

**BirdLife International Vietnam Programme
in collaboration with the
Forest Inventory and Planning Institute**

**An Investment Plan for
Ngoc Linh Nature Reserve,
Kon Tum Province, Vietnam**

A Contribution to the Management Plan

**Conservation Report
Number 5**

An Investment Plan for
Ngoc Linh Nature Reserve,
Kon Tum Province, Vietnam

A Contribution to the Management Plan

by

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Conventions Used

Plant names, sequence and species limits follow Pham Hoang Ho (1991), with scientific names given at first mention and in Appendix 1. Mammal names (common and scientific), sequence and species limits follow Corbet and Hill (1992), 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), with scientific names given at first mention and in Appendix 3. Herpetile and butterfly names (common and scientific), sequence and species limits follow Nguyen Van Sang and Ho Thu Cuc (1996) and Corbet et al. (1992), respectively.

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

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

A threatened species is any species included in the IUCN Red Lists of Threatened Animals and Plants (IUCN 1996 and 1997) or in the Red Data Books of Vietnam (Anon. 1992 and 1996).

Endemic Bird Areas refer to an area supporting at least two restricted-range bird species. A restricted-range bird species is a species with a global range of less than 50,000 km².

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

Abbreviations and Acronyms Used

| | | |
|-------|---|--|
| BAP | - | Biodiversity Action Plan |
| CITES | - | Convention on International Trade in Endangered Species |
| EBA | - | Endemic Bird Area |
| EU | - | European Union |
| FAO | - | Food and Agriculture Organisation |
| FIPI | - | Forest Inventory and Planning Institute, Hanoi |
| FREC | - | Forest Resources and Environment Centre |
| GNP | - | Gross National Product |
| ICBP | - | International Council for Bird Preservation (now BirdLife International) |
| IUCN | - | World Conservation Union |
| MARD | - | Ministry of Agriculture and Rural Development |
| MOF | - | Ministry of Forestry (now part of MARD) |
| NGO | - | Non-Governmental Organisation |
| UNDP | - | United Nations Development Programme |
| WWF | - | World Wide Fund for Nature |

Map 1: Location of Ngoc Linh Nature Reserve, Kon Tum Province



Grid: UTM, zone 48

SCALE 1:1,000,000

Produced by the Forest Resources and Environment Centre of FIPI

Executive Summary

This report is an expanded translation of the investment plan for Ngoc Linh Nature Reserve, Kon Tum province, written in Vietnamese by the Forest Inventory and Planning Institute (FIPI) in collaboration with BirdLife International. The objective of the original investment plan was to provide the necessary information and justification to upgrade Ngoc Linh to a functioning nature reserve. The objective of this report is to provide a higher level of detail for an international audience interested in Ngoc Linh Nature Reserve, Kon Tum province.

In April-May 1996 and March-May 1998, BirdLife International worked in collaboration with FIPI to formulate an investment plan for Ngoc Linh Nature Reserve. The plan, funded by the European Union and BirdLife International, was part of the government's commitment to increase Vietnam's protected area coverage to 2 million hectares by the year 2000.

Ngoc Linh Nature Reserve, Kon Tum province, is located in Vietnam's Western Highlands. The area is at high elevation, with Mount Ngoc Linh, Vietnam's second highest peak at 2,598 m, as its most prominent feature. The nature reserve's proposed 41,420 ha coverage would be augmented by two adjacent proposed protected areas to the north: Ngoc Linh (Quang Nam province) and Song Thanh-Dakpring Nature Reserves. Together, the three nature reserves would cover more than 170,000 ha. Three Endemic Bird Areas (EBAs) were found in Vietnam. Bird endemism is believed to be a good indicator of an area's overall biodiversity. Fieldwork in Ngoc Linh Nature Reserve, Kon Tum province indicates that the area qualifies as Vietnam's fourth EBA and warrants protected area status.

To better assess the value of conserving the area, a preliminary inventory of Ngoc Linh's flora and fauna was conducted. The inventory found that the nature reserve is home to a number of endemic and threatened species. Four previously known restricted-range bird species were recorded, as were two species and 12 subspecies of birds new to science. The area is also home to two recently discovered mammal species. As for flora, 878 plant species were recorded, including 45 threatened plant species. The area is the only known location for the endemic Ngoc Linh or Vietnamese Ginseng *Panax vietnamensis*.

Fauna of Ngoc Linh Nature Reserve

| Group | Number of Species | % Threatened |
|------------|-------------------|--------------|
| Mammals | 52 | 42 |
| Birds | 190 | 9 |
| Reptiles | 41 | 39 |
| Amphibians | 23 | 22 |

Listed in either the IUCN Red List (IUCN 1996) or the Red Data Book of Vietnam (Anon. 1992).

A biodiversity comparison of Ngoc Linh Nature Reserve with nine Vietnamese national parks shows that Ngoc Linh ranks higher in levels of overall biodiversity than all but one of Vietnam's national parks (Cuc Phuong National Park).

A total of 13,876 people live in the nature reserve's buffer zone. Most of area's inhabitants (65%) are from the Xe Dang ethnic minority. The eight communes in the buffer zone suffer from poor access, a lack of health and education facilities, and a shortage of teachers and health workers.

About 75% of the area's inhabitants survive by shifting cultivation, hunting, and collecting forest products. A number of these people have been scheduled to receive permanent housing under a government settlement programme.

Wet rice cultivation, swidden agriculture and animal husbandry are the main economic activities in the area. Annual water shortages, however, mean that only one crop of rice per year can be produced. Forty percent of the area's population suffers from malnutrition and lacks sufficient food for at least one

month per year. Most households own livestock.

There are five state-run forest enterprises operating in the area. Rung Thong Forest Enterprise is the only one that is continuing to cut timber (6,000 m³ a year) and collect pine resin (30 tonnes a year) in the buffer zone. It is proposed that the people working in the forest enterprises will be recruited as nature reserve staff.

In order to conserve Ngoc Linh Nature Reserve, a number of development programmes are proposed. The first is to improve the nature reserve's infrastructure by constructing a new headquarters, building seven guard stations, demarcating the protected area boundary, and improving local trails and roads. The second is to implement a conservation and protection programme by hiring 42 forest guards, reforesting several areas with native species, and strengthening the ongoing government agroforestry programme. The third is to begin a scientific research programme to monitor and develop the area's flora and fauna. The fourth is to design and implement an environmental education and awareness campaign, and the fifth is to create an administrative structure and hire 13 managers and support staff.

The nature reserve would be managed by the Kon Tum Provincial People's Committee with the assistance of the Ministry of Agriculture and Rural Development (MARD). The total cost of the five programmes would be VND16,317 million over five years.

The objectives of the nature reserve would be to:

- conserve the representative tropical montane forest habitats;
- protect and maintain the area's rich biodiversity;
- protect the populations of threatened and endemic species;
- promote the creation of a buffer zone; and
- safeguard the watershed protection value of the area.

This report proposes that, once Ngoc Linh (Kon Tum province), Ngoc Linh (Quang Nam province) and Song Thanh-Dakpring (Quang Nam province) Nature Reserves have been established, they be upgraded to national park status. This would afford the highest management category to and ensure central government funding for an extensive, representative example of the Kontum Plateau EBA.

Tóm tắt quá trình thực hiện

Bản báo cáo này dịch từ “Dự án đầu tư khu Bảo tồn thiên nhiên Ngọc Linh, tỉnh Kon Tum” của Viện Điều tra quy hoạch rừng (FIPI) và BirdLife International. Mục tiêu của dự án đầu tư nhằm cung cấp những thông tin cần thiết và minh chứng cần thiết để nâng cấp Ngọc Linh thành khu Bảo tồn thiên nhiên. Mục đích của báo cáo này là đưa ra các thông tin ở mức cao và chi tiết hơn cho những độc giả quốc tế có quan tâm đến Khu Bảo tồn thiên nhiên Ngọc Linh, tỉnh Kon Tum.

Trong khoảng thời gian từ tháng 4 - 5 năm 1996 và từ tháng 3 - 5 năm 1998, tổ chức BirdLife International đã phối hợp với Viện Điều tra Quy hoạch Rừng (Hà Nội) trình bày dự án đầu tư cho Khu Bảo tồn thiên nhiên Ngọc Linh. Dự án này đã được Cộng đồng Châu Âu và tổ chức BirdLife International tài trợ và nó cũng là mục tiêu của Chính Phủ nhằm tăng diện tích các khu rừng đặc dụng ở Việt Nam lên tới 2 triệu ha vào năm 2000.

Khu Bảo tồn thiên nhiên Ngọc Linh nằm ở vị trí vùng đồi núi cao miền Trung Việt Nam. Khu vực này có độ cao lớn với nét đặc trưng tiêu biểu là đỉnh núi Ngọc Linh cao thứ nhì Việt Nam. Khu Bảo tồn thiên nhiên dự kiến 41,424 ha có thể tăng thêm nữa bởi hai khu vực bảo vệ liền kề nhau tới tận phía Bắc: Ngọc Linh (tỉnh Quảng Nam) và Khu Bảo tồn thiên nhiên Sông Thanh-Dakpring. Kết hợp cả 3 khu này lại thì diện tích trên 170,000 ha.

Năm 1992, tổ chức BirdLife International đã tiến hành khảo sát trên toàn thế giới và xác định được 221 trung tâm chim đặc hữu. Ba vùng chim đặc hữu đã được tìm thấy ở Việt Nam. “Chim đặc hữu” được coi là một chỉ thị tốt cho tính đa dạng sinh học toàn vùng. Qua thực địa ở khu Bảo tồn thiên nhiên Ngọc Linh đã cho thấy khu vực này có đủ khả năng để được chứng nhận là vùng Chim đặc hữu thứ tư ở Việt Nam.

Công việc điều tra sơ bộ về động, thực vật đã được tiến hành để đánh giá giá trị của nó được tốt hơn. Qua đó cho thấy Khu bảo tồn thiên nhiên đề xuất là nơi cư ngụ của một số loài đặc hữu và đang có nguy cơ bị đe dọa. Đã thu thập được 4 loài chim hiếm có trước đây, cùng với 2 loài và 11 phân loài chim mới cho khoa học. Khu vực này cũng là nơi cư trú cho những loài thú mới phát hiện gần đây. Về thực vật có 878 loài được thu thập, trong đó có 45 loài đang bị đe dọa. Đây là nơi cư ngụ của các loài đặc hữu và được biết đến là nơi duy nhất có loài Sâm Ngọc Linh (*Panax vietnamensis*).

Động thực vật khu bảo tồn thiên nhiên Ngọc Linh

| Nhóm | Số loài | Mức độ nguy cấp % |
|----------|---------|-------------------|
| Thú | 52 | 44 |
| Chim | 190 | 10 |
| Bò sát | 41 | 39 |
| Lưỡng cư | 23 | 22 |

Danh sách được sắp xếp theo IUCN Red Lists (IUCN1996) và Sách đỏ Việt Nam (Anon.1992).

So sánh về tính trạng đa dạng sinh học của Khu Bảo tồn thiên nhiên Ngọc Linh với 9 vườn Quốc gia khác cho thấy khu vực này xếp ở bậc cao hơn hẳn bởi tính đa dạng sinh học ở đây cao hơn tất cả các khu Vườn quốc gia khác (ví dụ như Vườn Quốc gia Cúc Phương).

Có 13,876 người sống trong vùng đệm của Khu Bảo tồn thiên nhiên. Chủ yếu tộc người Xê Đăng cư trú ở đây (65%). Tám xã vùng đệm đang chịu cảnh thiếu thốn về trang thiết bị y tế giáo dục; như không đủ giáo viên, nhân viên y tế. Đường sá đi lại trong vùng gặp nhiều khó khăn. Có khoảng 75% dân số sinh sống bằng phương thức du canh, săn bắn, thu hái các sản phẩm từ rừng. Một phần trong số họ đã được cấp nhà lâu dài trong kế hoạch định canh của Chính Phủ.



Cây cấy lúa nước, chăn nuôi gia súc là hoạt động kinh tế chính của vùng này. Vì thiếu nước nên một năm chỉ thu hoạch được một vụ lúa. Bốn mươi phần trăm dân số trong khu vực phải chịu cảnh đói ăn và thiếu lương thực ít nhất là một tháng/năm. Hầu hết các hộ dân đều chăn nuôi gia súc.

Trong vùng này có 5 lâm trường quốc doanh hoạt động. Ở trong vùng đệm chỉ còn duy nhất lâm trường Rừng Thông vẫn tiếp tục khai thác (6,000 m³/năm) và lấy nhựa thông (30 tấn/năm). Mong rằng những người làm việc ở các lâm trường trong rừng sẽ được bổ sung làm nhân viên của khu bảo tồn thiên nhiên.

Để Ngọc Linh trở thành 1 khu bảo tồn thiên nhiên bền vững, chúng tôi kiến nghị một số chương trình phát triển như sau:

1. Nâng cấp hạ tầng cơ sở của Khu Bảo tồn thiên nhiên bằng cách xây dựng một ban quản lý mới, xây dựng 7 trạm gác, phân ranh rới Khu Bảo tồn, nâng cấp đường sắt và đường bộ ở địa phương.
2. Thực hiện công tác bảo tồn và chương trình bảo vệ bằng cách tuyển 42 người bảo vệ, khôi phục lại nhiều khu vực rừng với các loài cây bản địa và tiếp tục hoàn thiện chính sách khuyến nông của chính phủ.
3. Bắt đầu các chương trình nghiên cứu khoa học để theo dõi và phát triển các loài động thực vật.
4. Dự thảo và thực hiện chương trình giáo dục về môi trường và chiến dịch nâng cao nhận thức.
5. Thiết lập một hệ thống hành chính và tuyển 13 người quản lý và những nhân viên giúp việc.

Khu bảo tồn thiên nhiên sẽ được UBND tỉnh Kon Tum quản lý với sự giúp đỡ của Bộ Nông nghiệp và phát triển nông thôn, Tổng chi phí cho cả năm chương trình hoạt động trên 5 năm sẽ là 16,317 triệu đồng.

Những mục tiêu của dự án là:

- Bảo vệ nét đặc trưng của sinh cảnh núi rừng nhiệt đới
- Bảo vệ và duy trì tính đa dạng sinh học cao của vùng này
- Bảo vệ các cá thể đặc hữu và đang bị đe dọa
- Tạo lập vùng đệm
- Bảo vệ giá trị phòng hộ đầu nguồn của khu vực.

