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A Feasibility Study for the Establishment of Ngoc Linh Nature Reserve, Quang Nam Province, Vietnam

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Missouri Botanical Garden

A Feasibility Study for the Establishment of Ngoc Linh Nature Reserve, Quang Nam Province, Vietnam

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Finally, the authors wish to thank Jonathan Eames, Ross Hughes, Craig Leisher and Chris Daly for their comments on the first draft of this report.

Conventions Used

Plant names, sequence and species limits follow Pham Hoang Ho (1991). Mammal names (common and scientific), sequence and species limits follow Corbet and Hill (1992) (except in the case of Lesser Woolly Horseshoe Bat *Rhinolophus beddomei*, which follows Bates and Harrison (1997)), with scientific names given at first mention and in Appendix 2. Bird names (common and scientific), sequence and species limits follow Inskipp *et al*. (1996) (except in the case of Annam Partridge *Arborophila merlini*, which follows Sibley and Monroe (1990)), with scientific names given at first mention and in Appendix 3. Reptile and amphibian names, sequence and species limits follow Nguyen Van Sang and Ho Thu Cuc (1996).

Diacritical marks are omitted from Vietnamese names due to typographical limitations and the restricted understanding of international readers, with the exception of Tra Don and Tra Do'n communes where the diacritical marks are needed to distinguish between them.

Locality names follow Department of Cartography 1:50,000 series maps (1994).

Glossary of Terms

Endemic Bird Area (EBA) refers to an area supporting at least two restricted-range bird species. A restricted-range bird species is one with a global breeding range of less than 50,000 km^2.

Globally threatened species refers to a species assigned a category of threat in the IUCN Red Lists of Threatened Animals and Plants (IUCN 1996 and 1997); the term excludes species listed as Near Threatened or Data Deficient.

Indochina refers to the biogeographic region of Cambodia, Laos and Vietnam.

Stakeholders refers to a groups who are likely to benefit from, and/or bear the costs of, establishment of a protected area.

The study area refers to Tra Linh, Tra Cang, Tra Do'n, Tra Tap and Tra Leng communes, Tra My district, Quang Nam province.

Abbreviations and Acronyms Used

AMNH	-	American Museum of Natural History
AusAID	-	Australian Agency for International Development
CERUPAD	-	Centre for Rural and Urban Planning and Development
DARD	-	Department of Agriculture and Rural Development
dbh	-	diameter at breast height (1.3 m)
EBA	-	Endemic Bird Area
FIPI	-	Forest Inventory and Planning Institute, Hanoi
FPD	-	Forest Protection Department
FREC	-	Forest Resources and Environment Centre
GNP	-	gross national product
ICBP	-	International Council for Bird Preservation (now BirdLife International)
IEBR	-	Institute of Ecology and Biological Resources
IUCN	-	World Conservation Union
MARD	-	Ministry of Agriculture and Rural Development
MOF	-	Ministry of Forestry (now part of MARD)
MPI	-	Ministry of Planning and Investment
NGO	-	non-governmental organisation
NTFP	-	non-timber forest products
RRA	-	rapid rural appraisal
RIDU	-	Rural Infrastructure Development Unit
ROM	-	Royal Ontario Museum
UNCDF	-	United Nations Capital Development Fund
UNDP	-	United Nations Development Programme

Executive Summary

Between March and June 1999, BirdLife International and the Forest Inventory and Planning Institute (FIPI), in collaboration with the American Museum of Natural History (AMNH), the Institute of Ecology and Biological Resources (IEBR), Hanoi, the Royal Ontario Museum (ROM), the Missouri Botanical Garden, and Quang Nam Provincial Forest Protection Department (FPD), conducted a field survey in southern Tra My district, Quang Nam province, Vietnam. The aim of this field survey was to assess the feasibility of establishing Ngoc Linh (Quang Nam) Nature Reserve. This report, which contains the results of the field survey, forms part of the process to establish this nature reserve. The contents of this report were approved by Quang Nam Provincial People's Committee, following a workshop held on 30 December 1999, and the report was submitted to the Ministry of Agriculture and Rural Development (MARD). If the contents of this report are approved by MARD, BirdLife International and FIPI will prepare an investment plan, which will be submitted to government for approval to establish the nature reserve.

Ngoc Linh (Quang Nam) proposed nature reserve is situated on the Kon Tum Plateau, a mountainous region supporting montane habitats that are isolated from similar areas by intervening areas of lower elevation. The proposed nature reserve supports high levels of endemism in plants and animals, and contains 4,273 ha of natural forest above 1,500 m. The known global range of one bird species, Golden-winged Laughingthrush *Garrulax ngoclinhensis*, is confined to Mount Ngoc Linh. As a result of the presence of Golden-winged Laughingthrush and three other restricted-range bird species, Ngoc Linh (Quang Nam) proposed nature reserve qualifies for inclusion in the Kon Tum Plateau Endemic Bird Area (EBA), the most recently discovered of Vietnam's four EBAs.

As a result of a less-than-comprehensive field survey, recorded levels of biodiversity at Ngoc Linh (Quang Nam) proposed nature reserve are generally lower than at other montane protected areas in Vietnam: a total of 385 plant, 51 mammal, 171 bird, 15 reptile and 25 amphibian species are known from the proposed nature reserve. It is likely, however, that underlying levels of biodiversity are at least as high as those in better studied areas.

The key conservation features of Ngoc Linh (Quang Nam) proposed nature reserve are the undisturbed, montane habitat types, and the large number of endemic and globally threatened species: 16 globally threatened plant species, seven globally threatened mammal species and three globally threatened bird species are known from the proposed nature reserve. In addition, Ngoc Linh (Quang Nam) protects the recently discovered endemic mammal, Truong Son Muntjac *Muntiacus truongsonensis*, which is currently known from only two other protected areas in Vietnam. Furthermore, the proposed nature reserve supports a continuum of natural habitat types from 150 to 2,598 m, which is the longest altitudinal gradient of natural habitat types remaining in Vietnam.

The principal economic value of the proposed nature reserve is watershed protection. Loss of forest cover could result in increased periods of drought, with negative repercussions for downstream communities, which depend upon rivers originating within the proposed nature reserve for irrigation and potable water. Forest at high elevations in the proposed nature reserve has a particularly important hydrological function as it can "capture" moisture by condensation and contribute this to the total yield of the watershed. Conversely, the forests of Ngoc Linh (Quang Nam) are also likely to play an important role in alleviating the severity of flooding, by slowing surface water run-off. The importance of this function is highlighted by the two bouts of severe flooding that devastated parts of Quang Nam province in November and December 1999.

A total of 11,591 people live in the buffer zone of the proposed nature reserve, although only two small villages are located within the proposed nature reserve boundary. The majority of these people are subsistence farmers, practising a mixture of rotational swidden agriculture and wet-rice cultivation. Over 97% of the inhabitants of the buffer zone belong to the Xe Dang, Ca Dong or Mnong ethnic minorities. Relative to other areas of Vietnam, overall levels of socio-economic development, as measured by either food production or mean per capita income, are low.

The overall level of impact of local people on the proposed nature reserve is moderately low. The average population density in the buffer zone communes is only 18 people per square kilometre, compared with 232 people per square kilometre for Vietnam as a whole. Agricultural practises appear to be largely sustainable: rates of conversion of forest to agriculture over the last 10 years are very low compared with other areas in the Western Highlands. However, clearance of forest for agriculture is likely to pose a formidable challenge to conservation in the future. This is likely to be driven by both natural population growth (based on the available data, the population growth rate in the buffer zone is 2.9% per annum) and settlement of migrants from other

areas. If conservation is to be effective, strategies will need to be developed to address both of these factors. Therefore, conservation measures must focus on limiting natural population growth, and controlling the settlement of migrants into the south of Tra My district, particularly in the area of a new economic zone at Tac Po village, just outside of the buffer zone.

Other threats to biodiversity are hunting and over-exploitation of non-timber forest products. Rapid rural appraisal (RRA) data indicate that abundances of forest products, such as muntjacs, wild pigs and rattans, have declined over the past 10 years, suggesting that these products are being exploited at unsustainable levels. These threats could be mitigated by such measures as cultivating NTFPs, controlling the wildlife trade, promoting alternative sources of income and conducting conservation awareness activities.

Based on the area's high biodiversity value but limited potential for tourism, this report recommends that Ngoc Linh (Quang Nam) be established as a protected area with the status of nature reserve. The nature reserve should cover 18,430 ha, comprising a strict protection area of 17,343 ha and a forest rehabilitation area of 1,087 ha. The buffer zone should cover 44,678 ha and include six communes: Tra Linh, Tra Cang, Tra Tap, Tra Do'n and Tra Leng communes in Tra My district, and Phuoc Thanh commune in Phuoc Son district. This report makes management recommendations for the strict protection area, forest rehabilitation area, and buffer zone. It also proposes management objectives and a staffing structure for the nature reserve.

Ngoc Linh (Quang Nam) proposed nature reserve is contiguous with Ngoc Linh (Kon Tum) Nature Reserve (41,420 ha) and Song Thanh-Dakpring proposed nature reserve (98,300 ha). When established, these three protected area will cover nearly 160,000 ha, and will form one of the largest areas of continuous conservation coverage in Vietnam. This report recommends that, after these areas are established, they be upgraded to national park status. This would afford the highest management category and ensure central government support for an extensive, representative area of the Kon Tum Plateau EBA.

Tóm tắt dự án

Trong khoảng thời gian từ tháng 3 đến tháng 6 năm 1999 Viện Điều tra quy hoạch rừng và tổ chức Bảo tồn chim quốc tế phối hợp với Viện sinh Thái Tài nguyên Sinh vật, Viện bảo tàng lịch sử Hoa Kỳ, Vườn thực vật Missouri, Chi Cục kiểm lâm Quảng Nam tiến hành khảo sát thực địa vùng nam huyện Trà My. Mục đích đợt khảo sát nhằm nghiên cứu tính khả thi của khu vực để là cơ sở cho việc thành lập khu bảo tồn thiên nhiên Ngọc Linh.

Ranh giới đề xuất khu bảo tồn thiên nhiên nằm ở trung tâm núi Ngọc Linh (2.598 m) là đỉnh núi cao nhất vùng Tây nguyên. Diện tích tự nhiên đề xuất khu bảo tồn 18.430 ha, nối với khu bảo tồn thiên nhiên Ngọc Linh tỉnh Kon Tum và khu Sông Thanh Đakpring, sau khi được thành lập 3 khu này sẽ có tổng diện tích rừng đặc dụng lớn nhất toàn quốc khoảng 160.000 ha.

Khu vực Ngọc Linh là nơi hội tụ các dạng sinh cảnh núi cao với 4.273 ha rừng tự nhiên ở đai cao trên 1.500 m, là nơi có tính đặc hữu cao với các loài động vật và thực vật phân bố hẹp như loài Khướu Ngọc Linh.

Do những hạn chế khi khảo sát thực địa, tính đa dạng sinh học của khu vực Ngọc Linh phản ánh khiêm tốn hơn so với các khu bảo vệ khác với 385 loài thực vật, 5 loài thú, 171 loài chim và 40 loài ếch nhái, bò sát

Khu bảo tồn thiên nhiên Ngọc Linh được xây dựng nhằm bảo vệ kiểu sinh cảnh rừng núi cao, diện tích lớn rừng chưa bị tác động, các loài đặc hữu và các loài bị đe doạ mang tính toàn cầu như mức độ đe doạ mang tính toàn cầu với thú có 7 loài, chim có 3 loài. Trong đó, loài Mang Trường Sơn, loài thú đặc hữu cho Việt Nam được phát hiện cho khoa học năm 1997 hiện tại phân bố của chúng mới được ghi nhận cho hai khu bảo tồn là khu bảo tồn Ngọc Linh Kon Tum và khu bảo tồn Kon Ka Kinh. Đặc biệt hơn so với các khu bảo vệ khác trong hệ thống rừng đặc dụng là sự đa dạng về kiểu sinh cảnh từ đai cao 150 m tới 2.598 m.

Dân số các xã vùng đệm khu bảo tồn 11.591 nhân khẩu, trong đó có hai thôn đang sinh sống trong ranh giới đề xuất khu bảo tồn. Cộng đồng địa phương ở đây sinh sống chủ yếu bằng nghề nông với phương thức canh tác chủ yếu là du canh và xen canh. Phần lớn cộng đồng đang định cư là tộc người Xê Đăng, Cà Dông và Mơ Nông, phát triển kinh tế xã hội trong vùng hạn chế sản lượng lương thực và thu nhập đầu người thấp.

Hiện tại, mức độ tác động của cộng đồng địa phương đối với khu bảo tồn thấp. Mật độ dân số bình quân toàn vùng là 18 người/km2, mặc dù phương thức canh tác nông nghiệp chính của cộng đồng địa phương là du canh song họ chỉ canh tác trên đất nương rẫy cũ, các loại đất trống nên diện tích rừng bị mất do canh tác nông nghiệp thấp hơn với các khu vực lân cận khác. Hiện nay sức ép lớn nhất với khu bảo tồn là tình trạng săn bắt động vật hoang dã và khai thác lâm sản ngoài gỗ, song trong tương lai mối đe doạ lớn nhất là việc phá rừng làm nương rẫy do sức ép gia tăng dân số, di dân tự do.

Với thực trạng của khu vực nghiên cứu hạn chế về tiềm năng du lịch sinh thái song tính đa dạng sinh học cao, khu vực Ngọc Linh Quảng Nam có đủ điều kiện được xây dựng thành khu bảo tồn, với tổng diện tích là 18.430 ha trong đó được chia thành hai phân khu: phân khu bảo vệ nghiêm ngặt 17.343 ha và phân khu phục hồi sinh thái 1.087 ha. Vùng đệm khu bảo tồn được quy hoạch cho 6 xã Trà Ling, Trà Cang, Trà Tập, Trà Dơn và Trà Leng thuộc huyện Trà My và xã Phước Thành thuộc huyện Phước Sơn. Dựa trên kết quả khảo sát đánh giá thực trạng của khu vực báo cáo đề xuất phương thức quản lý cho các phân khu bảo vệ nghiêm ngặt, phân khu phục hồi sinh thái, vùng đệm, nhân sự Ban quản lý và mục đích quản lý khu bảo tồn.

1. Introduction

This feasibility study has been prepared by BirdLife International and the Forest Inventory and Planning Institute (FIPI), as part of the European Union-funded project *Expanding the Protected Areas Network in Vietnam for the 21st Century*. Previously, feasibility studies and investment plans prepared by FIPI have followed the Guidelines of the Ministry of Forestry (MOF), dated July 1991, outlining the methods and contents of investment plans for the establishment of Special-use Forests. This feasibility study, however, follows a draft set of guidelines currently being prepared by FIPI and BirdLife International.

The aim of this feasibility study is to assess the feasibility of establishing a nature reserve in Tra My district, Quang Nam province. This is achieved through an evaluation of the biological and economic values of the area, an assessment of conflicting pressures on the area, and an analysis of the capacity of local institutions to establish and effectively manage the nature reserve.

The contents of this feasibility study were approved by Quang Nam Provincial People's Committee, following a workshop held on 30 December 1999. During 2000, an investment plan will be produced and submitted to the Ministry of Agriculture and Rural Development (MARD) and Ministry of Planning and Investment (MPI), in order to seek approval for funding for the establishment of Ngoc Linh (Quang Nam) Nature Reserve.

1.1 Background to Vietnam

Geography. The Socialist Republic of Vietnam is a relatively narrow strip running north-south along the eastern coast of the Indochinese Peninsula. With a 3,000 km coastline, Vietnam extends from 23°37.5' to 8°00.5'N. It is approximately 525 km across at its widest and 47 km across at its narrowest point. Vietnam's total land area is 331,689 km^2. Mountain ranges extend along Vietnam's border with the People's Republic of China in the north, and along the borders with the Lao People's Democratic Republic and the Kingdom of Cambodia in the west. The highest point is Mount Fan Si Pan in the far north at 3,143 m, although average mountain altitudes are around 1,000 m. Vietnam is topographically complex, with the exception of the narrow, coastal lowlands of the central region and the southern Mekong Delta region.

Demographics. The population of Vietnam is approximately 77 million people (1998), with a growth rate of 2.3% (at this rate, the population will double in 32 years). The country is composed of 61 provinces with 570 urban centres. Eighty percent of the population live in rural areas. Two cities have over 1 million inhabitants: Ho Chi Minh City (formerly Saigon) and Hanoi, the capital. Literacy rates are high: 93% for males and 83% for females. Life expectancy is 62 years for males and 67 years for females (Pham Ngoc Dang 1998).

Economics. Vietnam is currently undergoing an economic transition towards a more market-oriented economy. Vietnam's annual per capita gross national product (GNP) is about US$300 (UNDP 1999). GNP has been growing rapidly for the past decade. Vietnam's leading exports in order of contribution to GNP are crude oil, coal, rice, coffee, textiles, marine products, shoes, tea, cashew nuts and rubber. It is the world's third largest rice exporter and the fifth largest coffee exporter.

Environment. Economic growth, infrastructure development, population growth, protracted wars, and the development of agriculture, forestry and fishing industries have resulted in over-exploitation of Vietnam's natural resources. The environment in Vietnam has largely been compromised: forest cover has undergone a massive decline and is now estimated at 26% of the country's total land (Vo Quy 1998). Gross deforestation has been accompanied by degradation of arable land, soil erosion, destruction of water catchments, diminished groundwater sources, siltation and ecological degradation of coastal and submerged areas, and a loss of overall biodiversity within Vietnam.

1.2 Conservation in Vietnam

The government of Vietnam recognised the need for conserving and rehabilitating the natural environment at the end of the 1970s. Its first priority was to provide areas for settling war veterans. The second priority was chemical detoxification and remediation for human resettlement of areas affected by chemical defoliants. The third priority was given to reforestation, establishing protected areas and conversion of forests into cultivated land (MOF 1991a). Only in the 1990s has the conservation emphasis moved towards protecting endangered habitats and species.

Vietnam's forests are divided into three categories (MOF 1991a,b):

(a) Production Forests. These are forested areas which can be allocated to any organisation or individual (with management requirements and harvesting regulations) for domestic commercial timber needs as stipulated in Vietnam's Forestry Law, Articles 28-34;

(b) Protection Forests. These forested areas can be allocated to forestry agencies, people's committees, or to the people directly, for the main purposes of watershed protection, soil erosion control, and foreshore protection with special provisions as per Articles 35-37; and

(c) Special-use Forests (Protected Areas). These are forested lands allocated for environmental conservation, tourism, educational purposes, national defence, and other special uses. These lands can be allocated to organisations and agencies in the state forestry sector which are expected to generate revenues outside of the strict protection areas and follow management procedures as per Articles 39-41. Special-use Forests are further subdivided into:

    (i) *Cultural and Historical Sites* to preserve and maintain areas of national and cultural interest and importance;

    (ii) *Nature Reserves* intended to preserve all representative forest types and to conserve biodiversity; and

    (iii) *National Parks* to protect and conserve all major wildlife and habitat types found within Vietnam.

Vietnam currently has proposals for 105 protected areas, comprising 2,092,466 ha or 6% of the total land area. If these proposals are adopted, there will be 10 national parks, 61 nature reserves, and 34 cultural and historical sites (Dang Huy Huynh 1998). Vietnam is actively establishing new sites as part of its treaty obligations under the Convention on Biological Diversity. The policy document entitled *Renovation of Strategies for Forestry Development until the Year 2000* contains a commitment to expand Vietnam's system of Special-use Forests to 2 million ha by the year 2000, thereby doubling the network of protected areas.

Vietnam supports approximately 275 mammal species, 826 bird species, 260 reptile species, 82 amphibian species, 500 freshwater fish species, 2,000 marine fish species and 12,000 plant species (Dang Huy Huynh 1998, MacKinnon 1997).

1.3 The Kon Tum Plateau Endemic Bird Area

Initial surveys conducted by BirdLife International identified 218 centres of bird endemism world-wide, termed Endemic Bird Areas (EBAs) (ICBP 1992, Stattersfield *et al*. 1998). EBAs are areas which support at least two restricted-range bird species (species with a global range of less than 50,000 km^2), and are considered to be priority areas for conservation (Stattersfield *et al*. 1998). Three EBAs were identified in Vietnam: the Southern Vietnamese Lowlands, the Da Lat Plateau, and the Annamese Lowlands.

The Kon Tum Plateau is a mountainous region in the Western Highlands of Vietnam (also known as the Central Highlands), situated in northern Kon Tum and southern Quang Nam provinces. The highest point on the Kon Tum Plateau is Mount Ngoc Linh at 2,598 m. The high mountains of the Kon Tum Plateau are isolated from other high altitude areas in Vietnam and Laos by intervening areas of lower elevation. As a result, the Kon Tum Plateau supports a unique assemblage of plant and animal species and has high levels of endemism.

The Kon Tum Plateau was brought to the attention of the scientific community in 1998 by the discovery of two new bird species, Black-crowned Barwing *Actinodura sodangorum* (Eames *et al*. 1999a) and Golden-winged Laughingthrush *Garrulax ngoclinhensis* (Eames *et al*. 1999b), the first new bird species to be described from continental South-East Asia for 30 years. These new discoveries were made at Ngoc Linh (Kon Tum) Nature Reserve, and, along with five other restricted-range bird species recorded in the area, qualify the Kon Tum Plateau to become Vietnam's fourth EBA.

The Kon Tum Plateau EBA is also of high conservation importance due to the presence of several mammal species endemic to Vietnam or to Vietnam and Laos, including the recently discovered Truong Son Muntjac *Muntiacus truongsonensis* and Giant Muntjac *Megamuntiacus vuquangensis* (Le Trong Trai *et al.* 1999).

Protected Area Coverage. There are four planned protected areas in the Kon Tum Plateau EBA: Ngoc Linh (Kon Tum) (41,420 ha), Kon Ka Kinh (41,470 ha) and Kon Cha Rang (16,000 ha) Nature Reserves, and Ngoc Linh (Quang Nam) proposed nature reserve (18,430 ha). When all four nature reserves are established, they will cover a total area of about 120,000 ha, and will include significant areas of forest at high altitudes: the habitat type with the highest conservation significance.

1.4 Rationale for the Feasibility Study

History and Official Status. The original recommendation for establishing Ngoc Linh Nature Reserve was included in Ministerial Decision No. 194/CT, dated 9 August 1986, which proposed establishing a 20,000 ha nature reserve in Gia Lai-Kon Tum province (now Gia Lai and Kon Tum provinces) (Cao Van Sung 1995). In 1994, the Ministry of Forestry (now MARD) gave FIPI the responsibility to produce an investment plan for Ngoc Linh Nature Reserve in Quang Nam-Da Nang and Kon Tum provinces (FIPI 1994). However, this investment plan was not ratified at the ministerial level (Anon. 1998).

In 1997, as part of the European Union-funded project *Expanding the Protected Areas Network in Vietnam for the 21st Century*, a conference was held at Cuc Phuong National Park, attended by MARD, the forest protection department (FPD), FIPI, the Institute of Ecology and Biological Resources (IEBR), provincial leaders and international NGOs. The participants at this conference formulated a list of proposals for expanding Vietnam's system of protected areas (MARD 1997). This list, which is referred to as the "2010 list", includes a proposal to establish Ngoc Linh as a 50,000 ha nature reserve in Quang Nam[1] and Kon Tum provinces. This list has been submitted to government and is currently awaiting approval.

In 1998, MARD gave FIPI the responsibility for producing an investment plan for a nature reserve in Kon Tum province. Between March and May 1998, a field survey was conducted by FIPI in collaboration with BirdLife International. The investment plan was published in December 1998 (Anon. 1998) and Ngoc Linh (Kon Tum) Nature Reserve was established in 1999, covering 41,420 ha.

Following the establishment of Ngoc Linh (Kon Tum) Nature Reserve, MARD gave FIPI the responsibility for conducting a feasibility study for Ngoc Linh (Quang Nam) Nature Reserve, Quang Nam province. In March and June 1999, a team from FIPI and BirdLife International visited Quang Nam province to conduct this study. The biological data incorporated in the study were collected between March and May 1999 by an expedition from IEBR, the American Museum of Natural History (AMNH), the Royal Ontario Museum (ROM) and the Missouri Botanical Garden.

Management Authority. Inclusion of Ngoc Linh (Quang Nam) Nature Reserve within Vietnam's network of Special-use Forests would necessitate management responsibility being transferred to the Forest Protection Department within MARD who coordinate the protection of all Special-use Forests at the national level (MOF 1991a). The day-to-day management and administration of the nature reserve would, however, be undertaken by Quang Nam Provincial FPD via a management board, which would be established for this purpose.

1.5 Field Survey

Aim and Objectives. The aim of the field survey was to collected all data necessary for the preparation of a feasibility study for the establishment of Ngoc Linh (Quang Nam) Nature Reserve.

Specific objectives included to:

- collect data on the composition and distribution of major vegetation types;
- collect biodiversity data on plants, vertebrates and selected invertebrate groups;
- collect socio-economic data relating to land-use, demographics and use of natural resources;
- assess the institutional capacity of project partners and stakeholders involved in the establishment of the nature reserve; and

[1] Quang Nam province was created in 1996 following the division of Quang Nam-Da Nang into two provinces.

- formulate recommendations for protected area establishment and management.

Study Area. The study area originally encompassed areas in both Tra My and Phuoc Son districts, Quang Nam province. An initial visit to these districts during March 1999 by a team from FIPI and BirdLife International investigated the possibility of establishing a nature reserve incorporating parts of three communes in Phuoc Son district (Phuoc My, Phuoc Cong and Phuoc Thanh) and five communes in Tra My district (Tra Leng, Tra Tap, Tra Do'n, Tra Cang and Tra Linh). However, communications between Phuoc Son and Tra My districts are poor: the distance between the two district towns by road is 212 km. This, coupled with poor infrastructure within the districts and the remoteness of forest areas, would make management of these two areas as a single protected area difficult. Furthermore, parts of Phuoc My and Phuoc Cong communes have already been recommended for inclusion in the proposed Song Thanh-Dakpring Nature Reserve (Wikramanayake *et al.* 1997b). At a meeting held on 15 May 1999, attended by representatives of FIPI and BirdLife International, it was decided that a forthcoming investment plan for Song Thanh-Dakpring Nature Reserve should propose including areas of Phuoc My, Phuoc Cong and Phuoc Thanh communes, whilst Ngoc Linh (Quang Nam) Nature Reserve should include only areas in Tra My district. This decision is in accordance with the wishes of Quang Nam Provincial FPD.

As a result of this decision, and for the purposes of this report, the study area was defined as Tra Leng, Tra Tap, Tra Do'n, Tra Cang and Tra Linh communes, Tra My district. The study area is bounded by the coordinates 15º00' to 15º19'N and 107º56' to 108º07'E. It is bordered to the west by Phuoc Son district, to the south and west by Kon Tum province, and to the north and east by Tra Bui, Tra Giac, Tra Mai, Tra Don and Tra Nam communes, Tra My district. The study area is contiguous with Ngoc Linh (Kon Tum) Nature Reserve to the south and west, and with Song Thanh-Dakpring proposed nature reserve to the west (Map 1).

The study area lies 90 km south of Da Nang city. Tra My town is 50 km by road from Tam Ky town (the provincial capital), which is, in turn, 73 km from Da Nang city or 835 km from Hanoi. However, the study area is a further 28 km from Tra My town. The road linking Tam Ky and Tra My towns is surfaced and access is good but the unsurfaced road between Tra My town and the study area is in a poor condition and regularly impassable during the rainy season; however, there are plans to upgrade it in the near future.

Field Survey. The field survey comprised three components:

- initial visit between 8 and 29 March 1999;
- biodiversity survey between 6 March and 2 May 1999; and
- socio-economic survey between 1 and 12 June 1999.

The purpose of the initial visit was to collect general socio-economic data on demographics and land-use, and investigate the institutional capacity of partner institutions and positive and negative stakeholders in the nature reserve. The purpose of the biodiversity survey, based primarily in Tra Do'n commune, was to collect baseline data on the diversity and distribution of vertebrates and selected groups of invertebrates. Additionally, the structure and composition of major vegetation types was studied by means of vegetation plots. The purpose of the socio-economic survey, based in Tra Tap and Tra Do'n communes and employing rapid rural appraisal (RRA) techniques, was to collect data on agricultural practices, demographics and relative dependence on forest resources.

2. Physical and Biological Features

2.1 Biogeography

The study area is situated within the Bolovans-Kon Tum Montane Forests Ecoregion of the Indo-Pacific region (Wikramanayake *et al.* 1997a). According to the classification of MacKinnon (1997), the study area is located in sub-unit Ma (Central Annam Mountains) of the Indo-Chinese sub-region. This sub-unit contains the mountain block centred on the Kon Tum Plateau. The limited extent of this sub-unit reflects the biogeographic uniqueness of the study area, particularly the high altitude habitats on the Kon Tum Plateau.

2.2 Topography

The study area is located in the mountainous Western Highlands. The highest point in the study area, Mount Ngoc Linh, is, at 2,598 m, the highest point in the Western Highlands. Mount Ngoc Linh and surrounding mountains are connected to the Annamite (or Truong Son) Mountains by the Nam-Ngai-Dinh ridge, which runs from south-east to north-west. The peaks in this ridge are linked by a series of sharp ridges, which form the border between Kon Tum and Quang Nam provinces (Map 2). These high mountains and the adjacent highland areas are referred to as the Kon Tum Plateau. The Kon Tum Plateau is a mountain isolate, being separated by relatively long distances from other high altitude areas.

