank Prof. Dr Cao Van Sung, Director of the Institute of Ecology and Biological Resources. This report was peer reviewed by Dr Frank Lambert, Dr William Duckworth, Dr Philip McGowan, Frank Rozendaal and Dr David Harper. This report was copy-edited and proof read by Dr William Duckworth.

We would also like to extend our thanks to *Dansk Ornitologisk Forening* - BirdLife Denmark, and particularly Anita Pedersen (International Officer), the DOF International Committee and DOF Director Claus Oppermann, for endorsing this project.

iv Conventions and abbreviations used

Bird names (common and scientific), sequence and species limits follow Inskipp *et al.* (1996). Scientific names are given at first mention and in Appendix 3.

Mammal names (scientific), sequence and species limits follow Corbet and Hill (1992). Scientific names are given at first mention and in Appendix 4.

Diacritical marks are omitted from proper names in Vietnamese due to typographical limitations and the restricted understanding of the international readership.

Locality names follow the Department of Cartography 1:50,000 series maps (1993).

Indochina is used to refer to the biogeographical region including the countries of Vietnam, Cambodia, Laos, Thailand and Myanmar.

Abbreviations and Acronyms used:

a.s.l.	above sea level
DOSTE	Department of Science, Technology and the Environment
DPI	Department of Planning and Investment
FIPI	Forest Inventory and Planning Institute, Hanoi
FPD	Forest Protection Department
IEBR	Institute of Ecology and Biological Resources, Hanoi
MARD	Ministry of Agriculture and Rural Development
MOD	Ministry of Defence
MPI	Ministry of Planning and Investment
NGO	Non-Governmental Organization
s.f.	significant figures

1 Background - The Green Peafowl

1.1 Global status and distribution

The Green Peafowl *Pavo muticus* was formerly widespread across much of South-East Asia. At the turn of the century it was resident in north-east India, Bangladesh, Myanmar, Thailand, Malaysia (west), Indonesia (Java), Cambodia, Laos, Vietnam, and southern China (Delacour 1977). In the last few decades however, the species has undergone a massive decline and a recent review of status paints a bleak picture (McGowan *et al.* in press). This decline has led to the conservation of the species being considered as one of the highest action priorities by the Pheasant Specialist Group of the World Pheasant Association, the Species Survival Commission and BirdLife International. Current status assessments consider the species 'Vulnerable' (Collar *et al.* 1994) and 'Endangered' (McGowan and Garson 1995).

Information on the current status of Green Peafowl across its historical range is patchy. In north-east India and Bangladesh some recent unconfirmed sightings have been made but there have been no systematic surveys. Green Peafowl is now considered to be absent from most former sites in the region (McGowan *et al.* in press). In Thailand, the species is now only known from one location near the Myanmar border, Huai Kha Khaeng Wildlife Sanctuary (Round 1983, Stewart-Cox and Quinnell 1990), while the situation in Myanmar itself is largely unknown. Green Peafowl has already become extinct from peninsular Malaysia (Davison and Scriven 1987): the last birds were recorded around 1960 (Medway and Wells 1976). The somewhat isolated population that exists in Java (Indonesia) is still relatively widespread, although many local populations are very small (van Balen *et al.* 1995).

The largest populations of Green Peafowl are thought to remain in eastern Indochina (Cambodia, Laos and Vietnam). At the turn of the century the species was widespread and common across the region. Delacour and Jabouille (1925b) noted that "The peafowl is, with the Red Junglefowl [*Gallus gallus*], the commonest game-bird in Indo-China. It is found over the five states of the Union - from Tonkin to Cambodia, in Annam, Laos and Cochinchina." Information on current status again is patchy, but it is clear that a similar statement could not be made today.

Fieldwork carried out in Laos since 1988 has found evidence of small populations of birds at several sites. Larger numbers may survive only at a few locations and a large decline has clearly occurred (Evans and Timmins 1996). The situation in Cambodia is not clear. Recent surveys in the east of the country did however record Green Peafowl at several locations (Desai and Lic Vuthy 1996). Large areas of suitable habitat remain in Cambodia and it is possible that further fieldwork may reveal large numbers (McGowan *et al.* in press).

1.2 Status and distribution - Vietnam

In Vietnam, at the turn of the century, Green Peafowl were present in all regions except those dominated by wet rice cultivation (Delacour and Jabouille 1925a, Vo Quy 1975). Since then the Green Peafowl has undergone a massive range contraction to its present-day distribution (Le Trong Trai 1996). This range contraction has been particularly marked in the last 30 years.

Between 1962 and 1973, avifaunal surveys were made in the north of the country and Green Peafowl was recorded in six provinces: Lai Chau, Son La, Hoa Binh, Nghe An, Ha Tinh and Quang Binh (Dang Huy Huynh *et al.* 1974). Since 1975 Green Peafowl have only been recorded at one location within these provinces: Muong Nhe Nature Reserve in Lai Chau Province in 1991 (Cox *et al.* 1992).

There have been no more recent sightings and it seems likely that Green Peafowl is now extinct in most of these northern regions. Many areas however have not been adequately surveyed since 1975 and it is possible that some birds may still survive along the Laos-Vietnam border in Lai Chau and Son La provinces (Le Trong Trai 1997).

Recent records from central Vietnam are restricted to a report by villagers of birds in Ba Long Valley, Quang Tri Province in 1991 and a single sighting near Bach Ma National Park in Thua Thien Hue Province in 1990 (Robson *et al.* 1991). The Ba Long Valley has not been re-visited by ornithologists but no further records have been made at Bach Ma despite survey work and it is possible that Green Peafowl is now also extinct or nearly extinct in these central provinces.

The greatest potential for surviving populations is in the 'Western Highlands' (Tay Nguyen Plateau) of south-central Vietnam and in some of the lowland regions further south. Avifaunal surveys conducted between 1976 and 1980 in the western highland provinces of Dak Lak, Gia Lai, Kon Tum and Lam Dong recorded the presence of Green Peafowl in all four provinces (Truong Van La and Nguyen Cu 1981). Subsequently Green Peafowl were recorded again in Kon Tum, at Mom Ray Nature Reserve in 1984/5 (Do Tuoc and Ngo Tu 1985) and in Dak Lak at Yok Don National Park in 1989 (Laurie *et al.* 1989). In Yok Don National Park at this time Green Peafowl was said to be commonly seen and heard. In provinces adjacent to the Tay Nguyen Plateau, Green Peafowl have been recorded at Bu Gia Map Nature Reserve in Binh Phuoc Province (Anon. 1989) and in 1989/90 at Cat Tien National Park in Dong Nai Province. At this time it was estimated that up to 17 calling males were present in a *c.*13 km^2 area of the park (Robson *et al.* 1991).

Since 1991 the continuing presence of Green Peafowl in Vietnam has only been confirmed at Cat Tien National Park (J. C. Eames pers. comm., Atkins and Tentij pers. comm.) and in Dak Lak Province at four sites including Yok Don National Park (Le Xuan Canh *et al.* 1997). Recent unconfirmed reports have also been made from Mom Ray Nature Reserve (Kon Tum Province) and Bu Gia Map Nature Reserve (Binh Phuc Province).

In 1997 fieldwork confirmed that Green Peafowl were still present in small numbers in at least three locations in Cat Tien National Park (J. C. Eames pers. comm., Atkins and Tentij pers. comm.). This population has become increasingly isolated however, as much of the area surrounding Cat Tien National Park has become seriously degraded, or been converted to agriculture.

Survey work in Dak Lak, also from 1997 (Le Xuan Canh *et al.* 1997), recorded Green Peafowl at four locations. Green Peafowl were recorded despite the fact that this survey was not aimed at birds and was made in the wet season when peafowl are less likely to call and so consequently become far more difficult to record (see Methods). In Yok Don National Park a single bird was seen, and cast feathers were found at two other locations in the park. A sighting, cast feathers and / or footprints were recorded at two sites north of Yok Don National Park, in Ea Sup district. Villages reported the bird at a further site in Ea Kar district in the north-east of Dak Lak province.

This spectacular reduction in the Green Peafowl's distribution in Vietnam from being countrywide to only being known from two areas since 1991 may not be a complete picture. In particular, large areas of Western Highlands have remained unvisited since the 1976-1980 surveys (Truong Van La and Nguyen Cu 1981) and many parts of the highlands, Dak Lak in particular, still retain much forest (see Section 2.2). Although, as mentioned above, much of the area around Cat Tien National Park has become degraded or converted to agriculture, the same is not true of Yok Don National Park. The park forms part of a near continuous block of lowland forest extending north into Ea Sup district, south in Cu Jut and Dak Mil district and west into Cambodia. In 1997 Yok Don National Park guards reported Green Peafowl still present in good numbers in the park, despite the low number recorded during the visit

made by Le Xuan Canh *et al.* (1997). If Green Peafowl remain in good numbers in Yok Don National Park, the same may be true of the adjacent areas. Surveying these areas of Dak Lak was identified as a key priority for future work by both Le Trong Trai (1996) and by McGowan *et al.* (in press).

1.3 Ecology and habitat use

Present knowledge on the ecology and behaviour of Green Peafowl is somewhat limited. Hoogerwerf (1970) observed that birds were most attracted to pastures and park-like surroundings of light or open forest and to forest fringes, noting that birds would penetrate further into the forest if the presence of food or water made it necessary. This need for fresh water was also highlighted by Delacour (1977) describing the habitat of Green Peafowl as wide meandering rivers fringed by park-like areas where long grass was dotted with trees and forest patches. Johnsgard (1986) also considered good and plentiful supplies of water to be indispensable.

Recent work on Green Peafowl, particularly in Indochina, has frequently highlighted an apparent preference for open forest and river valleys. At the only remaining site in Thailand for Green Peafowl, Huai Kha Khaeng Wildlife Sanctuary, birds are found along the length of the Huai Kha Khaeng river which is shallow, sandy bottomed with grassy banks and surrounded by open deciduous forest on both sides (Round 1983, Stewart-Cox and Quinnell 1990). In Laos, Green Peafowl were most often recorded in areas of open dry deciduous forest, however in many areas rivers were said to dry up outside the rainy season and the only water sources then were temporary pools (Evans and Timmins 1996).

In Java the situation seems a little different: several Green Peafowl concentrations are in areas of open forest and park-like areas created by cattle grazing, but birds are also frequently recorded in teak and even rubber plantations, particularly if they are adjacent to suitable natural habitat (van Balen *et al.* 1995). Birds in two main sites do not appear to have year-round access to water and so seem not to have the high dependence on water mentioned by other authors (van Balen *et al.* 1995).

Some authors have commented on an apparent preference birds show for low altitudes. The majority of records are from the lowlands (0-500 m), however Green Peafowl have been recorded up to 3,000 m in Java (van Balen *et al.* 1995). Any apparent preference for lowlands may well be a secondary result of habitat preference.

Recent records of Green Peafowl from Vietnam (post-1991) have been from open forest areas, either dry deciduous forest or mixed forest, and typically along river valleys. Historical records of Green Peafowl in Vietnam have also been from lowland and montane evergreen forest as well as areas dominated by bamboo (Nguyen Cu pers. obs.).

Further work to determine habitat preferences more accurately, in order to investigate possible limiting factors such as water availability, are vital to developing a conservation strategy for the species. This point is made directly in recommendations for future action for the species by McGowan *et al.* (in press).

1.4 Conservation of Green Peafowl

The biggest threats to Green Peafowl across their range are considered to be from habitat loss and direct human exploitation by hunting birds for food and trade. Threats to Green Peafowl are discussed at length in McGowan and Garson (1995) and McGowan *et al.* (in press).

The apparent preference birds show for lowland riverine forest and adjacent open forest often brings them into direct competition with humans for habitat. These areas are frequently the first areas to be cleared by newly arriving people, a fact that has led to a distinct scarcity of this habitat across heavily populated regions of South-East Asia.

Direct exploitation by people has been attributed as the main reason for the decline or extinction of birds from remaining suitable habitat. In Malaysia, the eventual extinction from what was already a depleted habitat type was attributed to hunting. In Thailand the loss of Green Peafowl over almost the entire country has similarly been attributed to human persecution (Round 1988). Human exploitation of Green Peafowl can take the form of hunting for food, for the captive bird trade (adults, young and eggs) and, especially in Java, China, Laos and Thailand, for the trophy/ornament trade (McGowan *et al.* in press).

2 Background - Dak Lak Province

2.1 General topography and climate

Dak Lak Province lies on the Tay Nguyen Plateau (see Map 1) and is the largest province in Vietnam, covering 19,800 km^2. Despite being considered part of the 'western highlands', much of it lies between 200 m and 400 m above sea level (a.s.l.). Dak Lak Province forms a large basin, bordered to the north by the Annamite Mountains, to the east by the coastal ranges, and to the south by the Da Lat Plateau. In the south the land rises to Vietnam's third highest mountain, Chu Yang Sin (2,405 m).

Most of the rivers in Dak Lak drain west into Cambodia. The largest river is the Serepok, which is fed by the Krong No and Krong Ana rivers which drain much of the south and east of the province respectively. Other smaller rivers such as Ea H'leo, Ea Khal, Ea Wy drain northern parts. These smaller rivers join with the Serepok in Cambodia, the Serepok in turn then joins the Mekong River. The main rivers in Dak Lak are shown on Map 4.

In the lower altitude parts of Dak Lak rainfall is relatively low and very seasonal. A distinct dry season runs from November to April and annual rainfall is less than 1,600 mm/year (MPI *et al.* 1996). Many of the smaller rivers dry up completely outside of the rainy season. Rainfall increases with altitude and the mountain regions receive over 2,400 mm/year (MPI *et al.* 1996).

2.2 Habitat

Dak Lak still remains one of the most forested provinces of Vietnam. In 1996 the area of forest of all types (including plantation) was estimated at 12,232 km^2 (MPI *et al.* 1996). Forest cover in 1996 is shown in Map 2, prepared by the Remote Sensing - Ecology Department of IEBR (1998).

Of the total forested area, 3,511 km^2 is dry deciduous forest. This area represents 34% of the total area of dry deciduous forest in Vietnam (Dang Huy Huynh *et al.* 1995). This type of forest occurs in other provinces on the Tay Nguyen Plateau but by far the largest area exists in Dak Lak.

Dry deciduous forest occurs in lowland areas with low rainfall; leaves are dropped in response to the drought imposed by the long dry season. Within these deciduous forests, along watercourses small areas of lowland evergreen forest are supported. These strips of riverine forest represent one of the most threatened habitats in South-East Asia. Several rivers within the main deciduous forest areas of Dak Lak still support good undisturbed areas of riverine forest, particularly the Serepok, Ea H'Leo, Ya Lop and Dak Dam. Fires are frequent within the deciduous forest regions and possibly even maintain the climax vegetation, since most of the tree species present are largely fire resistant. However with the increase in human activity in the area, the frequency of fires is likely to have increased dramatically, and the impact of this is little known.

The remaining forested area of the province is predominantly mixed forest and evergreen forest. Much of the original mixed forest at medium altitudes has been cleared for agriculture as the soil is of very good quality and the climate is suitable, with higher rainfall than the lowlands. Evergreen and montane forest remains in higher altitude regions, particularly in the south and east of Dak Lak. Some evergreen forest areas are still quite extensive such as around Chu Yang Sin. Large areas of forest interspersed with grass and scrub are also present in Dak Lak.

Logging activity has been widespread in Dak Lak and very few areas of primary forest remain. A total of

6.8 million m^3 of timber were removed from the whole Tay Nguyen plateau between 1976 and 1996, a large proportion of this from Dak Lak (MPI *et al.* 1996). Most commercial logging has however been selective, although increasingly it seems that clear felling with subsequent conversion of the land to agriculture is more typical.

2.3 Human distribution

Dak Lak Province has a human population estimated in 1995 to be 1,242,000 (Anon. 1997) and due to the large size of the province this results in a low human density (61 people/ km^2) in comparison with most other Vietnamese provinces.

The human population in Dak Lak is not equally distributed across the province; human density varies considerably between districts. The district of Ea Sup for example has a density estimated in 1996 to be only 13.2 people per km^2. This makes it among the lowest in Vietnam. The district of Krong Ana by contrast has a density estimated at 243.7 people per km^2, a relatively high figure for an almost entirely rural district (Anon. 1997). Human density estimated in 1996 is shown for each district in Map 3. This clearly shows the uneven distribution of people across the province with a concentration of people in the central and eastern districts.

Dak Lak is targeted within Vietnam for economic expansion and this has fuelled a very high immigration rate from other provinces. Between 1979 and 1989 Dak Lak had the highest immigration of any province in Vietnam. The immigration continues, including many people arriving on government-sponsored programmes. In 1990, the population of Dak Lak was estimated at 1,026,000 people, by 1995 it had risen to 1,242,000 people and it is predicted to rise by the year 2000 to 1,441,000 people (Anon. 1994).

Another driving force behind the immigration is the quality of much of the province for agriculture. The last 20 years have seen a dramatic rise in the area of the province under agriculture. The present day figure of 2,308 km^2 is predicted to rise to 3,600 km^2 in the year 2000 and to 4,820 km^2 by the year 2010 (Anon. 1994). Much of this increased acreage is projected to be coffee, rubber, tea, cashew, peanuts, rice and maize.

The province is also targeted for industrial development, with expansion anticipated in hydro-electric power generation, metal processing, chemical manufacture, wood processing and construction materials. Targets proposed are aiming for a 250 % increase in gross domestic product (GDP) from heavy industry, and a 150 % increase in GDP from agriculture and forestry between 1993 and 2000 (Anon. 1994).

It seems little account has been taken of the environmental impact of the proposed development. Few strategic plans seem to have been made to ensure a sustainable use of resources as the human population grows and industrial and agricultural expansion continues.

2.4 Notable fauna and previous biological survey work

Much of the biological survey work in Dak Lak has centred on the dry deciduous forest regions. These forests are considered nationally and globally important for their populations of large mammals, particularly wild cattle and wild Asian Elephants *Elephas maximus*.

Of the wild cattle species, Gaur *Bos gaurus* and Banteng *B. javanicus* still survive in relatively large

numbers and both were recorded extensively by a recent survey (Le Xuan Canh *et al.* 1997). Reports also exist of wild Asian Buffalo *Bubalus arnee* and of Kouprey *Bos sauveli*. Both of these may still exist but neither was positively recorded during the survey, and reports by locals remain unsubstantiated (Le Xuan Canh 1997). The adjacent dry deciduous forest regions of Cambodia were known historically to support all four species (Desai and Lic Vuthy 1996) and so hope still remains that all are present in Dak Lak. Other mammal species of note recorded within the deciduous forest regions of Dak Lak include Asian Elephant, Asian Golden Cat *Catopuma temmincki*, Leopard *Panthera pardus*, Tiger P. *tigris*, Dhole *Cuon alpinus* and Eld's Deer *Cervus eldi*. An extensive review of the large mammal records from Dak Lak is made by Le Xuan Canh *et al.* (1997).