1. Introduction

This is an expanded English-language version of the original Vietnamese-language investment plan for Ngoc Linh Nature Reserve prepared by the Forest Inventory and Planning Institute (FIPI) and BirdLife International. The objective of the Vietnamese report was to provide the justification and details needed to formally establish Ngoc Linh Nature Reserve in Kon Tum province. The objective of the English translation is to serve as a source document for a wider audience.

1.1 Geography, Demographics, Economics and Environment

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 point and 47 km across at its narrowest point. Vietnam's total land area is 331,689 km². 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 comprised 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\$250 (World Bank 1997). 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 caused an over-exploitation of Vietnam's natural resources. The environment in Vietnam has largely been compromised; forest cover is estimated at less than 20% of the country's total land area (less than 10% primary forest) (Vo Quy 1998). Over the last two decades, there has been an average reduction of forest by 350,000 ha per year (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

The government of Vietnam recognised the necessity 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 the 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 Forest.** 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) **Watershed Protection Forest.** These forested areas can be allocated to forestry agencies, people's committees, or to the people directly, with the main purposes of watershed protection, soil erosion control, and foreshore protection with special provisions as per Articles 35-37; and
- (c) **Special-Use Forest (Protected Area).** These are forested lands allocated for environment 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 preservation 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 types of wildlife and habitat types found within the country of Vietnam.

Vietnam currently has proposals for 105 protected areas, comprising 976,000 ha or 3% of the total land area. If these proposals are adopted, there will be 10 national parks, 61 nature reserves, and 34 cultural of historical sites (Dang Huy Huynh 1998). Vietnam is actively gazetting new sites as part of its treaty obligations under the Convention on Biological Diversity. Under this treaty, Vietnam has agreed to establish 2,000,000 ha of protected areas by the year 2000, thereby doubling the network of Special-Use Forests.

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 1996).

1.3 The Kontum Plateau

The Kontum Plateau is the mountainous region centred on Kon Tum and southern Quang Nam provinces in the Western Highlands of Vietnam, also known as the Central Highlands, is the second highest montane area in Vietnam and includes the second highest mountain in Vietnam, Mount Ngoc Linh (2,598 m). Mount Ngoc Linh lies within Ngoc Linh Nature Reserve, a geographically isolated and unique area that encompasses lower and upper montane habitats within its conservation coverage. The Kontum Plateau region also supports extensive areas of primary forest.

1.4 Ngoc Linh Nature Reserve

The Ngoc Linh area was recognised for its unique flora, upper montane forest and a nationally famous endemic plant with purported medicinal qualities, Ngoc Linh or Vietnamese Ginseng *Panax vietnamensis*.



The conservation coverage of Ngoc Linh Nature Reserve is primarily comprised of degraded lower montane evergreen forest and pristine upper montane evergreen forest. This includes patches of primary forest and secondary lower montane evergreen forest from 1,500 to 1,700 m; above this altitude, the forest is largely pristine with a closed canopy. Predominantly upper montane primary evergreen forest extends from 1,700 to 2,400 m (Eames *et al.* 1999a).

The high montane peaks of Ngoc Linh Nature Reserve are also especially notable both for high levels of insulation and for extremely localised or restricted-range endemism. According to the Protected Areas System Review of the Indo-Malayan Realm (MacKinnon 1996), the Kontum Plateau, centred on Mount Ngoc Linh, lies within sub-unit Ma (Central Annam Mountains) which shows moderately high levels of endemism of conifers and birds. As such, the forest protected by Ngoc Linh Nature Reserve was the focus of ornithological surveys to elucidate areas for conservation planning in 1996 and 1998 (Eames *et al.* 1999a).

Ngoc Linh Nature Reserve also plays a very important role in the region's watershed management. The forest in Ngoc Linh, Dac Man and Dac Plo districts, and the Lo Xo Pass area encompasses the upstream catchments of all the main river systems in the region, including the Dac Mek, Dac Po Lo, Thu Bon and Dac Bla Rivers flowing to Laos. As a result, this forest plays a crucial economic role in Quang Nam and Kon Tum provinces as the main water source point for irrigation, domestic water supplies and the reservoir of Yaly Hydropower Station.

1.5 History and Official Status

The original recommendation for establishing Ngoc Linh Nature Reserve in Kon Tum province was made in 1986. Ngoc Linh Nature Reserve was included in Ministerial Decision No. 194/CT dated 9 August 1986, which proposed establishing 73 protected areas, including two national parks, 46 nature reserves, and 25 cultural and historical sites. Although this decree included the original recommendation for the formation of Ngoc Linh Nature Reserve in Kon Tum province, the proposed conservation coverage was only 20,000 ha (Cao Van Sung 1995). In the Biodiversity Action Plan for Vietnam (Government of the Socialist Republic of Vietnam 1994), Ngoc Linh Nature Reserve was listed as one of twelve priority areas in Vietnam for expansion in order to protect regional biodiversity.

1.6 Current Conservation Status

The 41,420 ha conservation coverage proposed for Ngoc Linh Nature Reserve includes the majority of extant primary forest in the area. From 1976 to 1995, the area which includes the nature reserve lost approximately 13% of its evergreen forest. The decrease in evergreen forest was accompanied by an increase in scrub and grasslands from 10 to 21% of the area. Ground surveys indicate that shifting cultivation was the primary cause of this significant loss of evergreen forest (Eames *et al.* 1999a). The rate of habitat loss due to shifting cultivation is increasing due to population growth in local communities.

Road construction plans for the Western Highlands also present a potential threat to Ngoc Linh Nature Reserve. A 1,789 km highway project, currently in the developmental phase, is aimed at traversing Vietnam's western border. National Highway 14, which bisects the nature reserve, is included for upgrading as part of this highway project, which would facilitate access to the forest and resources of Ngoc Linh Nature Reserve, and potentially increase the rate of forest degradation (Eames *et al.* 1999a).

The conservation coverage of the Ngoc Linh area of the northern Kontum Plateau would benefit from the planned establishment of two additional nature reserves, both abutting Ngoc Linh Nature Reserve to the east and north in Quang Nam province. These are Ngoc Linh (Quang Nam) Nature Reserve,



directly east of Ngoc Linh Nature Reserve (approximately 30,000 ha) and Song Thanh-Dakpring Nature Reserve (approximately 100,000 ha), currently proposed by the World Wide Fund for Nature's (WWF) Indochina Programme (Wikramanayake *et al.* 1997). Song Thanh-Dakpring Nature Reserve would include an area of Quang Nam province to the north of Ngoc Linh (Kon Tum) Nature Reserve, extending from the western boundary of Ngoc Linh (Quang Nam) Nature Reserve to Vietnam's border with Laos.

1.7 Current Legislative Status

Several documents govern the establishment, expansion, development, management and regulations of Vietnam's protected areas network, of which the most important for Ngoc Linh Nature Reserve are in chronological order:

- Ministerial Decision No. 194/CT dated 9 August 1986 proposing the establishment of 73 protected areas, including two national parks, 46 nature reserves, and 25 cultural and historical sites. This decree included the original recommendation for the formation of Ngoc Linh Nature Reserve in Kon Tum province;
- Ministerial Decision No. 1171/QD of 30 December 1986 which outlines the management regulations and objectives of 'Special-Use Forests';
- Ministerial Decision No. 62 LN/KL dated 3 February 1990, which regulates the principles and procedures for the establishment of 'Special-Use Forests';
- Guidelines of the Ministry of Forestry dated July 1991, outlining the methods and contents of feasibility studies for establishment of 'Special-Use Forests';
- The Forestry Sector Review, and the Tropical Forestry Action Programme and Plan were established in December 1991 under UNDP/FAO Project VIE/88/037 in order to institute Vietnam's terms of reference on forest policy and legislation;
- The Ministry of Forestry (now under the Ministry of Agriculture and Rural Development (MARD)) Letter No. 1,586 dated 13 July 1993, which regulates the establishment and requirements of buffer zones for Vietnam's national parks and nature reserves;
- Ministerial Decision 202 TTg dated 2 May 1994, defining the policies and legislation regarding the protection, regeneration and growing of forest;
- Ministry of Forestry Guidelines No. 09/KH dated 13 September 1994, governing the investment of capital in the forestry sector;
- Vietnam's treaty under the Convention on Biological Diversity in 1993, ratified in 1994, and thereby obliging Vietnam to increase its protected area coverage to two million hectares by the year 2000;
- Within the scope of the Convention on Biological Diversity, Vietnam formulated a national Biodiversity Action Plan (BAP), ratified under Ministerial Decree 845/TTg of 22 December 1995. Ngoc Linh Nature Reserve is listed in the BAP as one of twelve prioritised areas in Vietnam for expansion in order to protect regional biodiversity;



- The Vietnam Forestry Development Strategy was approved during the 11th National Assembly under Section 9 in March 1997. The Vietnam Forestry Development Strategy aims to plan the expansion of 'Special-Use Forests' by a further 1,444,900 ha by the year 2000; and
- Ministerial Decision No. 34, 1998-QD/BNN-Kh dated 24 February 1998, outlining areas for preliminary and feasibility studies in irrigation, agriculture and forestry projects during 1998 under the direct management of MARD. Ngoc Linh Nature Reserve in Kon Tum province is one of the priority projects proposed by MARD's designate, the Forest Inventory and Planning Institute (FIPI), to be assisted by BirdLife International.

1.8 Global Conservation Significance

Initial surveys conducted by BirdLife International identified 221 centres of bird endemism world-wide; termed Endemic Bird Areas (EBAs) (ICBP 1992). Three EBAs were identified in Vietnam: Da Lat Plateau in the Western Highlands, the Southern Vietnamese Lowlands, and the Annamese Lowlands in central Vietnam (ICBP 1992, Stattersfield *et al.* 1998). Recent surveys, conducted to provide baseline information for this investment plan, revealed that the bird fauna of Ngoc Linh Nature Reserve qualifies and upgrades the Kontum Plateau to Vietnam's fourth EBA.

Bird endemism is believed to be a good indicator of overall biodiversity. Thus, areas found to be foci of endemic birds should be assessed by conservation planners for inclusion in protected areas systems, as such areas often provide the most comprehensive conservation coverage (Eames *et al.* 1994).

Ornithologically, the results from this previously unsurveyed region included several significant finds, including two bird species new to science: Golden-winged Laughingthrush *Garrulax ngoclinhensis* (Eames *et al.* 1999b) and Black-crowned Barwing *Actinodura sodangorum* (Eames *et al.* 1999a). Additionally, 12 new bird subspecies were discovered in Ngoc Linh Nature Reserve (Eames *et al.* in press) (see Section 2.12 for more details). Furthermore, five previously known, restricted-range bird species were recorded at this site: Crested Argus *Rheinardia ocellata*, White-cheeked Laughingthrush *Garrulax vassali*, Black-hooded Laughingthrush *Garrulax milleti*, Short-tailed Scimitar Babbler *Jabouilleia danjoui* and Yellow-billed Nuthatch *Sitta solangiae*. Therefore, Ngoc Linh Nature Reserve lies within a new EBA: the Kontum Plateau EBA. This elevates the conservation significance of Ngoc Linh Nature Reserve and the wider area to international importance.

Discoveries of New Mammal Species. The Kontum Plateau EBA is also of world-wide significance because it harbours endemic mammal species. Of particular importance was the discovery in 1997 of the Truong Son Muntjac *Muntiacus truongsongensis* within forest extending from Ngoc Linh Nature Reserve into western Quang Nam province (Pham Mong Giao *et al.* 1998). Another recently discovered mammal that is also found within Ngoc Linh Nature Reserve is the Giant Muntjac *Megamuntiacus vuquangensis*, which represents a new genus (Do Tuoc *et al.* 1994).

Other Restricted-Range, Endemic and Red-Listed Species. The restricted-range bird fauna of Ngoc Linh Nature Reserve overlaps with that of both the Annamese Lowlands and Da Lat Plateau EBAs (Table 1). The restricted-range bird fauna of Ngoc Linh Nature Reserve includes Crested Argus, White-cheeked Laughingthrush, Black-hooded Laughingthrush, Short-tailed Scimitar Babbler and Yellow-billed Nuthatch, all of which are found in other Vietnamese EBAs.

Ngoc Linh Nature Reserve contains 17 red-listed bird species and 20 red-listed mammal species. Large mammal species of conservation importance found within the nature reserve include Tiger *Panthera tigris*, Clouded Leopard *Pardofelis nebulosa*, Asiatic Black Bear *Ursus thibetanus*, Sun Bear *Ursus malayanus*,



Buff-cheeked Gibbon *Hylobates gabriellae*, Giant Muntjac and Truong Son Muntjac. Moreover, there are 21 red-listed herpetiles.

Table 1: Comparison of Ngoc Linh’s Restricted-range Birds with Vietnam’s other EBAs

| Bird Species | Status | Kontum Plateau | Da Lat Plateau | Annamese Lowlands | Southern Vietnamese Lowlands |
|-------------------------------|---------------|----------------|----------------|-------------------|------------------------------|
| Crested Argus | Vulnerable | + | + | + | - |
| White-cheeked Laughingthrush | Least Concern | + | + | + | - |
| Black-hooded Laughingthrush | Vulnerable | + | + | - | - |
| Short-tailed Scimitar Babbler | Vulnerable | + | + | + | - |
| Yellow-billed Nuthatch | Vulnerable | + | + | - | - |

Regarding flora, Ngoc Linh Nature Reserve is home to 45 red-listed plant species and is the only known site of the endemic Ngoc Linh Ginseng. Eight other endemic plant species are also found in the nature reserve: *Pinus dalatensis*, *Amentotaxus poilanei*, *Cinnamomum balansae*, *Alchornea annamensis*, *Baccaurea silvestris*, *Bulbophyllum evrardii*, *Otochilus fuscus* and *Calamus poilanei*.

Collaborative Conservation Efforts. There is a need to officially establish Ngoc Linh Nature Reserve for protection as a representative area of the Kontum Plateau EBA and for its global conservation significance. In December 1996, the government of Vietnam approved the project “Expanding the Protected Areas Network in Vietnam for the 21st Century”, funded by the European Union (EU). This project is being implemented by BirdLife International and FIPI. This investment plan, which will contribute to the establishment of Ngoc Linh Nature Reserve, represents the second study to be researched and written as part of this collaborative conservation effort. The baseline research conducted to assist in this report strongly suggests that Ngoc Linh Nature Reserve can be an important part of Vietnam’s network of ‘Special-Use Forests’

1.9 Management Authority

Official status within Vietnam’s network of ‘Special-Use Forests’ would necessitate management responsibility being routed through the Kon Tum Provincial Forest Protection Department under MARD. Protection of all ‘Special-Use Forests’ is coordinated by MARD at the national level (MOF 1991a).