Slope ratios in the study area are rather high, typically 40 to 45º but sometimes as high as 60 to 65°. The highest slope ratios are on the east face of Mount Ngoc Linh, which descends from the summit at 2,598 m to the Tranh River valley at 150 m. Fifty eight percent of the proposed nature reserve lies above 1,000 m, including 60% of the natural forest (Table 1).

Table 1: Altitudinal Distribution within Ngoc Linh (Quang Nam) Proposed Nature Reserve

Altitudinal Range	Total Area (ha)	% of Total Area	Area of Natural Forest (ha)	% of Natural Forest
Less than 500 m	1,566	8.5	1,056	7.5
500 to 1,000 m	6,112	33.2	4,593	32.8
1,000 to 1,500 m	5,292	28.7	4,084	29.2
1,500 to 2,000 m	3,008	16.3	1,896	13.6
2,000 to 2,500 m	2,386	12.9	2,311	16.5
Greater than 2,500 m	66	0.4	66	0.4
Total	18,430	100.0	14,006	100.0

2.3 Geology

The Indoxinian Massif was formed during the Pre-cambrian Age, with its eastern perimeter creating a shield from Ngoc An to Ngoc Linh. Uneven subduction and geological erosion resulted in flattened and slanted surfaces with numerous displacement fractures. During the formation of the Viet-Lao Caledon enfolded syncline, from the Cambrian Period to the beginning of the Devonian, the Kon Tum Plateau split from the Indoxinian Massif.

The settling of the Kon Tum Plateau resulted from the Secong Fracture along the plateau's western side, and a southern fault line, both of which isolated the plateau from the Indoxinian Massif to the west. In addition, continuous tectonic movements created a number of fractures in a north-south direction, heightening some blocks and slanting others towards the west. In places where there were many sudden movements, many big fractures were created, which effused thick layers of basalt (Tran Duc Luong and Nguyen Xuan Bao eds. 1992).

2.4 Soils

According to the classification of Cao Liem and Nguyen Ba Nhuan (1985), the main soil types in the study area are:

(a) Highland Alittic Humus Soil (HA). This soil type is distributed at elevations above 2,000 m where the average temperatures are below 15°C. This soil type is always humid although the aeolian and soil layer are thin. The upper humus layer, however, is over 50 cm thick. In many places, such as on the summit of Mount Ngoc Linh, there is a very humid and porous humus layer over 1 m thick. The

soil layer is also humid, light textured and structureless. Below 35 cm is a layer of clay containing white rock crystals, with pH 4, 30% humus, and a C/N ratio of 25 to 35, which is liable to being washed off.

(b) Feralite Humus Soils in Medium High Mountains (FH). These soil types are distributed at elevations between 1,000 and 2,000 m. The climate at these elevations is always humid and cool, with temperatures between 15 and 20°C, and evaporation rates lower than rainfall rates. Lots of crude humus has accumulated, and the C/N ratio is 15 to 20. Feralite levels are lower than at low elevations and the humus layer is thick. These soil types are acidic, impermeable and have developed on three different mother rocks:

(i) *Yellow Feralite Humus Soil on Acid Magmatic Rock in Medium High Mountains* (FHa). The soil layer is thick, medium textured, acidic and poorly developed. This soil type is distributed on the slopes of Mount Ngoc Linh and other high mountains in the study area;

(ii) *Brown Feralite Humus Soil on Magmatic Alkaline and Neutral Rock in Medium High Mountains* (FHk). The soil layer is very thick, heavy textured, homogeneous, fertile and acidic. This soil type is mainly distributed at elevations between 1,000 and 1,500 m; and

(iii) *Yellow and Red Feralite Soil on Metamorphic Rock and Clay Schist in Medium High Mountains* (FHs). The soil layer is thick, heavy to medium textured, fertile, porous and acidic. This soil type is distributed between 1,000 and 2,000 m, over a large proportion of the proposed nature reserve.

(c) Feralite Soils in Lowlands (F). These soils are found between 150 and 1,000 m over a significant area of the proposed nature reserve. Due to lower rainfall rates and higher atmospheric and surface temperatures, the forest cover is more broken and open compared with forest at higher altitudes. Based on different tectonic rocks, there are the following three soils:

(i) *Yellow and Red Feralite Soil on Magmatic Acidic Rock in Lowlands* (Fa). The soil layer is of medium thickness, coarse grained and granular. The soil layer is subject to denutrification in deforested areas; and

(ii) *Yellow and Red Feralite Soil on Metamorphic Rock and Clay Schist in Lowlands* (Fs). The soil layer is thick, heavy textured (60% clay), well structured and very fertile.

(d) River and Stream Alluvial Soil (P). The soil layer is grey-brown in colour, thick, medium to light textured and porous. This soil type is very fertile and is distributed along rivers and streams and at the foot of mountains. Due to even topography in these areas, this soil type is preferred for cultivation.

2.5 Meteorology

The study area is located in a remote mountainous region without any weather stations. Therefore, meteorological data was collected from neighbouring weather stations located in Tra My, Ba To, Dac To and Kon Tum towns (Table 2). Hence, the data given in Table 2 are unlikely to accurately reflect meteorological conditions within the study area, particularly those in high-altitude areas.

The study area is located south of 16°N and has a true humid tropical climate. Within the study area, climate varies according to altitude: higher elevations experience lower temperatures and higher rainfall. The total annual number of rainy days at Tra My town is 173, whilst, at the summit of Mount Ngoc Linh, it is 250.

The climate of the Kon Tum Plateau varies considerably between Quang Nam and Kon Tum provinces. Tra My and Ba To weather stations, on the Quang Nam side of the mountain range, experience significantly higher total annual rainfall and annual mean temperatures than Dak To and Kon Tum weather stations on the Kon Tum side. The rainy season on the Kon Tum side lasts from April to October, whilst, on the Quang Nam side, it continues until January. The wetter and warmer climate on the Quang Nam side of the mountain range can be expected to lead to differences in composition of flora and fauna between Ngoc Linh (Quang Nam) proposed nature reserve and Ngoc Linh (Kon Tum) Nature Reserve.

Furthermore, altitudinal ranges of plant and animal species and altitudinal distributions of vegetation types can also be expected to vary between the two areas.

The dry season is very short, lasting only two months, from February to March. However, in some years, prolonged water shortages lead to low agricultural production and food shortages in certain areas. During the rainy season, heavy rains and a high incidence of typhoons bring floods to parts of the study area.

Table 2: Meteorological Data from Four Weather Stations near the Proposed Nature Reserve

Meteorological Data	Weather Station			
	Tra My	Ba To	Dac To	Kon Tum
Latitude	15°21'N	14°46'N	14°42'N	14°30'N
Longitude	108°13'E	108°43'E	107°49'E	108°01'E
Altitude (m)	200	150	650	536
Period of measurements	1978 to 1995	1980 to 1995	1981 to 1995	1976 to 1995
Total annual rainfall (mm)	3,841	3,608	2,172	1,804
Maximum daily rainfall (mm)	403	515	141	170
Months of maximum rainfall	Sep, Oct, Nov, Dec	Sep, Oct, Nov, Dec	Jun, Jul, Aug, Sep	Jun, Jul, Aug, Sep
Rainy season	Apr to Jan	May to Jan	Apr to Oct	Apr to Oct
Dry season	Feb to Mar	Feb to Apr	Nov to Mar	Nov to Mar
Annual no. of rainy days	173	140	140	132
Annual mean temperature (°C)	25.3	24.3	22.3	23.4
Annual mean humidity (% RH)	86	84	80	78
Evaporation (mm)	728	867	1,232	1,533

Source: Department of Meteorology and Hydrology, Hanoi

2.6 Hydrology

In general, the study area slopes from west to east. Thus the source of most streams in the area is the mountain ridge that forms the border between Quang Nam and Kon Tum provinces. The river systems in the study area are short, narrow, steep and fast flowing, and are, therefore, subject to erosion if forest cover is lost. In the rainy season, there are many sudden floods, which cause erosion of river banks and damage to irrigation schemes and other infrastructure. During the dry season, most watercourses are dry, with the exception of some larger streams and rivers. This presents a serious problem for local people with regard to agricultural production and domestic use of water.

There are two main river systems in the study area:

(a) Tranh River. The Tranh River originates in the south of Tra My district. The watershed of the Tranh River includes Tra Tap, Tra Cang and Tra Linh communes, and streams originating in forest at high elevations in these three communes feed the river. Flowing north, the Tranh River becomes the Thu Bon River, one of the most important rivers in Quang Nam province, which reaches the sea at Hoi An town

(b) Leng River. The Leng River originates at altitudes above 1,300 m in the north-west of the study area. It flows north-east then east to join the Tranh River downstream of Nuoc Xa village. The watershed of the Leng river comprises Tra Linh and Tra Do'n communes. The border between Tra Do'n and Tra Tap communes marks the boundary of the Leng and Tranh River watersheds, with streams in Tra Do'n commune feeding the Leng River and streams in Tra Tap commune feeding the Tranh River. The boundary between the two watersheds represent a natural division of the proposed nature reserve.

2.7 Flora Overview

A total of 385 plant species in 260 genera and 122 families were recorded during the field survey (Table 3 and Appendix 1). Of the 385 plant species found in the study area, 16 are listed in the IUCN Red List of Threatened Plants (IUCN 1997) as globally threatened (Table 4).

Table 3: Plants Recorded in the Study Area

Division	Families	Genera	Species
Lycopodiophyta	2	2	2
Polypodiophyta	14	28	43
Pinophyta	3	5	7
Magnoliophyta	103	225	333
Total	122	260	385

The study area supports several plant species that are endemic to Vietnam, including *Pinus dalatensis* and *Panax vietnamensis*. Six species recorded during the biodiversity survey in 1999 are new records for Vietnam: *Lasianthus poilanei*, *L. calycinus*, *Litosanthes biflora*, *Alpinia strobiliformis*, *Petrosavia stellaris* and *Mischobulbon cordifolium*. Furthermore, two, as yet unidentified, specimens may belong to undescribed species that are new to science.

The high-altitude habitats on Mount Ngoc Linh are isolated from other high-altitude areas by intervening areas of lower elevation. This biogeographic isolation has made Mount Ngoc Linh a centre of endemism.

Twelve of the 122 plant families recorded in the study area are represented by eight or more species: Orchidaceae (29), Rubiaceae (27), Myrsinaceae (13), Arecaceae (11), Dryopteridaceae (9), Lauraceae (9), Melastomataceae (9), Urticaceae (8), Araliaceae (8), Euphorbiaceae (8), Fagaceae (8) and Araceae (8). However, the tree flora is dominated by species from the less species-rich families, such as the Burseraceae, Elaeocarpaceae, Ulmaceae and Magnoliaceae.

Table 4: Globally Threatened Plant Species Recorded in the Study Area

Species	IUCN 1997
Archangiopteris subintegra	R
Dicranopteris linearis	V
Pinus dalatensis	E
Decussocarpus fleuyri	V
Coscinium fenestratum	R
Dipterocarpus baudii	V
Elaeocarpus darlacensis	R
Ardisia gracilipes	I
A. melastomoides	R
Leea stipulosa	R
Panax vietnamensis	E
Urophyllum argenteum	R
Lasianthus coeruleus	R
Licuala robinsoniana	R
Dioscorea dissimulans	R
Calamus scutellaris	R

Follows Pham Hoang Ho (1991)
Notes: E = Endangered; V = Vulnerable; R = Rare; I = Indeterminate as per IUCN (1997)

2.8 Land-use

Data on land-use were provided by district land-use maps (1:50,000 scale, UTM) compiled from ground surveys conducted in 1992. These data were verified by comparison to satellite maps produced by the American Museum of Natural History (AMNH) based on Landsat data from 9 January 1989 and 3 February 1998.

Natural forest (rich, medium, poor and regenerating forest) covers 14,006 ha or 76% of the proposed nature reserve, of which 50% is classified as rich forest. However, the vegetation types in Table 5 follow a forestry classification based upon the criterion of standing timber volume. Under this classification, forest at high altitudes, which is of naturally low stature, is classified as medium forest. Therefore, the figures in Table 5 tend to under-record the amount of undisturbed primary forest.

Table 5: Land-use at Ngoc Linh (Quang Nam) Proposed Nature Reserve

Vegetation Type	Tra Leng	Tra Do'n	Tra Tap	Tra Cang	Tra Linh	Total (ha)	%
Rich forest	2,819.9	2,432.7	1,688.2	0.0	0.0	6,940.8	37.7
Medium forest	0.0	0.0	702.4	1,066.3	1,141.9	2,910.6	15.8
Poor forest	0.0	970.2	620.8	924.2	1,010.7	3,525.9	19.1
Regenerating forest	502.2	0.0	126.3	0.0	0.0	628.5	3.4
Agricultural land (wet rice)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agricultural land (hill fields)	0.0	0.0	0.0	0.0	19.4	19.4	0.1
Grassland	180.5	0.0	0.0	0.0	0.0	180.5	1.0
Scrub	0.0	320.7	307.6	554.1	786.9	1,969.3	10.7
Scrub with scattered trees	679.9	365.7	772.5	411.5	0.0	2,229.6	12.1
Plantation forest	25.2	0.0	0.0	0.0	0.0	25.2	0.1
Total	4,207.7	4,089.3	4,217.8	2,956.1	2,958.9	18,429.8	100.0

Scrub and scrub with scattered trees cover 4,199 ha or 23% of the total area of the proposed nature reserve, accounting for the majority of the non-natural-forest areas. If suitably managed, these areas will be able to regenerate naturally into secondary forest. Only a tiny proportion of the proposed nature reserve (200 ha or 1% of the total area) is covered by agricultural land or grassland. Therefore, practically the entire area of the proposed nature reserve is of value for conservation.

The data from the district land-use maps correspond very well with the Landsat data. Classifying forest as areas greater than 10 m in height with canopy cover greater than 70%, Landsat data from 1998 indicate that forest covers 14,890 ha of the proposed nature reserve, or 80% of the total area.

2.9 Vegetation Types

The main vegetation types in the study area are classified according to Thai Van Trung (1978). Based upon this classification, the following vegetation types are found at Ngoc Linh (Quang Nam) proposed nature reserve:

(a) high montane broadleaf evergreen forest;

(b) medium montane broadleaf evergreen forest;

(c) low montane broadleaf evergreen forest; and

(d) secondary vegetation.

Vegetation types (a) and (b) broadly equate to tropical montane evergreen forest in the classification developed by MacKinnon and MacKinnon (1986) and refined by MacKinnon (1997), whilst vegetation type (c) broadly equates to semi-evergreen rainforest. Alternatively, under the classification developed by Whitmore (1975), vegetation type (a) broadly equates to upper montane rainforest, vegetation type (b) broadly equates to lower montane rainforest and vegetation type (c) broadly equates to tropical semi-evergreen rainforest.

High Montane Broadleaf Evergreen Forest

High montane broadleaf evergreen forest is distributed above 1,700 m but extends to altitudes as low as 1,500 m along well-drained ridge crests. This forest type is characterised by members of the Fagaceae (including *Lithocarpus* spp. and *Quercus* spp.), Lauraceae and Ericaceae (*Rhododendron* spp.). The soil layer is thin and covered in a layer of spongy moss. Epiphytic load is high in this forest type: orchids and ferns are common.

From 1,700 m to the ridge of Mount Ngoc Linh, there are small areas of mixed coniferous and broadleaf forest containing *Pinus dalatensis* (Le Van Cham pers. comm.). Elfin forest is distributed at the highest elevations, along the mountain ridge that separates Quang Nam and Kon Tum provinces (Le Trong Trai pers. comm.). Trees in this forest type exhibit stunted and xerophytic morphology due to strong winds, low nutrient availability and periods of drought.

Medium Montane Broadleaf Evergreen Forest

Medium montane broadleaf evergreen forest is distributed between c.1,000 and c.1,700 m, although it intergrades with forest types at higher and lower altitudes. In this forest type, the Fagaceae, Lauraceae and Magnoliaceae are well represented: in a sample plot at 1,400 m, members of the Fagaceae accounted for 13% of the total number and 13% of the total basal area of mature trees (dbh greater than 10 cm). These families are characteristic of montane forest in Vietnam above 1,000 m (Collins *et al.* 1991), and represent the Sino-Himalayan element of the flora of Mount Ngoc Linh (Nguyen Nghia Thin 1995). Additionally, several species of conifer are found in medium montane broadleaf evergreen forest, including *Podocarpus imbricatus*, *P. neriifolius* and *Dacrydium elatum*.

Generally, this forest type is distributed far from habitation. Consequently, areas visited during the field survey exhibited low levels of disturbance, with human impact limited to hunting and non-timber forest product collection. The forest canopy is closed and even, and most gaps are the result of natural tree fall. Canopy cover is approximately 80% (Figure 1).

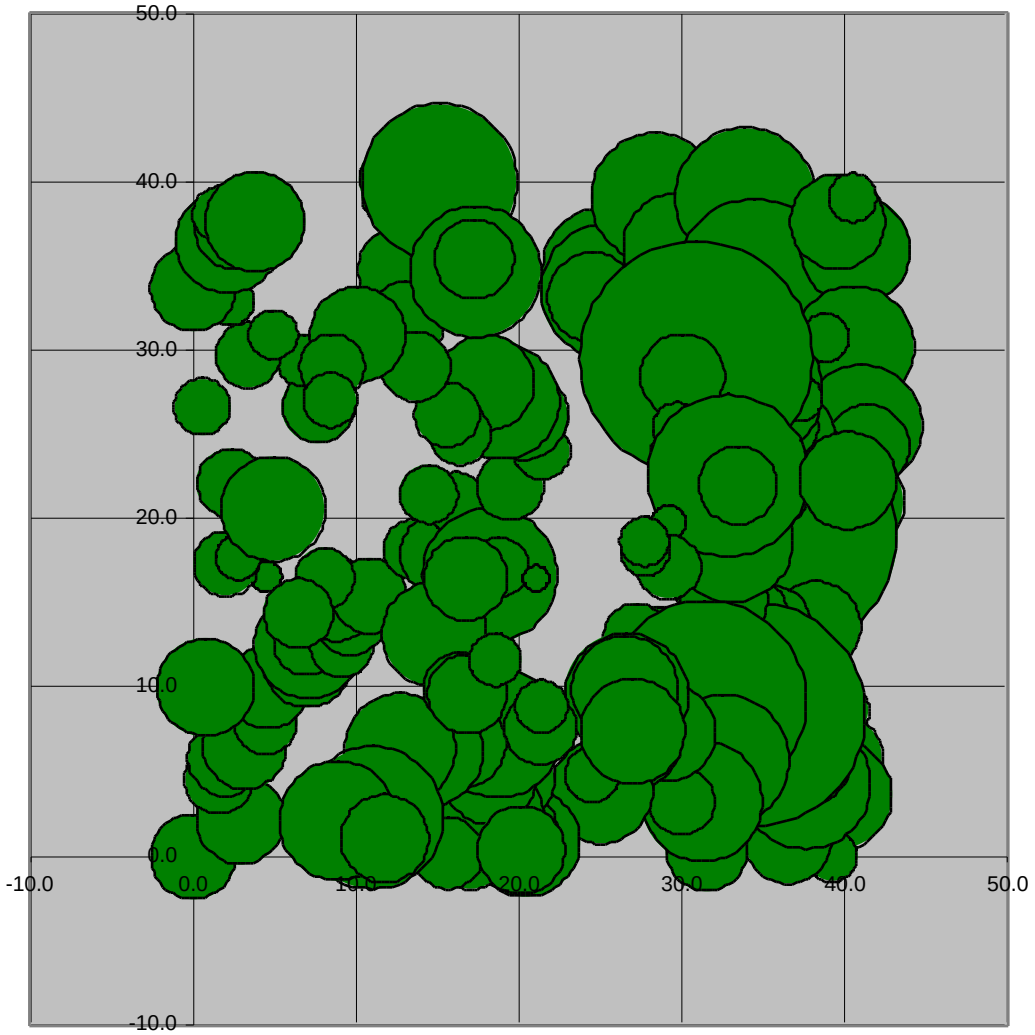


Figure 1: Canopy Cover at 1,400 m

Circles represent canopy extent of trees with dbh greater than 10 cm. X and Y axes show position of trees in the sample plot, adjusted for slope. Units: metres.

Forest structure data from a sample plot (40 by 40 m) in medium montane broadleaf evergreen forest at 1,400 m indicate that:

- Mean tree height: 12.2 m
- Mean tree dbh: 24.2 cm
- Mature tree density: 1,081 trees/ha
- Total basal area: 66.9 m^2/ha
- Canopy cover: c.80%
- Timber volume: 292 m^3/ha

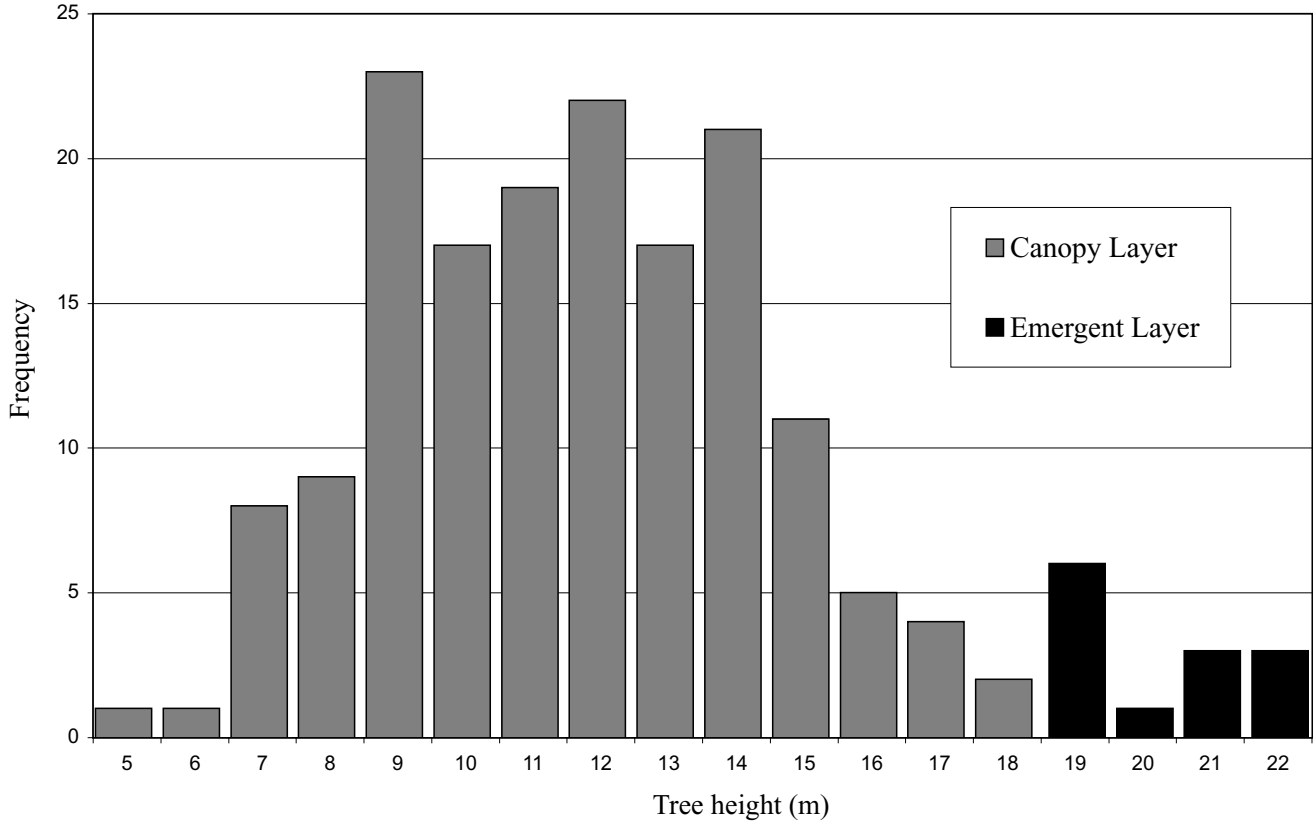


Figure 2: Distribution of Tree Heights at 1,400 m

Sample size = 173

At an elevation of 1,400 m, medium montane broadleaf evergreen forest is stratified into three layers (Figure 2):

(a) Emergent Layer. Emergent trees range in height between 19 and 22 m, with a mean of 20.2 m. The species composition of the emergent layer is similar to that of the canopy layer.

(b) Canopy Layer. The mean height of trees in the canopy layer is 11.6 m. There is no distinct middle layer as the canopy is low. The canopy layer is dominated by members of the Fagaceae (*Lithocarpus* spp., *Quercus* spp. and *Castanopsis* spp.), Lauraceae (*Litsea* sp. and *Cinnamomum* spp.), Podocarpaceae (*Podocarpus imbricatus* and *Dacrydium elatum*) and Araliaceae (*Macropanax simplicifolius* and *Schefflera* sp.).

(c) Ground Layer. The most common plant in the ground layer is the lycopodiophyte, *Selaginella rolandi-principis*, which grows at a density of over 50,000 stems per ha. Other constituents of the ground layer include shrubs, such as *Melastoma* sp. and *Lasianthus* sp., lianas, such as *Smilax* sp., and herbs, such as *Hedyotis* sp. and *Alpinia* sp.. This layer also contains saplings and seedlings of canopy species, indicating that natural recruitment is occurring. In some areas, the ground layer contains the dwarf bamboo *Arundinaria* aff. *baviensis*, which is 1.5 cm in diameter and 2.5 to 3.5 m in height, and grows at a density of 10,000 stems per ha.

Low Montane Broadleaf Evergreen Forest

Low montane broadleaf evergreen forest is distributed below 1,000 m, down to altitudes as low as 150 m in the north-east of the proposed nature reserve. Tree species diversity in this forest type is high, with no one family dominating. The tree flora contains a mixture of Sino-Himalayan elements, such as members of the Juglandaceae, Ulmaceae and Lauraceae, and Malesian elements, such as members of the Myrtaceae and Sterculiaceae (Nguyen Nghia Thin 1995).

Human habitation is often located adjacent to low montane broadleaf evergreen forest. As a result, large areas of this vegetation type have been cleared for agriculture, particularly in the south of the proposed nature reserve in Tra Cang and Tra Linh communes. However, levels of disturbance in remaining areas of forest are low, and rich forest is situated close to many villages, particularly in the north of the proposed nature reserve, in Tra Leng, Tra Do'n and Tra Tap communes (Map 3).

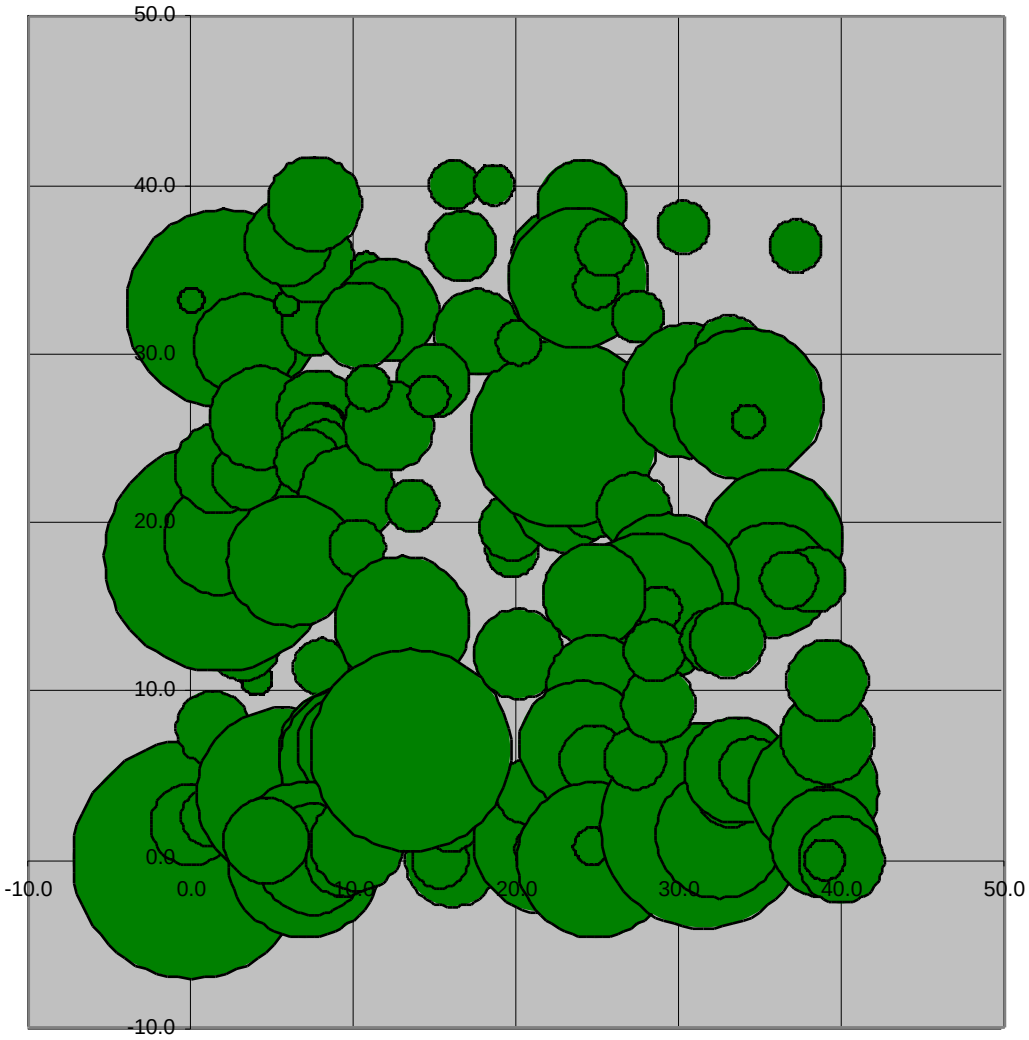


Figure 3: Canopy Cover at 900 m

Circles represent canopy extent of trees with dbh greater than 10 cm. X and Y axes show position of trees in the sample plot, adjusted for slope. Units: metres.