Little ornithological survey work has been carried out other than work centred within Yok Don or the pioneering collecting surveys made by Trung Van La and Nguyen Cu (1981). Birds were however recorded during the mammal surveys made by Laurie *et al.* (1989) and Le Xuan Canh *et al.* (1997). The lowland dry deciduous forest regions still support several large waterbirds including Woolly-necked Stork *Ciconia episcopus*, Lesser Adjutant *Leptoptilos javanicus*, Masked Finfoot *Heliopais personata*, and possibly Black Ibis *Pseudibis papillosa davisoni* and Giant Ibis *P. gigantea*. Also in the lowlands several large declining raptor species remain including Red-headed Vulture *Sarcogyps calvus*, White-rumped Vulture *Gyps bengalensis* and fish eagles *Ichthyophaga* spp.

The mountainous regions to the south and east of Dak Lak support numerous restricted range and endangered bird species. Chu Yang Sin lies within the Da Lat Plateau Endemic Bird Area (Stattersfield *et al.* 1998).

3 Aims of the survey

The survey aimed to:

- Investigate the range and status of Green Peafowl in Dak Lak Province
- Investigate habitat use and limiting factors
- Estimate relative density between key habitat types
- Predict the distribution of Green Peafowl across Dak Lak and estimate the population.
- Identify key areas for Green Peafowl
- Identify key management considerations
- Record all bird and mammal species encountered

4 Methods

4.1 Survey Methods

Surveying was carried out between 1 February and 4 May 1998. This survey used Green Peafowl calls as the primary tool to investigating distribution, relative density and habitat use of the species. The calls of Green Peafowl are very loud and easily audible in good conditions at distances up to about a kilometre. Green Peafowl give a range of calls, the commonest being the so called "wail", made predominantly, it is believed, by breeding males (Indrawan 1995). This survey was timed to take place at the period of maximum calling in the run-up to the breeding season when mature males are in open competition for females and territory. Outside of this period birds can remain very quiet.

A standardised point count methodology was used to record Green Peafowl. The method was designed to be fundamentally simple, as the majority of data were to be collected by previously untrained fieldworkers, and to allow a large area to be covered in a minimum of time. The method also allowed analysis on a number of levels.

Counts of two hours duration were made around sunrise (c.05h30-07h30) and dusk (c.16h30-18h30). Dusk counts were timed to extend beyond sunset. Two counts were made as the birds do not typically call frequently (see results). Counts were made by two observers. The compass bearing and type of call were noted for every Green Peafowl call heard. Type of call was described to a previously agreed notation covering the range of known calls.

At the end of a two hour recording period an estimation was made of the minimum number of calling birds present. This was based on direction and timing of calls. For example if two calls were heard in succession at widely differing compass bearings or distances, two birds would be assumed to be present. However if two calls in succession could not confidently be attributed to two birds, then the minimum number present was recorded as one. Whenever it was in doubt as to the number of birds calling, the minimum number was always assumed. This method reduces the incidence of double counting of birds within a recording period, but may underestimate the number of birds calling: the results are discussed in relation to this.

Sightings of Green Peafowl or their tracks were also recorded (separately) but were seldom made. Sightings of Green Peafowl are infrequent as the birds can be very cautious. Tracks are a useful indicator of presence but are not very suitable for a quantitative survey (Stewart-Cox and Quinnell 1990).

Simple habitat variables were recorded at each point count. These were:

- Forest type (if present) - The broadly defined forest type at the location of the count was defined as deciduous, evergreen or mixed depending on the dominance.

- Undergrowth type (if present) - The dominance of bamboo, grass or scrub was assessed at the count location on a 3 point scale (absent, present, dominant). The extent of recently burnt ground was similarly assessed.

- Canopy cover - A rough estimation of percentage canopy cover at the count location was made. Where an area was dominated by deciduous trees which had shed their leaves the estimate attempted to predict cover as if the trees were in leaf.

- Distance to water - The distance to water, standing or running, was determined as far as possible from

investigating the state of rivers and streams in the survey area and estimating distance, using maps if necessary. Dry rivers and streams were not counted. As this survey was conducted at the end of the dry season, in a particularly dry year (an El Nino year), water found was considered to be permanent. In this way this variable was taken to be the distance to permanent water.

- Distance to human settlement - The distance to permanent human settlement was determined by investigation, use of maps and discussion with guides and locals.

- Presence of grazing - The presence of domesticated grazing cattle was recorded.

No more detailed habitat variables were recorded, in part because of the need for simplicity, and partly as it was quite possible that the location of the point count may have been a considerable distance from the calling birds that were being recorded, a possibility that is considered in detail in Section 7.2.

Due to the large distance that Green Peafowl can be heard calling from, counts to be treated as independent data were spaced by at least 2 km. Some deliberate repeat counts were made, but these are analysed separately.

The location of points counts at a site was neither random nor systematic. This was not considered logistically possible, due to the need to cover a large number of sites, nor was it considered necessary to meet the main aims of the survey, namely to determine presence and absence over a large an area as possible and to investigate habitat associations. The former is best achieved by covering as many sites as possible, the latter by collecting as many independent data as possible.

Point counts were conducted simultaneously by three teams of two people on every feasible morning and evening. In order to maintain the distance between each count site a 4X4 vehicle was used to distribute survey teams. The vehicle was used to drop people in position before light (for morning counts) or in mid afternoon for evening counts. The use of the vehicle in this way may have introduced bias into the results as it virtually restricted surveying to areas that could be approached by vehicle. Survey teams could walk away from the drop off site but it was seldom feasible to proceed more than 1 km on foot away from vehicular access. Similarly the presence of the vehicle may have caused disturbance and affected calling activity. Results are considered in relation to these problems.

Numerous other considerations need to be made in the analysis of calling bird counts apart from those specifically mentioned here. These assumptions largely depend on the interpretation that is being made of the data, and are discussed in Bibby *et al.* (1992), in relation to point counts generally, and in Gates (1966), Gaston (1979) and Stewart-Cox and Quinnell (1990), with reference to Galliformes in particular. In this report limitations are discussed under the relevant section of the results and within the discussion chapters.

4.2 Other bird and mammal species

All bird and mammal species seen during the survey were recorded by site. No quantitative data were collected.

4.3 Identification of sites and access

Potential sites of interest were identified from existing forest cover maps (FIPI), topographic maps

(Department of Cartography 1:50,000 series) and land use maps (MPI *et al.* 1996). Potential sites were then prioritised on the basis of their likelihood of holding Green Peafowl based on the existing knowledge of habitat use by the species, such as forest areas, with wide rivers and few villages, and previous records from Dak Lak (see Section 1.2). Each site was visited for between 1 and 4 days. Camp-sites were made where suitable supply of water was available.

4.4 Statistical analysis

Statistical analysis was conducted using Excel Version 97 (Microsoft 1997) and SPSS version 7.0 (SPSS Inc. 1995). Map based analysis was made using MapInfo Professional version 4.0 (MapInfo Corporation 1995). Parametric statistics were used throughout as were two-tailed tests. Results were considered significant if $p < 0.05$ and highly significant if $p < 0.01$. Actual significance levels for all tests are given.

5 Site descriptions

During the survey 26 sites were visited; their locations are shown in Map 4. A brief description of key habitat features is shown in Table 1. Where the availability of water was restricted in the dry season, the names of the principal streams still with water are given. The exact location, within political divisions as well as geographical co-ordinates, and the dates visited is shown in Appendix 1. Each site is identified by a numeric code.

Most sites were not discrete areas, making the naming of sites difficult. Similarly sites were not surveyed systematically (see methods) which means quantitative habitat data cannot be given. A detailed qualitative description of sites was not considered very meaningful.

Table 1: Key characteristics of survey sites. Table shows administrative district, dominant and secondary habitat, presence of water in the dry season, presence of people and approximate altitudinal range. Exact location of sites is shown in Appendix 1 and Map 4.

Site	District	Dominant Habitat	Secondary habitat(s)	Water in dry season	Human presence	Altitude (m a.s.l.)
1	Ea Sup/Ea H'leo	dry deciduous forest	riverine forest	very restricted (Ea Khal, Ea Wy)	very low	200-400
2	Ea H'leo	dry deciduous forest	riverine forest	very restricted (Ea Puk, Ea Rok)	low	200-400
3	Ea H'leo	mixed forest	dry deciduous, riverine forest	present (Ea Hiao, Ea You)	high	400-600
4	Krong Nang	evergreen forest	mixed forest, agriculture	present	high	500-800
5	Cu M'ga / Ea Sup	dry deciduous forest	riverine forest	restricted (Ea Keu)	low	200-400
6	Ea Sup	dry deciduous forest	riverine forest	restricted (Serepok)	medium to high	200-300
7	Ea Sup	dry deciduous forest	riverine forest	restricted (Ea Khal, Ea H'Leo)	very low to medium	200-300
8	Ea Sup	dry deciduous forest	riverine forest	restricted (Ya Lop)	very low to medium	200-300
9	Ea Sup	dry deciduous forest	mixed forest	absent	very low	300-400
10	Buon Don	dry deciduous forest	mixed forest, riverine forest	very restricted (Dak Chua)	low	200-400
11	Dak R'Lap	evergreen forest	grassland	extensive	low	600-100
12	Dak R'Lap	evergreen forest	bamboo forest	extensive	low to medium	600-800
13	Dak Mil	dry deciduous forest	riverine forest	very restricted (Dak Dam)	very low	200-300
14	Dak Mil	evergreen forest	some grassland	extensive	low	700-1000
15	Cu Jut/Buon Don	dry deciduous forest	riverine forest	very restricted (Dak Ken, Dak Lao)	very low	200-300
16	M' Drak	evergreen forest	mixed forest, grassland	extensive	low	700-1000
17	Krong No	mixed forest	riverine forest, bamboo	fairly restricted (Ea Krong No)	medium	400-500
18	Lak	mixed forest	evergreen forest, agriculture	extensive	high	300-600
19	Lak	mixed forest	evergreen forest, agriculture	extensive	high	300-600
20	Krong No	mixed forest	evergreen forest	extensive	high	300-500
21	Krong No	mixed forest	riverine forest	extensive	high	200-400
22	Krong No	mixed forest, agriculture	wet rice	extensive	high	200-400
23	Krong No	mixed forest	evergreen forest	extensive	high	200-500
24	Ea Kar	mixed forest, grassland	dry deciduous forest	present	low to medium	200-500
25	Ea Sup	dry deciduous forest	riverine forest	very restricted (Ea H'Leo)	very low	200-300

6 Results

6.1 General

A total of 161 independent point counts were made at 26 sites in Dak Lak Province. Green Peafowl were recorded at 66 counts spread across 13 sites. A total of 356 Green Peafowl contacts were made representing a minimum of 187 birds. Mean number of contacts per point was 2.21 (S.E. = 0.32, range 0-23), representing a mean minimum number of birds per point of 1.16 (S.E. = 0.15, range 0-7).

Analysis of data followed three approaches. The first was a simple analysis of Green Peafowl status by site. The second was an analysis of habitat use and finally a map-based analysis was conducted to predict Green Peafowl distribution and estimate potential abundance in Dak Lak.

6.2 Status by site

Green Peafowl were recorded at the sites shown in Table 2. The table also shows the number of independent point counts made at each site, the number of these at which Green Peafowl were recorded, and the mean number of peafowl which were recorded. The mean number of birds recorded is only given as an indication of presence, not as a quantitative estimate of abundance. The results do not show relative density for each site due to the unsystematic way in which the data were collected. The results indicate those sites where the presence of Green Peafowl was confirmed by this survey. Exact location of every count where Green Peafowl were recorded is given in Appendix 2. Details of sites and their exact locations are shown in Table 1 and Appendix 1 respectively. Site locations are also shown on Map 4.

Table 2: Green Peafowl presence by site. Table shows site number (see Table 1), district, the total number of counts made at that site, the number of these that recorded Green Peafowl and the mean minimum number of Green Peafowl recorded at each count. Sites are listed in decreasing order of mean number of Green Peafowl recorded.

Site Number	District	Total counts	G.P. present	Mean number Green Peafowl	S.E. of mean
25	Ea Sup	12	9	3.08	0.74
1	Ea H'Leo / Ea Sup	11	9	2.91	0.79
7	Ea Sup	11	10	2.91	0.67
2	Ea H'Leo	13	8	1.62	0.46
5	Cu M'Ga, Ea Sup	11	5	1.45	0.61
8	Ea Sup	10	3	1.40	0.72
3	Ea H'Leo	3	2	1.33	0.88
13	Dak Mil	11	8	1.27	0.33
24	Ea Kar	4	2	1.00	0.71
15	Cu Jut / Buon Don	6	2	0.67	0.49
10	Buon Don	5	2	0.40	0.24
6	Ea Sup	14	4	0.29	0.13
11	Dak R'Lap	11	2	0.27	0.19
4	Krong Nang	4	0	0	0
9	Ea Sup	4	0	0	0
12	Dak R'Lap	8	0	0	0
14	Dak Mil	3	0	0	0
16	M'Drak	5	0	0	0
17	Krong No	7	0	0	0
18	Lak	1	0	0	0
19	Lak	1	0	0	0
20	Krong No	1	0	0	0
21	Krong No	2	0	0	0
22	Krong No	1	0	0	0
23	Krong No	2	0	0	0

By comparing Green Peafowl by site (Table 2) with the site descriptions (Table 1), it can be seen that those sites that recorded Green Peafowl were typically, but not exclusively, dry deciduous forest, often with riverine forest present and a low human population. The relative importance of particular sites is discussed at length in Sections 7.1 and 8.2.

6.3 Habitat use

6.3.1 Data analysis

To assess the effect of different habitat variables on the minimum number of Green Peafowl present, multiple regression was used. Due to the large number of factors potentially affecting Green Peafowl numbers it was necessary to use an analytical technique that could consider the effects simultaneously. Multiple regression (Fry 1993) is a robust tool that allows the relationship of several variables to be compared to a dependent variable at the same time. This is particularly useful when the dependent variable is likely to be strongly influenced by more than one independent variable.

Initially three independent variables were entered simultaneously, forest type, distance to water and distance to human settlement. These variables were chosen as it was felt during fieldwork that they may be important. The results showed all three factors had a highly significant effect on the number of Green Peafowl recorded ('forest' $\beta = 0.453$, $t = 6.452$, $p = 0.000$; 'distance to water' $\beta = -0.261$, $t = -3.594$, $p = 0.000$; 'distance to human settlement' $\beta = 0.183$, $t = 2.499$, $p = 0.013$; Overall model $R^2 = 0.242$, $F_{3,156} = 16.642$, $p = 0.000$). Distance to humans showed a negative relationship with Green Peafowl numbers while distance to water showed a positive relationship. The greatest number of Green Peafowl were found in deciduous forest followed by mixed then evergreen.

Distance to water was the replaced by a dichotomous factor 'presence of water within 2 km' and distance to humans was replaced with a dichotomous factor 'presence of human settlement within 2 km'. An analogous multiple regression analysis was performed again including forest type. The results showed a significant relationship for each variable again ('forest' $\beta = 0.453$, $t = 6.452$, $p = 0.000$; 'water present within 2 km' $\beta = 0.332$, $t = 4.628$, $p = 0.000$; 'human settlement present within 2 km' $\beta = -0.242$, $t = -3.454$, $p = 0.001$; Overall model $R^2 = 0.288$, $F_{3,156} = 21.035$, $p = 0.000$). The overall model showed a slightly better fit using the factors rather than the actual distance. Again Green Peafowl numbers were positively related to the presence of water, and negatively related to the presence of human settlement while numbers were greatest in deciduous forest followed by mixed then evergreen.

Next the effects of other habitat variables were tested . The following variables were entered simultaneously and tested against minimum number of Green Peafowl present:

- Forest type (deciduous/mixed/evergreen)
- Presence of humans within 2 km
- Presence of water within 2 km
- Bamboo (Absent/Present/Dominant)
- Grass (Absent/Present/Dominant)
- Burnt ground (Absent/Present/Dominant)
- Scrub (Absent/Present/Dominant)
- Cultivation (Absent/Present/Dominant)

The overall model was highly significant and showed a slightly better fit than did previous models (Overall model $R^2 = 0.329$, $F_{8,123} = 7.549$, $p = 0.000$); however, only the original three variables (forest,

water, humans) had a significant effect. Taking these into account, the remaining factors had no significant effects. Results are shown below:

- Forest type (β = 0.487, t = 5.528, p = 0.000)
- Presence of humans within 2 km (β = -0.288, t = -3.132, p = 0.002)
- Presence of water within 2 km (β = 0.400, t = 4.968, p = 0.000)
- Bamboo (β = 0.028, t = 0.338, p = 0.736)
- Grass (β = 0.026, t = 0.323, p = 0.747)
- Burnt ground (β = -0.055, t = -0.594, p = 0.554)
- Scrub (β = 0.115, t = 1.450, p = 0.149)
- Cultivation (β = 0.084, t = 0.913, p = 0.363)

To investigate further the relationship between forest type and the number of Green Peafowl recorded, a regression analysis was made including the variables 'presence of water within 2 km' and 'presence of human settlement within 2 km' but replacing 'forest type' with the estimation made of canopy cover. This analysis found that canopy cover had a significant negative relationship with Green Peafowl numbers ('Canopy cover' β = -0.266, t = -2.889, p = 0.005; 'water present within 2 km' β = 0.321, t = 3.449, p = 0.001; 'human settlement present within 2 km' β = -0.396, t = -4.228, p = 0.001; Overall model R^2 = 0.221, $F_{3,97}$ = 9.152, p = 0.000). This suggests that it may be the openness of the forest that causes the relationship between forest type and Green Peafowl.

Comparing mean scores for canopy cover between forest types goes some way to support this. The mean cover scores for each forest type were: deciduous = 36.3% (S.E. = 1.5), mixed = 35.8% (S.E. = 4.3), evergreen = 57.2 % (S.E. = 4.4). Cover varied significantly between forest types (One-way ANOVA: $F_{2,97}$ = 17.300, p = 0.000) while post-hoc tests (Tukey HSD), showed that the cover in deciduous and mixed forest did not differ significantly from each other (p = 0.993) but both varied significantly from evergreen forest (p = 0.000).

The effect of habitat variables on the presence or absence of Green Peafowl, as opposed to the minimum number, was tested by using multiple logistic regression. This works in a similar way but uses a dichotomous dependent variable, in this case the presence or absence of Green Peafowl at a count.

The three factors 'forest type', 'humans present within 2 km' and 'water present within 2 km' were entered simultaneously and a result equivalent to the similar test using number of birds was found. Forest type, presence of water, and humans all affected whether Green Peafowl were present or not ('forest type' β = -1.38, Wald = 25.93, p = 0.000; 'water present within 2 km' β = -1.93, Wald = 12.11, p = 0.001; 'human settlement present within 2 km' β = 1.31, Wald = 8.02, p = 0.005; Overall model X^2_3 = 46.99, p = 0.000).

Overall the results of this study show that of the habitat variables measured, forest type, canopy cover and the presence of water and/or humans have the largest effects on both whether Green Peafowl were recorded at a site or not and on the number of birds recorded.