2. Site Features

2.1 Location

Ngoc Linh Nature Reserve is located within Dac Glei and Dac To districts in the mountainous north of Kon Tum province. The nature reserve is defined by the coordinates: 14°45' to 15°15'N and 107°21' to 108°20'E. The nature reserve is approximately 87 km north-north-west of Kon Tum town and 100 km south-south-west of Da Nang city.

The nature reserve borders Giang and Phuoc Son districts in Quang Nam province to the north, and Tra My district, also in Quang Nam province, to the east. To the west, the nature reserve borders Dac Nhoong and Dac Plo communes, on the Vietnam-Laos border, as well as Dac Pek and Dac Glei communes, all of which are in Dac Glei district, Kon Tum province. To the south, the nature reserve borders Dac Na, Mang Xang and Ngoc Lay communes in Dac To district, Kon Tum province (Map 5).

Access Roads. National Highway 14 bisects the north-western section of Ngoc Linh Nature Reserve and is accessible by all vehicle types. National Highway 14 climbs through the upstream basin of the Dac Po Ko River in Dac Pek commune from the south, entering the nature reserve in Bac Man commune. Heading north through Dac Man commune, National Highway 14 then descends through the Dak Se River basin and criss-crosses the border between Kon Tum and Quang Nam provinces.

An unsurfaced road extends through the centre of Ngoc Linh Nature Reserve from west to east, following the Dak Mek River. This route connects Dac Choong village, nearly surrounded by the nature reserve's western boundary, and stops at Ngoc Linh village, which is completely encircled by the eastern section of the nature reserve.

2.2 Topography

Ngoc Linh Nature Reserve is located in the mountainous Western Highlands of central Vietnam. This area is also often referred to as the Central Highlands, or, in historical references, as the southernmost extension of the Annamite Cordillera or Annamite Mountains. Mount Ngoc Linh and the surrounding mountains are connected to the southern Annamite Mountains as part of the Nam-Ngai-Dinh Ridge, which extends away from the main north-south range from north-west to south-east. The summits of this ridge are linked by a series of sharp peaks, in all comprising the mountain ranges of western Quang Nam and northern Kon Tum provinces. These high mountains and their adjacent highland areas are collectively referred to as the Kontum Plateau. The high mountains of this plateau are isolates, being separated by relatively long distances from other high mountain blocks.

The slope ratio in Ngoc Linh Nature Reserve is rather high, typically 40 to 45° but sometimes as high as 60 to 65° in the north, particularly on Ngoc Tion (2,032 m), Ngoc Peukpee (1,728 m) and Ngoc Lum Heo (2,030 m) peaks. In the south-east of the nature reserve are the peaks of Ngoc Lepho (2,070 m) and Ngoc Pa (2,251 m). The highest peak is Mount Ngoc Linh (2,598 m) with a steep slope from the summit down to 300 m in Dac My valley. In the south-west of the nature reserve, the slope is more gentle because of the eroded basins of the Dac Mek, Dac Psi, Dac Na and Dac Glei Rivers. The altitudes in the south-west area range from 900 to 1,200 m. The topography remains complex but the slope ratios become lower as the highlands extend south into Dac Glei and Dac To districts.

2.3 Hydrology

In general, river systems in Ngoc Linh Nature Reserve are narrow, high energy, montane rivers which are undergoing extensive grading and erosion. During the rainy season, rivers undergo pulse-flow events,



resulting in sudden floods that can cause extensive erosion of river banks. Flood damage to lower lying areas is common, particularly to agricultural areas and irrigation projects. Groundwater run-off occurs at a high rate, as alluvial soils in the region are coarse grained, with a high proportion of sand (40 to 50%), and very porous.

During the dry season, rivers and streams at higher elevations and in open areas without forest cover are temporal. Water availability can be limited, making irrigation difficult in the lowlands. The main rivers flow all year at lower elevations. However, the extensive forest cover performs an important hydrological function by reducing seasonality in stream flow and peak flow volumes.

The mountains of Ngoc Linh Nature Reserve are the upstream water catchments of four main river systems:

- (a) **Dac Mek River.** This river originates below the summits of Mount Ngoc Linh (2,598 m) and Ngoc Pang (2,327 m) and runs through Ngoc Linh, Dac Choong, Muong Hoong and Dac Man communes. It merges into the Dac Se River, the main river flowing into the South China Sea at Da Nang city. This river is 60 km long with many large secondary branches such as the Dac Che and Dac Thiang Mek Rivers.
- (b) **Dac Po Ko River.** This river originates below the summit of Ngoc Nay (2,259 m) and peaks at 1,998 m, 1,855 m, 2,032 m and 2,003 m, runs through Dac Man and Dac Nhung communes, and then flows south to Dac Glei and Kon Tum towns. It also has many large secondary branches such as the Dac Na, Dac Ka Tan, Dac Psi and Dac Glei Rivers which also spring from Ngoc Linh, Ngoc Pang and some other high summits. This river flows to Dac Pla, then merges with the Krong Po Ko River at Kon Tum town. The Dac Po Ko River is the most important water source for Yaly Hydropower Station.
- (c) **Thu Bon River.** This river also originates from below Mount Ngoc Linh and other high peaks in the east and north-east of the nature reserve. The Thu Bon River flows in a south-west to north-east direction and reaches the South China Sea at the Hoi An estuary.
- (d) **Dac Plo River.** This is another river system originating from sources at high elevations in Ngoc Linh Nature Reserve. These secondary rivers flow into the Dac Plo River, travel through Laos, and eventually join the Mekong River. These secondary rivers are an important source of water for irrigated rice fields in Dac Plo commune.

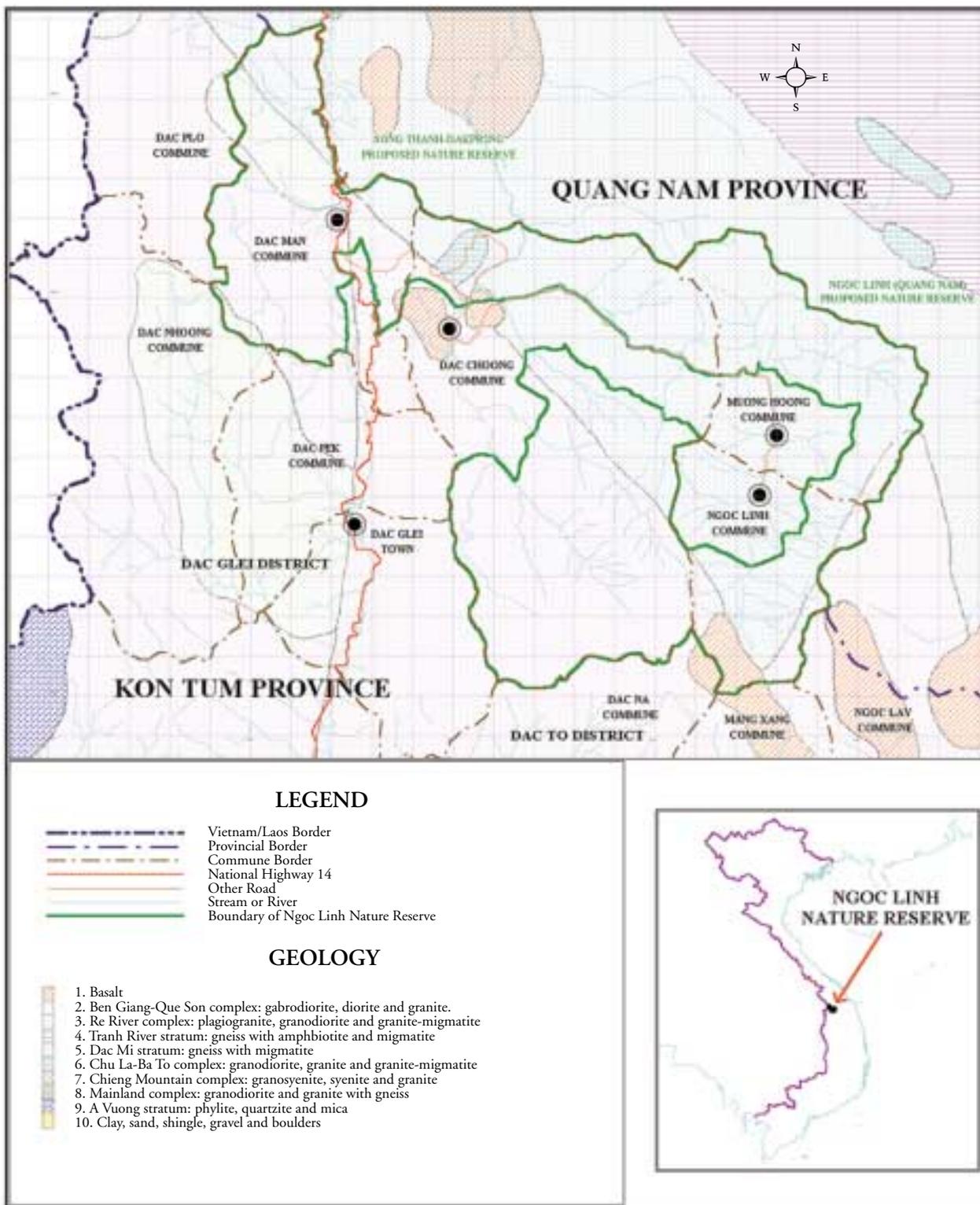
2.4 Geomorphology

During the Precambrian Age, the ancient Indoxinian Massif extruded from the sea with its eastern perimeter creating a shield ranging from Ngoc An to Ngoc Linh. Uneven subduction from the east 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 Kontum Plateau or submassif was formed by splitting from the Indoxinian Massif.

The settling of the Kontum 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 Himalayan movements created a number of fractures in a north-south direction, heightening some blocks and slanting others toward the west. In places where blocking was extreme, many big fractures were created that effused thick layers of basalt either irregularly or in large areas, as in the highlands south of Dac Glei and Dac To districts (Map 2).



Map 2: Geology of Ngoc Linh Nature Reserve



Grid: UTM, zone 48
Horizontal Datum: India 1960

SCALE 1:250,000

Produced by the Forest Resources and Environment Centre of FIPI

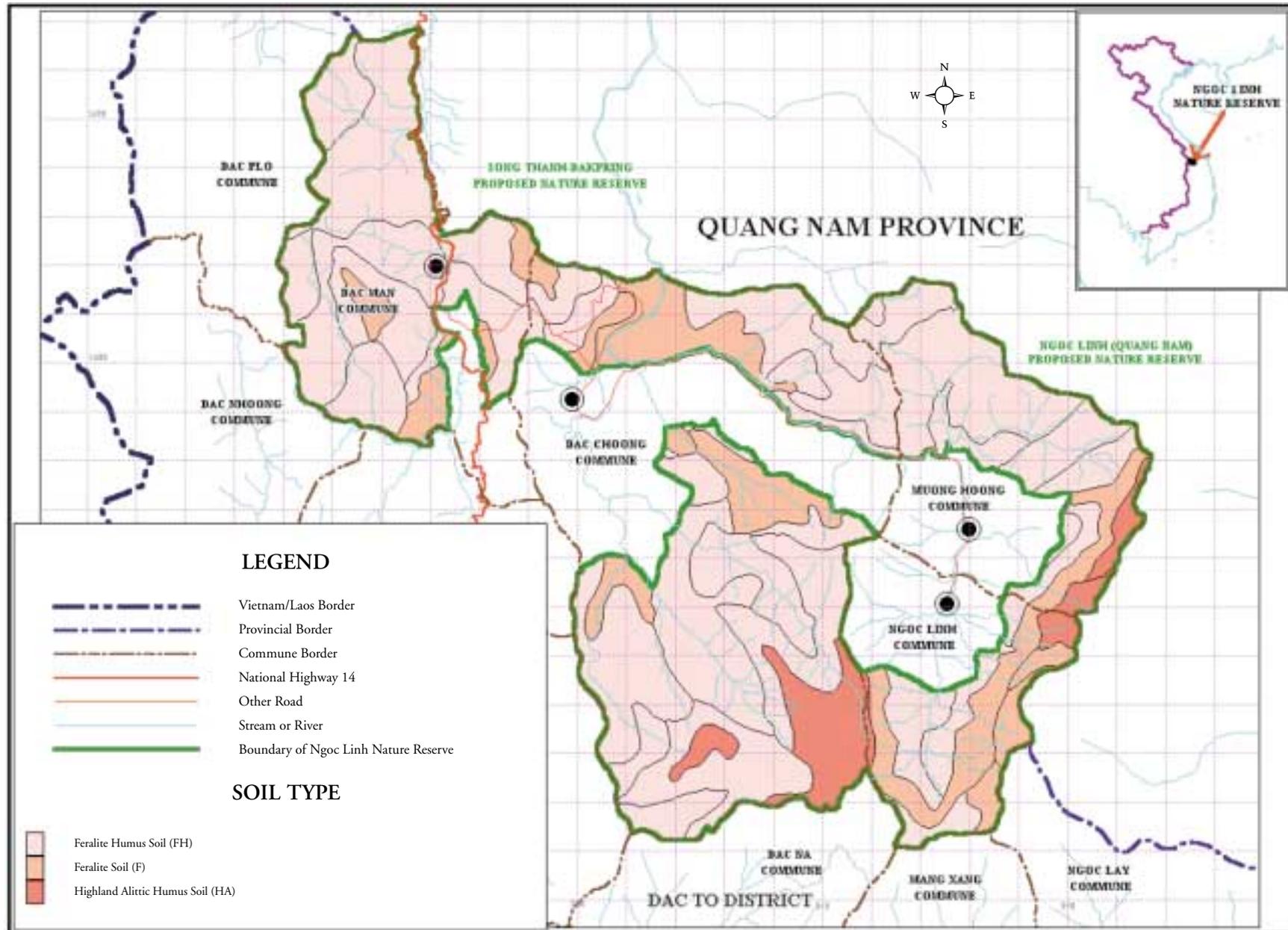
2.5 Soils

Field assessments and available data indicate that the main soils in the area are (Map 3):