Forest structure data from a sample plot (40 by 40 m) in low montane broadleaf evergreen forest at 900 m indicate that:

- Mean tree height: 15.8 m
- Mean tree dbh: 26.3 cm
- Mature tree density: 794 trees/ha
- Total basal area: 69.85 m^2/ha
- Canopy cover: c.85%
- Timber volume: 460 m^3/ha

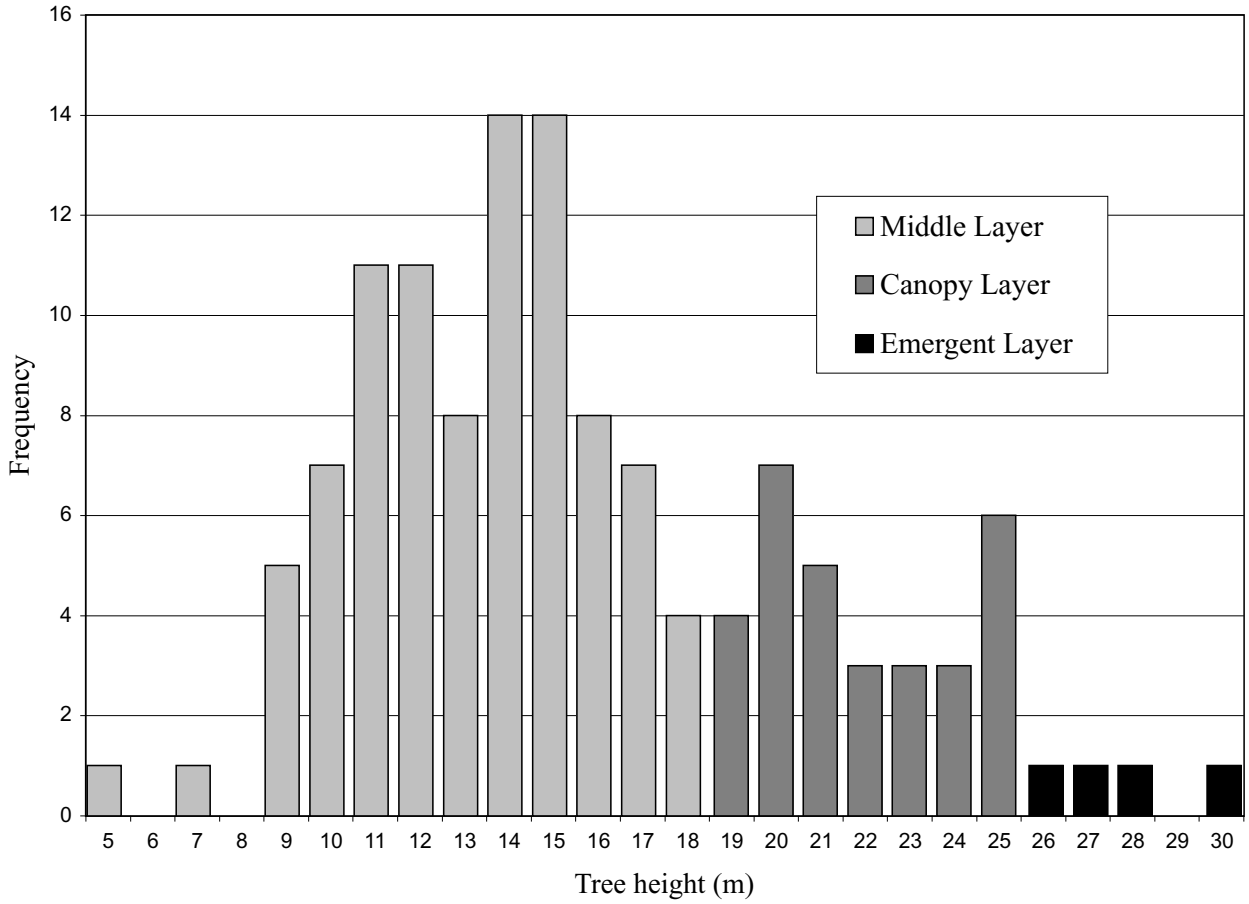


Figure 4: Distribution of Tree Heights at 900 m

Sample size = 127

At an elevation of 900 m, the canopy of low montane broadleaf evergreen forest is fairly uniform and there are very few emergents (Figure 4). Canopy cover is approximately 85% (Figure 3) and, consequently, ground layer vegetation is sparse and limited to shade-tolerant species. Forest structure data show an even distribution of mature trees between height classes (Figure 4), indicating that this forest type is a climax formation with low levels of disturbance. This forest type is stratified into four layers:

(a) Emergent Layer. This layer consists of a few large trees, with dbhs greater than 60 cm and a mean height of 27.8 m. Emergent trees include *Canarium album* and *Madhuca* sp.

(b) Canopy Layer. The canopy layer of low montane broadleaf evergreen forest is significantly higher than that of medium montane broadleaf forest. Trees in the canopy layer range between 19 and 25 m in height, with a mean of 21.9 m. Species diversity is high, including members of the Myristicaceae (*Knema* spp.), Guttiferae (*Garcinia merguensis* and *Calophyllum* sp.) and Sapotaceae (*Madhuca* sp.). Another family represented is the Burseraceae: some specimens of *Canarium album* have dbhs in excess of 100 cm.

(c) Middle Layer. The middle layer is continuous with the canopy layer, with trees ranging in height from 5 to 18 m, with a mean of 13.3 m. Species composition is similar between the two layers, as the middle layer contains many smaller specimens of canopy species. Smaller trees restricted to this layer include members of the Euphorbiaceae, Rubiaceae and Annonaceae.

(d) Ground Layer. The composition of the ground layer in low montane broadleaf evergreen forest is similar to that of high montane broadleaf evergreen forest. However, the ground layer vegetation is less abundant, and dominated by shade-tolerant species including ferns (Adiantaceae, etc) and palms (*Pinanga duperreana* and *Calamus* spp.).

Secondary Vegetation

As a result of rotational swidden cultivation, large areas of secondary vegetation have been formed within the proposed nature reserve, totalling 5,008 ha or 27% of the total area. The majority of this area comprises scrub, which often contains scattered broadleaf trees. However, in places where soil fertility has been severely depleted as a result of over-exploitation or repeated burning, smaller areas of grassland are found. Furthermore, in areas where the vegetation has been allowed to recover for an extended period following cultivation, secondary forest has developed.

Secondary vegetation is distributed at elevations up to 1,800 m, from villages to the edge of the primary forest. Within the proposed nature reserve, it is most widespread in Tra Leng commune. Areas of secondary vegetation are interspersed with cultivated hill fields and remnant patches of primary forest.

2.10 Mammals

A total of 51 mammal species were recorded in the study area, including 22 species of bat; these are listed in Appendix 2. Included in Appendix 2 are a number of preliminary identifications of specimens collected from local hunters' houses, for which final determinations are pending. Seven mammal species recorded at Ngoc Linh (Quang Nam) proposed nature reserve are listed in the IUCN Red List of Threatened Animals (IUCN 1996) as globally threatened (Table 6).

Table 6: Globally Threatened Mammal Species Recorded in the Study Area

Species	Scientific Name	IUCN 1996
Bear Macaque	*Macaca arctoides*	VU
Douc Langur	*Pygathrix nemaeus*	EN
[Indian Wild Dog or Dhole]	[*Cuon alpinus*]	VU
Asiatic Black Bear	*Ursus thibetanus*	VU
[Clouded Leopard]	[*Pardofelis nebulosa*]	VU
[Tiger]	[*Panthera tigris*]	EN
Southern Serow	*Naemorhedus sumatraensis*	VU

Follows Corbet and Hill (1992)
Notes: EN = Endangered; VU = Vulnerable as per IUCN (1996); species in brackets are unconfirmed records

All but three of the non-volant mammal species recorded at Ngoc Linh (Quang Nam) proposed nature reserve were recorded during surveys of contiguous Ngoc Linh (Kon Tum) Nature Reserve by BirdLife International and the Forest Inventory and Planning Institute (FIPI) (Le Trong Trai *et al.* 1999). This indicates a high degree of similarity between the mammal faunas of the two sites, and suggests that many of the species recorded at Ngoc Linh (Kon Tum) may be present at Ngoc Linh (Quang Nam) but not yet recorded there.

Key Mammal Records

Douc Langur *Pygathrix nemaeus*. This species was observed in low montane broadleaf evergreen forest on a single occasion during the field survey.

Truong Son Muntjac *Muntiacus truongsonensis*. Two skulls belonging to this species were obtained from village number 2, Tra Tap commune, which is situated close to undisturbed low montane and medium montane broadleaf evergreen forest. This species was reported by local hunters to be very common in forest in this commune. This species was only discovered in 1997, in Hien district, Quang Nam province, 70 km to the north-west of Ngoc Linh (Quang Nam) proposed nature reserve (Pham Mong Giao *et al.* 1998). It has since been recorded at Ngoc Linh (Kon Tum) Nature Reserve, Kon Tum province (Le Trong Trai *et al.* 1999) and at Kon Ka Kinh Nature Reserve, Gia Lai province (Le Trong Trai *et al.* 2000).

Tiger *Panthera tigris*. Hunters from village number 3, Tra Tap commune reported trapping two Tigers in pitfall traps lined with bamboo spikes in 1998. Villagers from Tra Tap commune claimed to have seen Tiger footprints as recently as May 1999. It is possible that these reports may refer to another large cat species, and further survey effort is required to confirm the presence of Tiger at Ngoc Linh (Quang Nam).

Temminck's Flying Squirrel *Petinomys setosus*. One specimen was collected in low montane evergreen forest in Tra Do'n commune, at around 850 m. This specimen represents the first record of the genus *Petinomys*

from Vietnam. Temminck's Flying Squirrel is known from northern Burma, northern Thailand, peninsular Malaysia, Sumatra and Borneo (Corbet and Hill 1992). The specimen collected at Ngoc Linh (Quang Nam) matches the description of *P. setosus morrisi* described from northern Burma (Dr J. Eger *in litt.*).

Bat Survey

A total of 22 bat species, representing five families and 12 genera, were recorded in the study area (Appendix 2). Six of these species represent new species records for Vietnam: Blandford's Fruit Bat *Sphaerias blandfordi*, Woolly Horseshoe Bat *Rhinolophus luctus*, Lesser Woolly Horseshoe Bat *R. beddomei*, Black Gilded Pipistrelle *Pipistrellus circumdatus*, Little Tube-nosed Bat *Murina aurata* and Forest Bat *Kerivoula flora*. The large number of new records for Vietnam reflects the small amount of information currently available on bat distributions in Vietnam but may also indicate the biological uniqueness of Mount Ngoc Linh within Vietnam.

2.11 Birds

A total of 152 bird species were recorded during the field survey. An additional 19 species were recorded at Ngoc Linh (Quang Nam) proposed nature reserve during a 1998 survey of neighbouring Ngoc Linh (Kon Tum) Nature Reserve by BirdLife International and FIPI (Le Trong Trai *et al.* 1999), bringing to 171 the total number of species recorded in the study area. The species list in Appendix 3 contains only sight records and preliminary field identifications; a final list awaits determinations of specimens by scientists at AMNH.

Incorporating data from the 1996 and 1998 surveys of Ngoc Linh (Kon Tum), during which 190 species were recorded (Le Trong Trai *et al.* 1999), the combined total number of bird species for Ngoc Linh (Kon Tum) and Ngoc Linh (Quang Nam) is 246. Of these 246 species, 116 are known from both areas, indicating a moderately high degree of similarity between the bird faunas of the two areas. This is to be expected because both areas are contiguous and support the same range of habitat types. Differences between the two bird faunas can be attributed to the concentration of survey effort at low elevations at Ngoc Linh (Quang Nam) but at high elevations at Ngoc Linh (Kon Tum). Further studies ought to reveal a greater amount of overlap between the two bird faunas.

Three globally threatened bird species were recorded at Ngoc Linh (Quang Nam) proposed nature reserve (Table 7). A further eight species found at the nature reserve are listed in Collar *et al.* (1994) as Near Threatened.

Four restricted-range bird species were recorded in the study area (Table 7), including the recently described Golden-winged Laughingthrush *Garrulax ngoclinhensis*, which was discovered at Ngoc Linh (Kon Tum) Nature Reserve (Eames *et al.* 1999b). The current known global range of this species is limited to montane forest habitats above 2,000 m at Ngoc Linh (Quang Nam) and Ngoc Linh (Kon Tum). A second recently described species, Black-crowned Barwing *Actinodura sodangorum*, which was also discovered at Ngoc Linh (Kon Tum) (Eames *et al.* 1999a), was not recorded during the field survey. However, due to the presence of extensive areas of suitable habitat (montane evergreen forest between 1,100 and 2,400 m) at Ngoc Linh (Quang Nam), further survey effort is likely to reveal the presence of this species at Ngoc Linh (Quang Nam).

Table 7: Globally Threatened and Restricted-range Bird Species Recorded in the Study Area

Species	Scientific Name	Restricted-range Species	Collar *et al.* 1994
Crested Argus	*Rheinardia ocellata*	RRS	VU
Yellow-billed Nuthatch	*Sitta solangiae*	RRS	VU
Golden-winged Laughingthrush	*Garrulax ngoclinhensis*	RRS	NE
Black-hooded Laughingthrush	*G. milleti*	RRS	VU

Follows Inskipp *et al.* (1996)
Notes: VU = Vulnerable as per Collar *et al.* (1994); NE = Not Evaluated; RRS = Restricted-range Species

2.12 Reptiles and Amphibians

A total of 15 reptile species in seven families were recorded during the field survey, as well as 25 amphibian species in five families. The species list in Appendix 4 contains only preliminary field identifications; a final list awaits determinations by scientists at AMNH. No species of reptile or amphibian recorded in the study area are listed in the IUCN Red List of Threatened Animals (IUCN 1996).

Fifteen species of reptile were recorded at Ngoc Linh (Quang Nam) compared with 41 species at Ngoc Linh (Kon Tum) (Le Trong Trai *et al*. 1999). However, the survey effort at Ngoc Linh (Kon Tum) was much higher, incorporating data from previous reports and information from interviews with local people as well as specimen data. With regard to amphibians, where survey effort was comparable between the two sites, 25 species were recorded at Ngoc Linh (Quang Nam) compared with 23 at Ngoc Linh (Kon Tum). This suggests that Ngoc Linh (Quang Nam) is at least as rich as Ngoc Linh (Kon Tum) in terms of overall species diversity of reptiles and amphibians.

3. Socio-economic Features

There are six communes in the buffer zone of Ngoc Linh (Quang Nam) proposed nature reserve: Tra Linh, Tra Cang, Tra Tap, Tra Do'n and Tra Leng in Tra My district, and Phuoc Thanh in Phuoc Son district[2]. Almost all villages and hamlets in these communes are located in remote, mountainous areas, accessible only on foot. Most inhabitants of the buffer zone communes are subsistence farmers, and agricultural productivity is constrained by the prevailing natural conditions. Infrastructure in the buffer zone is poor, contributing to low levels of economic activity and agricultural production.

3.1 Population and Infrastructure

Population

In the six buffer zone communes, there are 11,591 people in 1,729 households. The majority of these people (88%) live in Tra My district. Most of the inhabitants of the buffer zone communes belong to the Ca Dong, Mnong or Xe Dang (Sedang) ethnic groups, although there are a small number of Kinh (ethnic Vietnamese) people (Table 8). The Ca Dong are a sub-group of the Xe Dang ethnic group (Dang Nghiem Van *et al*. 1993).

Table 8: Population Statistics and Ethnic Composition in the Buffer Zone Communes

Commune	Population		Ethnic Group					Popn.
	H'holds	People	Kinh	Xe Dang	Ca Dong	Mnong	Other	Growth (%)
Tra Linh	275	2,070	0	2,070	0	0	0	3.7
Tra Cang	388	2,720	0	2,720	0	0	0	2.6
Tra Tap	261	1,660	0	0	1,657	0	3	2.4
Tra Do'n	373	2,261	269	0	1,985	0	7	3.2
Tra Leng	223	1,452	0	0	0	1,436	16	2.1
Phuoc Thanh	209	1,428	13	0	0	1,415	0	-
Total	1,729	11,591	282	4,790	3,642	2,851	26	2.9

Source: Tra My and Phuoc Son District Departments of Statistics, 1998
Population growth data from CERUPAD; source: Tra My district statistics, 1997; data not available for Phuoc Thanh commune

Population Distribution

The population of the buffer zone communes has a very scattered distribution. Population density is greatest along streams, rivers and roads, and in flat areas suitable for wet (paddy) rice cultivation. Most villages are located near the Tranh River, to the east of the proposed nature reserve boundary. There are 35 villages in the buffer zone communes but most comprise several scattered hamlets.

In spite of reportedly high death rates, data from the Centre for Rural and Urban Planning and Development (CERUPAD) show that population growth rates are high in most communes in the buffer zone (Table 8). However, these rates vary significantly between communes, with the population growth rate in Tra Linh commune being the highest. This is particularly significant because Tra Linh also has the highest population density (Table 9). During the field survey, it was not possible to collect data on the causes of population growth, but it was reported that there is currently no immigration into the buffer zone communes, so it can be inferred that natural growth is the principal cause.

In general, population densities are low: the population density for the buffer zone communes is 18 people per square kilometre, compared with 232 people per square kilometre for Vietnam as a whole. However, population density varies greatly between communes, following a gradient from north to south: Tra Leng and Phuoc Thanh communes in the north of the buffer zone have population densities of 12 and 9 people per square kilometre respectively; whilst the population density in Tra Linh commune is 33 people per square kilometre (Map 4). Generally, population density is inversely related to natural forest cover: those communes with a low proportion of natural forest cover have more land available for agriculture and can support a larger population (Table 9).

[2] According to Ministry of Forestry Circular 1586/LN/KL, dated 13 July 1993, a buffer zone is contiguous to, but outside of, a protected area. There are six communes in the buffer zone of Ngoc Linh (Quang Nam) proposed nature reserve, with a total area of 63,108 ha. However, the buffer zone only includes those areas that lie outside of the proposed nature reserve. Therefore, the total area of the buffer zone is 44,678 ha.

Table 9: Population Distribution and Density in the Buffer Zone Communes

Commune	Area (ha)	Popn.	Male	Female	Labour Force		No. of Villages	Density (people /km^2)	Natural Forest (%)
					Male	Female			
Tra Linh	6,300	2,070	1,060	1,010	374	395	4	33	45
Tra Cang	11,508	2,720	1,270	1,450	534	560	7	24	24
Tra Tap	7,560	1,660	822	838	355	340	4	22	54
Tra Do'n	10,370	2,261	1,081	1,180	435	425	6	22	60
Tra Leng	11,640	1,452	722	730	235	250	4	12	70
Phuoc Thanh	15,730	1,428	706	722	323	316	10	9	62
Total	63,108	11,591	5,661	5,930	2,256	2,286	35	18	54

Infrastructure

Transportation. In general, the transportation system in the buffer zone communes is very poor. With the exception of village number 6 in Tra Do'n commune, all villages in the buffer zone communes are inaccessible by car or truck. An unsurfaced road runs to the east of the Tranh River, between Tra My town and Tac Po village, Tra Mai commune (Map 4). However, all villages in the five buffer zone communes in Tra My district are located to the west of the Tranh River, which can only be crossed by ferry or via two degraded suspension bridges. Therefore, these villages can only be reached on foot, and many are inaccessible during the rainy season, when the river is in flood. Access to most villages and hamlets is via mountain trails. The poor transportation system is an obstacle to socio-economic development in the buffer zone communes. During the rapid rural appraisal (RRA), improved transportation was one of the top priorities of every local person interviewed.

New Economic Zone. Currently, the communes in the south of Tra My district, including Tra Linh, Tra Cang, Tra Tap and Tra Do'n in the buffer zone, are very remote from Tra My town. The high financial and labour costs of transporting produce to market or essential commodities to the villages are obstacles to economic development. In order to address this problem, the district people's committee plans to develop a new economic zone at Tac Po village, Tra Mai commune, adjacent to the buffer zone. The new economic zone will have a market and serve as a focus for economic activity in the area.

The government of Vietnam has allocated VND 72 billion to upgrade a 45 km stretch of road between Tra My town and Tac Po village. The planned start date for this project is 20 June 1999, and, according to the project plan, 10 km of road, and 19 bridges and drains will be built in the first year.

Irrigation. A number of buffer zone communes have irrigation systems, although the only one constructed with government funds is for 6 ha in Tra Cang commune. All other irrigation systems were constructed by local people with basic technologies. The quality of these systems is poor, and they do not provide sufficient water during the dry season and degrade badly during the rainy season.

Electricity. The river systems in the buffer zone communes are very suitable for the development of hydo-electric power schemes. Presently, however, neither the government nor any NGO has implemented such a scheme and the majority of households in the buffer zone communes are without electricity. Two medium-scale hydro-electric generators bought by local people are located in Tra Linh and Tra Leng communes. Furthermore, there are plans to build a hydo-electric power station on the Tranh River, in Tra Bui commune, in the near future.

As part of the project to establish a new economic zone at Tac Po, the electricity grid will be extended south from Tra My town: firstly to Tra Bui commune and then on to Tac Po village (C. Daly *in litt.*). The survey for the power lines has already been completed as far as Tra Bui commune, and construction is expected to commence towards the end of 1999.

Education

Each commune has a main school in the commune centre and subsidiary schools in other villages. The whole area has 84 classrooms for a total of 2,909 pupils (Table 10). Schools in all communes provide education to primary school level, although only children in Tra Linh, Tra Cang and Tra Tap communes can continue their education to lower secondary school level. There are currently no kindergartens in the buffer zone communes. Tra Leng and Phuoc Thanh communes have the lowest number of classrooms, because these communes are among the remotest in the buffer zone communes. Several villages and hamlets in these communes are without schools.

Table 10: Education Provision and Attendance in the Buffer Zone Communes

Commune	Primary School		Secondary School		Attendance (%)	No. of Classrooms	No. of Teachers	
	Class	Pupil	Class	Pupil			Kinh	Minority
Tra Linh	23	490	2	45	75	18	24	5
Tra Cang	32	800	2	53	80	19	36	4
Tra Tap	21	492	1	25	80	13	21	2
Tra Do'n	24	537	0	0	85	16	27	0
Tra Leng	17	330	0	0	60	9	18	0
Phuoc Thanh	-	260	0	0	-	9	-	-

The results of the RRA reveal that standards of education in the buffer zone communes are low. Contributory factors include shortage of teachers, insufficient training for teachers, shortage of classrooms, and an acute lack of teaching materials such as textbooks. Attendance rates are moderate, except in Tra Leng commune, where many children do not have access to education. The main reasons for non-attendance are that children are needed to work in the home or in the fields, especially during the planting and harvest times; that many children must travel very far to school, along paths that are often difficult during the rainy season; and that parents do not appreciate the importance of education for their children.

Of the children who do not attend school, a disproportionate number are girls because they are expected to help their parents around the house: doing chores and looking after younger siblings. Similarly, a disproportionate number are the children of poor households, whose parents cannot afford for them to attend school. This problem is particularly acute at upper secondary school level, where parents must pay for their children to attend boarding school in Tra My town. One consequence of lower educational standards amongst the poorer sections of the community is that these people may have fewer employment opportunities and may, therefore, be more reliant on subsistence agriculture and the exploitation of natural resources.

According to the RRA results from village number 4, Tra Tap commune, only 20% of people can speak Vietnamese fluently, whilst only 10% can read and write Vietnamese well. People with poor Vietnamese language skills are unable to represent their communities at the district or provincial level and are, therefore, unable to influence decisions regarding the allocation of resources for development.

Health Care

Health facilities in the buffer zone communes are inadequate, and there is a shortage of properly trained health care staff. Whilst each commune has a health station (Table 11), each health station must serve an average of 1,932 people. Almost all health care staff are ethnic minority people, and there are no fully qualified doctors working in the buffer zone communes. Furthermore, medicines and medical equipment are in short supply. Health stations have wooden walls and corrugated-metal roofs, with exception of Tra Do'n health centre, which was constructed by UNICEF in 1996.

Table 11: Health Care Staff and Common Medical Problems in the Buffer Zone Communes

Commune	Health Stations	Assistant Doctors	Nurses	Water Source	Common Medical Problems
Tra Linh	1	1	1	Stream	Malaria, diarrhoea, respiratory diseases, goitre
Tra Cang	1	1	2	Stream	Malaria, diarrhoea, respiratory diseases
Tra Tap	1	1	2	Stream	Malaria, diarrhoea, respiratory diseases
Tra Do'n	1	1	2	Stream	Malaria, diarrhoea, respiratory diseases
Tra Leng	1	1	3	Stream	Malaria, diarrhoea, respiratory diseases
Phuoc Thanh	1	-	-	-	-

The most common medical problems are malaria, diarrhoea, respiratory diseases and goitre. Unsafe water

sources and poor hygiene are responsible for diarrhoea, whilst geology and lack of access to iodinised salt are the causes of goitre. Of the common diseases, malaria is particularly prevalent amongst the local population. The incidence of malaria is highest from March to July. A national malaria eradication campaign sent professional staff to the communes, and supplied anti-malarial drugs, mosquito nets and insecticide sprays. The results of the RRA in Tra Tap commune reveal that, since the campaign began in 1997, the number of cases of malaria has sharply reduced, and there have been no deaths from the disease.

Family Planning. The national family planning programme has not been successful in the buffer zone communes, even though it has been assisted by the women's, youth and farmers' unions of Tra My district. Only a small proportion of couples practise family planning, with intra-uterine devices (IUDs) being the most popular method (Table 12). Family planning methods have been difficult to introduce because of the inaccessibility of the population, the reluctance of local people to change their lifestyles, and concerns amongst local people about health risks associated with different forms of contraception. Many couples have little incentive to limit the number of children they have because of high infant mortality rates, and the labour-intensive nature of traditional agricultural practises which rewards large household sizes.

Table 12: Family Planning Situation in the Buffer Zone Communes

Commune	Population	Number of Couples Practising Contraceptive Method				
		IUD	Male Sterilisation	Female Sterilisation	Condoms	Pill
Tra Linh	2,070	12	0	0	13	5
Tra Cang	2,720	59	4	0	11	3
Tra Tap	1,660	47	0	0	7	0
Tra Do'n	2,261	79	2	17	16	12
Tra Leng	1,452	34	10	0	22	0
Phuoc Son	1,428	-	-	-	-	-
Total	11,591	231	16	17	69	20

3.2 Economic Activities

Agriculture

At present, agriculture is the main economic activity in buffer zone communes. Rice, maize and cassava are the staple crops, with smaller amounts of sweet potato being grown. In many villages, wet rice has been cultivated for a long time: the RRA results from village number 4, Tra Tap commune reveal that wet rice has been grown since before 1975. However, hill (dry) rice is cultivated over a much larger area than wet rice (Table 13), and, whilst productivity is lower, the total yield of hill rice is usually greater (Table 14). None of the inhabitants of the buffer zone communes currently have land tenure certificates for their land.

Table 13: Agricultural Land in the Buffer Zone Communes

Commune	Wet Rice (ha)	Hill Rice (ha)	Maize (ha)	Cassava (ha)	Sweet Potato (ha)	Total (ha)
Tra Linh	42	57	60	58	8	225
Tra Cang	30	86	63	47	6	232
Tra Tap	31	61	47	59	9	207
Tra Do'n	45	105	39	48	10	247
Tra Leng	21	44	33	47	7	152
Phuoc Thanh	23	198	-	-	-	221
Total	192	551	242	259	40	1,284

Each household usually has at least two or three hill rice fields, as well as similar areas of maize and cassava. Hill rice is cultivated in sloping fields, for periods of two or three years, depending on the fertility of the soil. After the nutrient content of the soil becomes depleted and yields decline, new hill fields are created by slash and burn. Areas cleared for hill rice are usually old fields that have been allowed to lie fallow for periods of three to five years. These areas are often covered by scrub or secondary forest, and it is unusual for local people to clear primary forest for agriculture as this is more labour intensive and areas of primary forest are situated further from their villages. Field clearance usually takes place in late April or the beginning of May, at the end of the dry season. Due to the wet climate, accidental forest fires started by slash and burn activities are very infrequent.

Agricultural production in the buffer zone communes is low (Table 14), due to low productivity and a

shortage of arable land. Other factors contributing to low agricultural production are a lack of capital, reliance on traditional agricultural techniques, and low-yielding crop varieties. However, the biggest constraint on agricultural production is year-round water availability: in 1998, a severe drought resulted in low production in the buffer zone communes.