6.3.2 Limitations

All above analyses treat each point count (apart from deliberate repeats) as independent samples. For this to be true there must be no double counting between point counts. The minimum distance of 2 km between point counts was set to avoid incidence of double counting between simultaneous counts and is assumed to have done so adequately. Avoiding double counting between consecutive counts is perhaps more difficult. Consecutive counts made at a site were always greater than 2 km from previous counts and usually considerably more as different areas were approached for each morning and evening

counting session. However, it is impossible to be sure that birds do not travel several kilometres during the day or night, and so subsequently be double counted. Indrawan (1995) in his study of Green Peafowl in Java considered that breeding males (on whose calls this survey was predominantly based; see below) were quite territorial and faithful to an area. This suggests (although does not confirm) that males at least do not typically move over the large distances in the short space of time that they would need to do so in order to be double counted.

Using the minimum number of Green Peafowl present to compare the effect of habitat variables makes several more important assumptions. In particular, if birds are present they call, calling is independent between birds, and double counting of birds within a single count is avoided. All of these amount to questioning whether the number of birds recorded reflects the number of birds actually present and are examined below.

It is certainly true that not all birds call. Females and young will not call or call far more infrequently than breeding males (Indrawan 1995). The 'wail' was the commonest call heard in Indrawan's study (l,939 'wail' calls compared to 71 calls of all other types). In this study 'wail' calls were recorded 342 times compared with only 14 calls of other types. In Indrawan's study 'wail' calls were generally attributed to breeding males, based on calls that were made by visible birds and studies of roosting birds. This suggests that the analysis made in this study would be based largely on adult males, and the inclusion of calls by females and non-breeding males would be minimal. Previous studies have also shown that the presence of non-breeding males and females held a linear relationship with breeding males (Indrawan 1995). It follows from this that if all breeding males present called, then male calling is an index of overall abundance.

The second assumption that males call if present and that their calling is independent has been investigated in previous studies (Stewart-Cox and Quinnell 1990, Indrawan 1995) and was also investigated in this survey. Some systematic repeat counts were made by Stewart-Cox and Quinnell (1990) and by Indrawan (1995) and both considered that some variation did occur (suggesting that all birds present do not call or that birds move around), but sample sizes (number of independent locations) were small in both cases. In this study eight repeat counts were made (at sites where one or more birds were present during the first counting period). A repeatability test (Lessells and Boag 1987) was performed on the data. The test, although clearly based on a small sample size, found that the results were significantly repeatable (One-way ANOVA, $F_{7,15} = 7.992$, $p = 0.004$). This suggests that only 22 % of variation in counts is due to variation in calling activity at the count sites.

The study by Stewart-Cox and Quinnell (1990) suggested that calling was socially facilitated (i.e. birds are more likely to call if more birds are present), although the data presented do not make it clear if this was the case. In this study it was investigated whether calling may have been socially facilitated by comparing the minimum number of birds present and the average number of calls per bird (the total number of contacts divided by the minimum number of birds). This analysis found that the average number of calls per bird was significantly related to the minimum number of birds present. As the minimum number of birds present increased so did the average number of calls per bird (Pearson correlation coefficient 0.397, $p = 0.001$, $n = 66$). The relationship was quite weak but the result suggests that calling is somewhat socially facilitated. The number of calls per birds would however seem to increase with the number of birds, if the number of birds present was underestimated when at high densities, the possibility of which is discussed in Section 7.2. The possibility that calling may socially facilitated does not mean that if very few birds are present they will not call at all, but simply suggests that if more birds are present each bird will call more. Looking at the regression line of average calls per bird plotted against minimum number present suggests that when only one bird is present it should average about 1.5 calls, rising to around 2.5 calls when eight birds are present.

Measures taken to reduce the incidence of double counting of birds within a single point count were discussed in Section 4.1.

Investigations, both in this study and previous work, of the critical assumptions of the analyses are far from conclusive. The extent of introduced error is still little known. It is however felt that any error introduced by violation of these assumptions would be more likely to lead to Type I errors (erroneously accepting the null hypothesis) rather than Type II errors (erroneously rejecting the null hypothesis). The effect of errors will also be reduced if they remain constant across habitats and a large sample of independent data can be collected. All analyses only require that what is recorded is an index of what is actually present rather than an absolute measure of the number present. The results are discussed in light of possible violations of the assumptions.

6.4 Relative abundance and predicted distribution

Analysis in Section 6.3 identified key factors affecting the distribution of Green Peafowl. In this analysis we attempt to use this knowledge to predict the extent of suitable Green Peafowl habitat in Dak Lak, to investigate the relative abundance between habitat types and assess the value of different habitat types and areas.

Those factors found to affect the number and presence of Green Peafowl were used to define 12 habitat classes. These classes were defined on the basis of forest type, presence of water within 2 km and the presence of permanent human settlement within 2 km. The habitat classes and the mean number (with S.E.) of Green Peafowl recorded at counts within them are shown in Table 3. The sample size of counts is also shown. Several habitat types were not surveyed, this was generally due to the scarcity of these habitat types. The effect of this lack of data on subsequent analysis is discussed below.

The mean number of Green Peafowl recorded in each habitat can be taken as a measure of relative density. The justification that the mean value represents an index of the actual number of birds present is the same as that considered when using the number recorded at counts to investigate habitat use (Section 6.3.2). The justification and limitations were discussed at length in that section. It is felt that there are reasonable grounds to suppose that the number of birds recorded at a point count is an index of actual abundance. Given that the detection distance a of Green Peafowl call is broadly the same across the majority of habitats (for example it is not changed by the presence or absence of water in a given forest type), then the mean count of birds within each habitat type can be taken to be a measure of relative density.

It is worth noting that no attempt is made to use the mean number recorded to determine absolute densities (birds per unit area). To do this would require far more assumptions to be made, such as that no disturbance is caused by vehicles or observers, all males present call (as opposed to a constant proportion of males). A correction factor would also need to be added to estimate the total population size including non-breeding males and females. By only taking the data as relative density many sources of bias (discussed in Section 6.3.2) will not greatly affect the results, providing the biases remain constant across habitats; there is little reason to suspect they do not.

The results show that the highest density of Green Peafowl is in deciduous forest with permanent water present and no people within 2 km. The next highest density, with a value less than half as high, is in mixed forest with water and no people within 2 km. In the absence of permanent water the density in deciduous forest without people falls to a fifth of that when water is present.

A map of Dak Lak was then prepared using MapInfo Professional Version 4 (MapInfo Corporation 1995) . This map shows habitat type, human settlement and rivers and was used to identify all areas within 2 km of people and 2 km of water. The map was based on forest cover, land use and river data prepared from satellite imagery and existing maps, by the Remote Sensing - Ecology Department of IEBR in 1998. The accuracy of this map obviously affects the value of the results. The forest cover and land use maps were based on data collected in 1996. The human settlement distribution is definitely an underestimate as only large blocks are shown and much settlement expansion has occurred in the last 3 years (see Section 2.3). The distribution of rivers is of key concern. The map included all main rivers and streams, a large proportion of which are seasonal. This survey was undertaken during the dry season when many streams depicted on the map were dry. To account for this, two versions of the map were prepared, one using all rivers and streams, taken to represent the wet season, and a second map where only those rivers that retain water through the dry season were included. To prepare this map it was necessary to edit out many rivers and streams on the basis of knowledge gathered during fieldwork. The accuracy of these maps and the effect had on results is discussed below (Section 7.3).

Two maps depicting predicted Green Peafowl distribution were then prepared replacing habitat classes with the relative density estimated for that habitat class. One map was produced using minimum (dry season) river distribution (Map 5), the second using maximum (wet season) river distribution (Map 6).

Data were collected only during the dry season so it is completely unknown whether birds do in fact disperse into other areas during the wet season; distribution may in fact be limited to the dry season distribution (see below). Both maps were produced however, as, although wet season habitat use and distribution is unknown, there is some value to speculating which areas hold the habitats identified as the most important in the dry season. This and other factors to be considered in the interpretation of the maps is discussed in Section 7.3.

The maps highlight the importance for Green Peafowl in the north-west region of Dak Lak in general and in particular the rivers Ea H'Leo, Dak Dam, Ya Lop, Ea Wy, Ea Khal and Serepok. These important areas are discussed at length in Section 8.2.

Based on the maps the area of each habitat type was then calculated and is shown in Table 4 (dry season) and Table 5 (wet season). The areas are also shown as percentages of Dak Lak.

Using the mean number of birds recorded by habitat (Table 3), the percentage of the total population present in each habitat can be estimated by weighting the area of each habitat by the relative density recorded for it. This analysis was made on data for the dry season only as the results of this survey do not allow us to assume that during the wet season all habitat is occupied to the same extent as during the dry season.

Where no data existed for the relative density within a particular habitat, a value was estimated based on the values for other habitats and the results of the habitat use analysis. For example no data existed for evergreen forest without water but with people but a value was estimated for evergreen forest with water and with people and this was zero.

Table 3: Green Peafowl by habitat. The mean number of Green Peafowl recorded by habitat class, showing standard error of mean and sample size.

Habitat No.	Forest Type	Water Present 2 km	Human present 2 km	Mean Green Peafowl	Standard Error of mean	Sample size
1	Deciduous	✔		2.45	0.30	55
2	Deciduous	✔	✔	0.76	0.34	17
3	Deciduous			0.50	0.25	20
4	Deciduous		✔	-	-	0
5	Mixed	✔		1.07	0.54	14
6	Mixed	✔	✔	0.57	0.29	14
7	Mixed			0.33	0.33	3
8	Mixed		✔	-	-	0
9	Evergreen	✔		0.19	0.11	26
10	Evergreen	✔	✔	0	0	11
11	Evergreen			-	-	0
12	Evergreen		✔	-	-	0

Table 4: Area of important habitats in Dak Lak in the dry season (km^2). Percentages of the total are shown in parentheses (correct to 2 s.f.).

	Water, No Humans	Water, Humans	No Water, No Humans	No Water, Humans	Totals
Deciduous	645 (3%)	7 (<1%)	2,836 (14%)	24 (<1%)	3,512 (18%)
Mixed	64 (<1%)	4 (<1%)	547 (3%)	3 (<1%)	618 (3%)
Evergreen	4,575 (23%)	34 (<1%)	1,207 (6%)	46 (<1%)	5,862 (30%)
Other					9,808 (49%)
				Total =	19,800

Table 5: Area of important habitats in Dak Lak in the wet season (km^2). Percentages of the total are shown in parentheses (correct to 2 s.f.).

	Water, No Humans	Water, Humans	No Water, No Humans	No Water, Humans	Totals
Deciduous	2,116 (11%)	19 (<1%)	1,365 (7%)	12 (<1%)	3,512 (18%)
Mixed	422 (2%)	6 (<1%)	190 (1%)	0 (0%)	618 (3%)
Evergreen	4,575 (23%)	34 (<1%)	1,207 (6%)	46 (<1%)	5,862 (30%)
Other					9,808 (49%)
				Total =	19,800

The results of habitat analysis showed that the former would be less favourable than the latter so a value of zero was substituted for the missing data. Other cases were less clear cut but all of the habitats for which density information was missing were present in such small area in Dak Lak (this is why no data were collected from them) that the overall results will be little affected.

The percentage of the total number of Green Peafowl predicted to be in each of the habitat types during the dry season is shown in Table 6.

Table 6: Predicted percentages of Green Peafowl in Dak Lak by habitat. Values marked by "(est.)" are estimated values, see text.
This analysis further supports the importance of deciduous forest near water and away from people.

	Water, No Humans	Water, Humans	No Water, No Humans	No Water, Humans	Totals
Deciduous	38%	<1%	34%	<1% (est.)	72%
Mixed	2%	<1%	4%	<1% (est.)	6%
Evergreen	21%	<1%	<1% (est.)	<1% (est.)	21%
Other					<1% (est.)

This habitat only occupies around 3 % of Dak Lak in the dry season but is predicted to support 38 % of the Green Peafowl. All types of deciduous forest occupy only 18 % of Dak Lak but hold a predicted 72 % of Green Peafowl. These findings are discussed further in Section 7.3 and 8.2.

6.5 Other bird and mammal species recorded

6.5.1 Birds

Approximately 290 bird species were recorded during the survey. A complete list of birds, showing sites recorded, is included in Appendix 3.

The records of some notable bird species recorded within habitats and areas shown to be important for Green Peafowl, particularly the deciduous forest regions, are detailed below. Conservation status if applicable is taken from Collar *et al.* (1994). Additional notes are given for some other notable species (globally/regionally threatened) in Appendix 3.

Siamese Fireback *Lophura diardi* Vulnerable
A single bird was seen in deciduous forest near the Dak Dam stream in Dak Mil district. This species was also seen frequently outside peafowl areas, in evergreen forest at higher altitudes.

White-winged Duck *Cairina scutulata* Endangered
A pair was seen on the Dak Dam stream in Dak Mil District on 10 May. The stream forms the border between Vietnam and Cambodia so this sighting constitutes a record for both countries. Only a small length of the actual stream could be surveyed and it is possible more birds may be present.

Spot-bellied Eagle Owl *Bubo nipalensis* Near-threatened
A single bird was heard in Ea So, Ea Kar District on 9 February.

Pale-capped Pigeon *Columba punicea* Vulnerable
Two birds were seen on 4 February and three on 11 February in Ea So in Ea Kar district. A pair was seen at the Dak Dam stream in Dak Mil district on 9 May, before flying into Cambodia.

Grey-headed Fish Eagle *Ichthyophaga ichthyaetus* Near-threatened
A pair was seen displaying over the Ea H'leo River on the Cambodian border on 16 February. A pair was seen displaying at Diem lake, about 10 km east of Border Guard Station One on 18 February.

White-rumped Vulture *Gyps bengalensis* Near-threatened
Single birds were seen in flight near the Dak Rue stream on 19 February and near Border Guard Station

Two on 17 February. Singles were seen at Diem lake and over Guard Station One on 18 February.

Red-headed Vulture *Sarcogyps calvus* Near-threatened
Single birds were seen over the Ea Krong Hnang, Ea So in Ea Kar District on 9 February, and over border Guard Station One in Ea Sup district on 16 and 18 February. Two were seen at Diem lake on 18 February.

Rufous-winged Buzzard *Butastur liventer* Near-threatened
Two birds were seen near Guard Station Once, Ea Sup District on 16 February. Single birds were seen near the Ea H'Leo River (Site 7) on 21 March and near the Ya Lop River on 24 March.

White-rumped Falcon *Polihierax insignis* Near-threatened
A single bird was seen near the Ea H'Leo river on 21 March.

Woolly-necked Stork *Ciconia episcopus*
Up to three were seen near Guard Station One, Ea Sup District on 16 February. Birds were seen in pairs or small groups (<4) at Ea H'Leo River, Dak Dam stream, and near Border Guard Station One. Two were seen over Guard Station Two, Ea Sup District on 17 February. One was seen at Diem lake on 18 February. Three were seen 10 km east of Guard Station Two on 18 February.

Lesser Adjutant *Leptoptilos javanicus* Vulnerable
Three single birds were seen on over the Ea H'Leo River and near Border Guard Stations One and Two in Ea Sup District on 16 February. Ten were seen near Guard Station Two, Ea Sup District on 17 February. A single bird flew over Guard Station One on 18 February. A single bird was seen on the ground at Chu M'Lang also in Ea Sup District.

6.5.2 Mammals

Several mammal species were recorded during the survey; the list is short as our survey team contained no-one with a good knowledge of mammal tracks and signs. The records of some notable species recorded within habitats and areas shown to be important for Green Peafowl, particularly the deciduous forest regions, are detailed below. Conservation status if applicable is taken from IUCN (1996). The full species list is given in Appendix 4.

[**Douc Langur** *Pygathrix nemaeus* Endangered
A local guide from M'Drak reported this species to be uncommon.]

Buff-cheeked Gibbon *Hylobates gabriellae* Data Deficient
This species was fairly common in some areas. It was heard calling at Ea Wy on 7 March, from Guard Station 11 on 2, 3 and 4 April, in M'Drak forests on 27 and 28 April, and in forests of Krong No District on 3 May.

Dhole *Cuon alpinus* Vulnerable
Reported from Ea So. A single animal seen at dawn on 16 February between Guard Stations One and Two, Ea Sup District.

Asiatic Black Bear *Ursus thibetanus* Vulnerable
An Asiatic Black Bear was seen crossing the main road at 17h30 on 2 April near Border Guard Station 11. On 3 April another (or perhaps the same) was seen the same area. A local guide reported that

Asiatic Black Bear was also found in the forests of M'Drak District.

[**Leopard** *Panthera pardus*
Fresh tracks were found along the border road 4 km south of Guard Station Six in Dak Mil District on 9 May.]

[**Tiger** *Panthera tigris* Endangered
Soldiers and forest enterprise staff at Guard Station Six in Dak Mil District consistently reported Tigers to be present in the area; the last record was reported to have been approximately two weeks prior to our visit (on 8 May). On the 12 May a call identified as that of a Tiger was heard at a distance of around 100 m from the Dak Dam Stream 6 km north of Guard Station Six.]

Asian Elephant *Elephas maximus* Endangered
Elephant tracks were frequently found in the deciduous forest areas but it was not possible to separate wild animals from tamed ones.

[**Brow-antlered Deer** *Cervus eldi* Vulnerable
Tracks identified as this species were reported by a local hunter from M'Drak Forest Enterprise on 27 and 28 April.]

Gaur *Bos gaurus* Vulnerable
Many fresh tracks of this species were found on 5 February within Ea So, Ea Kar District, especially at "Bai Mil." Also, many tracks were found at Ea Bing/ Ea To Mot between 15 and 19 February.

Banteng *Bos javanicus* Endangered
On 6 February in the early morning (06h45), in Ea So, Ea Kar District there were about ten Banteng still feeding on open grassland near to a forest block within the reserve. These may have been the same group (about 20 animals) that Mr Vo Duc Long video taped some months before.

[**Wild Cattle**
Bos spp. tracks were frequently found throughout much of the deciduous forest regions of north-west Dak Lak. Unfortunately no member of our survey team could confidently identify them or separate them from domestic stock.]

[**Asian Buffalo** *Bubalus arnee* Endangered
Buffalo tracks were found in some remote locations, including adjacent to the Cambodian border near the Dak Dam stream in Dak Mil, but it is unclear whether they were from wild, domestic or feral stock. However, at Border Guard Station One, on 16 February, Mr Nguyen Minh Khe reported that some years ago a wild buffalo was shot.]

7 Discussion

7.1 Status and distribution

Green Peafowl were recorded during 65 point counts made at 13 sites; an estimated minimum of 187 birds were present. Birds were confirmed to be present in Yok Don National Park and at all sites where evidence was found by Le Xuan Canh *et al.* (1997) including Ya Lop and Ea So. In addition birds were confirmed in the districts of Cu Jut , Dak Mil, Dak R'Lap, Ea H'leo, Cu M'Gar, Buon Don (north-east of Yok Don), Krong Nang and extensively in Ea Sup. This is quite a widespread distribution in Dak Lak, covering much of the north and west of the province. Birds were frequently encountered along rivers in the deciduous forest regions of Ea Sup, Ea H'Leo, Cu Jut, Buon Don, and Dak Mil. Geographic locations of each of these sites are given in Appendix 1, and shown on Map 4, while the exact location of every positive count, along with the number recorded, is given in Appendix 2.