- (a) **Highland Alittic Humus Soil (HA)**. This soil type is distributed above a height of 2,000 m where the average temperature is below 15°C. Temperatures during the coldest months are 5 to 6°C and are lower than 20°C during the hottest months. The soil is always humid although the aeolian and soil layer are thin. However, the upper humus layer is over 50 cm thick. In many places, such as Ngoc Linh summit, there is a very humid and porous humus layer over one metre thick. The soil layer is also humid, light, textured and structureless. At an average depth of 35 cm is a layer of clay containing white rock crystal, with pH 4, 30% humus, and C/N ratio of 25 to 35, which is liable to being washed off. The total extent of this soil type is 7,600 ha, comprising 15.4% of the total nature reserve area.
- (b) **Feralite Humus Soil (FH)**. This soil type is distributed in areas from 1,000 to 2,000 m altitude. The climate at these altitudes is always humid and cool. Temperatures are between 15 and 20°C. Evaporation rates are lower than rainfall rates. Lots of crude humus has accumulated. The C/N ratio is 15 to 20. Feralite levels are comparatively low. The humus layer is thick. Soils are acidic, impermeable and have developed on three different mother rocks:
 - (i) *Yellow Feralite Humus Soil on Acid Magmatic Rock (FHa)*. These soils are thick layered, medium textured, acid and poorly developed. The area covered by this soil type is 4,800 ha, making up 9.7% of the nature reserve's area. These soils are distributed on the slopes of Mount Ngoc Linh and other high mountains in the region;
 - (ii) *Brown Feralite Humus Soil on Magmatic Alkaline and Neutral Rock (FHk)*. This soil layer is very thick, heavy textured, homogeneous, fertile and acidic. These soils cover 2,900 ha, which is 5.9% of the total area of the nature reserve. They are distributed mostly in Muong Hoong, Dac Man and Ngoc Linh communes, at a height of 1,000 to 1,500 m; and
 - (iii) *Yellow and Red Feralite Soil on Clay Schist and Metamorphic Rock (FHs)*. These are thick layered, heavy or medium textured, fertile, porous and acidic soils. They cover a large area of 23,130 ha, comprising 46.8% of the total area of the nature reserve. They are distributed between 1,000 and 2,000 m.
- (c) **Feralite Soil (F)**. These soils are found between 500 and 1,000 m and cover 21.2% of the total area of the nature reserve. Due to lower rainfall rates, higher atmospheric and surface temperatures, the forest cover is more broken and open as compared to 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)*. Medium layered, coarse grained, unconsolidated, granular soil. Subject to denitrification in deforested areas. This soil type covers 5,700 ha or 11.5% of the total area. These soils are distributed along rivers at the base of Mount Ngoc Linh;
 - (ii) *Brown and Red Feralite Soil on Magmatic Alkaline and Neutral Rock in Lowlands (Fk)*. Homogeneous, thick layered, 80% clay textured soils. This is a nutrient-rich soil that is compacted in deforested areas. This soil type covers 1,900 ha or 3.8% of the total area and is distributed along National Highway 14, near the Dac Mek River; and



Map 3: Soil Types of Ngoc Linh Nature Reserve



Grid: UTM, zone 48
Horizontal Datum: India 1960

SCALE 1:200,000

Map based on soil map produced by FIPI in 1994

- (iii) *Yellow and Red Feralite Soil on Metamorphic Rock and Clay Slate in Lowlands (Fs)*. These are deep layered, heavy textured (60% clay), good structured and very fertile soils. These soils comprise 2,900 ha and make up 5.9% of the total area of the nature reserve. They are distributed along National Highways 14A and 14B, and the Dac Mek Valley.
- (d) **River and Stream Alluvial Soil (P)**. Created from the alluvium along rivers and streams, or accumulated at the foot of mountains or hills; these are grey and brown, deeply layered, medium to light textured, porous soils. Due to the even topography of accumulation areas, most of these soils are utilised for agriculture. These soils cover 500 ha or 1% of the total area. They are very fertile soils and are distributed along all the rivers and streams in the region.

2.6 Meteorology

The study area is in a remote mountainous region without any weather stations. Therefore, meteorological data had to be collected from neighbouring weather stations located in Tra My, Ba To and Dac To districts, and Kon Tum town. These four locations are the closest stations that are capable of presenting data representative of the nature reserve's climatic conditions (Table 2).

Table 2: Meteorological Data from Four Weather Stations near Ngoc Linh 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 | 3,841 | 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 days | 140 days | 140 days | 132 days |
| Annual mean temperature (°C) | 25.3 | 24.3 | 22.3 | 23.4 |
| Annual humidity (% RH) | 86 | 84 | 80 | 78 |
| Evaporation (mm) | 728 mm | 867 mm | 1,232 mm | 1,533 mm |

Ngoc Linh Nature Reserve enjoys a humid tropical climate. However, as a high montane area with altitudes ranging from 500 to 2,598 m, the climate varies considerably. The average annual temperatures clearly reflect the topographical variation between the different weather stations. For instance, Tra My and Ba To, at an altitude of 200 m and located to the east and north-west of the study area, have average yearly temperatures of 24 and 25°C, respectively. In Dac To and Kon Tum, to the south-west of the nature reserve and at altitudes of 650 and 536 m, the average yearly temperatures are only 22 and 23°C, respectively.

Rainfall rates also vary with altitude, as mountains induce localised precipitation patterns from clouds carried by prevailing winds. The north-east side of Mount Ngoc Linh has a much higher rainfall rate than the south-west side. Total annual rainfall increases with altitude: Ba To, 3,608 mm; Tra My, 3,841 mm; and Ngoc Linh summit, 4,000 mm. The total number of rainy days per annum averages 170 ; however, at Ngoc Linh summit, it is 250.



To the north-east of the nature reserve, the rainy season begins around the end of April and extends to the end of January. There are only two months of dry season: February and March. To the south-west of the nature reserve, the rainy season starts in May and lasts until the end of October; and the dry season lasts for five months, from November to March or the beginning of April.

During the rainy season, there is a high incidence of typhoons in the region. However, typhoons never cross over to the western side of the Western Highlands. Therefore, the south-west of the study area never encounters storms, although it periodically suffers from floods brought on by prolonged rainfall. The dry season also exhibits very localised patterns, and causes severe water shortages in the west of the nature reserve.

2.7 Flora Overview

Data from two field surveys conducted in April-May 1996 and March-May 1998, revealed 878 plant species in 539 genera and 152 families (Table 3).

Out of 878 species found in the nature reserve, there are 45 threatened species, of which 19 are listed in the IUCN Red List of Threatened Plants (IUCN 1997) and 34 are listed in the Red Data Book of Vietnam

(Anon. 1996). There are 238 timber species, 169 medicinal species and 78 ornamental species. The flora of Ngoc Linh Nature Reserve is similar to that of Chu Yang Sin Nature Reserve and the Western Highlands as a whole (Table 4).

Table 3: Plants Found in Ngoc Linh Nature Reserve

| Order | Families | Genera | Species |
|----------------|----------|--------|---------|
| Psilotophyta | 1 | 1 | 1 |
| Lycopodiophyta | 2 | 3 | 4 |
| Equisetophyta | 1 | 1 | 1 |
| Polypodiophyta | 14 | 26 | 41 |
| Pinophyta | 6 | 10 | 12 |
| Magnoliophyta | 128 | 498 | 819 |
| Total | 152 | 539 | 878 |

Table 4: Plants Found in the Western Highlands

| Location | Area (ha) | Families | Genera | Species |
|-----------------------------|-----------|----------|--------|---------|
| Western Highlands | — | 223 | 1,139 | 3,201 |
| Chu Yang Sin Nature Reserve | 59,278 | 142 | 475 | 876 |
| Ngoc Linh Nature Reserve | 41,420 | 152 | 539 | 878 |

Mount Ngoc Linh, the second highest mountain in Vietnam and the highest mountain in southern Vietnam, represents the largest area of montane habitat on the Kontum Plateau. The mountain's geographical isolation has led to the evolution of several endemic species. Nine plant species found at Ngoc Linh Nature Reserve are endemic to Vietnam: *Panax vietnamensis*, *Pinus dalatensis*, *Amentotaxus poilanei*, *Cinnamomum balansae*, *Alchornea annamensis*, *Baccaurea silvestris*, *Bulbophyllum evrardii*, *Otochilus fuscus* and *Calamus poilanei*. The flora of Ngoc Linh shows many Sino-Himalayan affinities, and the area is also a haven for primitive taxa such as conifers and members of the Magnoliaceae, Annonaceae, Theaceae and Betulaceae.

In the known flora of Ngoc Linh, 26 families are represented by 10 or more species: Asteraceae (59), Orchidaceae (50), Rutaceae (41), Poaceae (29), Fagaceae (24), Moraceae, Euphorbiaceae (23), Araliaceae (18), Myrsinaceae, Cyperaceae (17), Lauraceae (16), Rosaceae (15), Fabaceae, Apocynaceae, Theaceae, Ericaceae, Araceae (14), Meliaceae, Anacardiaceae (13), Rutaceae (12), Lamiaceae (11), Polypodiaceae, Verbenaceae, Annonaceae, Mimosaceae and Melastomaceae (10). However, the tree flora is largely dominated by species from the less species-rich families such as the Fagaceae, Lauraceae, Hamamelidaceae, Magnoliaceae, Betulaceae, Pentaphragmaceae, Theaceae and Elaeocarpaceae.



Among the conifers, *Pinus kesiya* is widespread, either in monospecific stands or in mixed forest. Other coniferous tree species include *Pinus dalatensis*, *Dacrycarpus imbricatus* and *Keteleeria evelyniana*, which are not abundant but are represented by particularly large specimens.

There are many valuable plant species, particularly those used in traditional medicine. The Araliaceae contains large numbers of medicinal plant species, including the endemic Ngoc Linh Ginseng, which has been heavily over-exploited and is now endangered.

2.8 Forest and Vegetation Cover

Ngoc Linh Nature Reserve has a large area of extant forest cover: within the proposed boundaries of the nature reserve, forest cover makes up 88% of the total area (Table 5 and Map 4). The primary forest cover is also high and makes up approximately 60% of the total area. A large proportion of each of the main forest types and subtypes found in Ngoc Linh Nature Reserve is primary.

Table 5: Forest Cover in the Four Communes of Ngoc Linh Nature Reserve

| Forest Type | Dac Choong (ha) | Dac Man (ha) | Ngoc Linh (ha) | Muong Hoong (ha) | Total (ha) | % |
|---------------------|--------------------|-----------------|-------------------|---------------------|---------------|----|
| Rich Forest | 7,992 | 4,532 | 3,620 | 1,906 | 18,050 | 30 |
| Medium Forest | 6,919 | 2,995 | 700 | 3,251 | 13,865 | 23 |
| Poor Forest | 138 | 138 | 56 | 1,100 | 1,432 | 2 |
| Regenerating Forest | 1,924 | 3,765 | 1,020 | 1,566 | 8,275 | 14 |
| Coniferous Forest | 3,625 | 332 | 0 | 0 | 3,957 | 7 |
| Bamboo Forest | 0 | 0 | 249 | 245 | 739 | 1 |
| Scrub and Grassland | 5,724 | 2,550 | 1,720 | 1,344 | 11,338 | 19 |
| Scattered Trees | 280 | 138 | 25 | 68 | 511 | 1 |
| Agricultural Land | 38 | 50 | 35 | 980 | 1,103 | 2 |
| Total | 26,640 | 14,500 | 7,670 | 10,460 | 59,270 | — |

Although the forest types in Table 5 are based on a forestry classification, it is clear that the extent of rich and medium forest (which is roughly equivalent to primary forest) is great. These forest types are distributed at medium and high altitudes in Ngoc Linh Nature Reserve, extending south into Gia Lai and Dak Lak provinces, north into Quang Nam province and west into Laos.

2.9 Forest Types

Data on forest types was provided by vegetation maps (1:50,000 scale, UTM) compiled from remote sensing data by the Forest Resources and Environment Centre of FIPI in 1996 and verified by ground assessments in April 1998.

The main forest types are based upon the classification of Thai Van Trung (1978). Based on this classification, the following forest types are found in Ngoc Linh Nature Reserve:

- (a) high montane broadleaf evergreen forest;
- (b) medium to high montane broadleaf evergreen forest;
- (c) low montane broadleaf evergreen forest; and
- (d) secondary forest.

Forest types (a) and (b) broadly equate to tropical montane evergreen forest in the classification developed by MacKinnon and MacKinnon (1986) (and refined by MacKinnon in 1996), whilst forest type (c)



broadly equates to tropical semi-evergreen rainforest.

High Montane Broadleaf Evergreen Forest

This forest type is distributed from 2,000 to 2,598 m on Mount Ngoc Linh and is developed on alittic humus soils with a base of granite intermingled with rionite and daxite rocks. This forest type is largely undisturbed. The tree flora is composed mainly of broadleaf trees interspersed with a few conifers.

The tree flora includes members of the Lauraceae, Fagaceae, Theaceae, Araliaceae, Magnoliaceae, Aceraceae and Rosaceae, including *Pentaphylax* spp., *Quercus* spp., *Lithocarpus* spp., *Castanopsis* spp., *Litsea verticillata*, *Symplocos cochinchinensis*, *Eurya japonica*, *Elaeocarpus* spp., *Exbucklandia tonkinensis*, *E. populnea*, and *Turpinia montana*. There are also conifers such as *Dacrycarpus imbricatus*, *Podocarpus neriifolius*, *Pinus dalatensis* and *Dacrydium elatum*. Of the conifers, only *Pinus dalatensis* is present in large numbers.

This undisturbed forest exhibits dense canopy cover and a complex forest structure with a species-rich floral composition. This forest type is stratified into three layers. The characteristics of each of the forest layers are:

- (a) **Emergent Layer.** This dominant tree layer consists of the aforementioned broadleaf trees. The most notable emergents are *Quercus* spp., *Dacrycarpus imbricatus* and *Pinus dalatensis*, with diameters of 80 to 150 cm and heights of 25 to 30 m;
- (b) **Closed Canopy.** This layer of species-diverse and dense continuous forest cover includes small timber trees, trees of the Araliaceae and Euphorbiaceae. Trees in this layer are dense at 6,000 trees/ha; and
- (c) **Open Understorey, Shade-Tolerant Forest.** This foliage layer is interspersed with both shade-loving trees and saplings of the species found in the closed canopy and emergent layer (Table 6). This third storey forms a continuum to the forest floor, mixing with both monocotyledons and some dicotyledons that make up the shrub and herb layer.