Table 14: Agricultural Production in the Buffer Zone Communes

Commune	Wet Rice		Hill Rice		Maize		Cassava		Sweet Potato		Total Yield (tonnes)
	P	Y	P	Y	P	Y	P	Y	P	Y	
Tra Linh	2.30	96.6	1.35	77.0	0.57	34.2	13.9	270.1	3.5	9.3	487.2
Tra Cang	2.32	69.6	1.35	116.1	0.57	35.9	13.9	219.3	3.5	7.0	447.9
Tra Tap	2.42	75.0	1.35	82.4	0.56	26.3	13.5	264.0	3.5	10.5	458.2
Tra Do'n	2.50	112.5	1.35	141.8	0.59	23.0	13.5	216.0	3.5	11.7	505.0
Tra Leng	2.34	51.0	1.35	59.4	0.57	18.8	13.9	219.3	3.5	8.2	356.7
Phuoc Thanh	3.55	81.7	1.67	330.7	-	-	-	-	-	-	412.4

Source: Tra My and Phuoc Son District Departments of Statistics. Notes: P = Productivity (tonnes per ha); Y = Yield (tonnes)

According to RRA data, the busiest months for local people are April and May, when they must plant hill rice and harvest maize and the first wet rice crop (Table 15). September, October and November are also very busy, as wet rice, hill rice and cassava are harvested at this time. The hunting season is a busy time for men, although the time when hunting takes place varies between villages. Both sexes have a lot of free time during February and March, as there is little farming to do.

Table 15: Seasonal Calendar for Economic Activity

Activity	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Wet rice (2 crops)	P	T	T	H	P	P	T	T	H	H		P
Hill rice				P	P	T	T	T	T	H		
Maize	P	P	T	H								
Cassava (harvest year 2)		P	P						H	H		
Sweet potato			P	P	T	T	T	T	H	H		
Sesame				P	P	T	T	T	T	H	H	
Cinnamon		P	P/H			H						
Hunting	***	*	*	*	*			*	*	*	*	***
Labour – male	**	*	*	***	***	*	**	**	***	***	***	**
Labour – female	*	*	*	***	***	*	**	**	*	*	*	*
Income			*	*	*	*	*	*	***	***	***	

Source: RRA data from village no. 2, Tra Tap commune. Follows solar calendar: Month 1 = January
Key: P = Plant; T = Tend Crops; H = Harvest; * = Low; ** = Medium; *** = High

Animal Husbandry

Due to a shortage of suitable land, poor access to markets, and a lack of technical knowledge and veterinary care, commercial livestock raising is not widely practised in the buffer zone communes. Pigs and chickens are raised by most households for domestic consumption, whilst buffalo and cattle are less widely owned (Table 16). Buffalo are used for draught, whilst cattle are bred for commercial purposes. Most livestock is grazed extensively, and stall feeding is not widely practised. Animal husbandry is inefficient, although cattle breeding has potential as an income-generating activity.

Table 16: Livestock Ownership in the Buffer Zone Communes

Commune	Buffalo	Cattle	Pigs	Chickens	Ducks	Geese
Tra Linh	71	92	954	2,510	25	26
Tra Cang	226	169	1,402	1,650	48	55
Tra Tap	87	110	882	2,100	80	15
Tra Do'n	149	171	1,222	2,010	50	28
Tra Leng	118	100	815	1,990	20	19
Phuoc Thanh	142	114	173	-	-	-
Total	651	642	5,275	10,260	223	143

Few households currently own goats. However, according to local people's experiences in Tra Tap commune, goats have high potential for animal husbandry because they are easy to breed and resistant to disease. In order to promote animal husbandry, Tra My District Department of Agriculture and Rural Development

has introduced new breeds of cattle and pigs to the buffer zone communes.

Social Forestry

Although more than fifty percent of land in the six buffer zone communes is classified as forest land (Table 17), the high potential for social forestry has not been realised. Presently, very few households in these communes have been issued forest protection contracts or allocated land for forestry purposes.

Table 17: Current Land-use Classification in the Buffer Zone Communes

Commune	Agricultural Land (ha)	Forest Land (ha)	Bare Land (ha)	Other Uses (ha)	Total Area (ha)
Tra Linh	135	2,780	3,378	7	6,300
Tra Cang	306	3,101	8,094	7	11,508
Tra Tap	192	4,349	3,013	6	7,560
Tra Do'n	470	3,962	5,743	195	10,370
Tra Leng	338	9,628	1,666	8	11,640
Phuoc Thanh	268	10,122	5,313	27	15,730
Total	1,709	33,942	27,207	250	63,108

Other uses include roads, house plots and mining. Bare land includes fallow agricultural land, grassland and scrub

The principal tree species cultivated in the buffer zone communes is *Cinnamomum cassia*, from whose bark cinnamon is produced. In the 1980s, wild *C. cassia* was over-exploited in the forest to such a degree that supplies were exhausted. Now the species is cultivated but the supply of seed is very limited. According to Tra My District Department of Statistics, there were 54,300 *C. cassia* trees being grown under the forest canopy or on old rotational swidden cultivation in 1998 (Table 18). *C. cassia* is planted during February and March (Table 15) and harvesting of the bark can begin after 12 to 15 years. Depending upon quality, *C. cassia* bark fetches prices of VND 20,000 to 300,000 per kg. Although *C. cassia* is presently being grown in many villages, most plantations are not old enough for harvesting, with the exception of villages such as village number 5, Tra Do'n commune. *C. cassia* cultivation has great potential as an income-generating activity for the inhabitants of the buffer zone communes.

Table 18: Agroforestry and Vegetable Cultivation in the Buffer Zone Communes

Commune	Beans (ha)	Peanuts (ha)	Sesame (ha)	Sugar (ha)	Tobacco (ha)	Vegetables (ha)	Cinnamon (trees)	Tea (trees)
Tra Linh	0.6	0.4	0.8	0.6	0.5	0.8	14,000	590
Tra Cang	0.7	0.4	0.8	0.6	0.5	0.8	10,200	680
Tra Tap	1.3	0.4	0.8	0.6	0.5	0.8	9,900	740
Tra Do'n	1.3	1.0	0.6	0.6	0.6	0.8	10,200	730
Tra Leng	1.2	0.4	0.6	0.6	0.5	0.9	12,000	770

This table does not include data for Phuoc Thanh commune

Natural Resource Use

Hunting. Hunting is widespread in the buffer zone communes and a serious threat to biodiversity. Previously, all wildlife was hunted for local consumption, mainly as food. Recently, as the buffer zone communes have become increasingly accessible to wildlife traders, wildlife is increasingly hunted for sale (Table 19). Bears and "tigers" were reported to be especially valuable, with "tigers" fetching VND 27 million per animal. Two "tigers" were trapped by hunters from village number 3, Tra Tap commune in 1998.

Hunting with guns takes place during the wet season, when the leaf litter in the forest is wet and hunters can travel undetected. Hunting with traps is a more widespread activity, involving most households in the buffer zone communes, and takes place principally between September and December. According to the results of the RRA, each household sets about 75 traps annually, catching mainly wild pigs, muntjacs, porcupines, Red Junglefowl *Gallus gallus*, squirrels, civets and rats. Truong Son Muntjac was reported to be very common in primary forest habitats in Tra Tap commune and is caught regularly. The RRA results indicate that the abundances of most commonly hunted wildlife species have declined over the past 10 years (Table 19).

Timber Extraction. Despite the fact that high quality timber is abundant in forest areas close to most villages in the buffer zone communes, local people rarely build wooden houses, preferring other building materials, such as bamboo or thatch. The principal reason for this may be cultural. Therefore, local people only extract small amounts of timber, for such purposes as house-frame construction and tool manufacture. Likewise, the level of illegal timber extraction for sale is currently low, although the extraction of timber

from Tra Leng commune for transport to Tra My town has been observed during the dry season (C. Daly *in litt.*). It is not clear whether this is from areas inside or outside of the proposed nature reserve.

Non-timber Forest Product Collection. In addition to firewood, the most commonly collected non-timber forest products (NTFPs) in the buffer zone communes include rattans, bamboo, honey, *Litsea* sp. bark, and various fruits (Table 19). With the exception of bamboo and firewood, all of these products are mainly collected on a large scale for sale to traders who visit the villages. The RRA results suggested that many NTFPs are becoming scarce and more difficult to find in the forest.

One of the most valuable NTFPs at Ngoc Linh (Quang Nam) proposed nature reserve is the medicinal plant Ngoc Linh Ginseng *Panax vietnamensis*. This species is endemic to Vietnam and found only between elevations of 1,300 and 2,000 m on Mount Ngoc Linh in Quang Nam and Kon Tum provinces, and Mount Lang Bian in Lam Dong province. Collection of wild *P. vietnamensis* occurs at low levels as the species is now scarce in the forest. As a result of this, two medicinal plant nurseries have been established in Tra Linh commune to cultivate the species. This cultivation programme is being implemented by Quang Nam Medicine and Pharmacy Company and funded by Quang Nam Provincial Department of Science, Technology and the Environment.

Table 19: NTFP Exploitation in the Buffer Zone Communes

NTFP	Part	Where Collected	Month	Collectors	Sell	Use	Status	
							10 yrs ago	Now
Rattan	stem	medium and good forest	all year	men	yes	yes	+++	+
Bamboo	stem	bamboo forest	all year	men	no	yes	++	++
Bamboo	shoot	bamboo forest	11-12	men and women	no	yes	+++	+++
Honey	honey	medium and good forest	7-8	young men	yes	no	++	+
Zingiberaceae	fruit	medium and good forest	6	men and women	yes	no	++	+
Scaphium macropodium	fruit	good forest	7-8	young men	yes	no	++	+
Canarium sp.	fruit	good forest	-	young men	yes	no	++	+
Litsea sp.	bark	medium and good forest	all year	men and women	yes	no	++	+
Firewood	stem, branch	forest near village	all year	women	no	yes	+++	+++
Wild pig	animal	fields and forest	all year	men	no	yes	+++	++
Muntjac	animal	fields and forest	all year	men	no	yes	+++	++
Tiger	animal	fields and forest	all year	men	yes	no	++	+
Wild dog	animal	forest	all year	men	no	yes	++	+
Monkey	animal	medium and good forest	all year	men	yes	yes	+++	++
Gibbon	animal	good forest	all year	men	no	yes	++	++
Deer	animal	good forest	all year	men	no	yes	++	+
Serow	animal	good forest	all year	men	no	yes	++	+
Bear	animal	good forest	all year	men	yes	yes	++	++
Civet	animal	forest	all year	men	no	yes	+++	++
Squirrel	animal	forest	all year	men	no	yes	+++	++
Snake	animal	everywhere	all year	men	yes	no	+++	++
Red Junglefowl	animal	fields and forest	all year	men	no	yes	+++	+++
Porcupine	animal	fields and forest	all year	men	yes	yes	+++	++

Source: RRA data from villages no. 2 and no. 4, Tra Tap commune. Status: +++ = Abundant; ++ = Common; + = Scarce

Despite the proximity of forest to most villages in the buffer zone communes, the results of the RRA indicate that exploitation of natural resources accounts for only a small proportion of household income. However, in most cases, the NTFPs in the buffer zone and proposed nature reserve are currently being exploited at unsustainable levels.

Rural Economy

The households in the buffer zone communes have three major sources of income: agriculture, forestry and animal husbandry. Total annual food production in the buffer zone communes in 1998 was 2,667 tonnes (Table 14), corresponding to 230 kg per person per year. Rice only accounts for only 48% of total food production, and most households are dependent upon maize, sweet potato and, especially, cassava as food sources. Forde and Seneque (1995) accept 260 kg of rice equivalent as the minimum consumption standard per person per year. Therefore, the average household produces insufficient food to meet the nutritional requirements of its members. However, in every commune, agricultural production varies greatly between households, with some households producing surplus food and others suffering from prolonged food shortages.

The proportion of households suffering from food shortages is highest in Tra Tap commune, due to a shortage of agricultural land (Table 17), low water availability during the dry season and no irrigation system. The economic status of households in Tra Tap commune are correspondingly lower than in other communes in the buffer zone: Tra My District Department of Labour, War Invalids and Social Affairs classifies 91% of households in Tra Tap commune as either poor or hungry, compared with 44% in the five buffer zone communes in Tra My district combined (Table 20).

Table 20: Economic Status of Households in the Buffer Zone Communes

Commune	Number of Households				Percentage of H'holds Poor or Hungry	Mean per Capita Income (VND)
	Total	Medium	Poor	Hungry		
Tra Linh	300	130	125	45	57	753,000
Tra Cang	473	386	63	24	18	554,000
Tra Tap	261	23	180	58	91	867,000
Tra Do'n	454	317	102	35	30	825,000
Tra Leng	267	125	71	71	53	946,000
Total	1,755	981	541	233	44	762,000

Follows classification of Ministry of Labour, War Invalids and Social Affairs: poor households have less than 15 kg of rice equivalent per person per month; hungry households have less than 13 kg of rice equivalent per person per month. Data on mean per capita income from CERUPAD. This table does not include data for Phuoc Thanh commune

Wealth Ranking. During the RRA, local people classified households into three categories based upon the following criteria:

(a) Hungry Households. Hungry households have a small amount of agricultural land, areas of which may have low fertility or be far from their house. These households farm little or no wet rice. These households usually have a high ratio of dependents to labourers, and no capital to invest in agricultural technologies, such as chemical fertilizer or high-yielding varieties of seed. In general, they depend upon traditional agricultural techniques. Except for agriculture, these households have no other source of income.

(b) Poor Households. Poor households have sufficient agricultural land to meet their food requirements, and have a lower ratio of dependents to labourers. Beside agriculture, they may derive additional income from animal husbandry or forestry activities that can help them to overcome times of food shortage.

(c) Medium Households. Medium households have a large amount of agricultural land and a good supply of labour. Most importantly of all, they have wet rice land with fertile soil. This land is located close to their homes, which makes it convenient to look after and irrigate, therefore yields are high and stable. As a result, these households have enough rice for the whole year and do not depend upon other crops. Furthermore, these households derive additional income from animal husbandry, *Cinnamomum cassia* cultivation, salaried employment, and the sale of surplus rice and forest products.

The results of the RRA indicate that all households have economic incentives to exploit natural resources, either for household use or for sale. These incentives are greatest for "poor" and "hungry" households, who need to compensate for shortfalls in agricultural production. However, these households have less labour available to exploit natural resources than "medium" households. Hence, there is little correlation between economic status and natural resource use: "poor" and "hungry" households set similar numbers of traps, collect similar amounts of firewood and other NTFPs, and extract similar amounts of timber as "medium" households do.

Other Activities in the Buffer Zone Communes

Despite being prohibited by Quang Nam Provincial People's Committee, gold prospecting is currently taking place in the north of Tra Leng commune, near the border with Tra Bui commune, and in the west of Tra Leng commune, near village number 2; both areas are outside of the proposed nature reserve. Tra My District People's Committee permits surveying for gold but not extraction, however, gold is being extracted illegally. The use of chemicals, including cyanide, to extract gold was reported, which can have significant negative impacts on aquatic ecosystems and human health. As most gold prospectors reportedly come from communes outside of the buffer zone, halting this activity would have few negative impacts on the inhabitants of the buffer zone communes.

4. Institutional Capacity

4.1 Assessment of Quang Nam Provincial Forest Protection Department

Responsibilities. The responsibilities of Quang Nam Provincial Forest Protection Department (FPD) are to manage and protect all Production, Protection and Special-use Forests in Quang Nam province. Approximately 200,000 ha of Quang Nam province has been designated as Special-use Forest by the provincial FPD, although only three small areas have yet been decreed by the government. These areas are Cu Lao Cham Nature Reserve (1,535 ha), Ngu Hanh Son Cultural and Historical Site (400 ha) and Nui Thanh Cultural and Historical Site (1,500 ha). However, whilst these three areas were included on Government Decree 194/CT dated 9 August 1986 (Cao Van Sung 1995), they have not been established as protected areas. These areas are currently managed at the district level, not by the provincial FPD.

Capacity. The provincial FPD has 296 staff, as well as 152 local people who are employed at the commune level as forest guards. When Ngoc Linh (Quang Nam) Nature Reserve is established, existing staff will be transferred to the management board and nature reserve staff. Therefore, it will not be necessary to recruit new staff for the nature reserve.

Needs Assessment. The major limitation faced by the provincial FPD is lack of funds to establish and manage Ngoc Linh (Quang Nam) Nature Reserve. Unless funds are made available by the Ministry of Agriculture and Rural Development (MARD) or an external donor, it will not be possible to successfully establish the nature reserve.

A second limitation is the lack of experience in protected area establishment and management among FPD staff. It would be desirable, therefore, to recruit a number of staff with experience in protected area management elsewhere in Vietnam for key management positions in the nature reserve. Alternatively, the nature reserve directorate and key personnel at the provincial FPD should receive training in protected area management.

Attitude. The stated first priority of Quang Nam Provincial FPD is to establish Song Thanh-Dakpring Nature Reserve, an area of 98,300 ha in Hien, Giang and Phuoc Son districts. The stated second priority of the provincial FPD is to establish a 70,000 ha protected area along the A Vuong River in northern Hien district, as part of the "Green Corridor" project (Map 1). Ngoc Linh (Quang Nam) Nature Reserve was said to be of lower priority for establishment than these other two areas. The reasons for this may include that the provincial FPD believe that it will be easier to attract international funding for Song Thanh-Dakpring and the A Vuong River, and that they do not think the provincial people's committee will be able to provide the funds necessary to prepare an investment plan.

However, at a workshop held to discuss the contents of this feasibility study, representatives of the provincial FPD stated that they were keen to establish Ngoc Linh (Quang Nam) Nature Reserve during 2000. Furthermore, they agreed to increase forest protection measures in the area and to inform local people about the forthcoming establishment of the nature reserve.

4.2 Assessment of Tra My District Forest Protection Department

Responsibilities. The main responsibilities of Tra My District FPD are to protect and manage forest in Tra My district and to assist local people in conducting reforestation. There are 72,335 ha of natural forest in Tra My district, 19,252 ha of which are classified as rich forest. There is currently no Special-use Forest in the district. In the past, the district FPD managed the allocation of forest land in Tra Mai commune to individual households on one-year protection contracts. However, this activity was discontinued in 1998 due to the cessation of funding.

Capacity. The district FPD has 29 staff. In addition to the headquarters at Tra My town, there are two guard stations: one at Nuoc Xa village in Tra Do'n commune and one in Tra Duong commune. Nuoc Xa guard station will have a very important role in the control of timber extraction once the road between Tra My town and Tac Po village is upgraded. In 1995, the district FPD planned to build a guard station in Tac Po village but this did not go ahead because of lack of funds and a perceived low level of forest protection problems in this area.

The district FPD holds an annual training course for commune leaders on biodiversity conservation. This

activity could be incorporated into the education and awareness programme that will be initiated following the establishment of the nature reserve.

Needs Assessment. The district FPD directorate identified shortages of staff and equipment as major limitations on their work. In order to protect and manage the nature reserve, it will be necessary to invest in equipment, particularly vehicles and communications equipment, and to construct additional guard stations.

Attitude. Ostensibly, the district FPD would like Ngoc Linh (Quang Nam) Nature Reserve to be established as soon as possible: the directorate mentioned socio-economic development in the buffer zone and increased funding for forest protection as potential advantages of the nature reserve. However, they do not have a clear understanding of the implications of establishing the nature reserve and do not, therefore, have strong opinions about the matter.

Many district FPD staff are unhappy to work in remote areas, such as Nuoc Xa guard station. As the guard stations and, possibly, the headquarters of the nature reserve would be in remote locations, this might result in low morale among nature reserve staff.

4.3 Assessment of Other Stakeholders

Quang Nam Provincial People's Committee

Quang Nam Provincial People's Committee supports the establishment of Ngoc Linh (Quang Nam) Nature Reserve and endorses the contents of this feasibility study. The high biodiversity and watershed-protection values of the area were given as the principal reasons for this attitude. At a workshop held to discuss the contents of this feasibility study, it was clear that the catastrophic flooding that affected Quang Nam province in November and December 1999 had increased awareness of the importance of forest protection.

During 1999, Hoi An Ancient Town and My Son Sanctuary were inscribed as World Heritage Sites by the UNESCO World Heritage Committee. Both these sites lie along the Thu Bon River, downstream of Ngoc Linh (Quang Nam). Quang Nam Provincial People's Committee recognises that the establishment of Ngoc Linh (Quang Nam) Nature Reserve would play an important role in protecting the watershed of the Thu Bon River and, thereby, help the province to fulfil its international obligations to safeguard the integrity of these sites as laid out in Article 6 of the World Heritage Convention. Furthermore, the provincial people's committee requested that the investment plan for Ngoc Linh (Quang Nam) Nature Reserve evaluate the importance of the nature reserve in the context of the two World Heritage Sites. In the future, it may be possible to inscribe Ngoc Linh (Quang Nam) Nature Reserve as a World Heritage Site, and thus extend this status to the full biological, historical and ethnological diversity of the Thu Bon River watershed.

Tra My Forest Enterprise

Tra My Forest Enterprise is the only forest enterprise in Tra My district. The forest enterprise manages 35,669 ha of forest in Tra Bui, Tra Giac and Tra Leng communes (Map 4). In Tra Leng commune, the forest enterprise only manages three forest compartments in the north-east of the commune, totalling 4,165 ha. These compartments are outside of the proposed nature reserve, although inside the buffer zone. Therefore, there will be no conflict of interests between the forest enterprise and the nature reserve. Indeed, in the future, the management objectives of the forest enterprise can be revised to include social forestry activities in the buffer zone.

Tra My Forest Enterprise has 150 staff. The main activities of the forest enterprise are commercial timber extraction, forest protection, and reforestation. In 1999, the forest enterprise plans to exploit 3,800 ha of natural forest, extracting 900 m^3 of timber. This is only 25% of the total amount of timber extracted in 1998, since the focus of the forest enterprise's activities is shifting from exploitation of natural forest to reforestation. The forest enterprise plans to halt exploitation of natural forest by the year 2000. The forest enterprise manages 1,408 ha of plantation forest, none of which is located in the buffer zone. Trees used for plantation include *Dipterocarpus*, *Heritiera* and *Cinnamomum*. The forest enterprise started planting *Cinnamomum* in 1975; this tree can be harvested after 12 to 15 years.

Tra My Forest Enterprise has allocated 4,894 ha of forest land to individual households on one-year forest protection contracts, for which the households receive VND 40,000 to 50,000 per ha per year. Additionally, the forest enterprise allocates land on a longer-term basis. Plans for 1999 call for forest land to be allocated to 30 households for forestry purposes. These households will receive VND 300,000 per ha per year for

assisted natural regeneration, or VND 1.7 million per ha per year for replantation. Less forest land will be allocated during the year 2000 due to a reduction in available funds.

There are 530 households in the area managed by Tra My Forest Enterprise. In addition to social forestry activities, the forest enterprise has built wells, roads and irrigation systems for these households, as well as allocating 2,000 ha for forest gardens. With its large number of staff, the forest enterprise has experience in implementing rural development projects. Potentially, therefore, the forest enterprise could have a large role in implementing the buffer zone development programme for Ngoc Linh (Quang Nam) Nature Reserve.

Tra My District Department of Agriculture and Rural Development.

Tra My District Department of Agriculture and Rural Development (DARD) is responsible for raising socio-economic levels in the district by promoting new agricultural and forestry technologies. The district DARD mainly works through the leaders of the 21 communes in Tra My district to introduce new ideas to local people.

Tra My District DARD has eight staff: a director and vice-director, an accountant and cashier, and four extension workers. One extension worker provides advice in irrigation, one in animal husbandry, and two in forestry. The shortage of staff is acute in a district of 47,378 people, and this was identified as a major problem by the vice-director. Another constraint on the district DARD is a shortage of vehicles and equipment.

The district DARD supports the establishment of Ngoc Linh (Quang Nam) Nature Reserve because they expect that it will bring investment in the socio-economic development of communities around the nature reserve. Following the establishment of the nature reserve, the district DARD will have a major role in co-ordinating and implementing development projects in the buffer zone. However, in order to successfully fulfil this role, the institutional capacity of the district DARD will need to be strengthened via the recruitment and training of staff, and investment in vehicles and equipment.

The Rural Infrastructure Development Unit

The United Nations Development Programme (UNDP), the United Nations Capital Development Fund (UNCDF), Quang Nam Provincial People's Committee and the Australian Agency for International Development (AusAID) are currently providing assistance for a rural infrastructure development project in Tra My district. This project is managed by the Rural Infrastructure Development Unit (RIDU), the main office of which is located in Da Nang city. Capital for the US$1.7 million infrastructure-development project is predominantly from the government of Australia but with some funds from UNCDF and Quang Nam Provincial People's Committee.

The RIDU project will provide US$50,000 of commune-level assistance to each of 14 participating communes. The form this assistance will take is decided by a participatory process, and may include schemes such as schools, bridges, health care, irrigation or clean water. Additionally, the RIDU project will invest in several district-level schemes, namely improvements to footpaths and roads, and construction of suspension bridges, including two bridges across the Tranh River, linking Tra Tap and Tra Do'n communes to the road between Tak Po village and Tra My town.

Tra Do'n and Tra Leng communes are both included in the RIDU project. However, Tra Linh, Tra Cang and Tra Tap communes, along with three other communes in the south of Tra My district are not included. These communes will, instead, be included in the 1,715 Poorest Communes Programme. In 1999, the government of Vietnam intends to allocate an average of VND 410 million (US$29,000) to 1,000 of these communes for improvements to basic infrastructure.

5. Evaluation

5.1 Evaluation Criteria

In order to evaluate the overall importance of a site, it is useful to compare the site against a set of criteria for assessing a protected area's conservation value (Table 21). Ngoc Linh (Quang Nam) proposed nature reserve satisfies all of these criteria and can, therefore, be considered to have high conservation value.

Table 21: Conservation Evaluation of Ngoc Linh (Quang Nam) Proposed Nature Reserve

Conservation Criteria	Site Evaluation
Size: The area must be of a size and form sufficient to support ecological units or viable populations of flora and fauna. As a rule, conservation importance increases with protected-area size.	The proposed nature reserve covers 18,430 ha. It forms part of a larger conservation area including Ngoc Linh (Kon Tum) Nature Reserve (41,420 ha) and Song Thanh-Dakpring proposed nature reserve (98,300 ha).
Richness And Diversity: Usually linked with the diversity of habitat types; ecological gradients or ecotones should be represented because they support transitional communities.	The area contains three major natural habitat types. An altitudinal gradient exists across these habitat types between 150 and 2,598 m.
Naturalness: Assessment of the extent of primary habitats.	Primary forest (rich, medium and poor forest) covers 13,377 ha or 73% of the proposed nature reserve.
Rarity: The primary purpose of many protected areas is to protect rare and endangered species and habitats. Rarity may be a result of special habitat requirements, direct human pressure, or indirect human influences.	The area contains 16 plant, seven mammal and three bird species listed as globally threatened (IUCN 1996 and 1997). The area contains four restricted-range bird species.
Uniqueness: Areas which exhibit particular natural processes or which are poorly represented in the national protection system.	The area contains several plant species endemic to Vietnam, as well as a bird species, Golden-winged Laughingthrush, that is only known globally from high-altitude forest on Mount Ngoc Linh.
Typicalness: It is important to represent typical areas of common habitats and typical communities of a biome.	The proposed nature reserve contains large areas of undisturbed montane habitats characteristic of the Kon Tum Plateau EBA.
Fragility: A measure of an area's susceptibility to change through either natural or man-made processes.	Montane habitats are sensitive to disturbance and slow to recover.
Position as an Ecological Unit: To establish the area's position in an ecological unit, it is important to determine how or whether an area is linked to other areas of natural or semi-natural habitats.	The area is contiguous with montane habitats at Ngoc Linh (Kon Tum) Nature Reserve and habitats at lower altitude in Song Thanh-Dakpring proposed nature reserve; and is linked to forest areas in Laos.
Economic Value: An area may protect a valuable water catchment or a higher level of biogeographic subdivision.	The area protects the water catchment of the Tranh River, one of the major systems in Quang Nam province.
Conservation Opportunity: Socio-political climate is highly determinate in the success of any conservation area's future objectives and priorities.	There are currently no established protected areas in Quang Nam province. Commitment among local institutions varies from strong to weak.

5.2 Biodiversity Evaluation

Habitat Types

Ngoc Linh (Quang Nam) proposed nature reserve is a representative example of the natural vegetation of the Western Highlands, containing a full altitudinal range of habitat types in an undisturbed condition. A continuum of natural forest exists between 150 and 2,598 m. An altitudinal gradient of this extent is unique within Vietnam as, typically, forest at low elevations in other montane protected areas has been cleared for agriculture (e.g. Eames and Nguyen Cu 1994, Tordoff *et al.* 1999).

Different data give figures for forest cover ranging from 76 to 80% of the proposed nature reserve. Satellite

Satellite data indicate that a large proportion of this forest is relatively undisturbed, with disturbance limited to easily accessible areas in Tra Cang and Tra Tap communes and a large area around village number 4, Tra Leng commune and village number 5, Tra Do'n commune. Furthermore, the level of disturbance appears to decrease with increasing altitude, reflecting the greater accessibility of forest at low elevations: 38% of natural forest below 1,000 m is classified as poor or regenerating forest, compared with only 24% above 1,000 m. Therefore, forest at low elevations can be considered to be under the greatest pressure and should, thus, be made a priority for conservation in order to preserve the unique continuum of forest types within the proposed nature reserve.