The number of Green Peafowl recorded at each site is not considered to be representative of the relative density at the site. Point counts were located where access was possible. The state of access varied considerably between sites meaning that when a range of habitats existed at a site (such as forest within 2 km of water or more than 2 km from water) counts could not always be located so as to represent the range and availability of these habitat types.

The results clearly show the sites where the presence of Green Peafowl has been categorically confirmed. These results are returned to below and the importance of particular sites is discussed at length (Section 8.2).

7.2 Habitat Use

Analysis of habitat use by Green Peafowl identified three key factors that were related to the presence and number of Green Peafowl in the dry season. These factors were forest type, the presence and distance to water and the presence and distance to permanent human settlement.

Other factors that were found not to have a significant relationship were bamboo, grass, burnt ground, scrub and cultivation.

The results showed that deciduous forest held the most Green Peafowl followed by mixed forest and then evergreen forest. Green Peafowl numbers also varied with canopy cover, with deciduous forest and mixed forest being significantly more open than evergreen forest. These findings are consistent with previous studies on Green Peafowl. Hoogerwerf (1970) and Delacour (1977) both considered open forest to be the main habitat of birds.

At known Green Peafowl sites in Laos (Evans and Timmins 1996), Cambodia (Desai and Lic Vuthy 1996) and Thailand (Round 1983, Stewart-Cox and Quinnell 1990) the predominant forest type is open dry deciduous.

One important consideration of the results is whether the forest type recorded at the location of the count was equivalent to the forest type at the location of the birds. It is felt that due to the deliberately broad categorisation of forest type that in general the relationship between numbers and forest types is real. The same may not however be true when attempting to compare numbers with undergrowth type or cover, despite the fact that birds probably range over greater distances than we were recording them at (i.e. that the habitat recorded at the point count was in all probability often within the home range

of birds recorded). Birds may show a preference for particular forest or undergrowth types that this survey did not have the resolution to determine. Possibly the only truly accurate way to investigate fine-scale habitat use and requirements would be through radio tracking within a site of which detailed habitat maps had been prepared.

In the absence of such detailed studies, why Green Peafowl show an apparent preference for deciduous and mixed forest can only be speculated. Several authors have suggested the need for large clear areas in which to display gives a requirement for openness. However, in evolutionary terms few examples exist where it can be shown that the breeding system of a bird dictates the habitat requirements. In far more cases breeding system is believed to have evolved to suit habitat. Large galliformes are found in closed canopy evergreen forest, and some, such as Crested Argus *Rheinardia ocellata* and Great Argus *Argusianus argus*, have flamboyant displays involving very large trains, and loud calls.

The need for cover to hide and nest in and large trees to roost in may account for why peafowl need forested areas but not why open forest areas should be preferred to closed canopy forest.

Birds were occasionally recorded in evergreen forest areas so it would seem that they can survive there but why these areas apparently hold fewer is not known. It may be that such evergreen areas in which they were found held small open areas and so the apparent preference for openness was maintained. This survey method was too crude to be able to account for the presence of such small areas effectively.

It may be that open forest favours Green Peafowl's feeding methods or reduces the risk from predators. Alternatively it may be that breeding in dry deciduous forest allows large broods to be laid, timed to hatch when a seasonal flush of fallen fruit is available. Such conclusions are however beyond the scope of this investigation. The results of this study demonstrate a greater use of open deciduous and mixed forest over closed canopy evergreen forest but they say little about possible causal factors for this distribution.

It seems that Green Peafowl were present over a wider range of habitats formerly in Vietnam. Historic records frequently refer to areas in which the forest ranges from mixed to evergreen. It is however from these areas that birds appear to have been lost first. It may be that these were the first areas to be exploited by man, or that hunting birds in them was easier.

Selective logging of the forest appeared to have little adverse affect on the presence of Green Peafowl. No quantitative data were collected but almost every site visited had been selectively logged at least once. Even forest compartments that had been logged within the last year held birds. This finding is encouraging as it suggests that the temporary (yet quite extensive) disturbance caused by legal, controlled, logging activities may not have a particularly adverse affect, although more data should be collected before this can be claimed with confidence. The effect that logging has on increasing access to forest areas, and so consequently causing more long-term disturbance, is however a different matter.

The relationship between the number of birds and the presence of water is easier to understand. It has been noted by many previous observers including Hoogerwerf (1970) and Johnsgard (1986). During the dry season, when little water may be available from food, birds may have a daily requirement for rivers, streams or pools. Towards the end of the dry season, when temperatures are highest and water is at its most scarce, the birds begin breeding and in turn probably have a high demand for water to maintain condition. The requirement for water at this time may effectively restrict breeding birds to areas of year-round water. It is feasible however that when young are hatched birds may move to areas with temporary water. This survey was conducted at the height of the dry season and very few calling birds were present in areas where only dry rivers remained.

This study found a clear relationship between the number of Green Peafowl recorded and the distance to permanent human settlement, and the number of peafowl with presence of permanent human settlement within 2 km. A better fit to the model was achieved using the presence of settlement within 2 km rather than the distance. This is not entirely unexpected as one would predict beyond a certain distance, the distance to human settlement would cease to be important.

Why Green Peafowl should avoid human settlement is perhaps less obvious than it would at first seem. Indian Peafowl *Pavo cristatus* are often found within cultivated areas and even within villages. At the turn of the century Green Peafowl were reported as feeding in cultivated fields (Delacour and Jabouille 1925b). It seems likely that constant persecution whenever humans and birds now come into contact, along with a increased availability of guns may well have been the cause of the distribution observed today. It is also possible that the relationship between number of Green Peafowl and the proximity of humans is an aversion response on the part of the birds but it is as likely that birds close to humans have been hunted out.

The causal factors underlying the relationship between Green Peafowl and proximity to humans can only be speculated from this survey but the results clearly show that in close proximity the numbers of birds falls dramatically. The most likely explanation is persecution.

How much the results of this analysis are biased by the limitations of methodology (Sections 6.3.2 and 4.1) is unclear. That identical results in the habitat use analysis were achieved using presence/absence of birds and using minimum number of birds, supports the assumption that the number calling does reflect the number present. The small investigation of the repeatability of counts also supported this assumption.

Birds may have been underestimated in a bid to reduce incidence of double counting but it is likely that this affected birds at higher densities more than at lower (this would have the effect of reducing the power to detect habitat preferences when using minimum number). If calling was socially facilitated then it would have the opposite effect to that of underestimating number present when more birds were calling and in this way these two problems may have gone some way to cancel each other out!

Attempting to maintain true independence between point counts is assumed to have been largely successful, and any error introduced to be minimal.

The potential bias caused by access, both by limiting point counts to areas adjacent to tracks, and by the physical disturbance cause by the vehicle used to get to points, is likely to lead to underestimation of presence. As this source of bias remained virtually constant across counts (in that all count sites were approached by vehicle) it should not have had a large effect on the outcome of analysis. The number calling would still be an index of those present even if a constant proportion was disturbed into not calling each time. This problem would be far more difficult to overcome if the results were being interpreted as absolute densities (birds/unit area).

The results make clear the importance of water and humans while showing that deciduous forest is most used, even if it cannot be stated that such forest is most preferred.

7.3 Relative abundance and predicted distribution

The mean counts of Green Peafowl between habitats found that almost $2\frac{1}{2}$ times as many Green Peafowl were recorded in deciduous forest within 2 km of water and greater than 2 km from permanent

human settlement, than in any other habitat type. The next highest mean count was recorded in mixed forest within 2 km of water and greater than 2 km from settlement.

By taking these mean counts to be an accurate index of actual presence of birds (i.e. relative densities) the value of deciduous forest could be further demonstrated. Deciduous forest occupied only 18 % of the total land area of Dak Lak but it was predicted to hold around 70 % of the total number of Green Peafowl in the province. During the dry season the area of deciduous forest that is within 2 km of water and greater than 2 km from permanent human settlement was estimated at 3 %. This 3 % of land however was predicted to hold 38 % of the Green Peafowl in Dak Lak.

Mixed forest was estimated to only occupy around 3 % of Dak Lak and to hold around 6 % of Green Peafowl. The total area of mixed forest may however be underestimated as many areas will have been included as evergreen forest due to the accuracy of the maps available (see below). However the estimates of relative density of Green Peafowl between mixed forest and evergreen forest were both low. Evergreen forest was estimated to occupy 30 % of Dak Lak and to support 21 % of Green Peafowl.

The results clearly show the importance of protecting deciduous forest, and within deciduous forest protecting those areas near water and away from people.

Maps showing the predicted relative density of Green Peafowl in Dak Lak highlight the importance of the north-west of the province. Map 5, showing predicted distribution in the dry season, is based entirely on the data collected in this survey. Map 6, produced for the wet season, assumes that any seasonal rivers will be occupied to the same relative density as observed in the dry season. It is unknown whether this is true as Green Peafowl may be limited to those areas where permanent water is available (Section 7.2). The wet season map does serve to highlight those areas that might hold the most favourable habitat for Green Peafowl during the wet season. This habitat may be vitally important for newly hatched birds etc. but only surveys in the wet season could determine this.

The accuracy of the estimates made of percentage population by habitat is most affected by the accuracy of the maps and the accuracy of the density estimates. The accuracy of the maps is unavoidable. The extent of deciduous forest it was felt was reasonably accurate and this was the most important habitat in the analysis. The distribution of human settlement on the maps is not particularly accurate. The area covered by human settlements is almost certainly underestimated (it is partly for this reason that no attempt was made to calculate overall absolute population). The maps only include large areas of human settlement and do not account for the spread of small hamlets etc., all of which will affect Green Peafowl.

The accuracy of the relative density estimates is considered more reliable, at least for habitats where the mean is based on a reasonable sample size and the standard error is a low proportion of the mean. The factors affecting the accuracy of the density estimate are the same as those affecting analysis of number of calling birds compared with habitat variables (Section 6.3.2). The size of the standard error for a mean illustrates to some extent the combined effect of the various biases.

7.4 Other bird and mammal species

The deciduous forest regions of Dak Lak identified as the main areas for Green Peafowl also hold a distinctive community of other bird species. Typical species of this habitat include birds such as woodshrikes, orioles, and woodpeckers (with 18 species of the latter being recorded). Large areas of deciduous forest are also home to several large soaring raptor species including Red-headed Vulture and White-rumped Vulture. These birds need large open areas over which to search for carrion. Rufous-

winged Buzzard *Butastur liventer* and White-rumped Falcon *Polihierax insignis*, both categorized as near-threatened (Collar *et al.* 1994), were only recorded within the deciduous forests.

Around rivers within the deciduous forest, some important species of large waterbird were recorded. Most notable of these is the endangered White-winged Duck, a pair of which were seen on the Dak Dam stream. This bird is currently only known in Vietnam with certainty from two other sites (J. C. Eames pers. comm.) and it has not been seen at either for several years, despite searching. White-winged Ducks need slow flowing forest rivers, fringed by trees in which to roost and nest. Such habitat is very vulnerable to disturbance, a factor that has contributed greatly to the decline of the species. The Dak Dam stream is likely to retain birds as it remains little disturbed.

Other large waterbird species recorded along the rivers in the deciduous forest included Lesser Adjutant and Woolly-necked Stork. The rivers and seasonal wetlands of the deciduous forest areas may also be home to large ibis species. None was recorded during this survey but both Giant Ibis and Black Ibis are possible. Giant Ibis was recently discovered along a river in Ratanakiri Province in Cambodia within deciduous forest. Some of these wetland birds may conceivably be seasonal migrants, perhaps moving downstream into Cambodia during the height of the dry season and returning to regions of Dak Lak in the wet season.

The mammal community within the deciduous forest is notable. A low number of mammals was recorded by this survey due to the inexperience in mammal surveying. Previous surveys have made far more thorough attempts and should be referred to in this respect. Wild cattle species including Banteng and Gaur were recorded frequently in deciduous forest by Le Xuan Canh *et al.* (1997) and hope still exists that wild Asian Buffalo and Kouprey may remain. The areas are also home to several deer species including Indian Muntjac *Muntiacus muntjak*, Sambar *Cervus unicolor* and possibly Eld's Deer *Cervus eldi*.

Notable mammal species recorded provisionally by this survey did however include both Leopard and Tiger, near the Dak Dam stream, again highlighting the value of deciduous forest rivers when they are free from human disturbance; in this case the proximity to Cambodian border means human activity is low.

Mixed and evergreen forest bird communities were typically more diverse, holding species different from those in the dry deciduous forests. Bird communities in closed canopy forest at higher altitudes typically included more galliform species such as Germain's Peacock Pheasant, Siamese Fireback and Silver Pheasant *Lophura nycthemera* as well as numerous passerine species. Notable records included Black-hooded Laughingthrush *Garrulax milleti* at Dak Mol in Dak Mil district, found at the relatively low altitude of around 900 m. The forests in this region also held a high number of other species (see Appendix 3).

8 Key measures for conservation

8.1 Conservation of Green Peafowl

Investigation of habitat use by Green Peafowl highlighted the importance of deciduous forest, and within it, the effects of the proximity to water and human settlement.

Dry deciduous forest with water present within 2 km and no human settlement within 2 km held many more birds than did the next most occupied habitat type. As a result of this, such habitat during the dry season is predicted to hold around 40 % of the Green Peafowl in Dak Lak despite only occupying 3 % of the land area.

Other forest types held Green Peafowl but at far lower densities (see Table 3).

Previous studies of Green Peafowl have estimated a population density of birds in favourable habitat to be around one breeding male per km^2, or approximately four birds of all ages per km^2 (Stewart-Cox and Quinnell 1990, Indrawan 1995). Due to this low density the species requires large areas of forest to maintain viable populations. By this approximation of absolute density the prime undisturbed riverine forest of Yok Don National Park would only hold 122 breeding males or around 500 birds of all ages. A population of this size may well not be viable in the long term. It is clear that the existing areas of prime habitat outside of National Parks should receive immediate protection. Due to the size of the birds, their reluctance to fly long distances and their aversion to humans, fragmentation of the birds' habitat is likely to have a serious detrimental effect. It is not simply a case of conserving as much area as possible: the area protected should form a continuous block. Birds will not be able to disperse between isolated forest fragments and even small areas of human settlement may act as a barrier to dispersal.

The value of a large area of deciduous forest to Green Peafowl will almost entirely be determined by the availability of permanent water. Although it is not known if birds will disperse during the wet season to use temporary water supplies, during the dry season birds are effectively confined to where undisturbed access to water is available. If a large area of forest is protected but the permanent water supplies within it are not free from disturbance, the value of the entire forested area will be seriously diminished.

The expansion of humans into Green Peafowl habitat will have a three-fold detrimental effect:

Firstly, a direct loss of habitat. The spread of human settlements invariably brings a need for agricultural land and for water. The habitat occupied by the highest number of Green Peafowl is therefore also the habitat most desired by humans.

Secondly, apart from the direct loss of habitat, a wider area will be affected as disturbance is caused by activities such as wood collecting, grazing, fishing and hunting. Birds will be kept away from the human settlement. In this way settlements will act as a barrier for dispersal and gene flow. This will be most marked when the spread of human settlement follows linear feature such as roads or rivers, a pattern frequently observed.

Thirdly, the increase in human presence in an area will almost invariably lead to a rise in direct exploitation. Hunting of fully grown birds for meat and collecting of eggs were all reported while undertaking the survey.

Commercial selective logging activities appear not to have a large detrimental effect, although in this brief survey this could not categorically be stated. A large indirect detrimental affect can be caused by

the increased ease of access that results from logging activities. Logging requires the opening of access tracks to facilitate the removal of timber. Once logging is complete these access tracks are used by hunters to travel further into the forest, for illegal logging and firewood collecting activities and, at worst, by illegal settlers. Nearly all of these activities become centred around permanent water sources. Forest fires also increase as a result of the increased ease of access.

Many Green Peafowl were found in logging concession forest. The value of these areas can remain very high, without the need for further protected area designation, if logging is selective, carried out in strict rotation and access outside of logging periods is strictly prohibited. Many forest enterprise guard stations exist but more need to be established on all major access routes, patrolling needs to be increased and penalties for unauthorized intrusion made more severe. Restricting access in this way will increase both the economic and wildlife values of the forest.

To summarise, the key factor to consider in the conservation of Green Peafowl is to maintain large, continuous areas of deciduous forest with undisturbed access to permanent water. Human disturbance and illegal exploitation need to be severely controlled or stopped entirely. Ideally this would be implemented by establishing large protected areas complete with undisturbed permanent water supplies. However, increased protection of forestry concessions to restrict access outside of logging periods will go a long way to protect wildlife.

8.2 Key areas for Green Peafowl in Dak Lak

The survey recorded Green Peafowl at 13 sites in Dak Lak. Of the 13 sites only two sites did not lie in the north-west corner of the province in the districts of Ea Sup, Ea H'Leo, Buon Don, Cu Jut, Dak Mil and Cu M'Gar. In these districts the habitat is predominantly dry deciduous forest, the human population is low and areas of forest with undisturbed access to permanent water remain.

The predicted distribution echoed the survey findings, with the greatest concentration predicted in the north west corner of Dak Lak within the deciduous forest region and in particular along the rivers Ya Lop, Dak Dam, Dak Ken, Dak Rue, Ea Wy, Ea Rok, Ea Hiao, Ea Khal, Ea H'Leo and Serepok. Predicted distribution indicates that around 40 % of Dak Lak's Green Peafowl are present along these rivers.

Human settlements are spreading at an alarming rate, in particular along the Serepok, Ya Lop and Ea H'Leo. If this continues unchecked along these three rivers, the loss of Green Peafowl habitat is predicted to reduce the overall population of Green Peafowl by around 20 %. This figure could in fact be much higher as the value of adjacent forest away from permanent water would also be seriously reduced.

If human settlement and agricultural expansion is allowed to continue along all permanent rivers in the north-west region not currently included on both sides by a protected area, the overall loss to Green Peafowl numbers will be in excess of 35 %. This loss will be as a result of direct habitat destruction and likely to be considerably greater as a result of fragmentation, restricted movement and increased exploitation.

Presently Yok Don National Park is predicted to support to 11 % of birds. This figure may already be an over-estimate due to the recent spread of settlements along the north bank of the Serepok. As it seems unlikely that any Green Peafowl survive in any other established protected area in Dak Lak, this leaves around 80-90 % of Dak Lak's Green Peafowl population outside the protected area system.

A huge expansion of the current protected area system should be considered. In this report, several expansion schemes are proposed and the proportion of the Green Peafowl population that is predicted to be affected by each scheme is estimated.

These schemes are detailed below (Section 9.1.1) and include expansion southward of Yok Don National Park to include the border regions of Cu Jut and Dak Mil. This would enclose the Dak Dam stream and several smaller tributaries of the Serepok that flow north through Yok Don National Park such as Dak Klau and Dak Ken. The proposal would increase the area of Yok Don National Park by approximately 465 km^2 and increase the total Green Peafowl population covered by the protected area system to 17 %. This expansion would cover much of the border region to which access is already heavily restricted due to security reasons. Inclusion of this area in the National Park would give further authority to restrict access.