Data from 40 x 40 m sample plots indicate that:

- Average tree height: 18.5 m
- Average tree diameter at 1.3 m: 28.5 cm
- Mature tree density: 620 trees/ha
- Volume of timber: 360 m³/ha
- Sapling tree density: 6,000/ha

Table 6: Composition of Saplings in High Montane Broadleaf Evergreen Forest

| Taxon | Density |
|--|---------|
| <i>Eurya sinensis</i> var. <i>glabra</i> | 30% |
| <i>Pentaphylax</i> spp. | 20% |
| <i>Symplocos cochinchinensis</i> | 15% |
| <i>Quercus chevalieri</i> | 10% |
| <i>Neolitsea cambodiana</i> | 2% |
| <i>Randia</i> spp. | 2% |
| Other species | 21% |

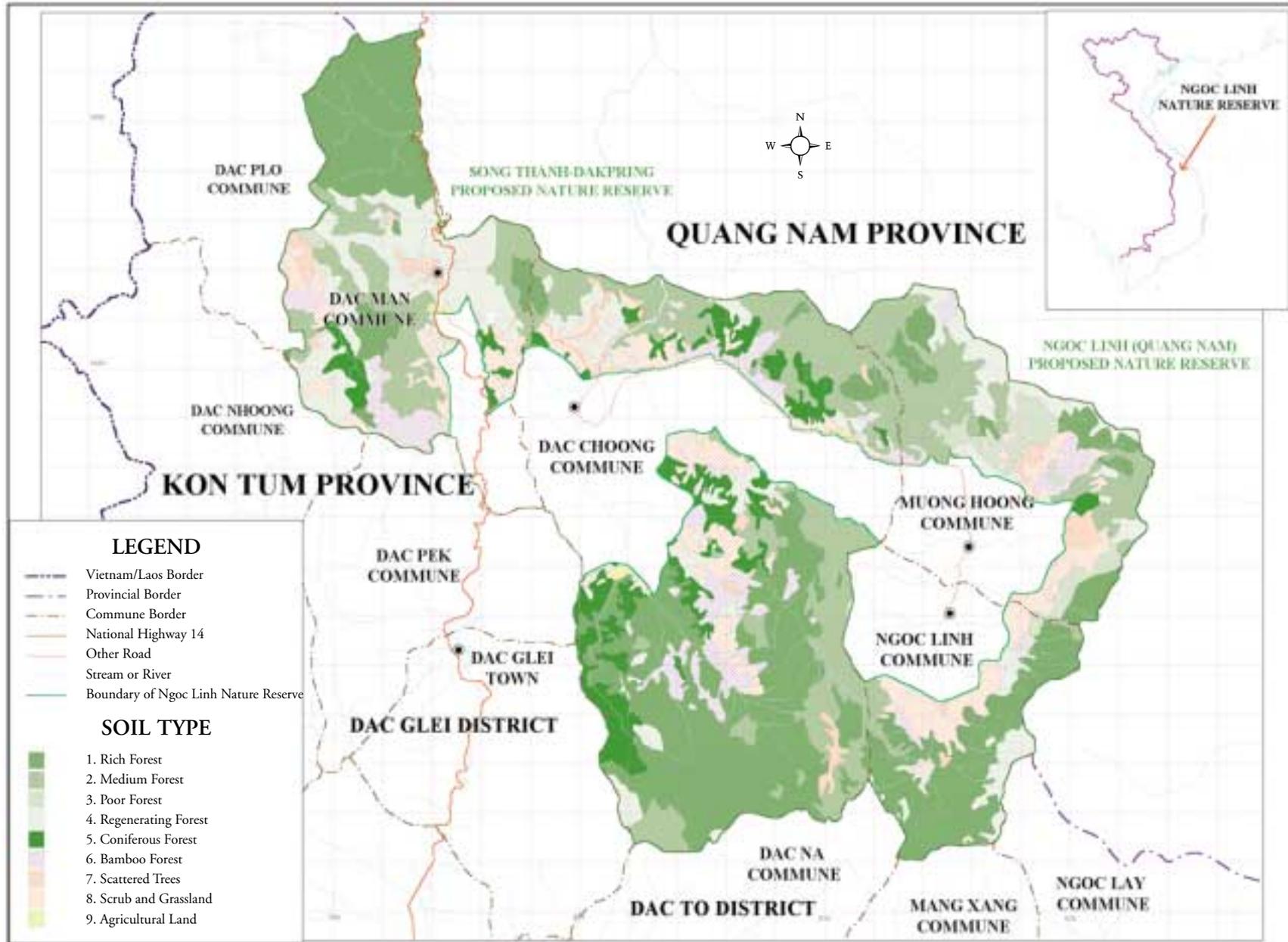
Subtype: a) Elfin Forest (above 2,300m)

This stunted forest subtype of high montane broadleaf evergreen forest is found distributed at altitudes above 2,300 m on the higher peaks of the Ngoc Linh range. Elfin forest is always found on slopes and ridges which experience strong wind and are continually shrouded in cloud. The tree heights are low, covered with thick moss, and found growing on a decomposed humus soil 60 to 70 cm thick. Typical tree species are *Rhododendron* spp., *Lyonia* spp., *Quercus* spp., *Anneslea fragrans*, *Elaeocarpus* spp. and *Sorbus wattii*.

In elfin forest, trees exhibit stunted morphology, they are not erect and tree size varies; tree diameters range from 2 to 6 cm and tree heights from 1.5 to 2 m. Trees which are sheltered from the prevailing winds can grow to larger sizes, with tree diameters from 6 to 14 cm and tree heights from 6 to 10 m. Elfin forest is rich in epiphytes: trees are covered by a layer of thick moss, and this forest type supports over 40 species of epiphytic orchids.



Map 4: Land Use in Ngoc Linh Nature Reserve



Grid: UTM, zone 48
Horizontal Datum: India 1960

SCALE 1:200,000

Map based on soil map produced by FIPI in 1994

Subtype: b) *Arundinaria vicinia* Forest (2,100 to 2,400 m)

On some of the higher mountains there is a zone of *Arundinaria vicinia* forest below the elfin forest. This forest type is commonest at altitudes between 2,300 and 2,400 m, although it is found as low as 2,100 m. The understorey is dominated by the dwarf bamboo, *A. vicinia*, which ranges from 1.3 to 1.7 cm in diameter, reaches 2.5 to 3.5 m in height, and grows at a density of 20,000 stems/ha.

This undisturbed forest contains many rare and endemic species. Endemic conifers include *Pinus dalatensis*, *Dacrydium elatum*, *Amentotaxus poilanei*, *Keteleeria evelyniana* and *Dacrycarpus imbricatus*.

Subtype: c) Mixed Coniferous and Broadleaf Forest containing *Pinus dalatensis* (~2,200 m)

This forest type is a mature, undisturbed mixed forest of conifers (mainly *Pinus dalatensis* and *Keteleeria evelyniana*) and broadleaf trees. It is distributed at an elevation of 2,200 m on a litter layer 1 to 1.6 m thick and composed mostly of pine needles. The humus layer is over 30 cm thick and contains many tree roots. Furthermore, a thin soil layer is found on yellow acidic magmatic rock.

The emergent layer is dominated by *P. dalatensis*, sparsely distributed in small, distinct stands, after which this forest subtype is named. These small stands are made up of trees reaching a height of 28 to 30 m, with an average diameter of 150 to 200 cm, and with thin, emergent crowns.

Trees in the closed canopy layer have comparatively small diameters and low tree heights. However, the tree density is very high, particularly in the areas with small *P. dalatensis* stands, and the broadleaf trees have thick crowns.

Medium to High Montane Broadleaf Evergreen Forest

This forest type, found between 1,000 and 2,000 m, comprises the largest area of forest in the nature reserve. It is distributed on the south-west side of Mount Ngoc Linh, Ngoc Lum Heo and Ngoc Pang, and also occurs up to the summits of the mountains adjacent to Lo Xo Pass, including the peaks at 1,998 , 1,728 , 1,855 and 1,785 m.

This forest type is developed on red, yellow and brown feralite humus soil, on a bed of bioclastic granite rock, basaltic extrusive rock and altered slate. The rocks are mostly altered and the soil layer is of medium thickness, at 0.8 m, with low erosion.

In general, this forest type can be considered primary, as only small areas have been converted to cultivation. Coniferous trees present include *Dacrydium elatum*, *Dacrycarpus imbricatus*, *Podocarpus kesiya* and *P. nerifolius*, which are randomly distributed on mountain sides and lower peaks.

Broadleaf trees are dominant at these altitudes, typically members of the Fagaceae (*Lithocarpus* spp. and *Quercus* spp.) and Lauraceae. The Magnoliaceae is also well represented with several species of *Michelia*, *Manglietia* and *Magnolia*. The Sapotaceae is represented by the densely distributed *Madhuca pasquieri*, with a mean diameter of 40 to 50 cm.

Data from primary medium to high montane broadleaf evergreen forest plots (40 x 40 m) indicate that:

- Average tree height: 16.1 m
- Maximum tree height: >20 m
- Average tree diameter at 1.3 m: 30 cm
- Maximum tree diameter at 1.3 m: >45 cm
- Mature tree density: 2,000 trees/ha
- Volume of timber: 340 m³/ha
- Sapling tree density: 10,000 trees/ha



This rich, undisturbed forest type is distributed not only on the slopes of Mount Ngoc Linh and Lo Xo Pass but is found throughout the Cong Troi area and the south of Mang Xang commune. Ngoc Linh Ginseng is unevenly distributed in this forest type at altitudes over 1,700 m.

At an elevation of 1,700 m, medium to high montane broadleaf evergreen forest is stratified into four layers:

- (a) **Emergent Layer.** The emergent layer in many areas is uniform and almost continuous. This layer is at a height of 15 to 17 m and consists mostly of broadleaf trees such as *Betula alnoides*, *Castanopsis indica* and *Dacrycarpus imbricatus*. This is only 2 to 4 m higher than the high montane broadleaf evergreen forest at higher elevations;
- (b) **Middle Layer.** The middle layer is not referred to as a closed canopy because it is broken by large areas or stands of emergent trees. Continuous areas of the middle layer are directly underneath, and often appear continuous with, the emergent layer. The canopy layer differs from the emergent layer primarily in that it includes many species in the Rubiaceae and Euphorbiaceae;
- (c) **Lower Layer.** The shade-tolerant lower layer is dominated by *Calamus* sp. and members of the Polypodiaceae; and
- (d) **Ground Layer.** The ground layer is a mixed shrub and herbaceous vegetation layer of both monocotyledons and dicotyledons. This layer includes saplings of the upper three vegetation layers which, particularly when growing with lianas, make small patches of this layer appear continuous with the lower forest layer.

Table 7: Composition of Mature Trees in Medium to High Montane Broadleaf Evergreen Forest

| Taxon | Density (%) | Basal Area (%) |
|---------------------------------------|-------------|----------------|
| 1. <i>Betula alnoides</i> | 13 | 20 |
| 2. <i>Eurya japonica</i> | 12 | 10 |
| 3. <i>Litsea verticillata</i> | 7 | 12 |
| 4. <i>Quercus</i> spp. | 7 | 11 |
| 5. <i>Castanopsis indica</i> | 6 | 15 |
| 6. <i>Symplocos cochinchinensis</i> | 6 | 5 |
| 7. <i>Engelhardtia</i> spp. | 6 | 4 |
| 8. <i>Cinnamomum balansae</i> | 6 | 1 |
| 9. <i>Quercus chevalieri</i> | 6 | 1 |
| 10. <i>Nephelium lappaceum</i> | 4 | 1 |
| 11. <i>Dacrycarpus imbricatus</i> | 4 | 5 |
| 12. <i>Schefflera octophylla</i> | 4 | 2 |
| 13. <i>Elaeocarpus</i> spp. | 4 | 1 |
| 14. <i>Pterospermum lanceaefolium</i> | 3 | 1 |
| 15. <i>Rhodoleia championii</i> | 8 | 1 |
| 16. Other species | 4 | 10 |

Forestry data on percentage density and basal area of each major tree species, used to calculate mean timber values, is also indicative of the dominant tree species in this forest type. These species are listed in descending order of density, and give a good view of the composition of this forest type (Table 7). The density of saplings in this forest type (Table 8) shows a different composition to the mature forest trees, suggesting that this highly developed forest type has complex stratification dynamics.

Low Montane Broadleaf Evergreen Forest

This forest type is distributed at altitudes less than 1,000 m, on red and yellow feralite soils with a bedrock of granite, arenaceous and other altered rocks. Although extensive

Table 8: Composition of Saplings in Medium to High Montane Broadleaf Evergreen Forest

| Taxon | Density (%) |
|-----------------------------------|-------------|
| 1. <i>Quercus</i> spp. | 20 |
| 2. <i>Eugenia</i> spp. | 16 |
| 3. Lauraceae | 16 |
| 4. <i>Gironniera subaequalis</i> | 9 |
| 5. <i>Albizia lucidior</i> | 7 |
| 6. <i>Mischocarpus sunndaicus</i> | 7 |
| 7. <i>Elaeocarpus</i> spp. | 5 |
| 8. <i>Litsea monopetala</i> | 5 |
| 9. <i>Randia acuminatissima</i> | 5 |
| 10. Other species | 7 |



areas of this forest type are disturbed, areas of primary forest remain.

The vegetation layers are uneven and continuous in areas, either due to human disturbance and/or a predominance of fast growing, light-tolerant trees. Fast growing trees in this forest type are numerous and include species found in the Myrtaceae, Meliaceae, Moraceae, Lauraceae, Fagaceae and Elaeocarpaceae.

Low montane broadleaf evergreen forest, where it has not been heavily disturbed, is stratified into three forest layers. These layers are:

- (a) **Emergent Layer.** The emergent layer is dominated by *Ficus* spp., such as *F. altissima*. The emergents are large trees with a mean diameter of 30 cm, a height of 17 m or over and a timber density of 100 m³/ha;
- (b) **Closed Canopy Layer.** This layer includes *Schefflera octophylla*, *Elaeocarpus* spp. and *Litsea* spp., as well as members of the Fagaceae and Theaceae; and
- (c) **Ground Layer.** There is a mixed understorey layer of shrubs herbs and saplings (Table 10). This dense ground layer also harbours climbers and is particularly difficult to navigate in more disturbed forest.

Logging data from a typical plot (40 x 40 m) in low montane broadleaf evergreen forest in the Thac Che area of Dac Man commune show that:

- Average tree height: 13.3 m
- Average tree diameter at 1.3 m: < 30 cm
- Mature tree density: 430 trees/ha
- Volume of timber: 160 m³/ha
- Sapling tree density: 5,000 trees/ha

Forestry data on percentage density and basal area of each major tree species is indicative of the dominant tree species in low montane broadleaf evergreen forest. These species are listed in descending order with respect to density, and give an indication of the composition of the tree community (Table 9).