Forest types represented in the proposed nature reserve include high montane broadleaf evergreen forest, medium montane broadleaf evergreen forest and low montane broadleaf evergreen forest. Of these, high montane broadleaf evergreen forest is of the highest conservation importance, because it is a rare habitat type in Vietnam and the only known habitat of Golden-winged Laughingthrush. Ngoc Linh (Quang Nam) proposed nature reserve contains 2,377 ha of natural forest above 2,000 m, including 1,561 ha classified as medium forest and therefore considered to be undisturbed primary forest.

Globally Threatened and Endemic Species

A total of 26 globally threatened species were recorded during the field survey, comprising 16 plant, seven mammal and three bird species. No globally threatened reptiles or amphibians were recorded. Of the 26 globally threatened species recorded, four are listed as Endangered in the IUCN Red Lists of Threatened Plants and Animals (IUCN 1996 and 1997): *Pinus dalatensis*, *Panax vietnamensis*, Douc Langur and Tiger.

Panax vietnamensis is known world-wide from only one other site apart from Mount Ngoc Linh: Mount Lang Bian in Bi Dup-Nui Ba Nature Reserve, Lam Dong province (Anon. 1996). Within Ngoc Linh (Quang Nam) proposed nature reserve, it is distributed mainly above 1,700 m, and only in Tra Linh commune. Habitat loss is a potential threat to this valuable medicinal plant, as forest has already been cleared at elevations up to 1,800 m in this commune. The greatest threat is currently over-exploitation, which has already lead to a significant decline in the abundance of this species. However, the cultivation of this species taking place at two medicinal plant nurseries in Tra Linh commune, may mitigate this problem, and should be encouraged as part of the nature reserve management plan.

Biodiversity Comparison with other Protected Areas in Vietnam

Overall Levels of Biodiversity. Recorded levels of biodiversity at Ngoc Linh (Quang Nam) proposed nature reserve are lower than at other montane protected areas in Vietnam[3] (Table 22). Due to wide variation in survey effort among sites, it is impossible to make meaningful comparisons of overall biodiversity. However, Ngoc Linh (Quang Nam) supports as wide a range of habitat types as at other montane protected areas in Vietnam, suggesting that underlying levels of biodiversity at the proposed nature reserve are at least as high as at other montane sites.

Table 22: Biodiversity Comparison of Ngoc Linh (Quang Nam) Proposed Nature Reserve with other Montane Protected Areas in Vietnam

Protected Area	Maximum Altitude (m)	Plant Species	Mammal Species	Bird Species	Restricted-range Bird Species
Ngoc Linh (Quang Nam)	2,598	385	51	171	4
Hoang Lien	3,143	2,024	66	347	4
Vu Quang	2,286	414	95	254	3
Ngoc Linh (Kon Tum)	2,598	878	52	190	7
Chu Yang Sin	2,442	694	49	203	6
Bi Dup-Nui Ba	2,287	827	93	202	9

Differences among sites in this table reflect differences in survey effort among sites, not differences in overall biodiversity

In Table 23, the mammal and bird faunas of Ngoc Linh (Quang Nam) proposed nature reserve are compared with those of other sites in the Bolovans-Kon Tum Montane Forests Ecoregion (Map 1). Ngoc Linh (Quang Nam) is comparable to other sites in terms of total number of mammal species recorded; although meaningful comparisons are made difficult by variation in survey effort between sites. Greater numbers of globally threatened mammal species have been recorded at Mom Ray Nature Reserve and Song Thanh-Dakpring proposed nature reserve than at Ngoc Linh (Quang Nam). This may be due to several factors: these sites are much bigger and support areas of forest large enough to support populations of large

[3] Montane protected areas are here defined as protected areas containing forest above 2,200 m.

mammals; these sites support extensive areas of forest at lower elevations, which is the preferred habitat type of many large mammals; there are lower human population densities in and around these sites; and these sites are contiguous with forest areas in Laos and Cambodia. However, the species lists for Mom Ray and Song Thanh-Dakpring include species *expected* to occur there on the basis of their known distributions and may, therefore, overestimate the number of globally threatened mammals at these sites (Do Tuoc and Ngo Tu 1995, Wikramanayake *et al.* 1997b).

Table 23: Comparison of the Mammal and Bird Faunas of Sites in the Bolovans-Kon Tum Montane Forests Ecoregion

Site	Area (ha)	Mammal Species	Threatened Mammals	Bird Species	Threatened Birds
Ngoc Linh (Quang Nam)	18,430	51	7	171	3
Bach Ma	22,031	55	13	231	6
Song Thanh-Dakpring	98,300	59	13	176	2
Ngoc Linh (Kon Tum)	41,420	52	8	190	5
Mom Ray	48,600	76	16	208	3
Kon Cha Rang	16,000	61	7	169	6
Kon Ka Kinh	41,710	42	7	160	4

The total number of bird species at Ngoc Linh (Quang Nam) is comparable to other sites in the Bolovans-Kon Tum Montane Forests Ecoregion. Only at Bach Ma, Mom Ray and Ngoc Linh (Kon Tum) Nature Reserves have significantly greater numbers of bird species been recorded. Once again, this can be attributed to variations in survey effort: there has been more than one bird survey at each of these three sites.

Restricted-range Bird Species. Table 24 shows the distribution of restricted-range bird species between sites in the Bolovans-Kon Tum Montane Forests Ecoregion. Mom Ray and Song Thanh-Dakpring support significantly fewer restricted-range species than the other sites. These two sites, which mainly support forest at lower elevations, would be expected to support fewer restricted-range species, many of which are restricted to higher elevations, such as Yellow-billed Nuthatch and Black-hooded Laughingthrush.

Table 24: Distribution of Range-restricted Bird Species between Sites in the Bolovans-Kon Tum Montane Forests Ecoregion

Restricted-range Species	Ngoc Linh (QN)	Bach Ma	Song Thanh-Dakpring	Ngoc Linh (KT)	Mom Ray	Kon Cha Rang	Kon Ka Kinh
Annam Partridge		*					
[Edwards's Pheasant]		*					
[Germain's Peacock Pheasant]					*		
Crested Argus	*	*	*	*		*	
Yellow-billed Nuthatch	*			*			*
White-cheeked Laughingthrush				*	*	*	*
Black-hooded Laughingthrush	*			*		*	*
Golden-winged Laughingthrush	*			*			
Short-tailed Scimitar Babbler		*		*		*	*
Grey-faced Tit Babbler		*				*	*
Black-crowned Barwing				*			
Total	4	5	1	7	2	5	5

Species in brackets are unconfirmed records

The third site in the Bolovans-Kon Tum Montane Forests Ecoregion to support mainly forest at lower altitudes is Bach Ma National Park. However, this is the only site in the ecoregion to be included in the Annamese Lowlands Endemic Bird Area (EBA), and this site supports several restricted-range species that are distributed at low elevations, such as Annam Partridge *Arborophila merlini*, Edwards's Pheasant *Lophura edwardsi* and Grey-faced Tit-babbler *Macronous kelleyi*. The composition of restricted-range species at Bach Ma is quite different than at other sites in the ecoregion: of the five restricted-range species found at Bach Ma, two are not found at any other site. In fact, Bach Ma National Park clearly does not belong in the Bolovans-Kon Tum Montane Forests Ecoregion but should be placed wholly within the Northern Vietnam Coastal Moist Forests Ecoregion; the boundaries of these ecoregions require redefining in this area.

Three of the restricted-range species recorded at Ngoc Linh (Quang Nam) proposed nature reserve are found in other EBAs and secondary EBAs in Vietnam and Laos. However, one species, Golden-winged Laughingthrush, is restricted to the Kon Tum Plateau EBA, and known globally only from Ngoc Linh (Quang Nam) and Ngoc Linh (Kon Tum). Therefore, Ngoc Linh (Quang Nam) qualifies for inclusion in the Kon Tum Plateau EBA.

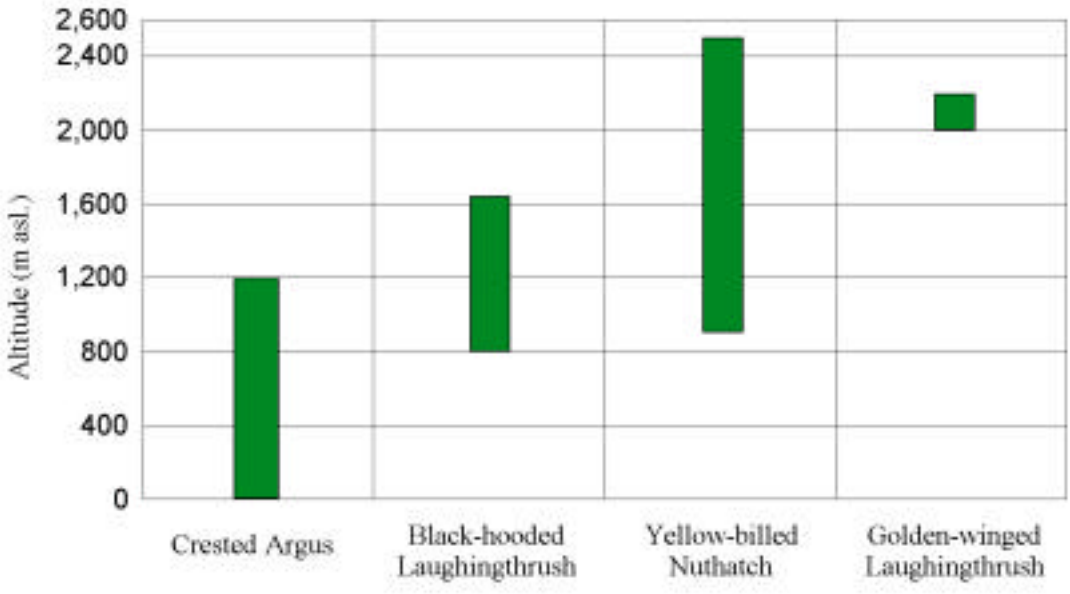


Figure 5: Altitude Ranges of Restricted-range Bird Species at Ngoc Linh (Quang Nam)

Figure 5 shows the altitudinal ranges of the four restricted-range bird species found at Ngoc Linh (Quang Nam) proposed nature reserve (Robson 2000). It is clear from this figure that, in order to protect all restricted-range species at Ngoc Linh (Quang Nam), it is necessary to preserve areas of suitable habitat at all elevations. Protecting the full range of habitats necessary for these species will also ensure that the full range of biodiversity at Ngoc Linh (Quang Nam) is adequately protected.

5.3 Socio-economic Evaluation

"Experience world-wide demonstrates that protected area management which fails to take appropriate account of the fundamental needs of people resident within and around the protected area is certain to fail" (Davey 1998).

Human Habitation within the Nature Reserve

Only two villages will be located within the nature reserve boundary: village number 5, Tra Do'n commune and village number 4, Tra Leng commune (Map 4). Very few people live in these villages: village number 5, Tra Do'n commune has only 45 inhabitants in two hamlets; and village number 4, Tra Leng commune, for which data could not be collected, was reported to have a similar number of inhabitants. Both rapid rural appraisal (RRA) and satellite data indicate that the impact of these people on surrounding forest areas is limited (Map 6). For instance, the inhabitants of village number 5, Tra Do'n commune farm wet rice and grow cinnamon, and, therefore, have no need for a large area of agricultural land. In 1997, 29 people moved from this village to Nuoc Xa village, although the remaining villagers stated that they had no intention of leaving.

Provided that the population of these villages does not increase dramatically, and that the villagers continue their current agricultural practices and do not clear land for hill agriculture, these people will not pose a big threat to biodiversity. Indeed, they may make a positive contribution to conservation, if they can be involved in social forestry activities to promote forest protection and natural regeneration.

Hunting

RRA data indicate that populations of most commonly hunted wildlife species have declined over the past 10 years. Given that there appears to have been little decrease in habitat quality or extent over the last 25 years (Map 6), these population declines may be attributed to hunting pressure. Indeed, the results of the field survey strongly suggest that hunting pressure, not habitat loss, is currently the biggest threat to the survival of animal populations at Ngoc Linh (Quang Nam), particularly large mammals, such as Sambar *Cervus unicolor* and Tiger, and endemic species such as Truong Son Muntjac and Douc Langur.

Non-timber Forest Product Collection

Collection of many non-timber forest products (NTFPs) appears to be occurring at unsustainable levels, as RRA data indicates that the abundances of all products collected commercially have declined significantly over the last 10 years, particularly in the case of rattans (Table 19). Unsustainable exploitation of plant species can lead to their local extinction or, at minimum, to their loss as an economic resource for local people. Hence, there exists an incentive to local people to change their patterns of natural resource use.

After the establishment of Ngoc Linh (Quang Nam) Nature Reserve, collection of NTFPs in the strict protection area should be prohibited. However, there are significant forest areas outside of the nature reserve where local people will be able to continue to collect NTFPs. Thus, the impact of establishing the nature reserve on most local communities, with regard to access to natural resources, will be mitigated. However, it is important that NTFP collection in forest areas outside of the nature reserve occurs sustainably, otherwise, as abundances of NTFPs decline, the incentive to collect them from forest areas in the nature reserve will increase. To this end, projects such as the medicinal plant centres in Tra Linh commune should be initiated to increase the supply of economically important NTFPs or provide alternatives. Also, enhancement-planting of certain species, such as rattans and bamboo, would be another way to promote sustainable use of NTFPs.

Timber Extraction

Ngoc Linh (Quang Nam) Nature Reserve will contain a high proportion (38%) of rich forest, and data from forest plots indicates that timber volume in certain areas is as high as 460 m^3/ha. Therefore, the potential for timber exploitation in the area is high. However, the demand for timber in Tra My district is currently being met by the activities of Tra My Forest Enterprise. Forest managed by this forest enterprise is at lower elevations and more accessible than forest in the nature reserve, and, therefore, is more suitable for commercial exploitation. All indications are that Tra My Forest Enterprise is exploiting the forest under its management in a sustainable manner, and that there will be no pressure to exploit the forest in the nature reserve commercially in the short or medium term.

The second potential threat is small-scale timber extraction, which could become a particular problem at low elevations where timber extraction is easier. Timber extraction for household use currently has a low impact on forest at Ngoc Linh (Quang Nam) because bamboo and thatch are the principal building materials used by local people, with wood only being used for house frames. Similarly, illegal extraction of timber for sale is currently taking place at low levels. The reasons for this include poor communications between villages in the buffer zone and the district towns making the extraction of timber difficult, and the operations of Tra My, Phuoc Hiep and Phuoc Son Forest Enterprises meeting the demand for timber in Tra My and Phuoc Son districts. However, with the upgrading of the road between Tac Po village and Tra My town, illegal exploitation of the forest in the nature reserve may become more economically viable. Indeed, there are reports of a plan to open a sawmill in Nuoc Xa village, adjacent to the boundary of the nature reserve to the north-east (C. Daly *in litt.*). For these reasons, the nature reserve headquarters at Nuoc Xa village will have a vital role in controlling the illegal extraction of timber from the southern part of the nature reserve.

Clearance of Land for Agriculture

Hill agriculture is the dominant agricultural system in the buffer zone: in any one year, over 1,000 ha of land are cultivated for hill rice, cassava, maize or sweet potato (Table 13), with a much larger area lying fallow. Throughout the buffer zone, hill rice is cultivated by rotational swidden agriculture. The idea that swidden agriculture is responsible for forest clearance is widespread amongst policy-makers (Brookfield 1988); however, this is not always the case.

The RRA results reveal that most land cleared for swidden fields is fallow land covered by scrub or secondary forest; primary forest is rarely, if ever, cleared. Furthermore, satellite data reveal that rates of forest loss are negligible: in the period between January 1989 and February 1998, 370 ha of forest within

the boundary of the proposed nature reserve were lost, representing only 2% of the total area of the proposed nature reserve (Map 6). This strongly suggests that rotational swidden agriculture is having few negative environmental impacts and is not resulting in a significant loss of forest cover. It should be recognised that rotational swidden agriculture can be a sustainable agricultural system, provided that sufficient land is available and population levels remain relatively stable. Therefore, it is undesirable to promote changes to traditional agricultural practises in the buffer zone.

More important threats come from immigration into the buffer zone, natural population growth, and conversion of agricultural land to forest land. These process can result in a shortening of the fallow cycle, leading to a decline in soil fertility and a need to clear more land for agriculture. As Rambo (1995) notes, "increase in population density is the biggest single factor in undermining the sustainability of swidden agricultural systems". The threat of forest clearance might, therefore, be addressed through: prevention of settlement in the buffer zone, particularly that associated with the development of the new economic zone at Tac Po village; improved access to family planning; recognition of land tenure rights for hill agricultural land; and ensuring that fallow agricultural land is not classified as forest land.

Forest Fire

Whilst fire is often used by local people to clear hill fields prior to planting, this does not represent a significant threat to biodiversity. The north-eastern side of the Kon Tum Plateau, in Quang Nam province, experiences a humid, tropical climate, with high total annual rainfall and a prolonged wet season. This, coupled with relatively low levels of disturbance, means that the forest in Tra My district has a high resistance to accidental fire.

Population Growth

Whilst not a direct threat to biodiversity in itself, population growth can lead to increased demand for forest resources, including timber, animal products and NTFPs, and, most significantly, clearance of forest for agriculture. Data from the Centre for Rural and Urban Planning and Development (CERUPAD) reveal that population growth rates in the buffer zone are high, although these vary significantly between communes. Anecdotal evidence suggests that natural growth is currently the largest cause of population growth, whereas rates of immigration to the buffer zone communes are currently low.

High death rates were identified as a major constraint on natural population growth. Given the high birth rates and low participation in the national family planning programme in the buffer zone, a decline in the death rate, perhaps due to a malaria eradication programme or the provision of clean water supplies, would result in a significant increase in the rate of population growth. Therefore, natural population growth has the potential to be a bigger problem in the future.

Probably the greatest potential threat to biodiversity at Ngoc Linh (Quang Nam) Nature Reserve is population growth due to immigration, particularly that related to the new economic zone at Tac Po village. Although the new economic zone may promote economic development in the buffer zone, it may also have negative impacts on the nature reserve if it encourages migrants from other areas to settle in the south of Tra My district. As Gilmour and Nguyen Van San (1999) observe, "continuing migration (government sponsored and voluntary) into the economic zones surrounding protected areas will negate the effects of initiatives designed to integrate conservation and development activities in the buffer zones". Problems arising from settlement in the buffer zone would be intensified because Tra Linh, Tra Cang, Tra Tap and Tra Do'n communes, which would be most affected by any immigration, are already the most densely populated in the buffer zone (Map 4).

Relative Levels of Impact

Due to constraints on the socio-economic survey, it was not possible to investigate variation in use of forest resources between villages, with respect to ethnicity or distance from the forest. Within villages, however, RRA data indicate that use of forest resources does not vary between households with respect to household wealth. Therefore, it can be inferred that there is little variation in use of forest resource between villages or communes with respect to the proportion of poor and hungry households. Factors with a greater influence on the level of impact on Ngoc Linh (Quang Nam) proposed nature reserve by the inhabitants of a particular village or commune are population density and the number of people per square kilometre of natural forest (Table 25).

Table 25: Estimated Relative Level of Impact on the Nature Reserve

Commune	Population Density (people/km^2)	Number of People per km^2 of Natural Forest	Relative Level of Impact on Nature Reserve
Tra Linh	33	78	High
Tra Cang	24	109	High
Tra Tap	22	39	Medium
Tra Do'n	22	40	Medium
Tra Leng	12	17	Low
Phuoc Thanh	9	15	Very Low

The estimated relative level of impact on the nature reserve of the inhabitants of each buffer zone commune is given in Table 25. Population densities are highest in the communes in the south of the buffer zone, therefore the current and future pressure to clear forest for agriculture is likely to be highest in these communes. This is already evident in Tra Linh and Tra Cang communes, where forest has been cleared at altitudes as high as 1,800 and 1,500 m respectively. Additionally, because Tra Linh and Tra Cang communes support relatively small areas of natural forest, the number of people per square kilometre of natural forest is far greater than in the other communes in the buffer zone. This effect is compounded by the fact that much of the remaining forest in these communes is at high elevations and relatively inaccessible. Therefore, the impact of local people on forest resources can be considered to be higher in these two communes than elsewhere in the buffer zone.

Conversely, the inhabitants of Tra Leng and Phuoc Thanh communes can be considered to have a relatively low impact on the nature reserve. Population densities are much lower in these communes, as are the numbers of people per square kilometre of natural forest. Furthermore, both these communes contain large areas of forest outside of the nature reserve. Indeed, it is unlikely that forest in the nature reserve is a source of forest products for anything other than a small proportion of households in Phuoc Thanh commune.

Therefore, the inhabitants of Tra Linh and Tra Cang communes can be expected to have the highest level of impact on the nature reserve; the inhabitants of Tra Tap and Tra Do'n communes can be expected to have a medium level of impact; the inhabitants of Tra Leng communes can be expected to have a low level of impact; whilst the inhabitants of Phuoc Thanh communes can be expected to have a very low level of impact. Hence, the efforts of the conservation and protection, and buffer zone development programmes should be targeted accordingly.

5.4 Institutional Evaluation

Overall, the institutional capacity of the key stakeholders who will be involved in the establishment and management of Ngoc Linh (Quang Nam) Nature Reserve is mixed. On the positive side, there are sufficient forest protection department (FPD) personnel in Quang Nam province to staff the nature reserve without new personnel needing to be recruited. Although it will, perhaps, be necessary to recruit a number of local people as commune-level forest guards. On the negative side, there are serious gaps in capacity amongst FPD staff, particularly a lack of experience in protected area management. However, this problem can be addressed by a programme of staff training and by recruiting key personnel with experience in protected area management from elsewhere in Vietnam.

Tra My District DARD lacks the staff and equipment necessary to implement an integrated programme of conservation and development in the buffer zone. Hence, investment in personnel, staff training and equipment is necessary in order for this department to fulfil its role. However, the capacity of Tra My Forest Enterprise to conduct social forestry and development activities is strong: the forest enterprise has both the necessary personnel and experience. There is no conflict between the forest enterprise and the nature reserve, and the possibility of actively involving the forest enterprise in the management of the nature reserve and, especially, in the implementation of the buffer zone development programme should be investigated.

Currently, there is no established protected area in Quang Nam province. The leaders of the provincial people's committee and FPD support the establishment of Ngoc Linh (Quang Nam) Nature Reserve because of the biodiversity and watershed-protection values of the area. However, there is a severe lack of resources, particularly financial ones, for protected area establishment in Quang Nam province. This problem is accentuated by the fact that there will be competition for resources between Song Thanh-Dakpring, the A Vuong River and Ngoc Linh (Quang Nam). Therefore, Ngoc Linh (Quang Nam) may have to rely heavily on the central government and international donors as sources of funding.

5.5 Qualitative Evaluation of Economic Benefits

Watershed Protection

The watershed protection value of the proposed nature reserve is immense as water availability is probably the single largest constraining factor on agricultural productivity. Forest cover regulates stream flow and, if forest cover is reduced, seasonality in stream flow increases, with increased peak flow volumes and increased periods of drought (Hamilton 1988). This will have negative repercussions, not only for communities living close to the nature reserve, but also for communities elsewhere in Quang Nam province that depend upon the Tranh River for irrigation and potable water.

High-altitude forest performs a particularly important hydrological function, because this forest can "capture" moisture by condensation from cloud cover (Hamilton 1988). This moisture, which is termed "occult" precipitation, contributes to the total yield of the watershed, and can account for over 20% of total precipitation in a tropical forest (Ekern 1964). Reduction in canopy cover and vertical structure in high-altitude forest decreases the capture of "occult" precipitation, which can lead to a decrease in total watershed yield (Zadroga 1981). This is particular problem during the dry season when "occult" precipitation can exceed the contribution made to stream flow by rainfall (Bruijnzeel 1986). Fortunately, of all the habitat types at Ngoc Linh (Quang Nam) proposed nature reserve, high montane broadleaf evergreen forest is the least threatened with clearance at the current time. However, particular conservation effort must be directed to protecting areas of this forest type in Tra Linh commune, where forest clearance for cultivation has occurred at elevations up to 1,800 m.

Another important hydrological function of forest is flood control (Sharma 1990). Loss of forest cover can lead to increases in the severity of flooding, due to increased rates of surface run-off. The two bouts of severe flooding that hit Quang Nam province in November and December 1999 highlight the need to maintain forest cover in the watersheds of the province's major rivers. This issue is now clearly recognised by Quang Nam Provincial People's Committee.

Non-timber Forest Products

Ngoc Linh (Quang Nam) proposed nature reserve contains a large number of plant and animal species with realised or potential economic value. Many of these species are currently exploited by local people for domestic use, and a smaller number are being exploited commercially. The economic importance of NTFPs to local people is high, especially as a source of income during times of food shortage. Although the exploitation of certain NTFPs is currently occurring at unsustainable levels, it may be possible to sustainably exploit them in the future, either through controls on harvesting or cultivation. A case in point is the valuable medicinal plant *Panax vietnamensis*: this species is now being cultivated in Tra Linh commune to meet the commercial demand for the product.

With correct management, the NTFP resources of the buffer zone can be sustainably harvested and continue to the meet the needs of the local communities. Furthermore, by maintaining the local communities' vested economic interest in the forest, their support for conservation can be more easily secured.

Tourism

Ecotourism. The ecotourism potential of the proposed nature reserve is currently limited due to poor road access and limited access to the forest, especially to high-altitude areas where many species of interest are found. Population sizes of large and medium-sized mammals are so low as to make observation of them in the wild almost impossible, and even bird species are difficult to observe. However, the area is of great scenic beauty, and efforts need to be made to investigate potential tourism opportunities complimentary to the World Heritage Sites at Hoi An and My Son.

Ethnotourism. The ethnotourism potential of Ngoc Linh (Quang Nam) proposed nature reserve is not as high as for other areas in Vietnam, notably Sa Pa, Bac Ha and Mai Chau, as the ethnic minority groups in the area retain fewer visible cultural features than those in other areas. This effect is intensified by the fact that those communities which have retained these features to the greatest degree tend to be the most remote and, consequently, least accessible to tourists.

5.6 Place in Vietnam's Protected Areas System

Table 26 compares the key features of Ngoc Linh (Quang Nam) proposed nature reserve with existing protected areas in Vietnam, and highlights those features that are currently under-represented within Vietnam's protected areas system.

Table 26: Inclusion of the Key Features of Ngoc Linh (Quang Nam) Proposed Nature Reserve within Decreed Protected Areas in Vietnam

Key Feature	Current Inclusion
Forest in the Bolovans-Kon Tum Montane Forests Ecoregion	Bach Ma; Ngoc Linh (Kon Tum); Kon Ka Kinh; Kon Cha Rang; Mom Ray
Forest in the Kon Tum Plateau EBA	Ngoc Linh (Kon Tum); Kon Ka Kinh; Kon Cha Rang
Forest above 2,200 m	Hoang Lien; Vu Quang; Ngoc Linh (Kon Tum); Chu Yang Sin; Bi Dup-Nui Ba
Forest continuum over an altitude range of 2,500 m	None
Panax vietnamensis	Ngoc Linh (Kon Tum); Bi Dup-Nui Ba
Golden-winged Laughingthrush	Ngoc Linh (Kon Tum)
Truong Son Muntjac	Ngoc Linh (Kon Tum); Kon Ka Kinh

The inclusion of Ngoc Linh (Quang Nam) in Vietnam's protected area system will have the following benefits: it will increase the protection coverage of the Bolovans-Kon Tum Montane Forests Ecoregion and the Kon Tum Plateau EBA; it will protect one of the few areas of forest habitat in Vietnam above 2,200 m; and it will increase the protection of a number of endemic species, including Golden-winged Laughingthrush, which is endemic to high-altitude forest on Mount Ngoc Linh and is currently only protected at Ngoc Linh (Kon Tum). A unique conservation feature of Ngoc Linh (Quang Nam) is that it contains a continuum of natural forest from 150 to 2,598 m: a continuum of natural habitat over an altitudinal range this great is found nowhere else in Vietnam. Continuums of this type are important for the conservation of forest-dependent species that migrate altitudinally (Guindon 1996).

In a recent review of the protected areas system of Vietnam, Wege *et al.* (1999) calculated that, in order for the Bolovans-Kon Tum Montane Forests Ecoregion to be equitably represented in Vietnam's protected areas system, a further 107,150 ha of forest should be included. They identified Quang Nam province as a priority for establishment of new protected areas as, currently, less than 10% of the natural forest in the province is decreed as Special-use Forest. Therefore, they recommended the establishment of Ngoc Linh (Quang Nam) Nature Reserve. Furthermore, they proposed that Ngoc Linh (Quang Nam), together with Song Thanh-Dakpring and Ngoc Linh (Kon Tum), should be recognised as one of 11 priority areas for the conservation of terrestrial forest in Vietnam. These three areas would benefit from being amalgamated into a single conservation management unit, most suitably a national park.

5.7 Economic Evaluation

Least-cost Alternative

If the economic costs associated with establishing and managing Ngoc Linh (Quang Nam) Nature Reserve are lower than for other sites of comparable conservation value, it should be given priority for establishment, in order to ensure the most efficient use of the limited funds available for conservation in Vietnam. Furthermore, if the cost of establishing and managing the nature reserve is low, resources available for conservation, either from the province, the government or international donors, can be allocated more effectively.