Northwards expansion along the Cambodian border as far as the Gia Lai border is proposed to enclose considerable lengths of the Serepok, Ea H'Leo, Dak Rue and Ya Lop rivers as well as a large number of seasonal streams. This would reach far beyond the existing proposed extension to the Dak Rue stream (Yok Don National Park Authority 1998) and is predicted to enclose 34 % of Dak Lak's Green Peafowl. This proposal would enclose much of the area recommended for inclusion in Yok Don National Park by Le Xuan Canh *et al.* (1997).

Further expansion to include the forested region covering the border between Ea Sup, Ea H'Leo, Cu M'Gar and Buon Don is also proposed. This scheme would enclose large sections of the rivers Ea H'Leo, Ea Wy, Ea Rok and Ea Khal, as well as large number of seasonal streams. This area alone is predicted to hold 22 % of the remaining Green Peafowl in the province.

Presently, outside of protected areas, only immediate border regions receive some protection from human exploitation. For security reasons access is severely restricted and the benefit to wildlife is clearly demonstrated by the number of Green Peafowl and other declining species recorded at border sites (such as Dak Dam stream and border regions in north-west Ea Sup at the confluence of Ea H'Leo and Ya Lop) and by the number of Green Peafowl predicted for these regions.

All of these proposals are for extensions along the Cambodian border. No physical barriers exist to Green Peafowl at the border and seasonal movement and dispersal is very likely to occur across the border in both directions. Development of the protected area system in Vietnam should be complemented by establishment of a large reserve on the Cambodian side of the border.

Away from the north-west corner of Dak Lak, relative density of Green Peafowl is predicted to be very low, a conclusion supported by observation. Green Peafowl may once have been present in far larger numbers in southern and eastern regions but the spread of human settlement (particularly along rivers), loss of forest and isolation of forest patches has had its effect.

Green Peafowl were recorded from Ea So sub-district in Ea Kar district. This area is also noted for its wild cattle population and was proposed as a protected area by Le Xuan Canh *et al.* (1997). This proposal is also supported by this survey. The number of Green Peafowl may be low here but their presence was confirmed and the area is threatened by agricultural expansion (Le Xuan Canh *et al.* 1997).

Green Peafowl were also recorded in the extreme south-west corner of Dak Lak. Here extensive areas of evergreen forest interspersed with grass patches remain and human disturbance is minimal due again to the proximity to the Cambodian border and security considerations. This area was very rich in other

bird life and it may be a good candidate for protected area status.

In order to establish or re-establish Green Peafowl in existing protected areas where they are now absent, the main considerations would include having relatively open forest habitat (this may rule out very closed canopy montane forest), then a reduction in human disturbance particularly near permanent water. Many protected areas may well be too small to support viable populations and if they are separated by areas dominated by people and agriculture then dispersal and movement of Green Peafowl between them is unlikely.

8.3 Other bird and mammal species

The conservation of many of the other key bird and mammal species typical of the deciduous forest regions of Dak Lak will involve many of the same considerations as those towards the conservation of Green Peafowl.

The large raptor species such as vultures and eagles all need large areas over which to range. Large waterbirds, such as storks and ibises, will also be heavily reliant on undisturbed water sources and temporary wetlands. For these bird species protecting the currently undisturbed waterways within the deciduous forest is a maximum priority.

The conservation needs of the large mammal community of the deciduous forest is considered in detail in Le Xuan Canh *et al.* (1997). Prime considerations for many of the large ungulates include a need for very large areas: Gaur, for example, were estimated to have a home range of 137 km^2 (Conry 1989). Access to permanent water was also considered very important for many species.

Many conservation measures advocated in this report regarding the conservation of Green Peafowl will also be of direct benefit to many of the other bird and mammal species. The deciduous forest regions of Ea Sup, Ea H'Leo, Buon Don, Cu Jut and Cu M'Gar are probably the most important areas in Vietnam for large mammals particularly cattle, elephants, deer and large cats. The rivers and permanent water sources within these districts will be of key importance to all deciduous forest species.

Two important evergreen forest regions lying outside of reserves were also identified. These were the north of Dak R'Lap in south-west Dak Lak, and Dak Mol in Dak Mil district. While not being of key conservation concern for Green Peafowl, they both held a high diversity of other bird life and both contained very good quality forest.

9 Recommendations for action - High priority

The following recommendations are based on the conclusions of the survey and address three main areas: protected area development, management policy and further fieldwork requirements. Where recommendations are congruent with recommendations of the Biodiversity Action Plan for Vietnam 1995 (approved by the Prime Minister, decision number 845/TTg, 22 December 1995) the relevant section of that report is cited.

Each recommendation is directed towards the authority or authorities with whom responsibility for implementation would lie.

The recommendations listed in this section are considered of the highest priority. Medium term recommendations are listed in Section 10.

9.1 Protected areas - expansion of Yok Don National Park

Attn: Central Government - MPI, MARD (FPD)
Provincial - People's Committee, MARD (FPD)

Pursuant with Section 3.2 "Revision of Protected Area System" Biodiversity Action Plan for Vietnam (1995). Specifically, expansion of Yok Don National Park is prioritized as Category A "of Global Importance".

Yok Don National Park should be greatly expanded in the north-west of Dak Lak to include as much dry deciduous forest as possible within the districts of Ea Sup, Ea H'Leo, Buon Don, Cu Jut, Dak Mil and Cu M'gar.

This expansion should be on a large scale containing as a continuous block as much forest as possible and enclosing completely as many permanent rivers, streams and other water sources as possible. Only by protecting a very large area will viable populations of Green Peafowl, wild cattle and other large mammals be safeguarded.

A key consideration with any expansion scheme is that rivers should never be made the boundaries of a reserve. Particularly in dry deciduous forest the value of a reserve will be determined by the presence of undisturbed permanent water. Protection of one side of a river with none on the other side amounts to no protection at all. Protected areas should also provide as large a continuous block of habitat as possible.

Five plans are proposed for expansion of Yok Don National Park (Map 7). The predicted benefit in terms of habitat enclosed by these schemes and in terms of the proportion of Green Peafowl present in Dak Lak that would be protected by each scheme is shown in Appendix 5 and Map 8.

Plan A is the current expansion plan proposed by Yok Don National Park Authority (1998). Plan B is a proposed expansion that would extend Plan A; this proposal is similar to the expansion plan proposed by Le Xuan Canh *et al.* (1997). Plan C is a new proposal for a southwards extension to Yok Don that should take place in addition to Plan A and B. Plan D is a proposal for a large extension in addition to Plans A, B and C, that should be seriously considered.

Plan A Northwards extension to Dak Rue stream

This is the scheme currently proposed by Yok Don National Park Authority (1998). This scheme would extend Yok Don National Park northwards beyond the Serepok to reach the Dak Rue stream, the western boundary being the Cambodian border and the eastern boundary being the Ea Sup-Buon Don road. While any extension is welcomed it is felt that this is not the best scheme. The extension does include both banks of the Serepok which is very important, but includes very few other permanent water sources. It also takes the Dak Rue stream to be the boundary (a feature to be strongly avoided; see above).

This extension covers approximately 560 km^2, but only includes around 50 km^2 of deciduous forest within 2 km of dry season water (compared with an estimated 123 km^2 in the existing Yok Don National Park). The proposed extension plan could be improved by placing the northern boundary 5-10 km north of the Dak Rue stream, but ideally the scheme should be replaced by a much larger extension north as far as the Gia Lai Province border (Plan B, below).

Any scheme that extends Yok Don National Park north of the Serepok needs to tackle the issue of the spread of human settlement along the river. Presently one small village (Bon Drang Phok) is established in what would become part of the park. Measures to contain or even relocate this village need to be seriously contemplated. Additionally, fishing activity along the river, particularly dynamite fishing, causes great disturbance and should be stopped.

Plan B Northward extension to the Gia Lai border

This scheme would extend Yok Don National Park northward from the proposed extension (Plan A) to reach the Ya Lop stream at the border between Dak Lak and Gia Lai. The western boundary would be formed by the Cambodian border. The eastern boundary would extend northwards from the north-east corner of the proposed extension avoiding the agricultural areas around Ea Sup town to meet the Ea H'Leo river at Ea Rok town. Northwards beyond Ea Rok the boundary would follow the road to meet the Gia Lai border where the Ya Lop river diverges from it. This expansion scheme is very similar to that proposed by Le Xuan Canh *et al.* (1997).

This extension would include a large part of the presently undisturbed dry deciduous forest of Ea Sup. It would completely enclose large sections of the Dak Rue stream, Ea Sup stream and the Ea H'Leo river, as well as affording some protection to a section of the Ya Lop river. The area enclosed by this extension, including the Plan A extension above, would be approximately 1,220 km^2. Of this nearly 200 km^2 would be undisturbed dry deciduous forest within 2 km of permanent water. The extended park would hold a predicted 34 % of the Green Peafowl in Dak Lak.

This scheme does not provide adequate protection to the Ya Lop river. This could only be achieved by protecting both sides of it. This would involve the establishment of a reserve in southern Gia Lai Province; a recommendation for this is made below (Section 10.1.3).

Plan C Southward Extension (Cu Jut, Dak Mil)

Yok Don National Park should be extended southwards along the Cambodian border into Cu Jut and Dak Mil districts. The Boundary would run south from Yok Don following the north-south ridge of higher land between the streams Dak Klau and Ea N'dri and extending to meet the existing border

guard post, some 2 km north of Dak Mil town. The Cambodian border would form the western boundary of the proposed extension.

This extension would increase the area of Yok Don National Park by approximately 465 km^2 and it would enclose the catchment of several streams that flow north into the existing park. Predictions show that the extension would give protection to a further 6 % of the Green Peafowl in Dak Lak.

As well as having Green Peafowl, the area adjacent to the Dak Dam stream that would be included in this extension, was found to be one of the richest sites visited for large mammals, with both Tiger and Leopard being recorded provisionally. The globally endangered White-winged Duck was also recorded here.

Plan D North-eastwards expansion

A large expansion of Yok Don to cover much of east Ea Sup district, west Ea H'Leo District and smaller sections of Buon Don and Cu M'Gar districts is also proposed. The western boundary of this extension would follow the eastern boundary of the proposed extension A and B, avoiding present agricultural areas. The northern boundary would be formed by the Gia Lai border, while the eastern boundary would follow the north-south ridge of higher land running along the Ea Sup and Ea H'Leo district border.

This extension would include large areas of presently undisturbed dry deciduous forest as well as large areas of mixed forest and areas currently protected as watershed forest. Many small streams and rivers would be enclosed such as Ea Wy, Ea Khal, Ea Hiao and Ea Rok, as well as a large section of the river Ea H'Leo. Many of these rivers are currently under great threat from the expanding human population.

This extension would cover around 1,200 km^2, of which nearly 200 km^2 is undisturbed dry deciduous forest within 2 km of permanent water. This area is predicted to hold 22 % of the Green Peafowl in Dak Lak.

9.2 Management Recommendations

The following recommendations are made for new or improved management practices that will benefit Green Peafowl and other wildlife within their range.

9.2.1 Planning

Attn: Central Government - MPI, MARD
Provincial - MPI (DPI), MARD, People's Committee

- Pursuant with Biodiversity Action Plan Section 2.5 "Need for Further Policy Research"
- Stop settlement by immigrants in areas identified in this report as important to conservation
- Limit agricultural expansion in these areas
- Specifically stop expansion of people along the presently undisturbed year-round water-courses in Ea Sup, Ea H'Leo, Cu M'Gar, Dak Mil, Cu Jut and Buon Don. This includes the rivers Ea H'leo, Ya Lop, Serepok, Ea Wy, Ea Khal and other rivers detailed above in Section 8.2. This land only occupies about 3 % of Dak Lak but it is of exceptional value for biodiversity conservation and is predicted to hold around 40 % of the Green Peafowl in the province

- Develop a proper policy for land-use planning that takes account of conservation and natural resources
- Relocate illegal settlers

9.2.2 Forestry

Attn: Central Government - MARD (FPD)
Provincial - MARD (FPD)

- Pursuant with Biodiversity Action Plan Section 2.3 "Review of Forestry Policy and Practice".
- Forestry concessions or compartments that lie within the dry deciduous forest region of north-west Dak Lak should be recognized for their high biodiversity value.
- Compartments that lie outside of protected areas should be policed efficiently so as to prevent illegal use of the areas, including burning, grazing, illegal logging fire-wood collection, with particular attention to watercourses.
- Logging should be selective and carried out in strict rotations.
- After logging, access should be guarded or destroyed/blocked, a point specifically made in the Biodiversity Action Plan.

9.3 Further survey work

Attn: NGOs, FIPI, IEBR, DOSTE

9.3.1 Survey Gia Lai and Kon Tum Provinces

Deciduous forest areas in Gia Lai and Kon Tum should be surveyed as a priority. A method similar to that used in this survey could be employed to determine the extent of Green Peafowl and suitable habitat in these two provinces. Due to the development pressure on the whole of the Tay Nguyen plateau such a survey is urgent.

9.3.2 Surveys within Cambodia

Further surveys of Green Peafowl should be conducted in the Cambodian provinces of Mondulkiri and Ratanakiri. Extensive areas of suitable habitat appear to remain and should be afforded adequate protection.

10 Recommendations for action - Medium term

10.1 Protected area development

All pursuant with Biodiversity Action Plan Section 3.2 "Review of the Protected Area System".

10.1.1 New reserve establishment in Ea So (Ea Kar District)

Attn: Central Government - MPI, MARD (FPD)
Provincial - People's Committee, MARD (FPD)

The proposal made by Le Xuan Canh *et al.* (1997) is fully endorsed by this project.

10.1.2 Reserve development in Cambodia

Attn: NGOs, Ministry of Environment (Cambodia)

The habitat in the adjacent Cambodian province of Mondulkiri forms a continuous area with that in Dak Lak. Establishment of this as a nature reserve, perhaps based on northwards extension of Phnom Nam Lyr Nature Reserve, would increase dramatically the value of all the area.

10.1.3 Protected area in southern Gia Lai

Attn: : Central Government - MPI, MARD (FPD)
Provincial (Gia Lai) - People's Committee, MARD (FPD)

Following the proposed survey of southern Gia Lai province, proposal should be made for creation of a protected area that encloses any high value areas of dry deciduous forest identified. This will form a continuous block with the proposed protected areas in Dak Lak.

10.2 Management recommendations

10.2.1 Reserve management

Attn: Central Government - MARD (FPD)
Provincial - MARD (FPD)

- Pursuant with Biodiversity Action Plan Section 3.2 "Strengthening the Management of Protected Areas".
- Prevent the spread of illegal settlements within protected areas.
- Relocate illegal settlers.
- Control fishing activities: stop dynamite and electro fishing.
- Stop illegal wood extraction (for timber and firewood).
- Stop illegal hunting activities.
- Train staff in effective reserve management.

10.2.2 Border regions

Attn: Central Government - MoD, People's Committee, Army, Border Police
Provincial - MoD, People's Committee, Army, Border Police

- Pursuant with Biodiversity Action Plan Section 2.1 "Institutional Responsibilities". In that section it is recommended that the armed forces "play a constructive role in ecological reconstruction" by measures including forestry and fishery protection.
- The border regions are some of the richest for wildlife as a result of the low level of human disturbance.
- Border guards could then be given the authority to patrol a wider band along the border (20 km) and authority to police illegal logging and hunting activities within this band.
- If reserve extension goes ahead, border guards could be given authority to patrol within the reserve and to limit access.
- Establishment of a reserve and use of the army (including providing them with any training and resources required) would be efficient use of manpower and give additional security to the border regions.

10.2.3 Conservation awareness

Attn: Provincial - People's Committee, Department of Education

- Pursuant with Biodiversity Action Plan Section 2.1 "Institutional Responsibilities"; in that section it is recommended that the Department of Education introduce environmental teaching.
- Awareness campaign to teach a greater understanding of forest ecosystems and their conservation, and to appreciate in particular the value of the deciduous forest areas of Dak Lak. Could be conducted (for example) through schools and through a poster campaign.

10.3 Further survey work

Attn: NGOs, FIPI, IEBR, DOSTE

10.3.1 Monitor Green Peafowl status

Repeated surveys of the same sites visited during this survey could be used to determine if the range of birds had contracted at all.

10.3.2 Wet season survey

A repeat survey of Dak Lak conducted in the wet season, concentrating on seasonal streams to try and see to what extent these areas are occupied. Such a survey would be more difficult as it would be outside of the main calling period of birds and tracks and signs may need to be relied on to a greater degree. A survey timed for the wet season may also yield interesting information regarding the use of the area by breeding large water birds.