Secondary Vegetation

Areas of secondary regrowth have been created largely as a result of shifting agriculture. Five secondary vegetation subtypes are found within Ngoc Linh Nature Reserve. Most are located on fallow or abandoned agricultural land.

Table 9: Composition of Mature Trees in Low Montane Broadleaf Evergreen Forest

| Taxon | Density (%) | Basal area (%) |
|------------------------------------|-------------|----------------|
| 1. Fagaceae | 33 | 35 |
| 2. <i>Schefflera octophylla</i> | 11 | 9 |
| 3. Theaceae | 11 | 8 |
| 4. <i>Elaeocarpus</i> spp. | 10 | 9 |
| 5. <i>Choerospondias axillaris</i> | 10 | 15 |
| 6. <i>Aglaia gigantea</i> | 7 | 6 |
| 7. Lauraceae | 6 | 9 |
| 8. <i>Sloanea sinensis</i> | 4 | 4 |
| 9. <i>Litsea monopetala</i> | 3 | 2 |
| 10. Annonaceae | 3 | 2 |
| 11. <i>Albizia lucidior</i> | 2 | 1 |

Table 10: Composition of Saplings in Low Montane Broadleaf Evergreen Forest

| Taxon | Density (%) |
|-------------------------------------|-------------|
| 1. Fagaceae | 31 |
| 2. Lauraceae | 19 |
| 3. <i>Elaeocarpus</i> sp. | 12 |
| 4. Theaceae | 10 |
| 5. <i>Albizia lucidior</i> | 10 |
| 6. <i>Engelhardtia roxburghiana</i> | 6 |
| 7. <i>Schefflera octophylla</i> | 5 |
| 8. Other species | 7 |



Subtype: a) Mixed Broadleaf and Bamboo Forest

Mixed broadleaf and bamboo forest is distributed at altitudes below 1,200 m, and occurs adjacent to rivers, streams and villages in lower valleys. This forest type is often found on fallow agricultural land.

The dominant bamboo species of this forest type is *Dinochloa* sp. Some characteristics of this species are:

- Average stem height: 7.5 to 8 m
- Average stem diameter at 1.3 m: 4.5 to 5 cm

Subtype: b) Pure Bamboo Forest Complex

This forest type is found growing on fallow agricultural lands which have not been used for a long period of time. This is an interesting forest type as it is not monotypic but a complex of several bamboo species. Some mature trees are interspersed with the bamboo but very few or no saplings are found in this forest type.

As in the mixed broadleaf and bamboo forest, the dominant bamboo species is *Dinochloa* sp. which is found growing in large plots along National Highway 14, as well as along rivers and streams. Stands of *Dinochloa* sp. are characterised by:

- Average stem density: 36,000 to 42,000 stems/ha
- Percent leaf/stem cover: 80 to 90%

Another bamboo species, which grows in large monospecific stands, is *Gigantochloa nigro-ciliata*. This species grows very well on fertile lands and characteristically has:

- Average stem diameter at 1.3 m: 3 to 3.5 cm
- Average stem height: 4 to 4.5 m

There are other bamboo species growing in large monospecific stands: the next most prevalent species is *Bambusa balcoa*, found below 1,200 m, and randomly distributed along roads, rivers, streams and cultivated areas.

Subtype: c) Secondary Broadleaf Evergreen Forest

This forest type is associated with fallow agricultural land, and over-exploited and degraded forest areas. This forest type has two distinct forest layers: the understory comprises herbaceous plants and tree saplings, whilst the canopy layer consists of fast growing, light-tolerant tree species such as *Symplocos cochinchinensis*, *Eurya sinensis* and members of the Theaceae and Fagaceae. Dominant tree taxa are listed in Table 11.

Data from a typical plot (40 x 40 m) of secondary broadleaf evergreen forest, on agricultural land left fallow for 20 years at an elevation of 1,500 m on Mount Ngoc Linh, indicate that:

- Average tree height: 15 m
- Average tree diameter at 1.3 m: 18 cm
- Mature tree density: 690 trees/ha

Table 11: Composition of Mature Trees in Secondary Broadleaf Evergreen Forest

| Taxon | Density (%) | Basal Area (%) |
|-------------------------------------|-------------|----------------|
| 1. Fagaceae | 51 | 60 |
| 2. <i>Symplocos cochinchinensis</i> | 22 | 10 |
| 3. Theaceae | 10 | 12 |
| 4. <i>Eurya tonkinensis</i> | 4 | 8 |
| 5. <i>Acer tonkinensis</i> | 3 | 2 |
| 6. <i>Pentaphylax</i> sp. | 3 | 3 |
| 7. <i>Elaeocarpus</i> sp. | 3 | 3 |
| 8. <i>Prunus arborea</i> | 1 | 2 |

- Volume of timber: 120 m³/ha
- Total basal area: 18 m²/ha
- Percent canopy cover: 70 to 80%

Subtype: d) Grassland and Scrub

Grassland and scrub are found in areas subjected to intensive and unregulated cultivation in the past. This vegetation type is widespread, and commonly distributed along rivers and near villages. The total area of grassland and scrub found in Ngoc Linh Nature Reserve is 11,338 ha or 19.1% of the total area.

Most commonly, scrub is interspersed with small broadleaf trees at a mean height of 8 to 10 m, the structure of this layer is simple and is comprised of members of the Fagaceae with a few members of the Euphorbiaceae.

The height of the vegetation is under 3 m. Grasses are the main ground cover and vary in composition, although *Phragmites vallatoria* and *Erianthus arundinaceus* are typically present. Grasses are seasonal, growing during the rainy season and dying off during the dry season. Dry grasslands are vulnerable to fire.

Subtype: e) Coniferous Forest

This is a well-represented forest type, distributed mainly in the west and south-west of Ngoc Linh Nature Reserve, at altitudes between 900 and 2,000 m. Below these altitudes there are only randomly distributed species of *Pinus kesiya*, which is the predominant tree species in the coniferous forest. Stands of fire-tolerant coniferous forest are found at uniform stages of development. However, different stands are at different stages of development, due to variation in the intensity and frequency of forest fires throughout the nature reserve. Coniferous forest can be further divided into two subtypes as follows:

- (a) **Pure Coniferous Forest (Pinus kesiya Forest).** This forest type consists of nearly or entirely monospecific stands of *Pinus kesiya*, a fire tolerant species. This forest type is mostly found on feralite soils and on differing beds of granite, basalt and arenaceous rocks. The soil profile is deep at 50 to 100 cm thick and acidic, with pH values of 4.5 to 5.5. The humus layer is a thick layer of pine needles; and
- (b) **Mixed Coniferous and Broadleaf Forest.** Coniferous trees such as *Pinus dalatensis* and *Dacrycarpus* spp. are sparsely distributed with broadleaf trees from the Fagaceae, Lauraceae, Magnoliaceae, Betulaceae, Pentaphylaceae, and Theaceae, forming mixed forest. This extremely variable forest type is suspected to be a transitional stage between forest where succession is controlled by fire ecology and mature low montane broadleaf evergreen forest. The humus layer of dried pine needles and leaves is very thick, sometimes up to 20 cm, and very combustible.

Mature coniferous forest is uniformly 25 to 30 m in height and is the tallest forest type in Ngoc Linh Nature Reserve. Coniferous forest exhibits several features that promote frequent forest fires which exclude trees which are not fire-tolerant. In particular, large amounts of combustible litter are produced, creating a thick fuel layer on the ground. The forest is comparatively more open to wind and sunlight, disrupting the humid ground layer, elevating the ground air temperature, lowering the relative humidity, drying the fuel layer, and lowering the level of soil moisture. Coniferous trees have a complex system of surface roots and deep primary tap roots, helping again to lower the level of soil moisture available to other species, and providing these trees with access to deeper groundwater not available to broadleaf trees with shallow surface roots.



In the pure coniferous forest, *Pinus kesiya* commonly comprises 90% of the tree flora, with other species belonging to the Fagaceae and Euphorbiaceae. Mature, monospecific stands of *Pinus kesiya* are found in Dac Choong commune.

Data from typical plots (40 x 40 m) of representative mature coniferous forest in Mang Xang commune, Dac Plo district show that:

- Average tree height: 28 m
- Average tree diameter at 1.3 m: 45 cm
- Mature tree density: 500 trees/ha
- Volume of timber: 116 m³/ha
- Percent leaf cover: 50 to 60%
- Sapling tree density: 2,500 trees/ha

2.10 Fauna Overview

The fauna of Ngoc Linh Nature Reserve had not been studied prior to the field surveys in 1996 and 1998. These surveys revealed a total of 306 vertebrate species in Ngoc Linh Nature Reserve, including 52 mammal species, 190 bird species, 41 reptile species and 23 amphibian species (Table 12).

Table 12: Vertebrate Species Recorded in Ngoc Linh Nature Reserve

| Class | Orders | Families | Species |
|------------|--------|----------|---------|
| Mammals | 7 | 21 | 52 |
| Birds | 11 | 33 | 190 |
| Reptiles | 2 | 14 | 41 |
| Amphibians | 2 | 6 | 23 |
| Total | 20 | 67 | 306 |

2.11 Mammals

A total of 52 mammal species in 7 orders and 21 families were recorded in the nature reserve (Appendix 2); although the orders Rodentia and Chiroptera were not included in the survey.

Identification of hunting trophies increased the known range of the recently discovered Giant Muntjac to include Lo Xo Pass (15°03'48"N 107°44'18"E) in Dac Man commune, Dac Glei district, Kon Tum province. Identification of hunting trophies also extends the known range of the recently discovered Truong Son Muntjac to include Ngoc Linh Nature Reserve. Truong Son Muntjac inhabits areas near Lo Xo Pass, Dac Man, Dac Plo and Mang Xang communes in Dac Glei and Dac To districts, Kon Tum province.

There are a total of 20 mammal species that are red-listed, which is equivalent to 39% of the known mammal species in Ngoc Linh Nature Reserve. This figure includes 14 species that are listed in the IUCN Red List of Threatened Animals (IUCN 1996) and 16 species listed in the Red Data Book of Vietnam (Anon. 1992) (Table 13).

2.12 Birds

Field surveys revealed 190 bird species in Ngoc Linh Nature Reserve (Appendix 3). Of the 190 bird species found in Ngoc Linh Nature Reserve, a total of 17 are listed by Collar *et al.* (1994) and/or the Red Data Book of Vietnam (Anon. 1992) (Table 14). A further seven species are restricted-range endemics.

The surveys have revealed high levels of endemism, particularly amongst babblers (Sylviidae: Garrulacinae and Sylviinae). Remarkably, two new species of babbler were discovered in Ngoc Linh Nature Reserve: Golden-winged Laughingthrush (Eames *et al.* 1999b) (Figure 1) and Black-crowned Barwing (Eames



Table 13: Red-listed Mammals Recorded in Ngoc Linh Nature Reserve

| Species | Scientific Name | Current Status | |
|---------------------------------|---------------------------------|----------------|------------|
| | | IUCN 1996 | Anon. 1992 |
| Pangolins: | Pholidota: | | |
| Pangolins | Manidae | | |
| 1. Sunda Pangolin | <i>Manis javanica</i> | NT | |
| Primates: | Primates: | | |
| Lorises | Loridae | | |
| 2. Slow Loris | <i>Nycticebus coucang</i> | | V |
| Old-world monkeys | Cercopithecidae | | |
| 3. Pig-tailed Macaque | <i>Macaca nemestrina</i> | VU | V |
| 4. Rhesus Macaque | <i>M. mulatta</i> | NT | |
| 5. Bear Macaque | <i>M. arctoides</i> | VU | V |
| Gibbons | Hylobatidae | | |
| 6. Buff-cheeked Gibbon | <i>Hylobates gabriellae</i> | DD | |
| Carnivores: | Carnivora: | | |
| Dogs and Foxes | Canidae | | |
| 7. Indian Wild Dog or Dhole | <i>Cuon alpinus</i> | VU | E |
| Bears | Ursidae | | |
| 8. Asiatic Black Bear | <i>Ursus thibetanus</i> | VU | E |
| 9. Sun Bear | <i>U. malayanus</i> | DD | E |
| Weasels, etc. | Mustelidae | | |
| 10. Large-toothed Ferret Badger | <i>Melogale personata</i> | | R |
| 11. Eurasian Otter | <i>Lutra lutra</i> | | T |
| Civets | Viverridae | | |
| 12. Binturong | <i>Arctictis binturong</i> | | V |
| 13. Small-toothed Palm Civet | <i>Arctogalidia trivirgata</i> | | V |
| Cats | Felidae | | |
| 14. Golden Cat | <i>Catopuma temminckii</i> | NT | V |
| 15. Marbled Cat | <i>Pardofelis marmorata</i> | | V |
| 16. Clouded Leopard | <i>P. nebulosa</i> | VU | V |
| 17. Tiger | <i>Panthera tigris</i> | EN | E |
| Even-toed Ungulates: | Artiodactyla: | | |
| Deer | Cervidae | | |
| Cattle, Antelopes, Goats | Bovidae | | |
| 18. Southern Serow | <i>Naemorhedus sumatraensis</i> | VU | V |
| Rodents: | Rodentia: | | |
| Flying Squirrels | Pteromyidae | | |
| 19. Red Giant Flying Squirrel | <i>Petaurista philippensis</i> | | R |
| Old-world Porcupines | Hystricidae | | |
| 20. Malayan Porcupine | <i>Hystrix brachyura</i> | VU | |

Follows Corbet and Hill (1992)

Notes: EN/E = Endangered; VU/V = Vulnerable; NT = Near Threatened; T = Threatened; R = Rare; DD = Data Deficient as per IUCN (1996) and Anon. (1992)

et al. 1999a). Along with the discovery of two new bird species, 12 new subspecies of babbler were discovered within Ngoc Linh Nature Reserve (Eames *et al.* in press):

- Black-hooded Laughingthrush
- Red-tailed Laughingthrush
- Coral-billed Scimitar Babbler *Pomatorhinus ferruginosus* subsp. *nov.*
- Short-tailed Scimitar Babbler



Table 14: Threatened Birds Recorded in Ngoc Linh Nature Reserve

| Species | Scientific Name | Current Status | |
|-----------------------------------|---|---------------------------|------------|
| | | Collar <i>et al.</i> 1994 | Anon. 1992 |
| | Phasianidae | | |
| 1. Siamese Fireback | <i>Lophura diardi</i> | VU | T |
| 2. Silver Pheasant | <i>L. nychthemera</i> | | T |
| 3. Crested Argus | <i>Rheinardia ocellata</i> | VU | T |
| | Bucerotidae | | |
| 4. Wreathed Hornbill | <i>Aceros undulatus</i> | | T |
| 5. Brown Hornbill | <i>Anorrhinus tickelli</i> | NT | T |
| 6. Great Hornbill | <i>Buceros bicornis</i> | | T |
| | Halcyonidae | | |
| 7. Ruddy Kingfisher | <i>Halcyon coromanda</i> | | R |
| | Strigidae | | |
| 8. Brown Wood-owl | <i>Strix leptogrammica</i> | | R |
| | Eurylaimidae | | |
| 9. Long-tailed Broadbill | <i>Psarisomus dalhousiae</i> | | T |
| | Corvidae | | |
| 10. White-winged Magpie | <i>Urocissa whiteheadi</i> | NT | |
| 11. Indochinese Green Magpie | <i>Cissa hypoleuca</i> | NT | |
| | Muscicapidae | | |
| 12. Green Cochoa | <i>Cochoa viridis</i> | NT | |
| | Sittidae | | |
| 13. Yellow-billed Nuthatch | <i>Sitta solangiae</i> | VU | T |
| | Sylviidae | | |
| 14. Black-hooded Laughingthrush | <i>G. milleti</i> subsp. <i>nov.</i> | VU | R |
| 15. White-cheeked Laughingthrush | <i>G. vassali</i> | VU | T |
| 16. Red-tailed Laughingthrush | <i>G. milnei</i> subsp. <i>nov.</i> | NT | |
| 17. Short-tailed Scimitar Babbler | <i>Jabouilleia danjoui</i> subsp. <i>nov.</i> | VU | T |

Follows Inskipp *et al.* (1996).