Factors which can be expected to reduce the cost of establishing and managing Ngoc Linh (Quang Nam) Nature Reserve include the following:

- current threats to biodiversity are low relative to many other sites in Vietnam, therefore less conservation effort is required;
- access to the proposed nature reserve from the west is limited by a mountain ridge backed by a nature reserve, therefore guard stations are only required on the northern and eastern sides;
- recruitment of forest protection staff is not necessary, as existing staff will be transferred to the nature reserve from within Quang Nam province;
- the road between Tra My town and the nature reserve headquarters is being upgraded as

part of the project to develop a new economic zone at Tac Po village;
- measures to actively rehabilitate degraded habitats are unnecessary as natural regeneration is the most appropriate method for use in the forest rehabilitation area;
- there are no villages within the strict protection area, therefore there is no need to relocate villages;
- the buffer zone development programme will be relatively inexpensive because the major focus will be on extension and awareness activities, and there will be little expenditure on infrastructure development;
- community development activities are already being implemented in the buffer zone by the Rural Infrastructure Development Unit (RIDU);
- funds from the 661 Programme have been allocated for social forestry activities in the buffer zone; and
- Ngoc Linh (Quang Nam) is attractive to NGOs and international donors.

Factors which can be expected to increase the cost of establishing and managing Ngoc Linh (Quang Nam) Nature Reserve include the following:

- the remoteness of many areas within the nature reserve will make the construction and maintenance of some guard stations expensive;
- the lack of experience in protected area management amongst FPD personnel in Quang Nam province will require investment in staff training;
- investment to increase the capacity of Tra My District DARD and other institutions that will be involved in the buffer zone development programme will be required; and
- Ngoc Linh (Quang Nam) will have to compete for provincial resources with Song Thanh-Dakpring and the "Green Corridor" project along the A Vuong River, which may make reliance on central government resources greater.

In summary, Ngoc Linh (Quang Nam) can be considered to be a relatively low-cost option for protecting montane habitats in the Western Highlands.

Opportunity Cost

If Ngoc Linh (Quang Nam) Nature Reserve is established, the provincial and district authorities will experience an opportunity cost, measured in terms of loss of benefits that could otherwise be gained from managing the area in an alternative way. The opportunity cost of not designating the proposed nature reserve as production forest can be considered to be minimal because Tra My Forest Enterprise currently meets the local demand for timber, and because the proposed nature reserve is less suitable for timber extraction than other areas in Tra My district due to its inaccessibility and the relatively low timber volume of forest at high altitudes.

The opportunity cost of prohibiting gold prospecting and other forms of mineral extraction in the proposed nature reserve is unquantifiable. The fact that gold prospecting is currently occurring in Tra Leng commune suggests that there may be pressure to prospect for minerals in the proposed nature reserve in the future. However, the negative impacts to the environment and public health arising from gold prospecting mean that the net benefits of this activity are questionable in any case.

Potentially, the most significant opportunity costs are those associated with the establishment of a new economic zone at Tac Po village. One of the main objectives of the nature reserve management board will be to prevent settlement of migrants into the buffer zone. If restrictions on settlement are implemented, they are likely to constrain development around Tac Po new economic zone, which borders Tra Tap and Tra Cang communes in the buffer zone (Map 4). The effects this will have depend upon the exact nature of the plans that the district and provincial authorities have for the new economic zone. If it is intended as a focus for economic activity in the south of Tra My district, then the effects will be limited. However, if the district and provincial authorities intend to settle migrants, either from within Tra My district or from elsewhere in Vietnam, in the area, then the establishment of the nature reserve will have a high opportunity cost.

5.8 Risk Evaluation

Table 27 outlines the major threats to biodiversity at Ngoc Linh (Quang Nam) proposed nature reserve and details the actions necessary to mitigate these threats. In order to assess the feasibility of establishing a protected area at Ngoc Linh (Quang Nam), it is necessary to assess the feasibility of mitigating the threats to biodiversity identified in this study.

Table 27: Threats to Biodiversity at Ngoc Linh (Quang Nam) Proposed Nature Reserve

Threat	Level	Causes	Mitigation
Clearance of forest for agriculture	Low (current) High (potential)	· Natural population growth · Settlement of migrants	· Improve access to family planning · Recognise land tenure rights · Control migration to Tac Po new economic zone
Hunting	High (current)	· Domestic demand · Demand from wildlife trade	· Enforce management regulations · Conduct conservation awareness · Promote alternative sources of income · Control wildlife trade
Over-exploitation of NTFPs	Medium (current)	· Domestic demand · Commercial demand from traders	· Enforce management regulations · Conduct conservation awareness · Cultivate NTFP species · Promote alternative sources of income
Timber extraction	Low (current) Medium (potential)	· Domestic demand (current) · Commercial demand (potential)	· Enforce management regulations · Conduct social forestry schemes to provide an alternative source of timber
Isolation of nature reserve from forest areas to west	Medium (potential)	· Development of National Highway 14 through Phuoc Son and Dac Glei districts	· Protection of forest along the route of National Highway 14

Mitigation. Improve access to family planning.

Feasibility. The national family planning programme is currently operating in the buffer zone communes. However, rates of participation in this programme are currently low (Table 12) and population growth rates are high (Table 8). The existing structure (involving the local women's, farmers' and youth unions) provides a channel through which additional funding can be allocated to this programme. However, the low rates of participation in the family planning programme result, not only from a lack of resources to implement the programme, but also from the inaccessibility of the population, fears amongst local people about the safety of contraception, and disincentives to practice family planning. While these factors remain, it is unlikely that family planning will be widely adopted amongst local communities.

Mitigation. Recognise land tenure rights.

Feasibility. None of the inhabitants of the buffer zone currently have land tenure certificates for their agricultural land. However, it is necessary to recognise these rights in order to discourage the settlement of migrants in the buffer zone, and protect traditional agricultural practices that are environmentally sustainable. Provision for the allocation of annual crop land and residential land to individual households is made under Article 20 of the 1993 Land Law (Government of the Socialist Republic of Vietnam 1993). However, this law makes no provision for the allocation of land used for rotational swidden cultivation. Indeed, Article 26 states that land shall revert to the state "where the land user leaves the land unused for twelve consecutive months". If the inhabitants of the buffer zone cannot be issued with land tenure certificates for hill agricultural land, it is essential that the district authorities recognise their traditional user rights to this land, including fallow land. Most importantly, fallow land should not be reclassified as forest land for plantation or natural regeneration of forest, a practice which has had negative effects in other areas of Vietnam (Hjemdahl and Nguyen Van Minh 1997). This would be consistent with Article 44 of the 1993 Land Law which states that "the government shall stipulate... ...the area of unused land, bare hills and mountains... ...which households may use for agricultural production, afforestation and aquaculture".

Mitigation. Control migration to Tac Po new economic zone.

Feasibility. The development of a new economic zone at Tac Po village and the upgrading of the road to Tra My town will create conditions that will encourage migrants to settle in the south of Tra My district from other parts of the district and from other areas in Vietnam. Whether these settlers will be spontaneous migrants or people moved as part of an officially sponsored trans-migration scheme largely depends upon the plans that the district and provincial authorities have for the new economic zone. If it is intended to act as a focus for economic development in the south of the district, it will be possible to control spontaneous migrants through a combination of strict enforcement of legislation on illegal settlement and recognition of the land-use rights of local people through the issuing of land tenure certificates. However, if it is intended that Tac Po new economic zone will be a destination for trans-migration from more densely populated areas, then this is incompatible with the aims of the nature reserve. Under these circumstances, it will be impossible to prevent settlement of migrants without a complete reappraisal of the function of the new economic zone.

Mitigation. Enforce management regulations.

Feasibility. There are several obstacles to enforcing the management regulations for the nature reserve and buffer zone, including inaccessibility of large areas of the nature reserve, difficulties in identifying suitable locations for guard stations and low motivation of nature reserve staff. Given the remoteness of many communities and forest areas, and the potential for conflicts between the nature reserve and local communities, any management regime which is implemented by enforcement alone is likely to be unsuccessful. However, a management regime can be successful if it is implemented with the consent and participation of local communities, and if enforcement is reserved for only the most serious infringements, such as hunting of threatened species. No management regime can ever prevent all infringements of management regulations but it should be possible to limit infringements to sustainable levels.

Mitigation. Conduct conservation awareness.

Feasibility. With appropriate training and resources, the staff of the nature reserve will be able to conduct a programme of conservation awareness activities, targeting both children and adults. Models for conservation awareness programmes have already been developed for use in protected areas in Vietnam; for instance, the programme developed by Fauna and Flora International at Cuc Phuong National Park. Nature reserve staff could be placed on one of these programmes for training prior to initiating a programme at Ngoc Linh (Quang Nam). One obstacle to conservation awareness is the remoteness of many communities in the buffer zone. However, this problem can be overcome if the nature reserve staff introduce conservation awareness activities through existing channels, for example by introducing environmental education into the curriculum in local schools.

Mitigation. Promote alternative sources of income.

Feasibility. The results of the RRA indicate that one sustainable income-generating activity with potential for development in the buffer zone is cinnamon cultivation: RRA data suggest that local people have free time during February, March and June, which are the months for planting and harvesting cinnamon (Table 14). Cinnamon has a high value-to-weight ratio, making cultivation in remote communities (from where it must be carried to market on foot) economically viable. Many local people possess the requisite knowledge and technology to cultivate the crop, and there are existing trade channels. Furthermore, cinnamon does not require large areas of land, and cinnamon plantations provide wildlife habitat and protection against soil erosion, as cinnamon trees are grown interspersed with shade trees.

Another activity with high potential for development in the buffer zone is animal husbandry. Although several constraining factors, including distance from markets and lack of technical knowledge, limit the potential for commercial livestock raising, the introduction of new animal husbandry techniques or new breeds of livestock could help meet domestic demand for animal protein; this, in turn, could lead to a reduction in hunting pressures. Goats were identified as one animal with a high potential because they are easy to breed and resistant to disease.

Mitigation. Control wildlife trade.

Feasibility. Whilst management regulations prohibiting the hunting of animals cannot easily be enforced, those prohibiting trade in wildlife can be enforced much more effectively. By controlling trade in wildlife,

one of the main incentives for hunting can be removed. It is important to develop an understanding of the underlying economic factors driving trade in wildlife, in order that appropriate conservation measures may be proposed. Measures to control trade in wildlife appropriate for Ngoc Linh (Quang Nam) may include prohibiting the sale of wildlife at markets at Tac Po village and Tra My town, and checkpoints on the road between Tac Po village and Tra My town.

Mitigation. Cultivate NTFP species.

Feasibility. In Tra Linh commune, the medicinal plant, *Panax vietnamensis*, is currently being cultivated. The potential, therefore, exists for cultivating other NTFP species for both household consumption and commercial purposes. Pilot schemes to identify suitable species and promote their cultivation by local people could form part of the buffer zone development programme.

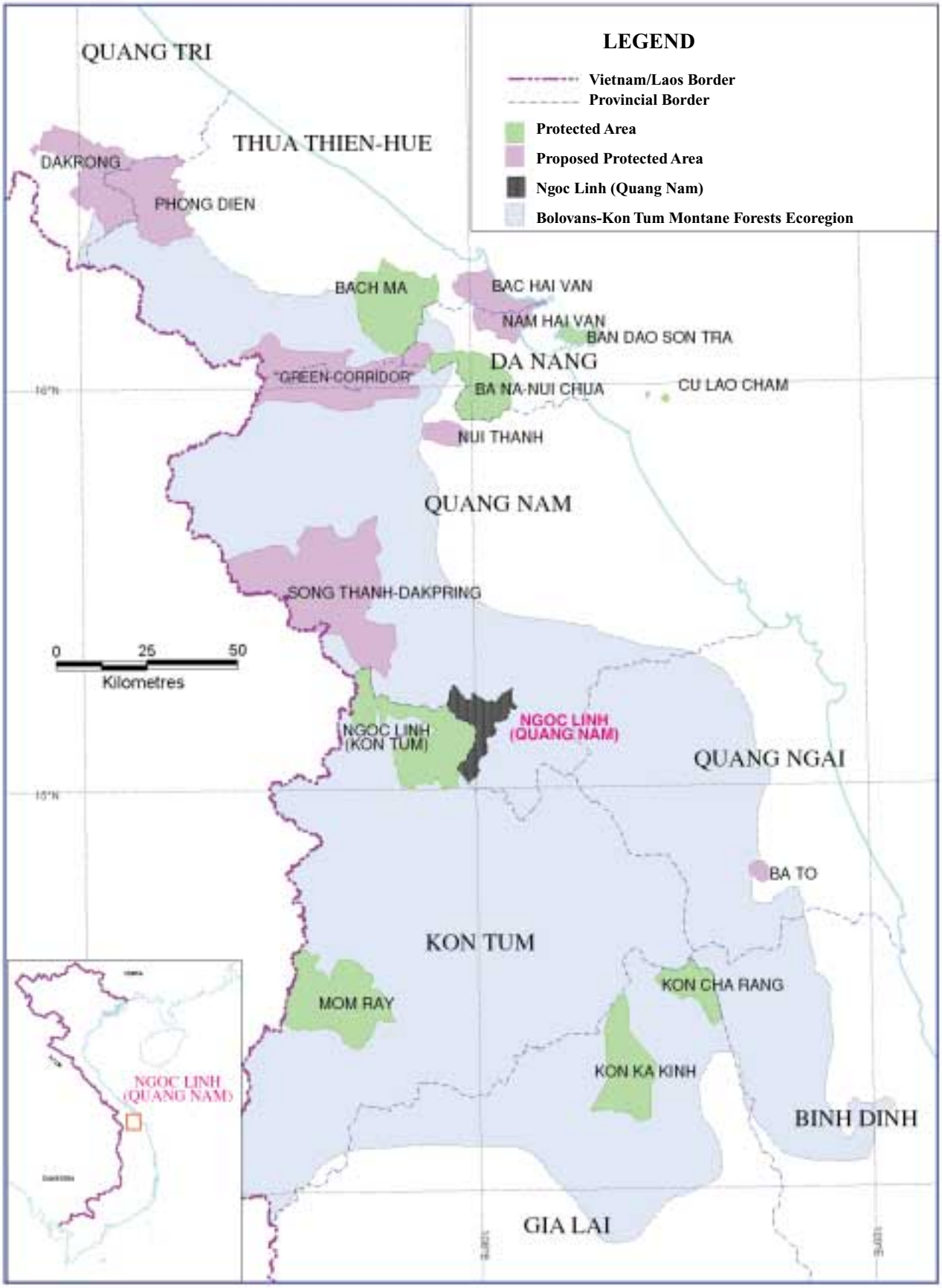
Mitigation. Conduct social forestry schemes to provide an alternative source of timber.

Feasibility. Article 3 of Government Decree No. 02/CP dated 15 January 1994 makes provision for forest land without forest and unforested land to be allocated to individual households for plantation or natural regeneration (MOF 1994). Funding is available for these activities through the 661 Programme, which will be administered in the buffer zone by the nature reserve management board. The commercial demand for timber in Tra My district can be met by the activities of Tra My Forest Enterprise. However, limited and regulated extraction of timber from forest areas in the buffer zone for household use may need to continue until such time as plantation forests become productive.

Mitigation. Protection of forest along the route of National Highway 14.

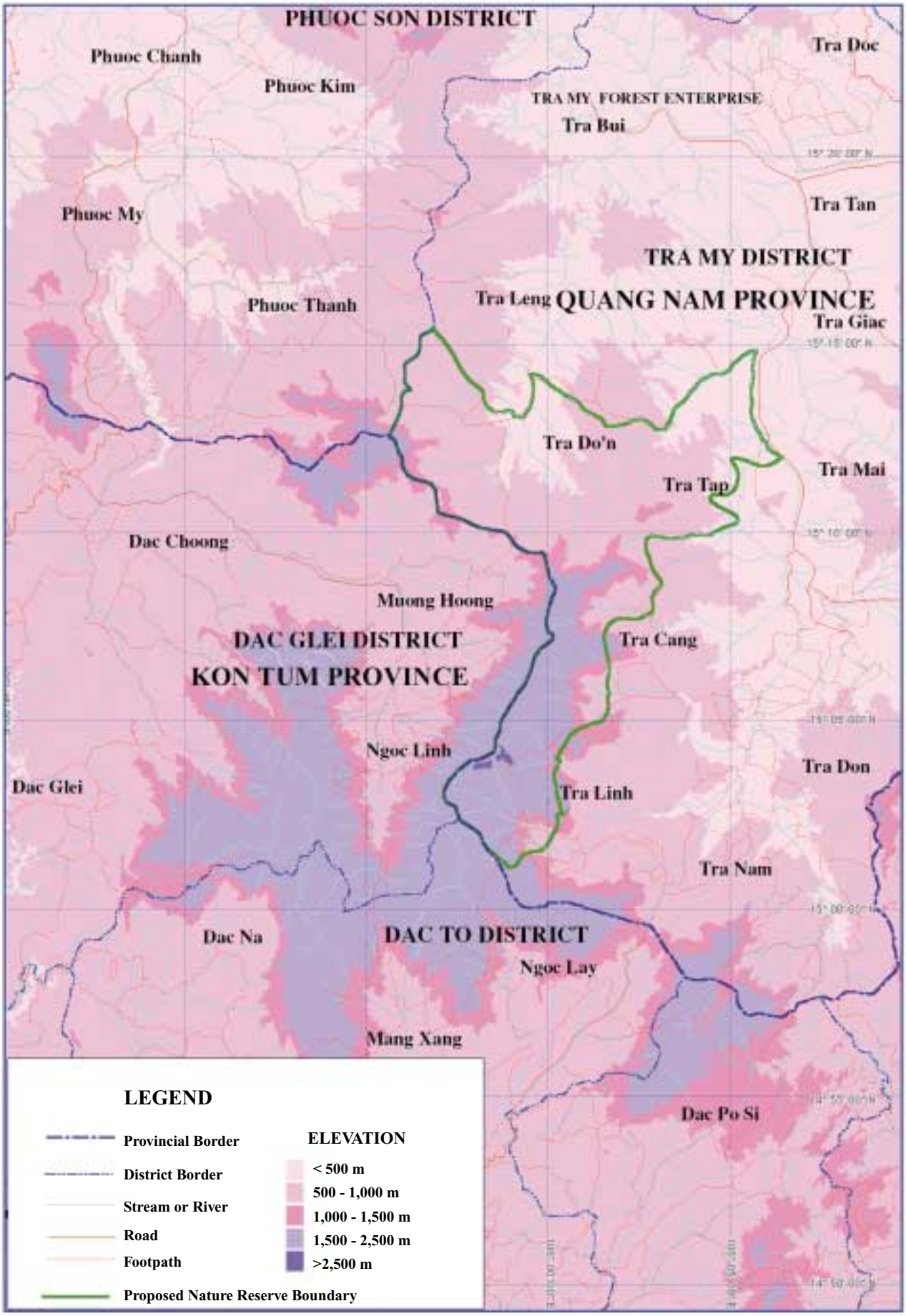
Feasibility . There are plans to upgrade National Highway 14, which passes through Quang Nam and Kon Tum provinces to the west of Ngoc Linh (Quang Nam) proposed nature reserve. It is likely that upgrading this road will encourage migrants to settle along the route, leading to forest clearance for agriculture. However, forest along the route of National Highway 14 in Dac Man commune, Dac Glei district is already protected by Ngoc Linh (Kon Tum) Nature Reserve (Le Trong Trai *et al.* 1999). Furthermore, forest along the route in Phuoc My commune, Phuoc Son district lies within the boundary of Song Thanh-Dakpring proposed nature reserve (Wikramanayake *et al.* 1997b). Providing that the management regulations in these two protected areas are strictly enforced, there is no reason why Ngoc Linh (Quang Nam) and Ngoc Linh (Kon Tum) should become isolated from forest areas to the west, in Phuoc Son district and Laos.