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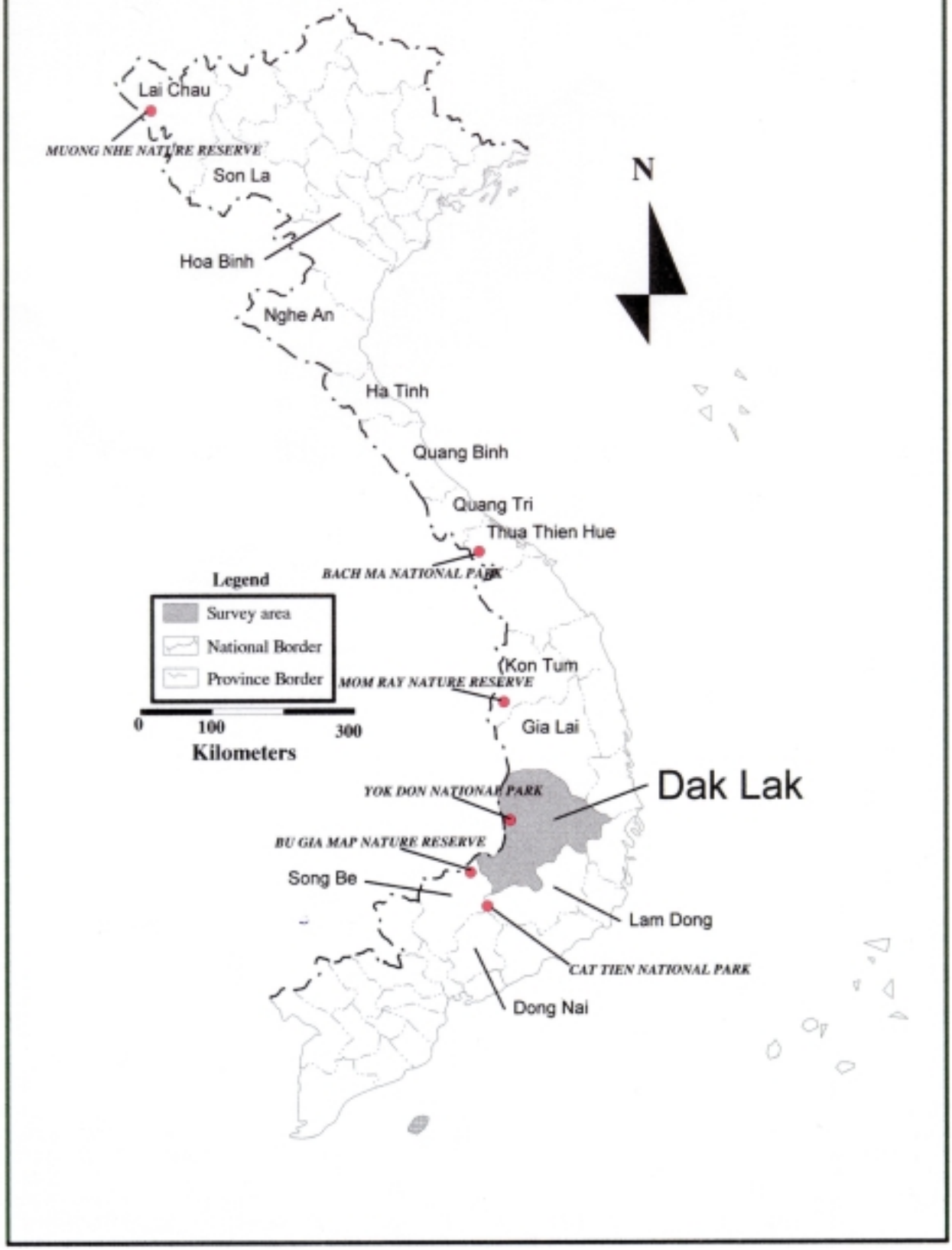
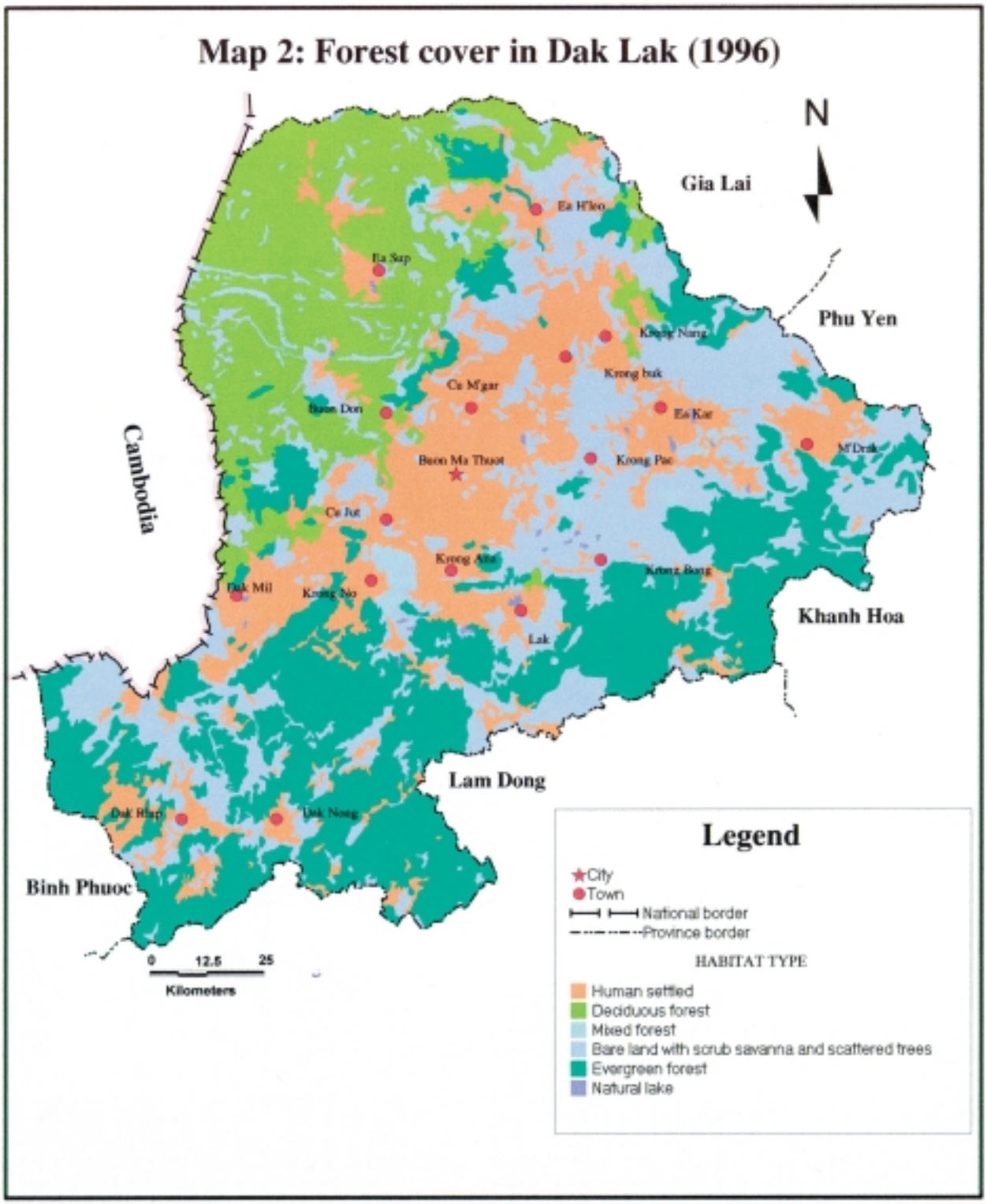
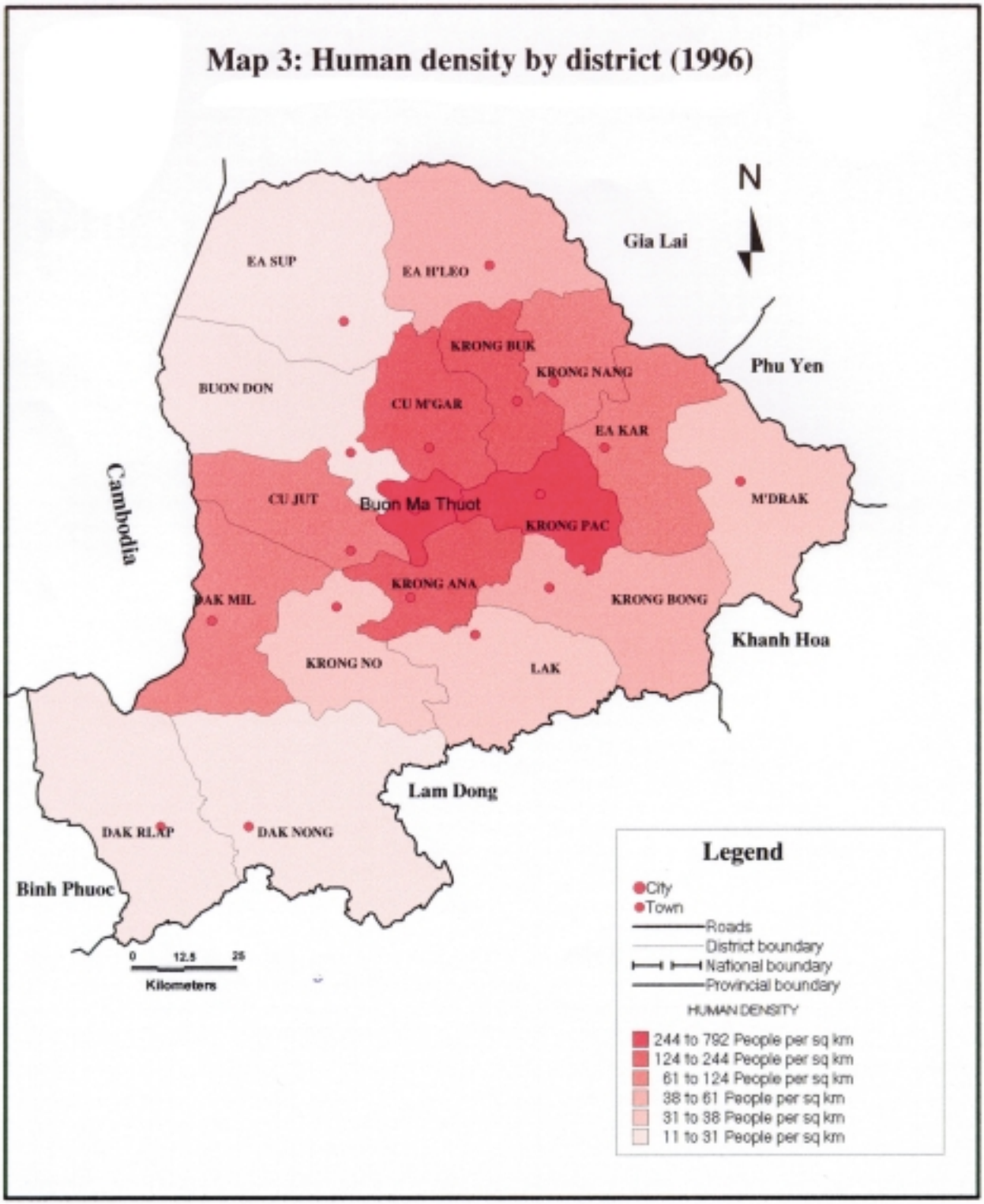
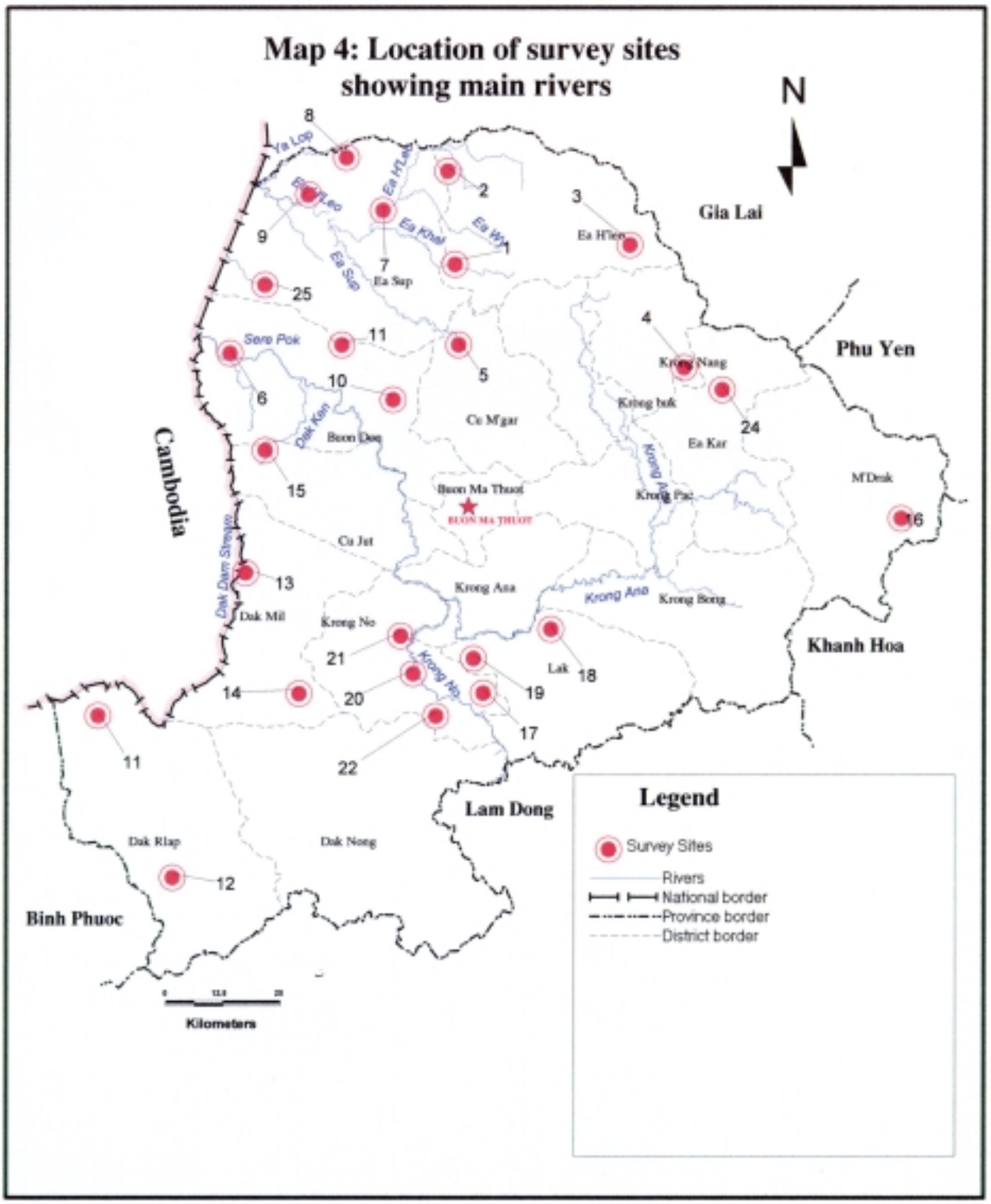
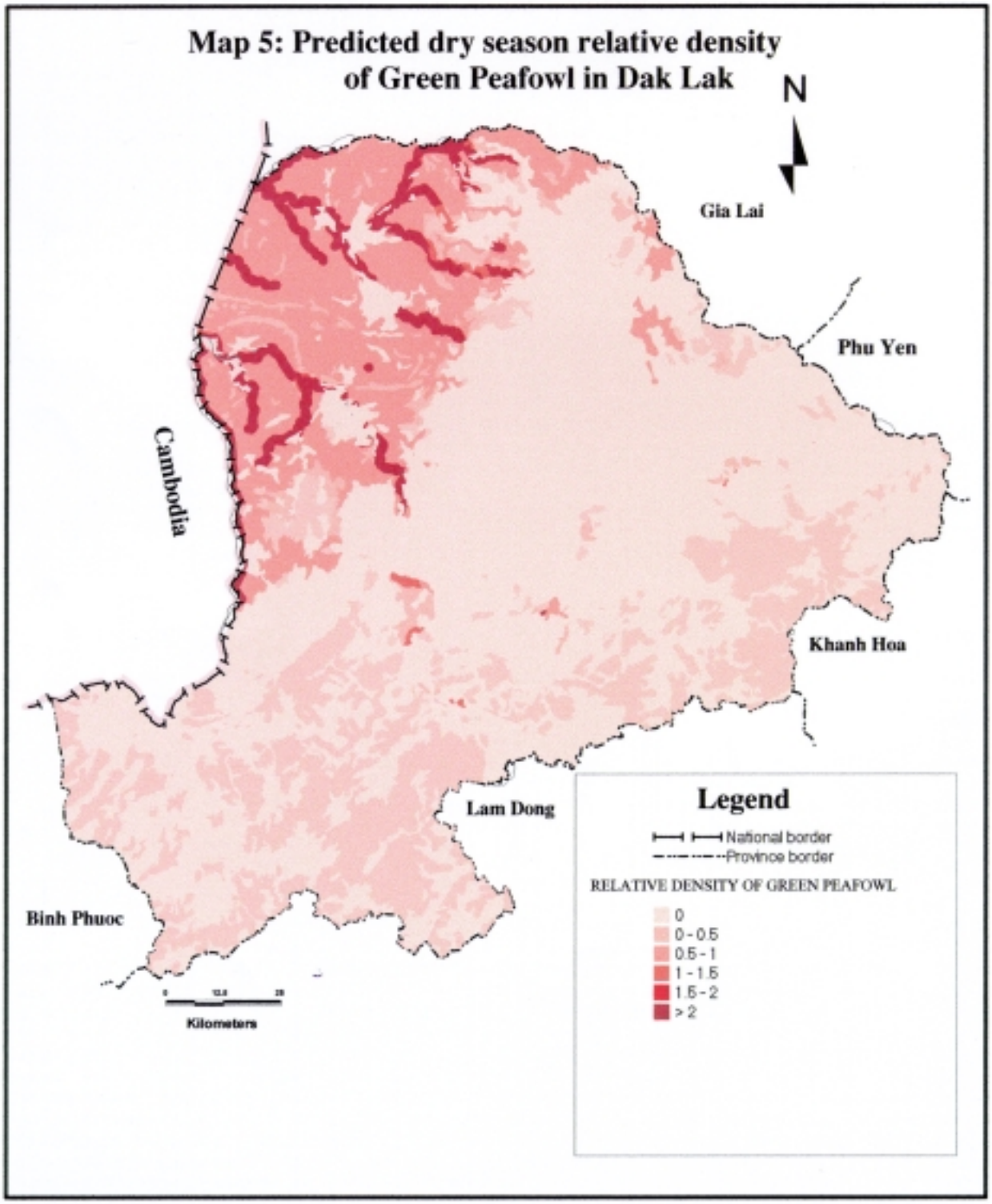
Map 1: Location of Dak Lak in Vietnam, showing major locations referred to in the text

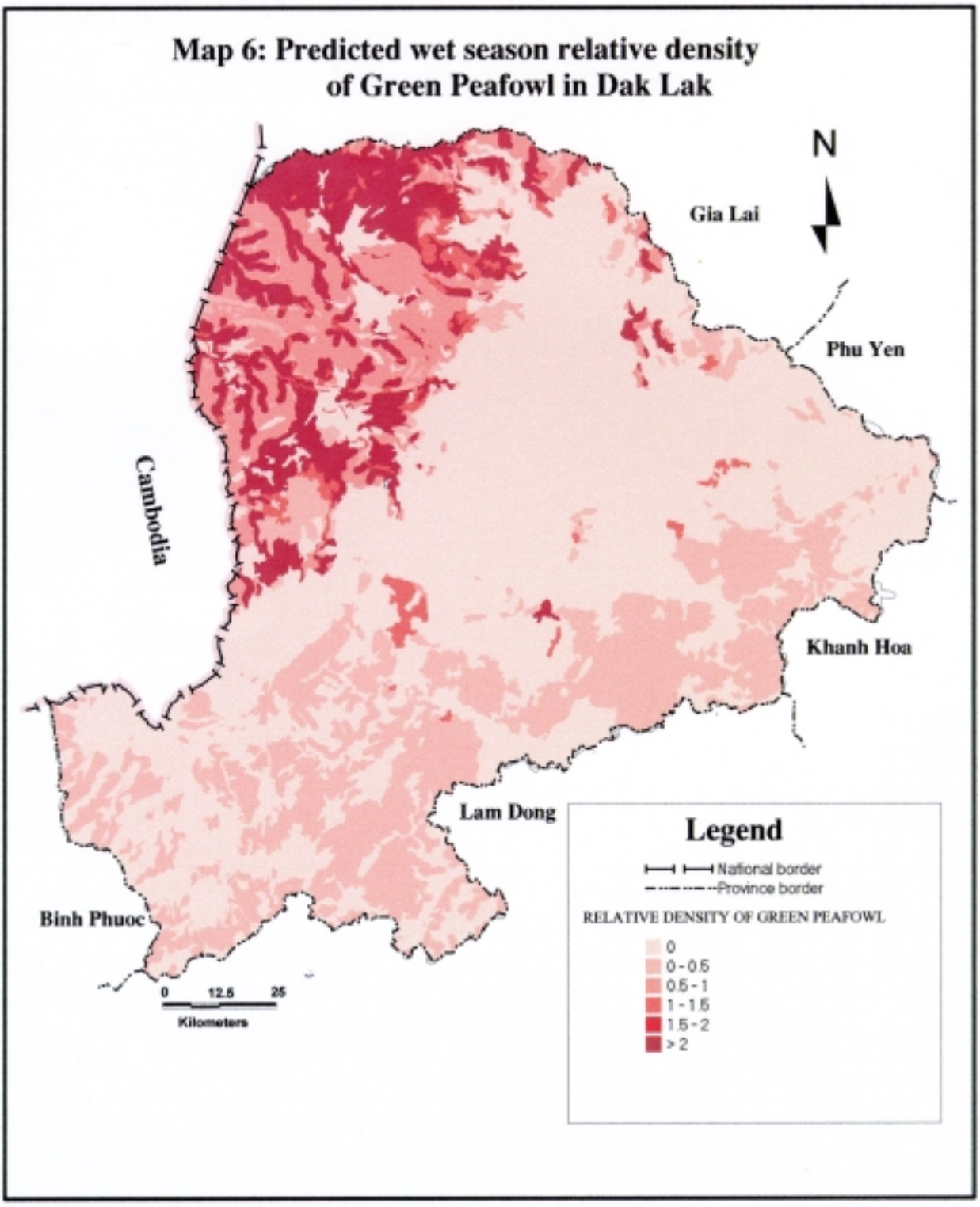



Map 2: Forest cover in Dak Lak (1996)
N
Gia Lai
Phu Yen
Khanh Hoa
Lam Dong
Binh Phuoc
Cambodia
Ea H'leo
Ea Sup
Krong Nang
Krong buk
Cu M'gar
Buon Don
Ea Kar
M'Drak
Buon Ma Thuot
Krong Pac
Cu Jut
Krong Ana
Krong Bong
Dak Mil
Krong No
Lak
Dak Nong
0 12.5 25
Kilometers
Legend
City
Town
National border
Province border
HABITAT TYPE
Human settled
Deciduous forest
Mixed forest
Bare land with scrub savanna and scattered trees
Evergreen forest
Natural lake