Notes: VU/V = Vulnerable; T = Threatened; NT = Near Threatened; R = Rare as per Collar *et al.* (1994) and Anon. (1992).

- *Cutia Cutia nipalensis* subsp. *nov.*
- Chestnut-tailed Minla *Minla strigula* subsp. *nov.*
- Rufous-winged Fulvetta *Alcippe castaneiceps* subsp. *nov.*
- Rusty-capped Fulvetta *A. dubia* subsp. *nov.*
- Rufous-backed Sibia *Heterophasia annectans* subsp. *nov.*
- Black-headed Sibia *H. melanoleuca* subsp. *nov.*
- Stripe-throated Yuhina *Yuhina gularis* subsp. *nov.*
- Black-throated Parrotbill *Paradoxornis nipalensis* subsp. *nov.*

Whilst the bird flora of Ngoc Linh has high levels of endemism, it also has a significant Sino-Himalayan component: 136 of the species found at Ngoc Linh Nature Reserve (72%) are also found in northern and north-western Vietnam. These Sino-Himalayan affinities can be attributed in part to the montane habitats found at Ngoc Linh Nature Reserve and their connection to the Annamite Mountains.



2.13 Herpetiles

Of the 41 reptiles and 23 amphibians found in the nature reserve (Appendix 4), 21 are listed in the IUCN Red List of Threatened Animals (IUCN 1996) or in the Red Data Book of Vietnam (Anon. 1992) (Table 15).

Table 15: Endemic and Red-Listed Herpetiles Recorded in Ngoc Linh Nature Reserve

| Order, Family, Species | Endemic Species | Current Status | |
|--------------------------------------|-----------------|----------------|------------|
| | | IUCN 1996 | Anon. 1992 |
| Squamata: | | | |
| Gekkonidae | | | |
| 1. <i>Gekko gecko</i> | | | T |
| Scincidae | | | |
| 2. <i>Scincella rufocaudata</i> | EV | | |
| Agamidae | | | |
| 3. <i>Physignathus cocincinus</i> | | | V |
| 4. <i>Acanthosaura lepidogaster</i> | | | T |
| Varanidae | | | |
| 5. <i>Varanus nebulosus</i> | | | V |
| 6. <i>V. salvator</i> | | | V |
| Boidae | | | |
| 7. <i>Python molurus</i> | | NT | V |
| 8. <i>P. reticulatus</i> | | | V |
| Colubridae | | | |
| 9. <i>Ptyas korros</i> | | | T |
| Elapidae | | | |
| 10. <i>Bungarus fasciatus</i> | | | T |
| 11. <i>Ophiophagus hannah</i> | | | E |
| 12. <i>Naja naja</i> | | | T |
| Testudinata: | | | |
| Emydidae | | | |
| 13. <i>Cistoclemmys galbinifrons</i> | EV | NT | V |
| 14. <i>Cuora trifasciata</i> | | EN | V |
| Platysternidae | | | |
| 15. <i>Platysternum megacephalum</i> | | DD | R |
| Trionychidae | | | |
| 16. <i>Palea steindachneri</i> | | NT | |
| Testudinidae | | | |
| 17. <i>Indotestudo elongata</i> | | VU | V |
| Apoda: | | | |
| Coeciliidae | | | |
| 18. <i>Ichthyophis glutinosus</i> | | | V |
| Anura: | | | |
| Pelobatidae | | | |
| 19. <i>Megophrys longipes</i> | | | T |
| Bufonidae | | | |
| 20. <i>Bufo galeatus</i> | | | R |
| Ranidae | | | |
| 21. <i>Rana verrucospinosa</i> | EV | | |
| 22. <i>R. andersoni</i> | | | T |
| Rhacophoridae | | | |
| 23. <i>Rhacophorus nigropalmatus</i> | | | T |

Follows Nguyen Van Sang and Ho Thu Cuc (1996)

Notes: EN/E = Endangered; VU/V = Vulnerable; T = threatened; NT = Near Threatened; R = Rare; DD = Data deficient as per IUCN (1996) and Anon. (1992). EV = endemic to Vietnam.



Twenty two percent of the amphibians, and 39% of the reptiles of Ngoc Linh Nature Reserve are red-listed. The herpetiles listed in the Red Data Book of Vietnam include 15 reptiles, (five lizards, six snakes and four turtles) and five amphibians. Three of the herpetile species recorded at Ngoc Linh Nature Reserve are endemic to Vietnam: *Scincella rufocaudata*, *Cistoclemmys galbinifrons* and *Rana verrucospinosa*.

2.14 Butterflies

A total of 236 butterfly species have been recorded in Ngoc Linh Nature Reserve (Appendix 5). These species belong to 11 families: the Papilionidae (22), Pieridae (23), Danaidae (9), Satyridae (33), Amathusiidae (9), Nymphalidae (51), Acraeidae (2), Libytheidae (1), Riodinidae (11), Lycaenidae (46), and Hesperidae (29).

Amongst the butterflies collected in Ngoc Linh Nature Reserve, 18 taxa have not been previously classified, and most of these are new to science. The new butterfly taxa include members of the genera *Neorina*, *Limenitis*, *Thoressa*, *Calaenorrhinus*, *Aldania* and *Dodona*. In addition, many of the other butterfly species collected are new subspecies, for instance, *Aemona amathusia* which was originally described from the Himalayas. Some of butterfly species are known to be restricted to one habitat type, such as *Lethe siderea*, *L. sura*, *L. latiaris*, *L. sinorix*, *Orinoma damaris*, *Callerebia narasingha*, *Stichopthalma lousia* and *Neope armandii*, all of which represent new subspecies which have probably not yet been described.

There are 26 butterfly species within seven families found in Ngoc Linh Nature Reserve, which have not been previously recorded in Vietnam, and whose known ranges have been extended. Additionally, there are 18 butterfly species that are new species records for central Vietnam.

Biogeographically, 51% of the species collected in Ngoc Linh Nature Reserve (119 species) are Indo-Malayan species. Another 15% of the butterflies are species endemic to the eastern Himalayas. There are 34 butterfly species (15%) found from India to northern Indochina.

Butterflies can be separated into groups based on their altitudinal distribution. Of a total of 236 butterfly species, 102 species are found between altitudes of 1,500 and 2,300 m (Sites S1, S2 and S3; Appendix 5), and 179 species are found at altitudes between 900 and 1,500 m (Sites S4, S5, S6 and S7; Appendix 5). Only 48 butterfly species are found at elevations below 1,500 m. A group of 42 species with restricted ranges were identified as high altitude or montane species. Another group of 42 species with restricted ranges were identified as lower altitude species (Table 16).

The butterfly community of Ngoc Linh Nature Reserve is very species diverse and includes many endemic species. A significant proportion of the butterfly community is of Sino-Himalayan origin. Another notable feature is the prevalence of undescribed species, new species records for Vietnam, and new species records for central Vietnam. One species found in Ngoc Linh Nature Reserve, *Teinopalpus imperialis*, is listed by IUCN (1996).

Butterfly communities are indicative of habitat diversity, especially as butterflies exhibit a high degree of niche separation by utilising a wide variety of species-specific food plants. The altitudinal changes in the butterfly community composition are indicative of altitudinal variation in forest types in Ngoc Linh Nature Reserve. Furthermore, based on the diversity of the butterfly communities, each altitudinal zone is extremely habitat diverse. The diverse habitats of Ngoc Linh Nature Reserve deserve protection as one of Vietnam's truly unique conservation sites.

Table 16: Altitudinal Ranges of Butterflies in Ngoc Linh Nature Reserve

| Family | No. Species found between 900 and 1,500 m | Restricted-range Species between 900 and 1,500 m | No. Species found between 1,500 and 2,300 m | Restricted-range Species between 1,500 and 2,000 m |
|--------------|---|--|---|--|
| Papilionidae | 19 | 3 | 7 | 3 |
| Pieridae | 22 | 2 | 13 | 2 |
| Danaidae | 8 | 0 | 2 | 1 |
| Satyridae | 23 | 12 | 20 | 14 |
| Amathusiidae | 8 | 8 | 2 | 2 |
| Nymphalidae | 40 | 6 | 22 | 7 |
| Acraeidae | 2 | 0 | 1 | 0 |
| Libytheidae | 1 | 0 | 0 | 0 |
| Riodinidae | 7 | 1 | 8 | 4 |
| Lycaenidae | 31 | 6 | 15 | 4 |
| Hesperiidae | 18 | 4 | 12 | 5 |
| Total | 179 | 42 | 102 | 42 |

2.15 Socio-Cultural Features

The buffer zone of Ngoc Linh Nature Reserve includes five communes in Dac Glei district and three communes in Dac To district (Table 17). The total human population of these communes is 13,876 people or 37% of the two districts' combined population. The residents of the buffer zone are members of five ethnic groups. The Xe Dang ethnic minority are the largest population, comprising 65% of the people in the area. The De ethnic minority comprise 26.3%, the Trieng De ethnic minority 7.3%, the Chau ethnic minority 0.7%, and the Kinh (majority Vietnamese) only 0.3% of the local population. Other ethnic minorities comprise only 0.4% of the local population. The Xe Dang ethnic minority inhabit Dac To district. The De ethnic minority mostly live in Dac Plo and Dac Man communes of Dac To district. The remaining ethnic minority people reside in Dac Glei district (Map 5).

The five buffer zone communes in Dac Glei district have a total population of 8,543 people or 61.5% of the buffer zone's population. The three buffer zone communes in Dac To district have a total population of 5,333 people or 38.5% of the buffer zone's population. The average population density in the buffer zone is 17 people/km². Communes located within the buffer zone contain very little agricultural land, with only between 1,000 and 2,400 m² per person. Most cultivated lands are single-crop fields. Exploitation of forest products is common in the nature reserve area.

Table 17: Population Statistics and Ethnic Composition

| District/ Commune | Total Popn. | Male | Female | Ethnic Group | | | | | |
|----------------------|----------------|-------|--------|--------------|---------|-------|-----------|------|-------|
| | | | | Kinh | Xe Dang | De | Trieng Re | Chau | Other |
| Dac Glei district | 8,543 | 3,748 | 4,795 | 47 | 3,659 | 3,658 | 1,032 | 95 | 52 |
| Dac Plo | 932 | 400 | 552 | 0 | 0 | 932 | 0 | 0 | 0 |
| Dac Man | 867 | 381 | 486 | 0 | 0 | 867 | 0 | 0 | 0 |
| Dac Choong | 2,975 | 1,309 | 1,646 | 32 | 0 | 1,859 | 1,032 | 0 | 52 |
| Muong Hoong | 1,994 | 877 | 1,117 | 15 | 1,884 | 0 | 0 | 95 | 0 |
| Ngoc Linh | 1,775 | 781 | 994 | 0 | 1,775 | 0 | 0 | 0 | 0 |
| Dac To district | 5,333 | 2,557 | 2,776 | 0 | 5,333 | 0 | 0 | 0 | 0 |
| Dac Na | 1,970 | 952 | 1,018 | 0 | 1,970 | 0 | 0 | 0 | 0 |
| Mang Xang | 2,315 | 1,103 | 1,212 | 0 | 2,315 | 0 | 0 | 0 | 0 |
| Ngoc Lay | 1,048 | 502 | 546 | 0 | 1,048 | 0 | 0 | 0 | 0 |
| Total | 13,876 | 6,305 | 7,571 | 47 | 8,992 | 3,658 | 1,032 | 95 | 52 |



Population Distribution

The human populations within Ngoc Linh Nature Reserve's buffer zone are concentrated in 19 villages and comprise 2,714 households (Table 18). Of these, Dac Man commune has the lowest population, with 867 people living in three villages along National Highway 14. The most populated commune is Dac Choong with 2,975 people, spread throughout 16 villages. Three communes are almost completely surrounded by Ngoc Linh Nature Reserve: Dac Choong, Muong Hoong and Ngoc Linh.

Table 18: Population Distribution, Density and Growth in the Buffer Zone

| District/ Commune | Area (ha) | Popn. | No. of Villages | No. of Households | Density (pers/km ²) | Popn. Growth (%) |
|----------------------|--------------|--------|--------------------|----------------------|------------------------------------|---------------------|
| Dac Glei district | 72,842 | 8,543 | 46 | 1,691 | 12 | — |
| Dac Plo | 17,289 | 932 | 5 | 219 | 6 | 2.7 |
| Dac Man | 11,931 | 867 | 3 | 169 | 12 | 2.7 |
| Dac Choong | 26,512 | 2,975 | 16 | 687 | 11 | 2.7 |
| Muong Hoong | 8,776 | 1,994 | 6 | 363 | 23 | 2.7 |
| Ngoc Linh | 8,334 | 1,775 | 16 | 253 | 21 | 2.7 |
| Dac To district | 27,297 | 5,333 | 34 | 1,023 | 20 | — |
| Dac Na | 8,126 | 1,970 | 14 | 403 | 24 | 2.3 |
| Mang Xang | 8,878 | 2,315 | 10 | 397 | 26 | 2.3 |
| Ngoc Lay | 10,293 | 1,048 | 10 | 223 | 10 | 2.3 |
| Total | 100,139 | 13,876 | 80 | 2,714 | 14 | — |

Households commonly contain three generations of one family: grandparents, parents and an average of five to six children. Population growth rates are high, averaging 2.5% per annum; the rate of population growth is especially high in Dac To commune, at 2.7% per annum. Natural forest is still widespread in the area, due to the lack of technology to convert this to agricultural land, difficult living conditions in the area, and the low productivity of existing small agricultural areas. The main economic activities are wet rice cultivation, shifting agriculture, animal husbandry and exploitation of the surrounding forest.