Map 1: Location of Ngoc Linh (Quang Nam) Proposed Nature Reserve



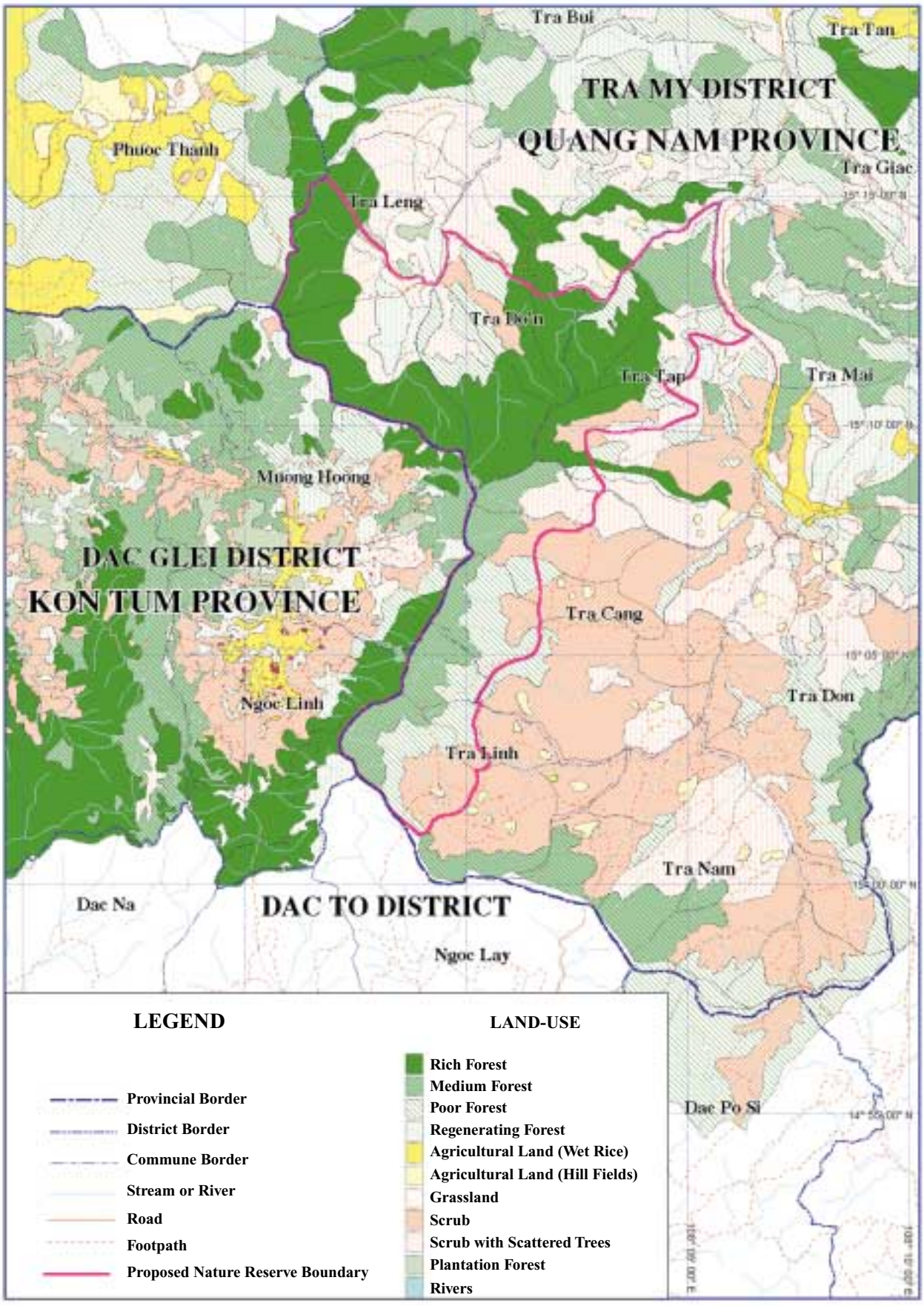
SCALE: 1:1,500,000

Map 2: Topography of Ngoc Linh (Quang Nam) Proposed Nature Reserve



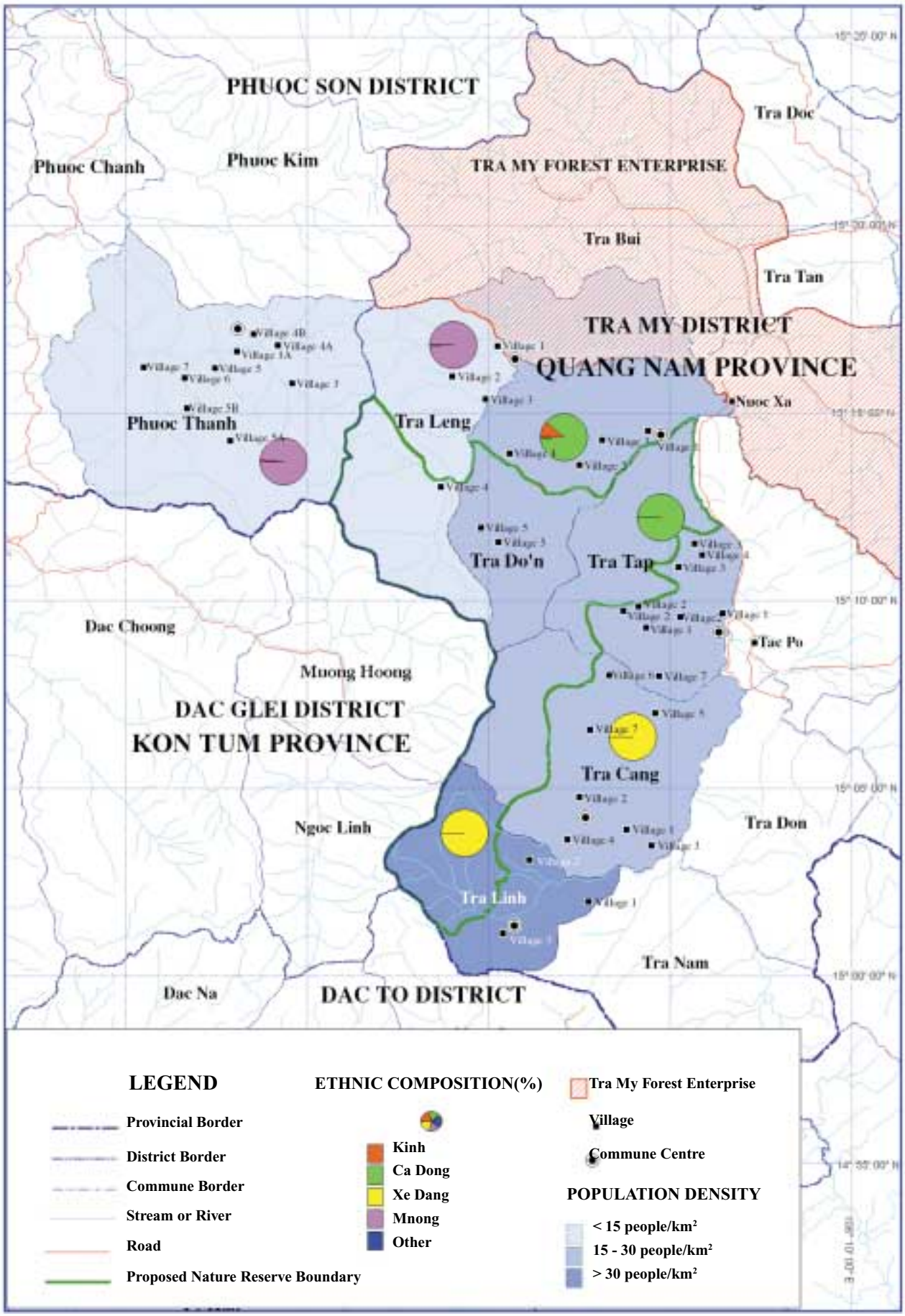
SCALE: 1:250,000

Map 3: Land-use in Ngoc Linh (Quang Nam) Proposed Nature Reserve



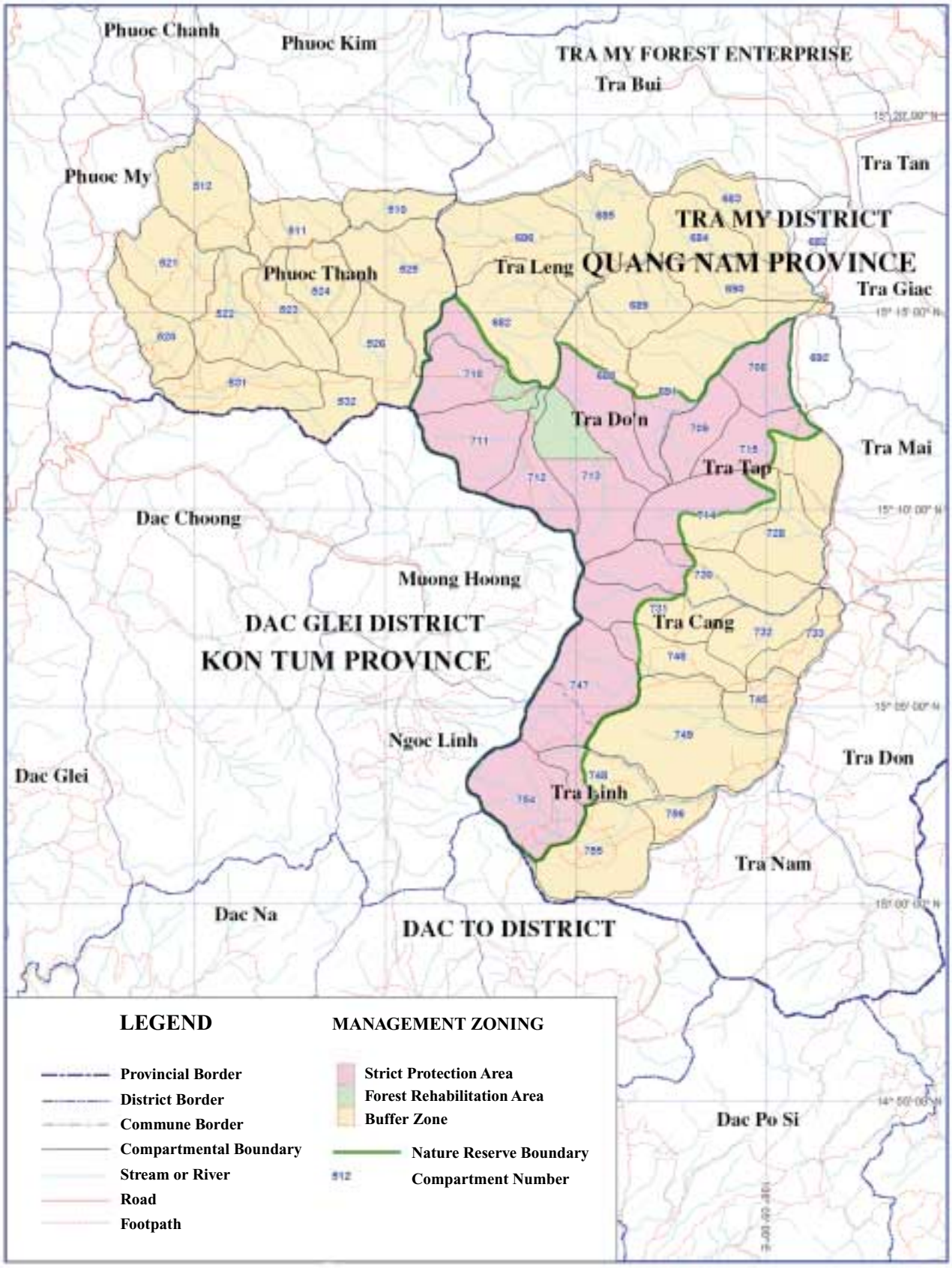
SCALE: 1:200,000

Map 4: Population Density and Ethnic Composition of Communes in the Buffer Zone



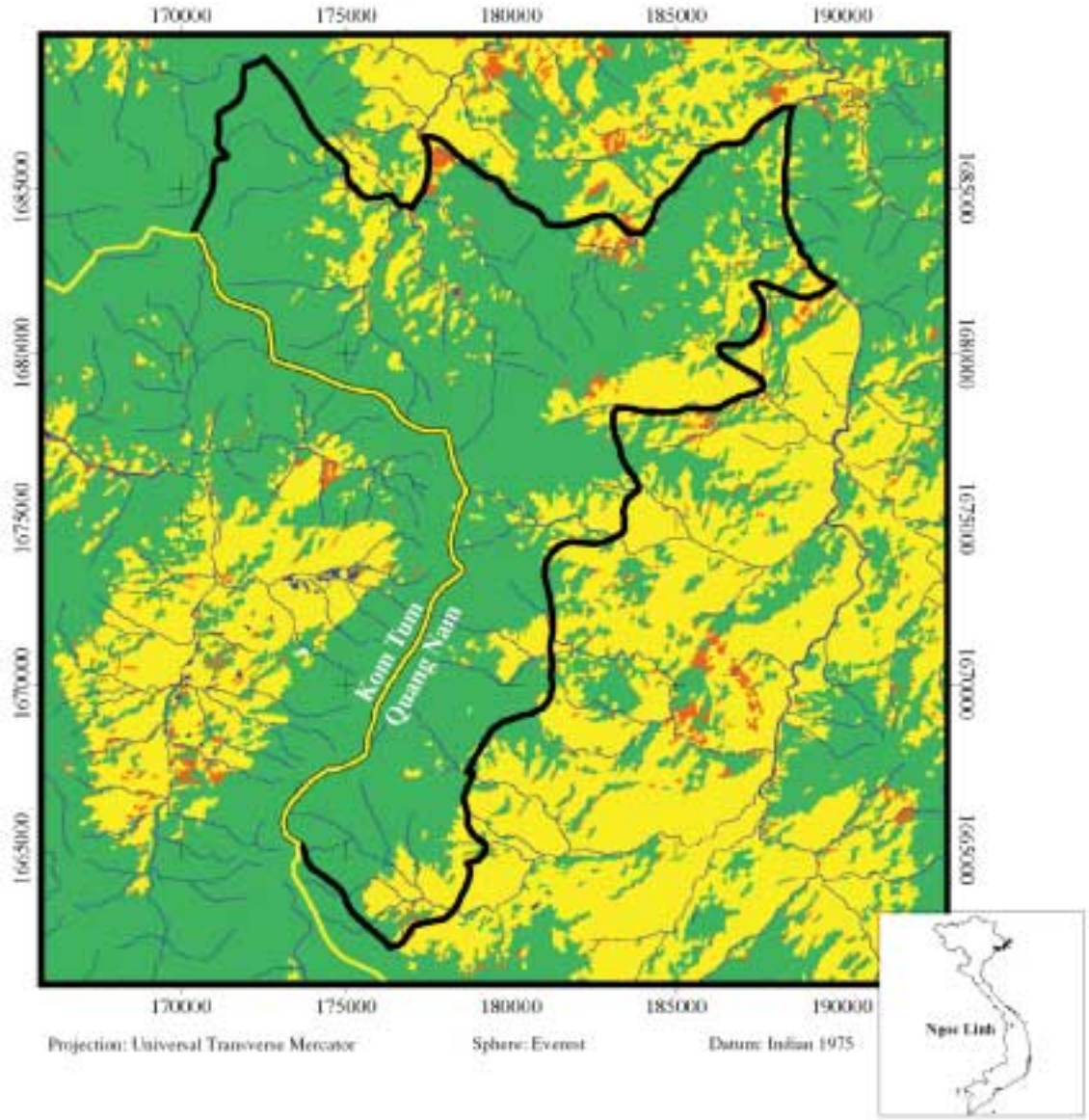
SCALE: 1:250,000

Map 5: Proposed Management Zoning of Ngoc Linh (Quang Nam) Nature Reserve



SCALE: 1:250,000

Map 6: Forest Conversion in the Study Area 1989 - 1998



LEGEND

- **Forest**
- **Non-Forest**
- **Deforestation**
- **Rivers**
- **Provincial Boundary**
- **Proposed Nature Reserve Boundary**

5 0 Scale 1:200,000 5 10 Kilometers

3 0 3 6 Miles

Forest refers to areas greater than 10 m in height,with a canopy cover of greater than 70%.

Non-forest refers to degraded forest, scrub, grassland, cultivated areas and bare ground.

Deforestation refers to areas where forest has been converted to non-forest in the period between 1989 and 1998.

Sources: Forest Inventory and Planning Institute
1:50,000 DMA L-7014 Series - Sheet #6639III, #6639IV
1:50,000 DMA L-7014 Series - Sheet #6539I, #6539II
Landsat 5124-050 03- Feb-1998. 09-Jan-1989

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Appendix 1: Flora Recorded in the Study Area

Division, Family, Genus and Species	Voucher	Notes
Lycopodiophyta		
Lycopodiaceae		
Huperzia serrata (Thunb.) Trevis.	VA 1127	M
Selaginellaceae		
Selaginella rolandi-principis Alston	VA 1318	
Pteridophyta		
Angiopteridaceae		
Archangiopteris subintegra (Hayata)?	VA 994	R
Angiopteris yunnanensis Hieron	VA 1307	
Osmundaceae		
Osmunda vachellii Hook.	VA 1227	M
Adiantaceae		
Taenitis blechnoides (Wild.) Sw.	VA 997	
Antrophyum annamensis Chr. & Tard.	VA 1301	
Pteris porphyrophlebia C. Chr. & Ching ex Ching	VA 1300	
Hymenophyllaceae		
Crepidomanes radicans (Sw.)?	VA 1132	
C. sumatranum (Bosch.) Copel	VA 1193	
Cephalomanes obscurum (Blume) K. Iwats.	VA 1000 VA 1001	
Gleicheniaceae		
Diptopterygium blotiana (C. Chr.) Nakai	VA 1320	
Dicranopteris linearis (Burm. f.) Underw	VA 1319	M,V
Polypodiaceae		
Pyrrosia flocculosa (D. Don) Ching	VA 1194	
Colysis pteropus (Blume) Bosman	VA 1303	
Selliguea lateritia (Baker) Hovekamp	VA 999 VA 1217 VA 1226	
Lepisorus subrostratus (C. Chr.) C. Chr. & Tardieu	VA 1025 VA 1032	
Grammitidaceae		
Ctenopteris barathrophylla (Baker) Parris	VA 1304	
Cyatheaceae		
Cyathea salletti Tardieu & C. Chr.	VA 993 VA 1262	
C. latebrosa (Wall. ex Hook.) Copel.	VA 1263	
Dennstaedtiaceae		
Lindsaea oblanceolata Alderw	VA 1302 VA 1329	
L. chienii Ching	VA 938	
L. javanensis Blume	VA 922	
L. dissectiformis Ching	VA 944	
L. decomposita Willd.	VA 921	
Thelypteridaceae		
Trigonospora ciliata (Benth.) Holtum	VA 950	
Aspleniaceae		
Asplenium tenerum G. Forst.	VA 1223	
A. normale D. Don	VA 941	
A. obscurum Blume	VA 1299	
Lunathyrium japonicum (Thunb.) Kurata	VA 998 VA1224 VA 1298	
Diplazium lobbianum (Hook.) T. Moore	VA 1007 VA 1310	
D. malaccense C. Presl	VA 918 VA 996	
D. polypodioides Blume	VA 1022	
Dryopteridaceae		
Tectaria dubia (C. B Clarke ex Baker) Ching	VA 1309	
T. kusukusensis (Hayata) Lellinger	VA 1257	
T. polymorpha (Wall. ex Hook.) Copel	VA 1251	
T. triglossa C. Chr. & Tardieu	VA 1306	
T. variabilis Tardieu & Ching	VA 995 VA 1195 VA 1305	
Dryopteris sp.	VA 1275 VA 1276 VA 1278	
Arachniodes hasseltii (Blume) Ching	VA 1019 VA 1021 VA 1131	
A. speciosa (D. Don) Ching	VA 1130	
Pleocnemia leuzeana (Gaudich.) C. Presl	VA 1277	
Lomariopsidaceae		
Lomariopsis spectabilis (Kunze) Mett.	VA 1245	
Davalliaceae		
Davallia repens (L. f.) Kuhn	VA 1308	
Nephrolepis cordifolia (L.) C. Presl	VA 1020	
Pinophyta		
Gnetaceae		
Gnetum gnemon L. var. *griffithii* Margf.	observed	
G. montanum Margf.	observed	
Pinaceae		
Pinus dalatensis Ferre	observed	W,M,E
Podocarpaceae		
Podocarpus imbricatus (Blume) De Laub.	VA 924	W,M,O
P. neriifolius D. Don	observed	W
Decussocarpus fleuryi (Hickel) De Laub.	VA 920	M,V
Dacrydium elatum (Roxb.) Wall.	VA 933	W,M
Magnoliophyta		
Magnoliopsida		
Magnoliaceae		
Magnolia annamensis Dandy	VA 1264	
M. sp.	VA 1325	
Pachylarnax precalva Dandy	observed	
Michelia foveolata Merr. ex Dandy	VA 1324	
Annonaceae		
Enicosanthella petelotii (Merr.) Ban	observed	
Polyalthia clemensorum Ast.	observed	
Goniothalamus touranensis Ast.	VA 1046	
Myristicaceae		
Knema pachycarpa J.J. de Wilde	observed	W
K. saxatilis J.J. de Wilde	observed	W
K. sessiliflora J.J. de Wilde	observed	W
Chloranthaceae		
Chloranthus erectus (Benth. & Hook. f) Verdc.	VA 1294	M
Hedyosmum orientale Merr. & Chun.	VA 1030 VA 1230 VA 1023	
Piperaceae		
Piper bavinum C. DC.	VA 1258	
P. boehmeriaefolium Wall. ex C. DC. var. *tonkinensis* A. DC.	VA 1163	M
P. hymenophyllum Miq.	VA 1167 VA 1231	
P. khasianum C. DC.	VA 1143	
P. penangense C. DC.	VA 914 VA 1075	
P. sp	VA 1166	
Aristolochiaceae		
Asarum aff. *balansae* Franch.	observed	M
Illiciaceae		
Illicium tenuifolium (Ridl.) A.C. Sm.	VA 958 VA 1198	
Schisandraceae		
Kadsura coccinea (Lem.) A.C. Sm.	observed	
K. roxburghiana Arn.	observed	
Ranunculaceae		
Naravelia laurifolia Wall. ex Hook.f.	observed	
Anemone sumatrana De Vriese	observed	
Lardizabalaceae		
Stauntonia cavaleriana Gagnep	VA 1252	
Menispermaceae		
Anamirta cocculus (L.) Wight et Arn.	observed	M

Division, Family, Genus and Species	Voucher	Notes
Coscinium fenestratum (Gaertn.) Colebr.	observed	R
Tiliacora acuminata (Lamk.) Miers	VA 1144	M
Lauraceae		
Cinnamomum durifolium Kost.	VA 1099	
C. sericans Hance	VA 1136	
Litsea chartacea (Nees) Hook. f.	VA 1165	
L. grandifolia Lecomte	observed	W
L. robusta Blume	observed	W
L. yunnanensis Yang & P. H. Hoang	VA 972	
Lindera reflexa Hemsl.	VA 1249	
L. sp.	VA 1038	
Cryptocarya sp.	VA 1202	
Hernandiaceae		
Illigera parviflora Dunn	observed	
Actinidiaceae		
Actinidia latifolia (Gardner et Champ) Merr	observed	
Saurauja nepaulensis DC.	observed	
S. roxburghii Wall.	observed	
Theaceae		
Eurya japonica Thunb.	VA 1060 VA 1066	
Pyrenaria jonqueriana Pierre	VA 1158 VA 1211	
Camellia oleifera C. Abel.	observed	
C. sinensis (L.) O. Kuntze	VA 1192	
Gordonia bidoupensis Gagnep.	VA 1110	
Schima argentea Pritz ex Diels	VA 1064	
Dipterocarpaceae		
Dipterocarpus baudii Korth	observed	W,V
Ancistrocladaceae		
Ancistrocladus tectorius (Lour.) Merr.	observed	
Pentaphylaceae		
Pentaphylax euryoides Gartner et Champ.	observed	W
Guttiferae		
Garcinia gaudichaudii Planch & Triana	VA 1188	
G. merguensis Wight	observed	W
G. multiflora Champ. ex Benth.	VA 1317	M
G. oliveri Pierre	observed	
Calophyllum sp.	observed	
Elaeocarpaceae		
Elaeocarpus darlacensis Gagnep.	observed	W,R
E. kontumensis Gagnep.	observed	W
Tiliaceae		
Grewia bulot Gagnep.	VA 1270	
Sterculiaceae		
Byttneria pilosa Roxb.	observed	
Sterculia henryi Hemsl.	VA 1034 VA 1139 VA 1140 VA 1281	
S. lanceolata Cav.	VA 1281	
Scaphium macropodium (Miq.) Beumee	observed	M
Flacourtiaceae		
Hydnocarpus annamensis (Gagnep.) Lesc. et Sleumer	observed	
Passifloraceae		
Passiflora foetida L.	observed	M
Adenia banaensis Cuss.	VA 1164	
Begoniaceae		
Begonia aptera Blume	VA 1010 VA 1274 VA 1052	M
B. rex Putz	VA 1052	M
Ericaceae		
Rhododendron sp.1	VA 1059	
R. sp.2	observed	
Vaccinium bullatum (Dop.) Sleumer	VA 1232	
Enkianthus quinqueflorus Lour.	VA 939 VA 1080	
Ebenaceae		
Diospyros ferrea aff var *littorea* (R Br) Bak	VA 967	

Division, Family, Genus and Species	Voucher	Notes
Styracaceae		
Alniphyllum eberhardtii Guill.	VA 1070	
Symplocaceae		
Symplocos adenophylla Wall.	VA 1072 VA 1094 VA 1096 VA 1113 VA 1125	
S. adenophylla aff. var. *touranensis* (Guill.) Nooteb.	VA 946 VA 1108	
S. annamensis Nooteb.	VA 1042 VA 1189	
S. aff. *atriolivacea* Merr. & Chun ex Li	VA 930	
S. glomerata King ex Gamble	VA 1128	
S. guillauminii Merr.	VA 971	
S. sp.	VA 1168 VA 1186 VA 1233	
Myrsinaceae		
Maesa membranacea A. DC.	VA 1017	
Embelia parviflora Wall. ex A. DC.	VA 1109	M
Ardisia incarnata Pitard	VA 1074	
A. merrillii Walker	VA 1316	
A. virens Kurz	VA 1244	M
A. albomaculata Pitard.	VA 1330	
A. gracilipes K. Larsen & Hu	VA 916 VA 957	I
A. melastomoides Pit	VA 1210	R
A. quinquegona Blume	VA 1076	M
A. humilis Vahl	VA 912	M
A. silvestris Pitard	VA 1033	M
A. retroflexa E. Walker	VA 970	
A. sp.	VA 968 VA 1077	
Amaranthaceae		
Cyathula prostata (L.) Blume	observed	
Achyranthes aspera L.	observed	M
Connaraceae		
Rourea minor (Gagnep.) Aubl. subsp. *monadelpha* (Roxb.) Vid.	VA 1182	
Pittosporaceae		
Pittosporum tetraspermum W. & Arn.	VA 900	
Rosaceae		
Rubus cochinchinensis Tratt.	observed	M
R. alceaefolius Poir.	observed	M
R. moluccanus L.	observed	
Duchesnea indica (Andr.) Focke	observed	
Prunus arborea (Blume) Kalkman	observed	W
Saxifragaceae		
Dichroa hirsuta Gapnep.	VA 988 VA 1229	
Fabaceae		
Mimosoideae		
Archidendron robinsonii (Gagnep.) Niels.	VA 1160	
Proteaceae		
Helicia excelsa (Roxb.) Blume	VA 1266	
Lecythidaceae		
Barringtonia coccinea (Locer) H. Kost	observed	
B. eberhardtii Gagnep.	observed	
Sonneratiaceae		
Duabanga grandiflora (DC.) Walp.	observed	W
Lythraceae		
Lagerstroemia tomentosa Presl.	observed	W
Thymeleaceae		
Aquilaria crassna Pierre	interview	
Wikstroemia poilanei Leandri.	VA 1081	
Myrtaceae		
Syzygium abortivum (Gagn.) Merr & Perry	VA 1089	
S. bonii (Gagnep.) Merr. & Perry	VA 901	
S. wightianum W. & Arn.	VA 1248	
Melastomataceae		
Melastoma imbricatum Wall. ex Clarke.		

Division, Family, Genus and Species	Voucher	Notes
Oxyspora aff. *balansaei* Gagnep.	VA 1112	
O. sp.	VA 902	
Blastus borneensis Cogn.	VA 955 VA 1047	
Phyllagathis truncata Hans.	VA 935 VA 1313	
Medinilla pterocaula Blume	VA 1026	
Pseudodissochaeta assamica (C. B. Clarke) M. P. Nayar.	VA 949 VA 1016 VA 1247	
Memecylon harmandii Guill.	VA 1073 VA 1122	
Combretaceae		
Combretum pilosum Roxb.	observed	
Rhizophoraceae		
Carallia brachiata (Lour.) Merr.	observed	
Cornaceae		
Mastixia arborea (Wight) C.B. Clarke	observed	W
Olacaceae		
Anacolosa poilanei Gagnep.	VA 1084 VA 1123	
Erythropalum scandens Blume	observed	
Opiliaceae		
Lepionurus silvestris Blume	observes	
Loranthaceae		
Helixanthera parasitica Lour.	VA 1093	
Balanophoraceae		
Balanophora fungosa J.R. & G. Forster subsp. *indica* (Arn.) Hans	VA 1134	M
Celastraceae		
Euonymus cuspidatus Loesn.	VA 1100	
E. laxiflorus Champ. in Benth. ex Hook. f.	VA 909 VA 959 VA 1161	
Aquifoliaceae		
Ilex annamensis Tard.	VA 1201	
I. confertiflora Merr.	VA 1068	
Icacinaceae		
Stemonurus chingianus (Hand.- Mazz.) Sleum.	VA 1107	
Euphorbiaceae		
Glochidion sp.	VA 1148	
Antidesma hainanensis Merr.	VA 977 VA 1049	
A. sp.1	VA 904 VA 982 VA 989 VA 1039 VA 1138 VA 1184	
A. sp.2	VA 905 VA 1218	
Claoxylon hainanensis Pax. & Hoffm.	VA 1268	
C. indicum (Blume) Endl. ex Hassk.	VA1162	
C. longifolium (Blume) Endl. ex Hassk.	VA 1291	
Endospermum chinense Benth.	observed	
Balsaminaceae		
Impatiens sp.	observed	
Sabiaceae		
Meliosma sp.		
Polygalaceae		
Polygala karensium Kurz	VA 1065	
Burseraceae		
Canarium album (Lour.) Raeusch. ex DC.	VA 1156	W
Meliaceae		
Trichilia connaroides (W. & A.) Bentv. f. *glabra* Bentv.	VA 1173 VA 1236 VA 1197	M
Dysoxylum binectariferum (Roxb.) Hook. ex Bedd.	VA 1256	
Amoora gigantea Pierre	observed	W
Rutaceae		
Evodia lepta (Spreng.) Merr.	VA 947	M

Division, Family, Genus and Species	Voucher	Notes
	VA 962 VA 1083 VA 1240 VA 1312	
Glycosmis sapindoides Lindl. ex Oliv.	VA 1280	
Luvunga scandens Ham	VA 940 VA 1083	M
Leeaceae		
Leea stipulosa Gagnep.	VA 1055	R
Vitaceae		
Tetrastigma gaudichaudianum Pl.	VA 1045	
Araliaceae		
Schefflera violea C.B. Shang	observed	M
S. octophylla (Lour.) Harms	observed	M
Trevesia palmata (Roxb. et Lindl.) Visi	observed	M
Brassaiopsis glomerulata (Blume) Regel.	VA 1292	
Macropanax simplicifolius C.B. Shang	observed	
M. skortsovii Ha	observed	
Panax vietnamensis Ha & Grushv.	interview	M,E
Aralia armata Seem.	observed	
Hamamelidaceae		
Symingtonia populnea (Griff.) Steenis	observed	W
Rhodoleia championii Hook. f.	observed	W
Ulmaceae		
Gironniera subequalis Pl.	VA 1062 VA 1088 VA 1141	
Trema orientalis (L.) Blume	observed	
Moraceae		
Artocarpus melinoxyla Gagnep.	VA 1242	W
Ficus pyriformis Hook. & Arn.	VA 1157	
F. simplicissima Lour. var. *annamica* (Gagnep.) Corner	observed	
F. hederacea Roxb.	VA 1285	
F. kontumense Corner	observed	
F. oligodon Miq.	VA 1269	W
F. fistulosa Reinw. x Blume	VA 1296	
Urticaceae		
Poikilospermum suaveolens (Blume) Merr.	VA 1334	
Elatostema cuneatum Wight	VA 990	
E. dissectum Wedd.	VA 1027	
Pellionia bulbifera Hook. f.	VA 1028	
P. radicans Wedd. in DC. f. *grandis* Gagnep.	VA 1288	M
Pouzolzia hirta Hassk.	observed	
P. sanguinea (Blume) Merr.	observed	
Debregeasia sp.	VA 1029	
Juglandaceae		
Engelhardia roxburghiana Wall.	observed	W
Fagaceae		
Castanopsis quangtriensis Hick. & Cam.	VA 1067 VA 1092	
C. sp	observed	
Lithocarpus gagnepainiana A. Cam.	VA 1114	
L. gigantophylla (Hick. & Cam.) A. Cam.	VA 1181	
L. hamata A. Cam.	VA 1024	
L. obovatifolia Hick & Cam.	VA 1097	
Quercus sp.1	observed	
Q. sp.2	observed	
Betulaceae		
Betula alnoides Buch. Ham ex D. Don.	VA 1071	M
Loganiaceae		
Fagraea ceilanica Thunb.	observed	
Apocynaceae		
Melodinus annamensis Pit.	observed	
Alstonia scholaris (L.) R.Br.	observed	W
Rauvolfia yunnanensis Tsiang	VA 1159 VA 1286	M
Tabernaemontana buffalina Lour.	VA 1152 VA 1209 VA 917	M
T. pallida (Pierre ex Spire) Hua	VA 1044 VA 1213	M

Division, Family, Genus and Species	Voucher	Notes
Asclepiadaceae		
Centrostemma multiflorum (Blume) Decne	VA 1012 VA 1185	
Dischianthus urceolatus (Decne) Tsiang	VA 1208	
Dischidia sp.	VA 1225	
Convolvulaceae		
Xenostegia tridentata (L.) Austin et Staples	observed	
Ipomoea involucrata P. Beauv.	observed	
Boraginaceae		
Heliotropium indicum L.	observed	
Verbenaceae		
Callicarpa albida Blume	observed	
C. nudiflora Hook. et Arn.	observed	
Tsoongia axillariflora Merr.	VA 929 VA 986	M
Lamiaceae		
Gomphostemma lucidum Wall.	observed	
G. niveum Hook. f.	observed	
Plantaginaceae		
Plantago asiatica A. DC.	observed	M.
Buddleiaceae		
Buddleia paniculata Wall.	observed	
Oleaceae		
Jasminum subtriplinerve Blume	VA 1172	M
Scrophulariaceae		
Torenia benthamiana Hance	observed	
Gesneriaceae		
Aeschynanthus longicaulis Wall. ex R. Br.	VA 1214	
A. moningeriae (Merr.) Chun	VA 1056 VA 1147 VA 1200	
Didissandra clemensiae Pell.	VA 1203	
Rhynchothecum latifolium Hook	VA 1053	
Acanthaceae		
Staurogyne debilis (T. Anders.) C. B. Clarke ex Merr.	VA 1221 VA 1149	
S. hypoleucum (Benoist) Benoist	VA 932	
Justicia vagabunda R. Ben.	VA 979	
Bignoniaceae		
Radermachera hainanensis Merr.	observed	
Pentaphragmaceae		
Pentaphragma gamopetalum Gagnep.	observed	
P. sinense Hemsl. et Wils.	observed	
Campanulaceae		
Codonopsis javanica (Blume) Hook. f.	observed	M
Lobelia zeylanica L.	observed	
Pratia nummularia (Lam.) A.Br et Aschers	observed	
Rubiaceae		
Mussaenda aff. *cambodiana* Pierre.	VA 1191	
M. erosa Champ.	VA 985	
Hedyotis pilulifera Pitard.	VA 1170 VA 1282	
Ophiorrhiza baviensis Dreake.	VA 1009 VA 1085 VA 1295	
Xanthophytum attopeuensis (Pit.) Lo Hsien Shui		
Myrioneuron effusum (Drade) Merr.	VA 1054	
M. sp.	VA 975	
Mycetia sp.	VA 1289	
Urophyllum argenteum Pitard.	VA 934 VA 1129	R
Aidia cochinchinensis Lour.	VA973 VA 1090	
A. oxyodonta var. *microdonta* (Pit.) Pham.	VA 1041 VA 1137	
Diplospora viridiflora DC.	VA 954 VA 983 VA 1036	
Ixora coccinea L.	VA 1063	M
I. sp.	VA 1204 VA 1207	
Pavetta tomentosa Roxb. ex Sw.	VA 1175	

Division, Family, Genus and Species	Voucher	Notes
Psychotria montana Blume	VA 1101 VA 1111	
P. morindoides Hutch.	VA 981 VA 903	
P. sp.	VA 1048	
Tarenna thorelii Pitard.	VA 1215	
Lasianthus coeruleus Pitard.	VA 942	R
L. poilanei Pitard.	VA 911	
L. calycinus Dunn.	VA 1228	NV
L. kwangtungensis Merr.	VA 925	NV
Morinda sp.	VA 1106	
Prismatomeris tetrandra (Roxb.) Schum. subsp. *malayana* (Ridl.) J. J. Jonhanss	VA 978	
P. sp.	VA 928 VA 952 VA 1051 VA 1087	
Litosanthes biflora Blume	VA 1004	NV
Caprifoliaceae		
Viburnum lutescens Blume	VA 1015 VA 1169 VA 1287	
Liliopsida		
Araceae		
Pothos balansae Engler	VA 1037	
P. yunnanensis Engler	VA 982	
Anadendrum montanum Schott.	VA 926 VA 1238	
Rhapidophora korthalsii Schott.	observed	M
R. chevalieri Gagnep.	observed	M
Schismatoglottis calyptrata (Roxb.) Zoll. & Mor.	VA 1247	
Aglaonema modestum Schott. ex Engl.	observed	
Amorphophallus sp.	observed	
Commelinaceae		
Pollia thyrsiflora (Blume) Endl. ex Hassk	VA 1011 VA 1284	
Arecaceae		
Licuala robinsoniana Becc.	VA 1235	R
L. ternata Griff.	VA 908 VA 919 VA 1133 VA 1239	
Caryota sympetala Gagnep.	observed	
Arenga pinnata (Wurmb.) Merr.	observed	
Areca triandra Roxb.	observed	
Pinanga annamensis Megalon	observed	
P. duperreana Pierre ex Gagnep.	VA 1008	
Calamus amarus Lour.	VA 966 VA 1246	
C. faberi Becc.	VA 1327	
C. scutellaris Becc.	VA 1326	R
Daemonorops geniculatus Mart.	VA 1005 VA 1328	
Musaceae		
Musa sp.	observed	
Zingiberaceae		
Alpinia strobiliformis T. L. Wu	VA 1104	NV
A. sp.	VA 943	
Hedychium poilanei K. Larsen	VA 960	
Marantaceae		
Phrynium dispermum Gagnep.	observed	
Donax cannaeformis (G. Forst.) K. Schum.	observed	
Hemodoraceae		
Ophiopogon regnieri Bois.	VA 937	
Liliaceae		
Petrosavia stellaris Bec.	VA 1116 VA 1323	NV
Chlorophytum laxum R.Br.	observed	O
Dianella nemorosa Lam. ex Schiller f.	VA 1002 VA 1241	M
Disporum trabeculatum Gagnep.	VA 1167 VA 1265	

Division, Family, Genus and Species	Voucher	Notes
Aspidistra typica Baill.	VA 906 VA 1260 VA 1261	
Smilacaceae		
Smilax corbularia Kunth	VA 932 VA 964 VA 1091 VA 1124 VA 1105	M
S. inversa T. Koyama	VA 1155	
S. lanceifolia Roxb.	VA 1117	M
S. sp.	VA 963	PNS
Amaryllidaceae		
Curculigo gracilis (Kurz.) Wall. ex Hook. f.	VA 1259	M
Cyperaceae		
Carex cryptostachys Brongn.	VA 956	
Mapania macrocephala (Gaudich.) K. Schum.	VA 936	
M. nudispica Koyama	VA 905	
Poaceae		
Arundinaria aff. *baviensis* Bal.	observed	
Bambusa balcoa Roxb.	observed	
Dendrocalamus membranaceus Munro	observed	
Lophatherum gracile Brogn.	VA 1293	M
Taccaceae		
Tacca integrifolia Ker Gawl.	observed	M
Dioscoreaceae		
Dioscorea cirrhosa Prain. et Burk	observed	
D. dissimulans Prain. et Burk	observed	R
D. triphylla L.	observed	
Orchidaceae		
Apostasia nuda R. Br.	VA 1003	
A. wallichii R. Br.	observed	
Aphyllorchis montana Reichb. f.	VA 1013	
Goodyera biflora (Lindl.) Hook. f.	VA 1040	
Zeuxine affinis (Lindl.) Benth.	VA 1142	
Cryptostylis arachnites (Blume) Hassk.	VA 1115	
Podochilus intermedius Aver.	VA 1031	
P. microphyllus Lindl.	VA 1273	
Appendicula reflexa Blume	VA 991	
Calanthe lyroglossa Reichb. f.	VA 907	
Mischobulbon cordifolium (Hook. f.) Schltr.	VA 1254	NV
Liparis mannii Reichb. f.	VA 1255	
L. balansae Gagnep.	VA 1283	
L. caespitosa (Thouars) Lindl.	VA 1014	
L. acutissima Reichb. f.	VA 1305 VA 1311	
Dendrobium nobile Lindl.	observed	O
D. oxyphyllum Gagnep.	observed	O
Eria paniculata Lindl.	observed	
E. amica Reichb. f.	VA 1275	
E. foetida Aver.	VA 1014	
E. apertiflora Summerh.	VA 1006	
Gastrochilus obliquus (Lindl.) O. Kuntz.	VA 1321	
Bulbophyllum fibratum (Gagnep.) Seidenf.	VA 1332	
B. corallinum Tix. & Guill.	VA 1331	
Panisea albiflora (Ridl.) Seidenf.	VA 1315	
Pholidota chinensis Lindl.	VA 931 VA 987	
Cymbidium ensifolium (L.) Sw.	observed	O
Renanthera annamensis Gagnep.	observed	O
Orchidaceae sp.	VA 1145	PNS

Follows Pham Hoang Ho (1991).Notes: M = Medicinal; W = Wood; O = Ornamental; NV = New record for Vietnam; PNS = Potential new species. E = Endangered; V = Vulnerable; R = Rare; I = Indeterminate as per IUCN (1997). Voucher specimens are held at the IEBR herbarium, with duplicates held at the Missouri Botanical Garden.