Map 3: Human density by district (1996)
N
Gia Lai
Phu Yen
Khanh Hoa
Lam Dong
Binh Phuoc
Cambodia
EA SUP
EA H'LEO
BUON DON
KRONG BUK
KRONG NANG
CU M'GAR
EA KAR
M'DRAK
CU JUT
Buon Ma Thuot
KRONG PAC
KRONG ANA
KRONG BONG
DAK MIL
KRONG NO
LAK
DAK RLAP
DAK NONG
0 12.5 25
Kilometers
Legend
City
Town
Roads
District boundary
National boundary
Provincial boundary
HUMAN DENSITY
244 to 792 People per sq km
124 to 244 People per sq km
61 to 124 People per sq km
38 to 61 People per sq km
31 to 38 People per sq km
11 to 31 People per sq km


Map 4: Location of survey sites showing main rivers
N
Gia Lai
Phu Yen
Khanh Hoa
Lam Dong
Binh Phuoc
Cambodia
Ea H'leo
Ea Sup
Cu M'gar
Buon Don
Buon Ma Thuot
BUON MA THUOT
Cu Jut
Dak Mil
Krong No
Krong Ana
Krong Bong
Krong Pac
Ea Kar
M'Drak
Krong Buk
Krong Nang
Lak
Dak Nong
Dak Rlap
Ya Lop
Ea H'Leo
Ea Khal
Ea Wy
Ea Suo
Sere Pok
Dak Kien
Dak Dam Stream
Krong Ho
0 12.5 25
Kilometers
Legend
Survey Sites
Rivers
National border
Province border
District border


Map 5: Predicted dry season relative density of Green Peafowl in Dak Lak
N
Gia Lai
Phu Yen
Cambodia
Khanh Hoa
Lam Dong
Binh Phuoc
Kilometers
Legend
National border
Province border
RELATIVE DENSITY OF GREEN PEAFOWL
0
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
> 2


Map 6: Predicted wet season relative density of Green Peafowl in Dak Lak
N
Gia Lai
Phu Yen
Cambodia
Khanh Hoa
Lam Dong
Binh Phuoc
0 12.5 25
Kilometers
Legend
National border
Province border
RELATIVE DENSITY OF GREEN PEAFOWL
0
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
> 2


Map 7: Details of north-west Dak Lak
showing proposed Yok Don National Park extensions
D
B
A
C
YOK DON
NATIONAL PARK
Ea Sup district
Ea H'leo district
Ea H'Leo
Ea Sup
Cu M'gar district
Buon Don
Quang Phu
Cu Jut district
Buon Ma Thuot
Ea Tling
Dak Mam
Dak Mil
Dak Mil district
N
0
12.5
25
Kilometers
Legend
Rivers
National border
Town

Map 8: Yok Don National Park extension details

Plan A

Extension northwards to Dak Rue
Total area = 557 km sqr.
Undisturbed decid. forest nr. water = 51 km sqr.
Predicted percentage of Green Peafowl = 8%

Plan B

Extension northwards from Dak Rue to Gia Lai
Total area = 660 km sqr.
Undisturbed decid. forest nr. water = 142 km sqr.
Predicted percentage of Green Peafowl = 15%

Plan C

Extension southwards into Dak Mil
Total area = 465 km sqr.
Undisturbed decid. forest nr. water = 51 km sqr.
Predicted percentage of Green Peafowl = 6%

Plan D

Extension north-eastwards to Ea H'Leo
Total area = 1195 km sqr.
Undisturbed decid. forest nr. water = 199 km sqr.
Predicted percentage of Green Peafowl = 22%

Appendix 1: Site Locations

Site locations, showing district and sub-district, map references and dates visited.

Site	Dates	Sub District	District	Map North	Map East
1	04-06/03/98	Ea Le/Ea Nam/Ea H'leo	Ea Sup/Ea H'leo	13° 00' 30"-13° 12' 23"	107° 57' 10"-108° 59'00"
2	06-09/03/98	Ea Wy/Ea H'leo	Ea H'leo	13° 16' 30"-13° 22' 30"	107° 58' 04"-108° 04' 44"
3	09-10/03/98	Ea Hiao	Ea H'leo	13° 18' 30"-13° 18' 45"	108° 18' 40-108° 19' 10"
4	10-11/03/98	Ea Tam	Krong Nang	12° 55' 05''-12° 58' 30"	108° 27' 20''-108° 28" 00"
5	12-14/03/98	Ea Kiet/Ea Sup	Cu Mga / Ea Sup	13° 00' 05"-13° 59' 35"	108° 00' 00"-108° 01' 00"
6	17-19/03/98	Krong Na	Ea Sup	12° 28' 50''-13° 00' 05"	107°31' 30"-107° 45' 00"
7	21-22/03/98	Ea Rok	Ea Sup	13° 14' 30"-13° 20' 08"	107° 39' 00''-107°55' 30"
8	23-25/03/98	Ea Rok	Ea Sup	13° 17' 20"-13° 22' 00"	107° 45' 00''-107° 49' 20"
9	26-27/03/98	Ea Sup	Ea Sup	13° 00' 30"-13° 12' 23"	107° 01' 40"-107° 47' 00"
10	27-28/03/98	Ea Wel	Buon Don	12° 54' 00"-12° 54' 30"	107° 51"00"-107° 52' 00
11	02-04/04/98	Quang Truc	Dak Lap	12° 14' 00-12° 17' 30"	107° 10' 30"-107° 45
12	06-07/04/98	Quang Tin	Dak Lap	12° 01' 00"-12° 05"00"	107° 19' 30"-107° 20' 03"
13	08-11/04/98	Dak Lao	Dak Mil	12° 17' 30"-12° 18' 20"	107° 40' 00"-107° 41'21"
14	14/4/98	Dak Mol	Dak Mil	12° 17' 30"-12° 18' 20"	107° 40' 00"-107° 41'21"
15	11-13/04/98	Ea Po/Krong Na	Cu Jut/Buon Don	12° 43' 00" -12° 48' 03"	107° 34' 11"-107° 37' 30"
16	27-28/04/98	Ea Trang	M'drak	12° 36' 00"-12° 37' 00"	108° 46' 30"-108°48' 03"
17	24-25/04/98	Nam Ca	Krong No	12° 15' 10"-12° 18' 20"	108° 00' 00"-108° 04' 15"
18	21/4/98	Yang Tao	Lak	12° 27' 00"	108° 14' 30"
19	20/4/98	Buon Triet	Lak	12° 22' 30"	108° 04' 00"
20	4/5/98	Nam Nung	Krong No	12° 19' 50"	107° 51' 20"
21	4/5/98	Duc Lap	Krong No	12° 31' 00"-12° 31' 40"	107° 51' 30"-107° 54' 10"
22	3/5/98	Ea K'bil	Krong No	12° 19' 40"	107° 57' 30"
23	3/5/98	Quang Phu	Krong No	12° 15' 30"-12° 16' 15"	107° 57' 40"-107° 58' 50"
24	08-12/02/98	Ea So	Ea Kar	12° 54' 40"-12° 57' 40"	108° 38' 15"-108°42' 20"
25	15-19/02/98	Ea Bung/Ea To Mot	Ea Sup	13° 06' 40"-13° 14' 30"	107° 25' 26"-108° 40' 00"

Appendix 2: Green Peafowl Records

Locations of every positive Green Peafowl point count, showing date, location, district, grid reference and the minimum number of green peafowl present (GP). Site number refers to the sites listed in Appendix 1 and detailed in Table 1 (main text).

Site	Date	Locality	District	Map North	Map East	GP
1	4/3/98	Ea Khal Stream	Ea H'leo	13° 09' 35''	107° 58' 36''	2
1	5/3/98	Chu Kbang Mountain	Ea Sup	13° 08' 36''	107° 57' 30''	1
1	5/3/98	Ea Kning Stream	Ea Sup	13° 12' 00''	107° 58' 30''	7
1	5/3/98	Ea Le (Chu KBang Mountain)	Ea Sup	13° 00' 30''	107° 58' 04''	1
1	5/3/98	Ea Wy Stream	Ea H'leo	13° 12' 20''	107° 59' 00''	1
1	6/3/98	Ea Wy Forest Enterprise	Ea H'leo	13° 12' 23''	108° 01' 35''	7
1	6/3/98	Ea Rok Stream	Ea Sup	13° 08' 00''	107° 58' 30''	4
1	6/3/98	Ea Rok	Ea H'leo	13° 08' 20''	108° 59' 00''	4
2	6/3/98	Ea Wy Forest Enterprise (Ea Puk Stream)	Ea H'leo	13° 12' 37''	108° 00' 06''	1
2	6/3/98	Ea Puk Stream	Ea H'leo	13° 16' 30''	108° 00' 00''	2
2	7/3/98	Ea Drang Stream	Ea H'leo	13° 18' 14''	107° 58' 04''	2
2	7/3/98	Ea Rok Stream	Ea H'leo	13° 17' 30''	107° 59' 40''	4
2	8/3/98	Not named	Ea H'leo	13° 19' 20''	107° 59' 00''	5
2	8/3/98	Ea Drang Stream (Chu Pha)	Ea H'leo	13° 17' 50''	108° 00' 13''	3
2	8/3/98	Ok Stream	Ea H'leo	13° 22' 20''	108° 01 ' 40''	2
2	9/3/98	Chu Pha Forest Enterprise	Ea H'leo	13° 03' 02''	108° 03' 34''	2
3	10/3/98	Ea Hiao Stream	Ea H'leo	13° 18' 45''	108° 19' 10''	1
3	10/3/98	Ea You Stream	Ea Hleo	13° 18' 30''	108° 18' 40''	3
5	12/3/98	Buon Jawam (Ea Keu Stream)	Cu Mga	13° 01'20''	108° 00' 00''	2
5	13/3/98	Buon Jawam Forest Enterprise	Cu Mga	13° 01' 30''	108° 00' 10''	2
5	13/3/98	Buon Jawam Forest Enterprise	Cu Mga	13° 02'30''	108° 00' 10''	6
5	14/3/98	Buon Jawam Forest Enterprise	Cu Mga	12° 59'35''	108° 00' 25''	2
5	14/3/98	Buon Jawam Forest Enterprise	Cu Mga	13° 00'15''	108° 00' 15''	4
6	18/3/98	Ea Drang Pok Forest Enterprise	Ea Sup	12° 59' 48''	107 ° 32' 15''	1
6	18/3/98	Serepok River	Ea Sup	12° 58' 10''	107 ° 40' 40''	1
6	18/3/98	Serepok River	Ea Sup	12° 59' 00''	107 ° 33' 20''	1
6	19/3/98	Serepok River	Ea Sup	12° 59' 00''	107 ° 36' 00''	1
7	5/3/98	Ea Khal Stream	Ea H'leo	13° 11' 20''	107° 58' 00''	5
7	21/3/98	Ea H'leo River	Ea Sup	13° 16' 32''	107° 52' 28''	1
7	21/3/98	Ea H'leo River	Ea Sup	13° 18' 30''	107° 44' 30''	2
7	21/3/98	Ea H'leo River	Ea Sup	13° 16' 30''	107° 51' 30''	7
7	21/3/98	North of Ea Rok	Ea Sup	13° 19' 20''	107° 55' 00''	1
7	22/3/98	South of Ea Rok	Ea Sup	13° 14' 30''	107° 49' 00''	1
7	22/3/98	Ea H'leo River	Ea Sup	13° 17' 55''	107° 39' 00''	2
7	22/3/98	Ea H'leo River	Ea Sup	13° 20' 08''	???	4
7	22/3/98	Ea H'leo River	Ea Sup	13° 14' 46''	107° 50' 19''	5
7	22/3/98	Fun Ro Stream	Ea Sup	13° 15' 00''	107° 55' 20''	5
7	22/3/98	North Ea Rok	Ea Sup	13° 21' 00''	107° 55' 30''	4
8	24/3/98	Tieu Teo Mountain (Ya Lop River)	Ea Sup	13° 18' 40''	107 ° 48' 45''	4
8	24/3/98	West of Ya Lop River	Ea Sup	13° 21' 30''	107 ° 45' 00''	5
8	24/3/98	Ya Lop River	Ea Sup	13° 21' 30''	107 ° 45' 50''	5
10	27/3/98	Ea Tul Forest Enterprise	Buon Don	12° 54' 20''	107 ° 51' 50''	1
10	27/3/98	Ea Tul Forest Enterprise	Buon Don	12° 54' 30''	107 ° 51' 30''	1
11	2/4/98	Border Guard Station 11	Dak Lap	12° 17' 30"	107° 17' 00"	1
11	2/4/98	Quang Truc	Dak Lap	12° 17' 00"	107° 17' 10"	2
13	8/4/98	Dak Dam (Border Guard Station 6)	Dak Mil	12° 39' 00"	107° 33' 50"	3
13	9/4/98	Dak Dam (Border Guard Station 6)	Dak Mil	12° 39' 40"	107° 44' 10"	1
13	9/4/98	Dak Dam (Border Guard Station 6)	Dak Mil	12° 38' 00"	107° 34 '00"	2
13	9/4/98	Dak Mil Forest Enterprise	Dak Mil	12° 36' 15"	107° 34' 26"	3
13	10/4/98	Dak Dam (Border Guard Station 6)	Dak Mil	12° 41' 40"	107° 34' 20"	1
13	10/4/98	Dak Dam (Border Guard Station 6)	Dak Mil	12° 35' 50"	107° 35' 40"	2
13	10/4/98	Dak Lao Forest Enterprise	Dak Mil	12° 42' 15"	107° 34' 10"	1
13	11/4/98	Dak Dam (Border Guard Station 6)	Dak Mil	12° 32' 30"	107° 36' 30"	1
15	12/4/98	Dak Ken (Yok Dol)	Cu Jut	12° 46' 24"	107° 37' 30"	3
15	12/4/98	Dak Lao	Cu Jut	12° 43' 00"	107 34' 30"	1
24	9/2/98	Ea So, Krong H'Nang	Ea Kar	12° 54' 40''	108 ° 42' 20''	3
24	11/2/98	Ea So Ban Minh	Ea Kar	12° 57' 30''	108 ° 38' 15''	1
25	16/2/98	Ea H'leo River	Ea Sup	??	??	5
25	17/2/98	Border Guard Station 2	Ea Sup	13° 07' 20''	107 ° 32' 05''	5
25	18/2/98	Border Guard Station 1	Ea Sup	13° 12' 00''	107 ° 34' 00''	7
25	18/2/98	Border Guard Station 2	Ea Sup	13° 14' 30''	107 ° 35' 30''	6
25	18/2/98	Border Guard Station 1	Ea Sup	13° 12' 47''	107 ° 25' 26''	5
25	19/2/98	Border Guard Station 2	Ea Sup	13° 08' 30''	107 ° 36' 30''	1
25	19/2/98	Border Guard Station 2	Ea Sup	13° 08' 00''	107 ° 35' 20''	1
25	19/2/98	Dak Rue Watershed	Ea Sup	13° 06' 40''	107 ° 40' 00''	4
25	19/2/98	Near Border Guard Station 2	Ea Sup	13° 07' 30''	107 ° 37' 30''	3

Appendix 3: Bird species recorded during the survey

Birds species recorded during the survey (between 2 February and 4 May 1998). Common and scientific names, species limits and sequence follow Inskipp *et al.* (1996). Additional notes on species marked with '*' are shown as a footnote. See also main text (Section 6.5.1). Sites numbers refer to the sites detailed in Table 1 (main text) and Appendix 1. Dates on which sites were visited are shown in Appendix 1.