Appendix 2: Preliminary List of Mammals Recorded in the Study Area

No.	Common Name	Order, Family, Genus and Species	IUCN 1996	Data Source
	Treeshrews:	Scandentia:		
	Treeshrews	Tupaiidae		
1	Northern Treeshrew	*Tupaia belangeri*		O
	Bats:	Chiroptera:		
	Old-World Fruit Bats	Pteropodidae		
2	Short-nosed Fruit Bat	*Cynopterus sphinx*		S
3	Ratanaworabhan's Fruit Bat	*Megaerops niphanae*		S
4	Blandford's Fruit Bat	*Sphaerias blandfordi*		
5	Hill Long-tongued Fruit Bat	*Macroglossus sobrinus*		S
	False Vampire Bats	Megadermatidae		
6	Lesser False Vampire Bat	*Megaderma spasma*		S
	Horseshoe Bats	Rhinolophidae		
7	Woolly Horseshoe Bat	*Rhinolophus luctus*		S
8	Lesser Woolly Horseshoe Bat	*R. beddomei*		S
9	Pearson's Horseshoe Bat	*R. pearsonii*		S
10	Blyth's Horseshoe Bat	*R. lepidus*		S
11	Intermediate Horseshoe Bat	*R. affinis*		S
	Old-World Leaf-nosed Bats	Hipposideridae		
12	Andersen's Leaf-nosed Bat	*Hipposideros pomona*	DD	S
13	Intermediate Roundleaf Bat	*H. larvatus*		S
	Evening Bats	Vespertilionidae		
14	Nepalese Whiskered Bat	*Myotis muricola*		S
15	Daubenton's Bat	*M. daubentonii*		S
16	Greater Flat-headed Bat	*Tylonycteris robustula*		S
17	Black Gilded Pipistrelle	*Pipistrellus circumdatus*		S
18	Little Tube-nosed Bat	*Murina aurata*		S
19	Scully's Tube-nosed Bat	*M. tubinaris*		S
20	Round-eared Tube-nosed Bat	*M. cyclotis*		S
21	Tube-nosed Bat species	*M.* sp.		S
22	Hardwicke's Forest Bat	*Kerivoula hardwickii*		S
23	Forest Bat	*K. flora*		S
	Primates:	Primates:		
	Old-World Monkeys	Cercopithecidae		
24	Rhesus Macaque	*Macaca mulatta*	NT	O
25	Bear Macaque	*M. arctoides*	VU	C
26	Douc Langur	*Pygathrix nemaeus* ssp.	EN	O
	Carnivores:	Carnivora:		
	Dog and Foxes	Canidae		
27	[Indian Wild Dog or Dhole]	[*Cuon alpinus*]	VU	R
	Bears	Ursidae		
28	Asiatic Black Bear	*Ursus thibetanus*	VU	T
	Weasels, etc	Mustelidae		
29	Yellow-throated Marten	*Martes flavigula*		O
30	Hog-badger	*Arctonyx collaris*		R
31	Eurasian Otter	*Lutra lutra*		O
	Civets	Viverridae		
32	Common Palm Civet	*Paradoxurus hermaphroditus*		C
33	Masked Palm Civet	*Paguma larvata*		C

No.	Common Name	Order, Family, Genus and Species	IUCN 1996	Data Source
34	Binturong	*Arctictis binturong*		R
	Mongooses	Herpestidae		
35	Small Asian Mongoose	*Herpestes javanicus*		O
	Cats	Felidae		
36	Leopard Cat	*Prionailurus bengalensis*		C
37	[Golden Cat]	[*Catopuma temminckii*]	NT	T
38	[Clouded Leopard]	[*Pardofelis nebulosa*]	VU	T
39	[Tiger]	[*Panthera tigris*]	EN	I
	Even-toed Ungulates:	Artiodactyla:		
	Pigs	Suidae		
40	Pig species	*Sus* sp.		T
	Deer	Cervidae		
41	Sambar	*Cervus unicolor*		T,R
42	Truong Son Muntjac	*Muntiacus truongsonensis*	N/E	R
43	Indian Muntjac or Barking Deer	*M. muntjak*		R
	Cattle, Antelopes, etc	Bovidae		
44	Southern Serow	*Naemorhedus sumatraensis*	VU	R
	Rodents:	Rodentia:		
	Non-flying Squirrels	Sciuridae		
45	Black Giant Squirrel	*Ratufa bicolor*		O
46	Pallas's Squirrel	*Callosciurus erythraeus*		O
47	Cambodian Striped Tree-squirrel	*Tamiops rodolphii*		O
48	Red-cheeked Squirrel	*Dremomys rufigenis*		O
	Flying Squirrels	Pteromyidae		
49	Red Giant Flying Squirrel	*Petaurista philippensis*		O
50	Temminck's Flying Squirrel	*Petinomys setosus*		S
	Mice, Rats, etc	Muridae		
51	Chestnut Rat	*Niviventer fulvescens*		C

Follows Corbet and Hill (1992)
Status: EN = Endangered; VU = Vulnerable; NT = Near Threatened as per IUCN (1996); N/E = Not Evaluated
Data Source: S = Specimen trapped in the wild; O = Observed in the wild; T = Tracks or traces found; R = Remains found in local villager's house; C = Camera trap photograph; I = Interview data
Notes: species in brackets are unconfirmed records; all species idenified from remains found in local villagers' houses are considered provisional records pending final determination of specimens

Appendix 3: Preliminary List of Birds Recorded in the Study Area

No.	Common Name	Order, Family,Genus and Species	Record	Collar et al. 1994	Notes
		Galliformes			
		Phasianidae			
1	Rufous-throated Partridge	*Arborophila rufogularis*	3		
2	Bar-backed Partridge	*A. brunneopectus*	3		
3	Silver Pheasant	*Lophura nycthemera*	1		
4	Crested Argus	*Rheinardia ocellata*	3,4	VU	RRS
		Piciformes			
		Picidae			
5	White-browed Piculet	*Sasia ochracea*	4		
6	Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*	4		
7	Laced Woodpecker	*Picus vittatus*	3		
8	Bay Woodpecker	*Blythipicus pyrrhotis*	2,3		
		Megalaimidae			
9	Red-vented Barbet	*Megalaima lagrandieri*	3		
10	Golden-throated Barbet	*M. franklinii*	1,2,3,4		
		Bucerotiformes			
		Bucerotidae			
11	Brown Hornbill	*Anorrhinus tickelli*	2	NT	
		Trogoniformes			
		Trogonidae			
12	Red-headed Trogon	*Harpactes erythrocephalus*	1,2,3,4		
		Coraciiformes			
		Coraciidae			
13	Dollarbird	*Eurystomus orientalis*	4		
		Alcedinidae			
14	Common Kingfisher	*Alcedo atthis*	3		
		Halcyonidae			
15	Banded Kingfisher	*Lacedo pulchella*	1,3		
16	Stork-billed Kingfisher	*Halcyon capensis*	3		
17	White-throated Kingfisher	*H. smyrnensis*	3		
18	Black-capped Kingfisher	*H. pileata*	3		
		Meropidae			
19	Blue-tailed Bee-eater	*Merops philippinus*	3		
		Cuculiformes			
		Cuculidae			
20	Hodgson's Hawk Cuckoo	*Hierococcyx fugax*	3		
21	Indian Cuckoo	*Cuculus micropterus*	3,4		
22	Eurasian Cuckoo	*C. canorus*	3,4		
23	Banded Bay Cuckoo	*Cacomantis sonneratii*	2		
24	Plaintive Cuckoo	*C. merulinus*	3,4		
25	Asian Emerald Cuckoo	*Chrysococcyx maculatus*	3		
26	Drongo Cuckoo	*Surniculus lugubris*	3,4		
27	Asian Koel	*Eudynamys scolopacea*	3		
28	Green-billed Malkoha	*Phaenicophaeus tristis*	3,4		
		Centropodidae			
29	Greater Coucal	*Centropus sinensis*	3		

No.	Common Name	Order, Family,Genus and Species	Record	Collar et al. 1994	Notes
		Psittaciformes			
		Psittacidae			
30	Vernal Hanging Parrot	*Loriculus vernalis*	3		
31	Red-breasted Parakeet	*Psittacula alexandri*	3		
		Apodiformes			
		Apodidae			
32	Needletail species	*Hirundapus* sp.	3		
		Strigiformes			
		Tytonidae			
33	Oriental Bay Owl	*Phodilus badius*	3		
		Strigidae			
34	Mountain Scops Owl	*Otus spilocephalus*	1,2,3		
35	Collared Scops Owl	*O. bakkamoena*	1,3		
36	Brown Wood Owl	*Strix leptogrammica*	3		
37	Collared Owlet	*Glaucidium brodiei*	1,3,4		
		Eurostopodidae			
38	Great Eared Nightjar	*Eurostopodus macrotis*	3		
		Columbiformes			
		Columbidae			
39	Spotted Dove	*Streptopelia chinensis*	3,4		
40	Barred Cuckoo Dove	*Macropygia unchall*	3		
41	Thick-billed Green Pigeon	*Treron curvirostra*	4		
42	Green Imperial Pigeon	*Ducula aenea*	4		
43	Mountain Imperial Pigeon	*D. badia*	2,3		
		Ciconiiformes			
		Scolopacidae			
44	Wood Sandpiper	*Tringa glareola*	3		
		Accipitridae			
45	Oriental Honey-buzzard	*Pernis ptilorhynchus*	3,4		
46	Crested Serpent Eagle	*Spilornis cheela*	3,4		
47	Crested Goshawk	*Accipiter trivirgatus*	4		
48	Common Buzzard	*Buteo buteo*	3		
49	Black Eagle	*Ictinaetus malayensis*	2,4		
		Ardeidae			
50	Little Egret	*Egretta garzetta*	3		
51	Great Egret	*Casmerodius albus*	3		
52	Cattle Egret	*Bubulcus ibis*	3		
53	Chinese Pond Heron	*Ardeola bacchus*	3		
54	Little Heron	*Butorides striatus*	3		
		Passeriformes			
		Pittidae			
55	Blue-naped / Blue-rumped Pitta	*Pitta nipalensis / soror*	1,3	NT	
		Eurylaimidae			
56	Silver-breasted Broadbill	*Serilophus lunatus*	1		
57	Long-tailed Broadbill	*Psarisomus dalhousiae*	3,4		
		Irenidae			
58	Asian Fairy Bluebird	*Irena puella*	3,4		
59	Orange-bellied Leafbird	*Chloropsis hardwickii*	3,4		
		Corvidae			
60	White-winged Magpie	*Urocissa whiteheadi*	2,3	NT	

No.	Common Name	Order, Family,Genus and Species	Record	Collar et al. 1994	Notes
61	Common Green Magpie	*Cissa chinensis*	3		
62	Indochinese Green Magpie	*C. hypoleuca*	1,3	NT	
63	Racket-tailed Treepie	*Crypsirina temia*	3		
64	Large-billed Crow	*Corvus macrorhynchos*	3,4		
65	Ashy Woodswallow	*Artamus fuscus*	3		
66	Maroon Oriole	*Oriolus traillii*	2,3,4		
67	Indochinese Cuckooshrike	*C. polioptera*	2,3		
68	Black-winged Cuckooshrike	*C. melaschistos*	2		
69	Grey-chinned Minivet	*Pericrocotus solaris*	3,4		
70	Long-tailed Minivet	*P. ethologus*	2,3,4		
71	Scarlet Minivet	*P. flammeus*	3,4		
72	Bar-winged Flycatcher-shrike	*Hemipus picatus*	3,4		
73	Black Drongo	*Dicrurus macrocercus*	3		
74	Ashy Drongo	*D. leucophaeus*	4		
75	Crow-billed Drongo	*D. annectans*	1		
76	Bronzed Drongo	*D. aeneus*	3		
77	Lesser Racket-tailed Drongo	*D. remifer*	1,3		
78	Greater Racket-tailed Drongo	*D. paradiseus*	3,4		
79	Black-naped Monarch	*Hypothymis azurea*	1,3		
80	Asian Paradise-flycatcher	*Terpsiphone paradisi*	1,3,4		
		Muscicapidae			
81	Blue Whistling Thrush	*Myophonus caeruleus*	2,3		
82	Siberian Thrush	*Zoothera sibirica*	4		
83	Scaly Thrush	*Z. dauma*	1		
84	Dark-sided Thrush	*Z. marginata*	1		
85	Lesser Shortwing	*Brachypteryx leucophrys*	4		
86	White-browed Shortwing	*B. montana*	2		
87	Ferruginous Flycatcher	*Muscicapa ferruginea*	1,3		
88	White-gorgeted Flycatcher	*Ficedula monileger*	1,3		
89	Blue-and-white Flycatcher	*Cyanoptila cyanomelana*	3		
90	Large Niltava	*Niltava grandis*	1,2,3		
91	Small Niltava	*N. macgrigoriae*	1,3		
92	Fujian Niltava	*N. davidi*	1	NT	
93	White-tailed Flycatcher	*Cyornis concretus*	1,3		
94	[Pale Blue Flycatcher]	[*C. unicolor*]	1,3		
95	Blue-throated Flycatcher	*C. rubeculoides*	1,3		
96	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	3,4		
97	Siberian Blue Robin	*Luscinia cyane*	1		
98	Oriental Magpie Robin	*Copsychus saularis*	3		
99	White-rumped Shama	*C. malabaricus*	1,3,4		
100	Slaty-backed Forktail	*Enicurus schistaceus*	1,2		
101	White-crowned Forktail	*E. leschenaulti*	1		
102	Green Cochoa	*Cochoa viridis*	1,3	NT	
103	Common Stonechat	*Saxicola torquata*	3		
		Sturnidae			
104	Black-collared Starling	*Sturnus nigricollis*	4		
105	Hill Myna	*Gracula religiosa*	3		
		Sittidae			
106	Yellow-billed Nuthatch	*Sitta solangiae*	3,4	VU	RRS

No.	Common Name	Order, Family,Genus and Species	Record	Collar et al. 1994	Notes
		Paridae			
107	Yellow-cheeked Tit	*Parus spilonotus*	2,3		
108	Yellow-browed Tit	*Sylviparus modestus*	2		
109	Sultan Tit	*Melanochlora sultanea*	1,3,4		
		Aegithalidae			
110	Black-throated Tit	*Aegithalos concinnus*	2,3		
		Hirundinidae			
111	Barn Swallow	*Hirundo rustica*	3,4		
112	Wire-tailed Swallow	*H. smithii*	3		
113	Red-rumped Swallow	*H. daurica*	4		
114	Asian House Martin	*Delichon dasypus*	3		
		Pycnonotidae			
115	Black-crested Bulbul	*Pycnonotus melanicterus*	3		
116	Red-whiskered Bulbul	*P. jocosus*	1,3,4		
117	Puff-throated Bulbul	*Alophoixus pallidus*	1,3,4		
118	Mountain Bulbul	*Hypsipetes mcclellandii*	1,3		
		Cisticolidae			
119	Zitting Cisticola	*Cisticola juncidis*	3		
120	Yellow-bellied Prinia	*Prinia flaviventris*	3		
		Sylviidae			
121	Asian Stubtail	*Urosphena squameiceps*	1		
122	Common Tailorbird	*Orthotomus sutorius*	3		
123	Dark-necked Tailorbird	*O. atrogularis*	3		
124	Yellow-browed Warbler	*Phylloscopus inornatus*	1,3		
125	Greenish Warbler	*P. trochiloides*	2		
126	White-tailed Leaf Warbler	*P. davisoni*	2		
127	Golden-spectacled Warbler	*Seicercus burkii*	2		
128	White-spectacled Warbler	*S. affinis*	2		
129	Grey-cheeked Warbler	*S. poliogenys*	1,3		
130	Chestnut-crowned Warbler	*S. castaniceps*	1,3		
131	White-crested Laughingthrush	*Garrulax leucolophus*	3		
132	Golden-winged Laughingthrush	*G. ngoclinhensis*	2	NE	RRS
133	Black-hooded Laughingthrush	*G. milleti*	1,3,4	VU	RRS
134	Black-throated Laughingthrush	*G. chinensis*	3		
135	Red-tailed Laughingthrush	*G. milnei*	2,3	NT	
136	Buff-breasted Babbler	*Pellorneum tickelli*	1,3		
137	Large Scimitar Babbler	*Pomatorhinus hypoleucos*	3		
138	Coral-billed Scimitar Babbler	*P. ferruginosus*	1,3		
139	Streaked Wren Babbler	*Napothera brevicaudata*	1,2,3		
140	Rufous-fronted Babbler	*Stachyris rufifrons*	2		
141	Golden Babbler	*S. chrysaea*	1,3		
142	Grey-throated Babbler	*S. nigriceps*	1,3		
143	Striped Tit Babbler	*Macronous gularis*	1,3		
144	Cutia	*Cutia nipalensis*	2		
145	White-browed Shrike Babbler	*Pteruthius flaviscapis*	3		
146	Chestnut-fronted Shrike Babbler	*P. aenobarbus*	2,3		
147	Blue-winged Minla	*Minla cyanouroptera*	2		
148	Red-tailed Minla	*M. ignotincta*	2		
149	Golden-breasted Fulvetta	*Alcippe chrysotis*	2		
150	Rufous-winged Fulvetta	*A. castaneceps*	2		

No.	Common Name	Order, Family,Genus and Species	Record	Collar et al. 1994	Notes
151	Streaked-throated Fulvetta	*A. cinereiceps*	2		
152	Rufous-throated Fulvetta	*A. rufogularis*	1,3	NT	
153a	Mountain Fulvetta	*A. peracensis grotei*	1,3		
153b	Mountain Fulvetta	*A. p. annamensis*	1,2,3,4		
154	Black-headed Sibia	*Heterophasia melanoleuca*	2		
155	Stripe-throated Yuhina	*Yuhina gularis*	2		
156	Black-chinned Yuhina	*Y. nigrimenta*	1,3		
157	White-bellied Yuhina	*Y. zantholeuca*	1,2,3,4		
158	Grey-headed Parrotbill	*Paradoxornis gularis*	1,3		
159	Black-throated Parrotbill	*P. nipalensis*	3		
		Nectariniidae			
160	Plain Flowerpecker	*Dicaeum concolor*	3		
161	Fire-breasted Flowerpecker	*D. ignipectus*	3		
162	Ruby-cheeked Sunbird	*Anthreptes singalensis*	3		
163	Olive-backed Sunbird	*Nectarinia jugularis*	3		
164	Mrs Gould's Sunbird	*Aethopyga gouldiae*	3		
165	Green-tailed Sunbird	*A. nipalensis*	2,3		
166	Fork-tailed Sunbird	*A. christinae*	3,4		
167	Black-throated Sunbird	*A. saturata*	3,4		
168	Crimson Sunbird	*A. siparaja*	1,3,4		
169	Little Spiderhunter	*Arachnothera longirostra*	1,3		
170	Streaked Spiderhunter	*A. magna*	1,2,3,4		
		Passeridae			
171	White-rumped Munia	*Lonchura striata*	3		

Follows Inskipp *et al.* (1996)

Record: 1: Preliminary idenification of specimen(s) collected March-April 1999, Tra Do'n commune, between 900 and 1,500 m
2: Field observation March-May 1998, Tra Linh commune, between 1,200 and 2,598 m; observer Le Trong Trai
3: Field observation March-April 1999, Tra Do'n communes, between 150 and 1,650 m; observer B.F. King
4: Field observation March 1999, Tra Do'n, Tra Giac and Tra Don communes, between 150 and 1,500 m; observer A.W. Tordoff
the species in brackets is an unconfirmed record

Status: VU = Vulnerable; NT = Near Threatened as per Collar *et al* (1994); NE = Not Evaluated

Notes: RRS = Restricted-range Species

Appendix 4: Preliminary List of Reptiles and Amphibians Recorded in the Study Area

No.	Class, Order, Family, Genus and Species	Data Source
	Reptilia	
	Squamata:	
	Gekkonidae	
1	*Cyrtodactylus irregularis*	S
2	*Gekko gecko*	O
	Agamidae	
3	*Acanthosaura capra*	S
4	*A. crucigera*	S
5	*Draco maculatus*	O
	Scincidae	
6	*Mabuya longicaudata*	S
7	*Scincella* sp.	S
	Lacertidae	
8	*Takydromus* sp.	S
	Anguidae	
9	*Ophisaurus sokolovi*	S
	Colubridae	
10	*Amphiesma* sp.	S
11	*Calamaria septentrionalis*	S
12	*Dendrelaphis pictus*	S
13	*Pareas hamptoni*	S
14	*Sinonatrix trianguligea*	S
	Viperidae	
15	*Trimeresurus stejnegeri*	S
	Amphibia	
	Anura:	
	Pelobatidae	
16	*Leptobrachium* (*Leptobrachium*) sp.	S
17	*Leptobrachium* (*Leptolalax*) *pelodytoides*	S
18	*L.* (*Leptolalax*) sp.	S
19	*Megophrys lateralis*	S
	Bufonidae	
20	*Bufo galeatus*	S
21	*B. melanostictus*	S
22	*Ophryophryne microstoma*	S
23	*O. poilani*	S
	Ranidae	
24	*Occidozyga lima*	S
25	*Rana blythi*	S
26	*R. kuhlii*	S
27	*R. limnocharis*	S
28	*R. livida*	S
29	*R. ricketti*	S
30	*R. spinosa*	S
31	*R. verrucospinosa*	S
32	*R.* sp.	S

No.	Class, Order, Family, Genus and Species	Data Source
	Rhacophoridae	
33	*Rhacophorus annamensis*	S
34	*R. calcaneus*	S
35	*R. leucomystax*.	S
36	*R. verucosus*	S
	Microhylidae	
37	*Microhyla annamensis*	S
38	*M. heymonsi*	S
39	*M. ornata*	S
40	*M. pulchra*	S

Follows Nguyen Van Sang and Ho Thu Cuc (1996)

THE EUROPEAN COMMUNITY AND VIETNAM

The principal objective of the European Community's (EC) co-operation strategy in Vietnam is to help consolidate Vietnam's transition towards a market economy, whilst promoting sustained growth and sustainable development and mitigating the social effects of this transition.

EC development co-operation gives priority to the protection of the environment and natural resources (in particular tropical forests), sustainable development of the rural sector and improvement of food security levels and support to social sectors affected by the transition to a market economy - mainly health and human resources.

EC economic co-operation is devised to improve the economic, legal and social environment for the private sector, including small and medium enterprises, to support on-going economic and administrative reforms and to promote the integration of Vietnam into regional and global economic frameworks.

Over the past five years (1994 to 1998) the European Community has allocated a total of Euro 200 million (US$ 211 million) in grant assistance to Vietnam.

The Forest Inventory and Planning Institute (FIPI) was established on 29 January 1961 by Government Decision 140/CP. FIPI is under the general juristiction of the Ministry of Agriculture and Rural Development (MARD). FIPI has a staff of 760, divided between the headquarters in Hanoi and six sub-institutes throughout Vietnam. At the headquarters in Hanoi, there is a map printing section and two scientific and technological centres: the Forest Resources and Environment Centre (FREC) and Centre for Forestry Information Consulting (CFIC).

FIPI's main roles are to (a) survey and monitor forest resources; (b) prepare forestry development plans at the national, regional and provincial level; (c) prepare feasibility studies and investment plans for national parks, nature reserves and forest enterprises; (d) develop and inspect the implementation of regulations and technical instructions related to forest inventory and management planning; (e) train forestry professionals in forest inventory and surveying techniques; (f) undertake applied research in the fields of forest inventory, management planning and forestry-based rural development; and (g) provide technical and consultative services for forestry development projects with national and international counterparts.

FIPI maintains and distributes up-to-date data on forest resources in Vietnam. FIPI has participated in many government-sponsored programmes on forestry, biodiversity conservation, and regional integrated socio-economic development planning. FIPI has implemented many forestry, upland rural development, and natural resources conservation projects supported by bilateral, multilateral, and non-governmental agencies.

BirdLife International is a global conservation federation with a worldwide network of Partner organizations, Representatives and committed individuals.

BirdLife International seeks to conserve all bird species on earth and their habitats and, through this, it works for the world's biological diversity. It recognizes that the problems affecting birds, their habitats and our global environment are linked inseparably with social, economic and cultural factors and that these can only be resolved if human societies function in an ecologically sustainable manner and if the needs, welfare and aspirations of people form a part of all conservation action.

Birds provide BirdLife International with a uniquely valuable focus: they are sensitive indicators of biological richness and environmental trends and fulfil many key ecological functions; they contribute greatly to our understanding of natural processes; they are an important economic resource; and they have inspired and delighted people of many cultures for centuries, which makes them excellent ambassadors for the promotion of conservation awareness and international collaboration.

BirdLife International pursues a programme of:

* scientific research and analysis to identify and monitor worldwide the most threatened bird species and the most critical sites for the conservation of bird diversity;

* advocacy and policy development to promote the conservation of birds and biodiversity through sustainability in the use of all natural resources;

* field action and country conservation programmes, ranging from community-based land-use and management projects to species recovery programmes benefiting both wildlife and people;

* network and capacity building to expand and strengthen the global partnership of conservation organizations and to promote worldwide interest in the conservation of birds and the wider environment.

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