Species	Common Name	Sites recorded
Francolinus pintadeanus	Chinese Francolin	1-13,15,22,23
Arborophila brunneopectus	Bar-backed Partridge	11,12
A. charltonii	Scaly-breasted Partridge	11,12,9
Gallus gallus	Red Junglefowl	1-16,22,23
Lophura nycthemera	Silver Pheasant	11,14
L. diardi	Siamese Fireback	11,13,14
Polyplectron germaini *	Germain's Peacock Pheasant *	4,11,12,14,16,23
Rheinardia ocellata *	Crested Argus *	16
Pavo muticus	Green Peafowl	1,2,3-8,10,11,13,24,25
Dendrocygna javanica	Lesser Whistling-duck	18,19
Cairina scutulata	White-winged Duck	13
Nettapus coromandelianus	Cotton Pygmy-goose	18,19
Turnix tanki	Yellow-legged Buttonquail	9
T. suscitator	Barred Buttonquail	2,7,9
Picumnus innominatus	Speckled Piculet	11,14
Dendrocopos canicapillus	Grey-capped Pygmy Woodpecker	6,11
D. macei	Fulvous-breasted Woodpecker	1
D. hyperythrus	Rufous-bellied Woodpecker	2
Celeus brachyurus	Rufous Woodpecker	6,13
Dryocopus javensis	White-bellied Woodpecker	1,2,6
Picus chlorolophus	Lesser Yellownape	1,5,6,8
P. flavinucha	Greater Yellownape	13
P. vittatus	Laced Woodpecker	1,8,16
P. erythropygius	Black-headed Woodpecker	1,3,5,6,7,8
P. canus	Grey-headed Woodpecker	1,5,6,7
Dinopium javanense	Common Flameback	1,2,7,13
Chrysocolaptes lucidus	Greater Flameback	1
Gecinulus viridis	Bamboo Woodpecker	5
Meiglyptes jugularis	Black-and-buff Woodpecker	13
Blythipicus pyrrhotis	Bay Woodpecker	16
Hemicircus concretus	Heart-spotted Woodpecker	1,16
Mulleripicus pulverulentus	Great Slaty Woodpecker	5,8,13
Megalaima lagrandieri	Red-vented Barbet	12,16
M. lineata	Lineated Barbet	1,2,4-8,11-16,22,24
M. faiostricta	Green-eared Barbet	14
M. oorti	Black-browed Barbet	11,13,14
M. australis	Blue-eared Barbet	11,13
M. haemacephala	Coppersmith Barbet	1,8,7,11,13
Anthracoceros albirostris	Oriental Pied Hornbill	4,5,6,8,12,13
Buceros bicornis *	Great Hornbill *	11,12,14
Aceros undulatus	Wreathed Hornbill	11
Anorrhinus tickelli *	Brown Hornbill *	16
Upupa epops	Common Hoopoe	1,2,5,6,7
Harpactes oreskios	Orange-breasted Trogon	14,16
H. erythrocephalus	Red-headed Trogon	11,14,16
Coracias benghalensis	Indian Roller	7,8,13
Eurystomus orientalis	Dollarbird	1,2,4,5,6,7,8,13
Alcedo atthis	Common Kingfisher	4,6,7,11,13
Lacedo pulchella	Banded Kingfisher	14
Halcyon capensis	Stork-billed Kingfisher	6,7,13
H. smyrnensis	White-throated Kingfisher	1,6,7,11,12,13
H. pileata	Black-capped Kingfisher	13
Ceryle rudis	Pied Kingfisher	18
Nyctyornis athertoni	Blue-bearded Bee-eater	13,14
Merops orientalis	Green Bee-eater	1,2,5,7,8
M. viridis	Blue-throated Bee-eater	7,8
M. leschenaulti	Chestnut-headed Bee-eater	1,11
Clamator coromandus	Chestnut-winged Cuckoo	12
Cuculus micropterus	Indian Cuckoo	13
Cacomantis merulinus	Plaintive Cuckoo	5,7

Species	Common Name	Sites recorded
Eudynamys scolopacea	Asian Koel	6,11,12,13,15
Centropus sinensis	Greater Coucal	2,3,4,5,6,7,8,13,15
Centropus bengalensis	Lesser Coucal	6,8,11
Loriculus vernalis	Vernal Hanging Parrot	1,11
Psittacula eupatria *	Alexandrine Parakeet *	15
P. finschii	Grey-headed Parakeet	1,6,7,8,13,15
P. roseata	Blossom-headed Parakeet	1,7
P. alexandri	Red-breasted Parakeet	1,3,8,13
Hirundapus cochinchinensis	Silver-backed Needletail	5,6,7,9
Cypsiurus balasiensis	Asian Palm Swift	24
Apus pacificus	Fork-tailed Swift	14
A. affinis	House Swift	5
Hemiprocne longipennis	Grey-rumped Treeswift	1-18,21,22
Tyto alba	Barn Owl	18
Otus spilocephalus	Mountain Scops Owl	11,12,14
O. sunia	Oriental Scops Owl	1,7,8,13
O. bakkamoena	Collared Scops Owl	3,6,11,12
Bubo nipalensis	Spot-bellied Eagle Owl	24
Ketupa zeylonensis	Brown Fish Owl	25
Glaucidium brodiei	Collared Owlet	4
G. cuculoides	Asian Barred Owlet	5
Caprimulgus indicus	Grey Nightjar	11
C. macrurus	Large-tailed Nightjar	1-15,17,22,24
C. affinis	Savanna Nightjar	8
Columba livia	Rock Pigeon (feral)	
C. punicea	Pale-capped Pigeon	13,24
Streptopelia chinensis	Spotted Dove	2-8,11,13,22,23
S. tranquebarica	Red Collared Dove	2,7,9
Macropygia unchall	Barred Cuckoo Dove	11,12
Chalcophaps indica	Emerald Dove	1,5,4,11,12,14
Treron bicincta	Orange-breasted Green Pigeon	12,24
T. curvirostra	Thick-billed Green Pigeon	2-15,21,22,24
T. phoenicoptera	Yellow-footed Green Pigeon	6,13
T. apicauda	Pin-tailed Green Pigeon	11,12,14
Ducula aenea	Green Imperial Pigeon	1,2,3,4,6,13
D. badia	Mountain Imperial Pigeon	5,11,12,14,16
Amaurornis phoenicurus	White-breasted Waterhen	6,13,15
Porzana fusca	Ruddy-breasted Crake	18
Porphyrio porphyrio	Purple Swamphen	18
Gallinula chloropus	Common Moorhen	18
Tringa nebularia	Common Greenshank	4
Actitis hypoleucos	Common Sandpiper	6,7,22
Hydrophasianus chirurgus	Pheasant-tailed Jacana	18
Himantopus himantopus	Black-winged Stilt	18
Charadrius dubius	Little Ringed Plover	(4),22,23
Vanellus indicus	Red-wattled Lapwing	5,6,7,8,11,14
Pandion haliaetus	Osprey	18
Aviceda leuphotes	Black Baza	2,4,5,6,7,13
Pernis ptilorhyncus	Oriental Honey-buzzard	13
Elanus caeruleus	Black-shouldered Kite	5,23
Gyps bengalensis	White-rumped Vulture	25
Sarcogyps calvus	Red-headed Vulture	25
Spilornis cheela	Crested Serpent Eagle	1,6,7,8,11,16
Accipiter trivirgatus	Crested Goshawk	5
A. badius	Shikra	2,4,5,6,7
A. soloensis	Chinese Sparrowhawk	24
Butastur liventer	Rufous-winged Buzzard	7,8
Hieraaetus kienerii	Rufous-bellied Eagle	11
Polihierax insignis	White-rumped Falcon	7,25
Microhierax caerulescens	Collared Falconet	6
Tachybaptus ruficollis	Little Grebe	18
Egretta garzetta	Little Egret	18
Ardea cinerea	Grey Heron	18
A. purpurea	Purple Heron	18
Casmerodius albus	Great Egret	18
Mesophoyx intermedia	Intermediate Egret	4,18
Bubulcus ibis	Cattle Egret	18,19,20,21
Ardeola bacchus	Chinese Pond Heron	1,2,3,4,5,6,7,11
Butorides striatus	Little Heron	12,13
Ixobrychus sinensis	Yellow Bittern	18
I. cinnamomeus	Cinnamon Bittern	5,12,18

Species	Common Name	Sites recorded
Ciconia episcopus	Woolly-necked Stork	7,13,25
Leptoptilos javanicus	Lesser Adjutant	7,25
Pitta cyanea	Blue Pitta	11,12,14
P. moluccensis	Blue-winged Pitta	12,13,20
Serilophus lunatus	Silver-breasted Broadbill	12,16
Irena puella	Asian Fairy Bluebird	11,12,13
Chloropsis cochinchinesis	Blue-winged Leafbird	1,4,5,6,9,11
C. aurifrons	Golden-fronted Leafbird	2,3,4,5,6,7,13
Lanius tigrinus	Tiger Shrike	7
L. collurioides	Burmese Shrike	2,3,5,6
L. schach	Long-tailed Shrike	23,25
Garrulus glandarius	Eurasian Jay	5,13
Urocissa erythrorhyncha	Red-billed Blue Magpie	1,2,6,7,13
Cissa hypoleuca	Indochinese Green Magpie	13
Dendrocitta vagabunda	Rufous Treepie	1,2,7,13
Crypsirina temia	Racket-tailed Treepie	7,13
Temnurus temnurus	Ratchet-tailed Treepie	14
Pica pica *	Black-billed Magpie *	7
Corvus macrorhynchos	Large-billed Crow	4,6,11,13
Artamus fuscus	Ashy Woodswallow	1
Oriolus chinensis	Black-naped Oriole	11,12,14
O. xanthornus	Black-hooded Oriole	1,2,7,13
O. traillii	Maroon Oriole	11
Coracina macei	Large Cuckooshrike	1,2,3,5,6,7
C. polioptera	Indochinese Cuckooshrike	10
Pericrocotus divaricatus	Ashy Minivet	6
P. cinnamomeus	Small Minivet	1,6,9
P. solaris	Grey-chinned Minivet	11
P. flammeus	Scarlet Minivet	4,5,6,11
Hemipus picatus	Bar-winged Flycatcher-shrike	1,5,6,7,8
Rhipidura albicollis	White-throated Fantail	8,11
R. aureola	White-browed Fantail	8,9,11
Dicrurus macrocercus	Black Drongo	4,5,6,7
D. leucophaeus	Ashy Drongo	1,2,5,6,7,11,15
D. annectans	Crow-billed Drongo	4,6,8,11,12
D. aeneus	Bronzed Drongo	1,5,6,11,13
D. remifer	Lesser Racket-tailed Drongo	11
D. hottentottus	Spangled Drongo	1,6,7,11
D. paradiseus	Greater Racket-tailed Drongo	1,6,7,11,13
Hypothymis azurea	Black-naped Monarch	1,2-7,11,12,13,15,16
Terpsiphone paradisi	Asian Paradise-flycatcher	13,16
Aegithina tiphia	Common Iora	2,3,4,5,6,7,9
A. lafresnayei	Great Iora	5,13
Tephrodornis gularis	Large Woodshrike	16
T. pondicerianus	Common Woodshrike	2,5,6,7,8,9
Myophonus caeruleus	Blue Whistling Thrush	4
Zoothera citrina	Orange-headed Thrush	11
Muscicapa dauurica	Asian Brown Flycatcher	1,5,13
Ficedula parva	Red-throated Flycatcher	1,2,5,6,7,12
Cyanoptila cyanomelana	Blue-and-white Flycatcher	6
Cyornis tickelliae	Tickell's Blue Flycatcher	6,7,13
Culicicapa ceylonensis	Grey-headed Canary Flycatcher	14
Luscinia cyane	Siberian Blue Robin	11,12,13,14
Copsychus saularis	Oriental Magpie Robin	7,13,16
C. malabaricus	White-rumped Shama	2,4,6,7,8,12,13,16
Enicurus schistaceus	Slaty-backed Forktail	11,16
E. leschenaulti	White-crowned Forktail	11
Saxicola torquata	Common Stonechat	7
S. caprata	Pied Bushchat	7
S. ferrea	Grey Bushchat	7
Sturnus malabaricus	Chestnut-tailed Starling	6,8
S. sinensis	White-shouldered Starling	6
S. nigricollis	Black-collared Starling	6
S. burmannicus	Vinous-breasted Starling	7,15
Acridotheres cinereus	White-vented Myna	8
Ampeliceps coronatus	Golden-crested Myna	1,2,5
Gracula religiosa	Hill Myna	1,2,3,5,6,13
Sitta castanea	Chestnut-bellied Nuthatch	1,5,6,7,13,15
S. frontalis	Velvet-fronted Nuthatch	6,11,13
Parus major	Great Tit	1,4,5,6,13
Melanochlora sultanea	Sultan Tit	16

Species	Common Name	Sites recorded
Hirundo rustica	Barn Swallow	4,5,11
H. daurica	Red-rumped Swallow	5,11,12
H. striolata	Striated Swallow	6,12
Delichon dasypus	Asian House Martin	11
Pycnonotus atriceps	Black-headed Bulbul	11
P. melanicterus	Black-crested Bulbul	1,2,4,5,11,13,16,22,24
P. jocosus	Red-whiskered Bulbul	1,3,5,11,16,21,22,23,24
P. aurigaster	Sooty-headed Bulbul	1,2,5,6,7,11,13,14,15,21
P. finlaysoni	Stripe-throated Bulbul	11,16
P. blanfordi	Streak-eared Bulbul	5,13
Alophoixus pallidus	Puff-throated Bulbul	4,16
A. ochraceus	Ochraceous Bulbul	23
Iole propinqua	Grey-eyed Bulbul	2,6,13
Hemixos flavala	Ashy Bulbul	11
Hypsipetes leucocephalus	Black Bulbul	7,11
Cisticola juncidis	Zitting Cisticola	22
Prinia polychroa	Brown Prinia	6
P. atrogularis	Hill Prinia	9
P. rufescens	Rufescent Prinia	1,3,5,7,8,12,13
P. flaviventris	Yellow-bellied Prinia	1
P. inornata	Plain Prinia	9
Locustella lanceolata	Lanceolated Warbler	11
Orthotomus cuculatus	Mountain Tailorbird	12,14
O. sutorius	Common Tailorbird	13
O. atroguralis	Dark-necked Tailorbird	4,6
Phylloscopus fuscatus	Dusky Warbler	7,8
P. schwarzi	Radde's Warbler	2,5,7
P. inornatus	Yellow-browed Warbler	2,5,11,12,13
P. borealis	Arctic Warbler	11
P. trochiloides	Greenish Warbler	5,11
Abroscopus superciliaris	Yellow-bellied Warbler	4,16
Garrulax leucolophus	White-crested Laughingthrush	1,2,6,7,11,13
G. chinensis	Black-throated Laughingthrush	19,21,23
G. monileger	Lesser Necklaced Laughingthrush	1,2,5,7
G. milleti	Black-hooded Laughingthrush	14
G. vassali	White-cheeked Laughingthrush	11,14,16
Pellorneum tickelli	Buff-breasted Babbler	12
P. albiventre	Spot-throated Babbler	11,12
P. ruficeps	Puff-throated Babbler	11,12,13,16
Malacopteron cinereum	Scaly-crowned Babbler	11,13,16
Pomatorhinus hypoleucos	Large Scimitar Babbler	12
P. schisticeps	White-browed Scimitar Babbler	14,19
Macronous kelleyi	Grey-faced Tit Babbler	12,13
M. gularis	Striped Tit Babbler	4,6,11,13,16
Timalia pileata	Chestnut-capped Babbler	24
Alcippe peracensis	Mountain Fulvetta	11
Yuhina nigrimenta	Black-chinned Yuhina	11
Y. zantholeuca	White-bellied Yuhina	13,16
Paradoxornis gularis	Grey-headed Parrotbill	11
Mirafra assamica	Rufous-winged Bushlark	2,6,7,8,11
Dicaeum agile	Thick-billed Flowerpecker	1,2,4,5
D. concolor	Plain Flowerpecker	3,7,13
D. cruentatum	Scarlet-backed Flowerpecker	2,12,13
Anthreptes singalensis	Ruby-cheeked Sunbird	4,13
Nectarinia jugularis	Olive-backed Sunbird	2,13
N. asiatica	Purple Sunbird	1,3,4,5,6,13,15
Aethopyga siparaja	Crimson Sunbird	4
Arachnothera longirostra	Little Spiderhunter	12
A. magna	Streaked Spiderhunter	12
Passer montanus	Eurasian Tree Sparrow	19,23
Dendronanthus indicus	Forest Wagtail	14
Motacilla alba	White Wagtail	6
M. cinerea	Grey Wagtail	1,2,4
Anthus rufulus	Paddyfield Pipit	11
A. hodgsoni	Olive-backed Pipit	6,7,13
Ploceus manyar	Streaked Weaver	19
P. philippinus	Baya Weaver	18,19
P. hypoxanthus	Asian Golden Weaver	19
Lonchura striata	White-rumped Munia	19
L. punctulata	Scaly-breasted Munia	12

Additional notes (species marked with an asterisk)

Germain's Peacock Pheasant	Frequently seen and heard in evergreen and mixed forest
Crested Argus	Seen, and heard frequently, at Site 16 in M'Drak district
Great Hornbill	2 birds at Site 11 (3/4/98), 1 at Site 12 (7/4/98), 1 at Site 14 (14/4/98)
Brown Hornbill	Single bird at Site 16 in M'Drak District (27/4/98)
Alexandrine Parakeet	Single bird near Border Station 5 in Cu Jut (11/4/98)
Black-billed Magpie	Single bird in forest edge near Ea H'Leo river, Ea Sup (23/3/98)
Asian Golden Weaver	Single bird at Boun Triet, Lac district (20/4/98)

Appendix 4: Mammal species recorded during the survey

Mammal species recorded during the survey (2 February - 4 May 1998). Scientific names, species limits and sequence follow Corbet and Hill (1992). Sites numbers refer to the sites detailed in Table 1 and Appendix 1. Where identification was in question square brackets are used. Some further details are provided in the main text (Section 6.5.2).

Notes:

A Seen / heard
B Tracks found
C Seen / heard - identification not certain
D Tracks found - identification not certain
E Reported by local people
F Domestic or feral stock not ruled out

Species	Common Name	Note	Site number
Macaca nemestrina	Pig-tailed Macaque	C	(16)
[*M. mulatta*]	[Rhesus Macaque]	E	(16), 6
M. fascicularis	Crab-eating Macaque	A	13
[*M. arctoides*]	[Stump-tailed Macaque]	E	(16), 6
Pygathrix nemaeus	Douc Langur	E	(16)
Hylobates gabriellae	Buff-cheeked Gibbon	A, E	1,2,11,(16,22,23)
[*Canis aureus*]	[Golden Jackal]	D	(9, 24)
Cuon alpinus	Dhole	A	(9,24)
Ursus thibetanus	Asiatic Black Bear	A, E	11,5
Paguma larvata	Masked Palm Civet	A	11
[*Panthera pardus*]	[Leopard]	D	13
[*P. tigris*]	[Tiger]	C, E	7,8,11
Elephas maximus	Asian Elephant	B, E, F	5,6,13
[*Sus scrofa*]	[Wild Pig]	A, D, E	(1-25)
Capricornis sumatraensis	Southern Serow	D, E	1, (16)
Cervus eldi	Brow-antlered Deer	E	(16)
C. unicolor	Sambar	A, D	11,13,(24), 25
Muntiacus muntjak	Indian Muntjac	A, E	(1-25)
Bos gaurus	Gaur	B, E	13, (24)
B. javanicus	Banteng	A, E	13, (24)
[*Bubalus arnee*]	[Asian Buffalo]	D, E, F	25
Menetes berdmorei	Indochinese Ground Squirrel	A	(1-25)
Lepus peguensis	Burmese Hare	A	(24)

Appendix 5: Yok Don National Park proposed extensions

The table shows the area of each proposed extension to Yok Don National Park. The table also shows the area of 'Prime habitat' for Green Peafowl, defined as dry deciduous forest within 2 km of water and greater than 2 km from human settlement. The percentage of the total population of Green Peafowl in Dak Lak predicted to lie in the extension is also given. The extensions are given a letter code, these refer to the main text (Section 9.1) and to Maps 7 and 8.

Extension	Plan	Total Area km^2	Prime habitat (dry season) km^2	Prime Habitat (wet season) km^2	Percentage total Green Peafowl
Yok Don National Park (existing)		554	123	232	11
Northwards to Dak Rue	A	557	51	179	8
Northwards to Gia Lai	B	660	142	228	15
Southwards to Dak Mil	C	465	51	180	6
Northeast to Ea H'Leo	D	1195	199	402	22
All Schemes (Total)		3431	566	1221	62