Sedentary and Nomadic Populations

In the buffer zone of Ngoc Linh Nature Reserve, there are 482 households with 2,303 people that have been scheduled for permanent dwellings provided through state-administered programmes. However, there is a sizeable itinerant population of 1,989 households and 10,554 people who subsist on shifting cultivation, and rely on hunting and collection of forest products. Of these, 1,248 households with 6,724 people are currently in temporary housing, whilst 741 households with 3,830 people live a nomadic or semi-nomadic existence and have not yet been scheduled for permanent housing (Table 19).

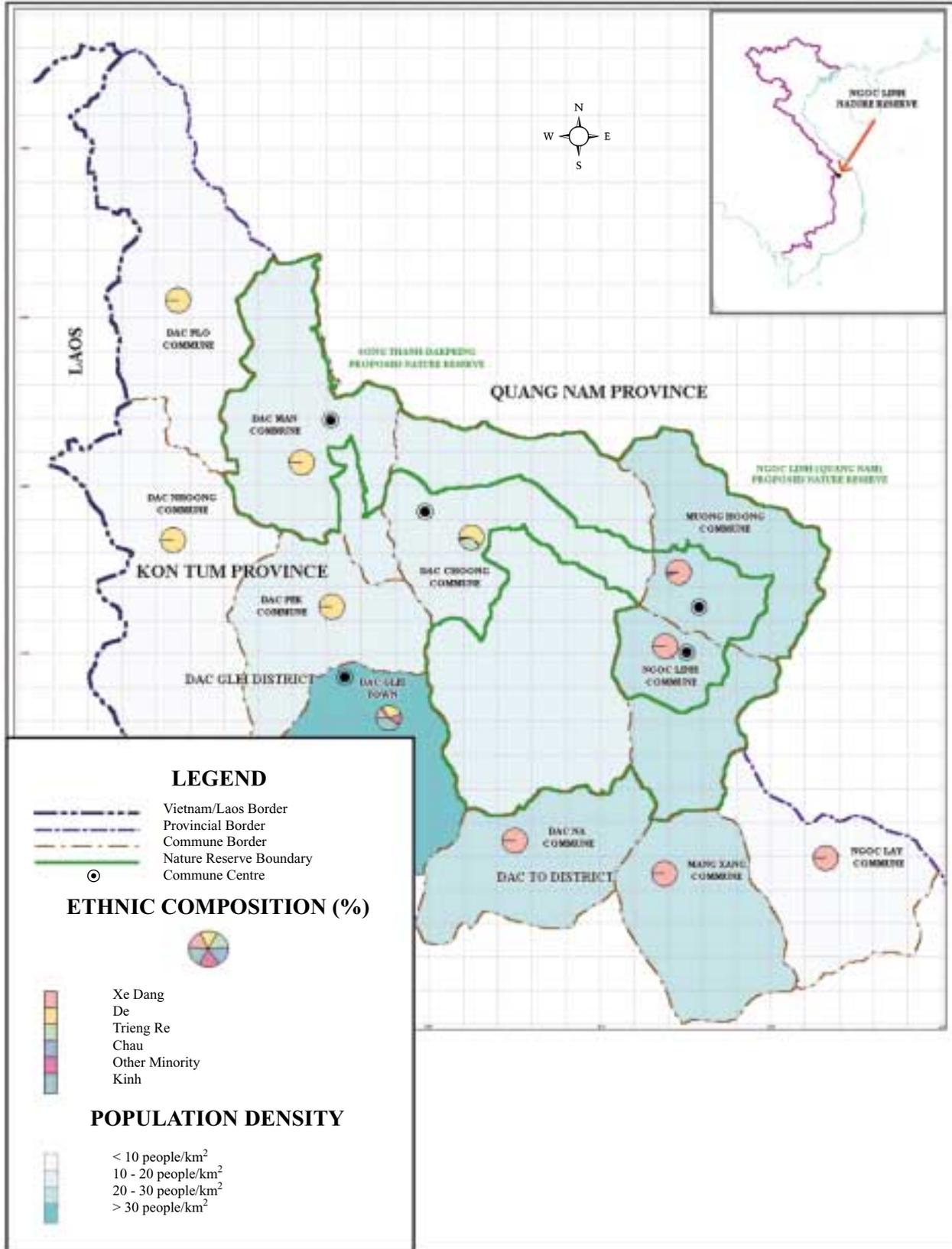
Table 19: Settlement in the Buffer Zone Communes

| District/ Commune | Total Population | | Settled Population | | Temporarily Settled Popn. | | Unsettled Population | |
|----------------------|---------------------|--------|-----------------------|--------|------------------------------|--------|-------------------------|--------|
| | H'shold | People | H'shold | People | H'shold | People | H'shold | People |
| Dac Glei district | 1,614 | 8,250 | 369 | 1,745 | 1,050 | 5,530 | 195 | 975 |
| Dac Plo/Dac Man* | 355 | 1,705 | 0 | 0 | 170 | 770 | 185 | 935 |
| Dac Choong | 654 | 2,894 | 198 | 862 | 446 | 1,992 | 10 | 40 |
| Muong Hoong | 354 | 1,900 | 113 | 584 | 241 | 1,316 | 0 | 0 |
| Ngoc Linh | 251 | 1,751 | 58 | 299 | 193 | 1,452 | 0 | 0 |
| Dac To district | 857 | 4,607 | 113 | 558 | 198 | 1,194 | 546 | 2,855 |
| Dac Na | 269 | 1,604 | 0 | 0 | 198 | 1,194 | 71 | 410 |
| Mang Xang | 391 | 2,068 | 113 | 558 | 0 | 0 | 278 | 1,510 |
| Ngoc Lay | 197 | 935 | 0 | 0 | 0 | 0 | 197 | 935 |
| Total | 2,471 | 12,857 | 482 | 2,303 | 1,248 | 6,724 | 741 | 3,830 |

* Dac Plo and Dac Man were administratively divided in 1997 and share data.



Map 5: Population Density and Ethnic Composition of Communes in the Buffer Zone



Grid: UTM, zone 48
Horizontal Datum: India 1960

SCALE 1:300,000

Produced by the Forest Resources and Environment Centre of FIPI

The temporarily settled and unsettled households are primarily found in the more mountainous areas on the borders of Dac To and Dac Glei districts, a remote area distant from settled communities and existing roads. The itinerant population, which lives a nomadic or semi-nomadic existence, suffers from malnutrition and is subject to seasonal famine. Access to transportation, educational facilities and clean water supplies is minimal; agricultural methods are primitive and inefficient; and the nomadic and semi-nomadic people have not been included in famine-alleviation programmes or in the national agroforestry programme.

Transportation

Within the buffer zone there are 336 km of roads, comprising 83 km of surfaced roads and 253 km of unsurfaced roads. The road system in the buffer zone links the main population centres or communes to each other and to the district administrative centre. However, transportation is still difficult, especially during the rainy season, due to the complex terrain and the prevalence of unpaved roads. Access to villages is mostly by mountain trails, and the smaller communes are up to 40 km from the district centres. The present transportation system is a considerable obstacle to the area's future development.

Health Care

The buffer zone has a district health service network to serve the communes. With the exception of Dac Man commune, every commune has its own health station. However, medical equipment is lacking and health stations are understaffed. Only three out of eight communes have assistant doctors on the staff and some communes have no formal health care workers. Qualified health care staff and proper services are rare.

The most common diseases and ailments are malaria, goitre and tuberculosis (Table 20). In particular, there is a malarial infection rate of 5 to 10%, and those infected require medical attention at least once every year. Despite a campaign to eradicate malaria, the local health care staff and cooperating agencies have had little success.

Table 20: Health Care Staff, Facilities and Diseases in the Buffer Zone

| District/ Commune | Health Stations | Number of Health Workers | | | Water Source | Common Diseases |
|----------------------|--------------------|--------------------------|---------------|--------|-----------------|------------------------|
| | | Doctors | Asst. Doctors | Nurses | | |
| Dac Glei district | 4 | 0 | 1 | 8 | Natural | TB and malaria |
| Dac Plo | 1 | 0 | 0 | 0 | " | " |
| Dac Man | 0 | 0 | 0 | 0 | " | " |
| Dac Choong | 1 | 0 | 1 | 2 | " | " |
| Muong Hoong | 1 | 0 | 0 | 3 | " | " |
| Ngoc Linh | 1 | 0 | 0 | 3 | " | " |
| Dac To district | 3 | 0 | 2 | 4 | Natural | TB, malaria and goitre |
| Dac Na | 1 | 0 | 1 | 2 | " | " |
| Mang Xang | 1 | 0 | 1 | 1 | " | " |
| Ngoc Lay | 1 | 0 | 0 | 1 | " | " |
| Total | 7 | 0 | 3 | 12 | — | — |

The national family planning programme has also had little success. The family planning programme has been difficult to implement due to a large, inaccessible population and the reluctance of local people to change their lifestyles.

Primary drinking water sources in the area are all from natural sources, including rivers, streams, seeps, springs and primitive groundwater wells. Unclean water consumption is the cause of most illness and disease in the area.



Education

Every commune has an educational system that incorporates kindergarten to primary school education, with the exception of Dac Choong and Dac Na communes which do not have kindergarten facilities. There is one secondary school in each district (in Ngoc Lay and Muong Hoong communes) (Table 21).

Table 21: Education Provision and Attendance in the Buffer Zone

| District/ Commune | Kindergarten | | Primary School | | Secondary School | | Atten- dance (%) | Number of Teachers | Shortage of Teachers |
|----------------------|--------------|-------|-------------------|-------|---------------------|-------|------------------------|--------------------------|----------------------------|
| | Class | Pupil | Class | Pupil | Class | Pupil | | | |
| Dac Glei district | 9 | 234 | 75 | 1,730 | 1 | 30 | 78 | 83 | 13 |
| Dac Plo | 1 | 20 | 9 | 196 | 0 | 0 | 60 | 7 | 0 |
| Dac Man | 2 | 26 | 12 | 240 | 0 | 0 | 70 | 10 | 0 |
| Dac Choong | 0 | 0 | 19 | 651 | 0 | 0 | 80 | 22 | 0 |
| Muong Hoong | 4 | 140 | 20 | 348 | 1 | 30 | 90 | 25 | 7 |
| Ngoc Linh | 2 | 48 | 15 | 295 | 0 | 0 | 90 | 19 | 6 |
| Dac To district | 3 | 59 | 33 | 786 | 1 | 7 | 71 | 72 | 9 |
| Dac Na | 0 | 0 | 5 | 126 | 0 | 0 | 75 | 25 | 0 |
| Mang Xang | 2 | 45 | 13 | 460 | 0 | 0 | 89 | 28 | 7 |
| Ngoc Lay | 1 | 14 | 15 | 200 | 1 | 7 | 50 | 19 | 2 |
| Total | 12 | 293 | 108 | 2,516 | 2 | 37 | 76 | 102 | 22 |

Seventy six percent of children attend secondary school. The lowest attendances are for Dac Plo (60%) and Ngoc Lay (50%) communes. There is little incentive for families to assure schooling for their children, and this presents a major obstacle to economic development. The main reasons for low attendance are that families are poor, that children are needed to work in the home or in the fields, and that it is too far to travel to school.

There is a serious shortfall in numbers of classrooms, desks, teachers and housing for teachers. There are only 99 classrooms in buffer zone, of which 23 classrooms are brick and all others are thatch. The area is currently in need of nine classrooms and 22 teachers. A shortage of qualified teachers results in large class sizes, and the level of education is poor. Some schools must hold mixed-grade classes due to the shortage of classrooms.

Cultivation Practices and Household Incomes

The area of agricultural land is very low, averaging 1,600 m² per person (Table 23). Wet rice cultivation is mostly on hillsides and with low-yielding strains, resulting in low productivity. Wet rice cultivation experiences annual shortages of water and can only produce one crop per year. Little investment has gone into secondary crop cultivation and production forest, and these represent only a small portion of household incomes. In the buffer zone, 1,066 households suffer from malnutrition (Table 22).

Communes suffering from high levels of famine include Ngoc Lay at 30%, Mang Xang at 31%, Dac Plo at 36% and Dac Man at 38% of the local population. On average, in communes in Dac To district, 35% of households have insufficient food, whilst the figure for Da Lay district is 42%. Most households actively exploit forest products in the nature reserve area; particularly households suffering from famine, whose main supplementary income comes from such forest products as firewood, honey, Ngoc Linh Ginseng and hunting. Forest products account for 20 to 25% of the total income of households in the buffer zone.

In comparison to other communes in the province and other buffer zones in Vietnam, the inhabitants of Ngoc Linh Nature Reserve's buffer zone have very low incomes. Their incomes are derived entirely from agriculture, forest products and animal husbandry.



Table 22: Agricultural Production and Famine Levels in the Buffer Zone

| District/ Commune | Total House- holds | Surplus Food Production | Sufficient Food Production | Households at Famine Level | | | |
|------------------------|--------------------------|-------------------------------|----------------------------------|----------------------------|------------------|------------------|------------------|
| | | | | Total | 1 to 2 Months | 3 to 4 Months | 5 to 6 Months |
| Dac Glei district | 1,691 | 30 | 954 | 707 | 121 | 251 | 335 |
| Dac Plo | 219 | 0 | 78 | 141 | 46 | 57 | 38 |
| Dac Man | 169 | 0 | 48 | 121 | 0 | 57 | 64 |
| Dac Choong | 687 | 0 | 470 | 217 | 0 | 79 | 138 |
| Muong Hoong | 363 | 30 | 185 | 148 | 0 | 58 | 90 |
| Ngoc Linh | 253 | 0 | 173 | 80 | 75 | 0 | 5 |
| Dac To district | 1,023 | 20 | 644 | 359 | 84 | 182 | 93 |
| Dac Na | 403 | 0 | 353 | 50 | 0 | 15 | 35 |
| Mang Xang | 397 | 20 | 223 | 154 | 69 | 47 | 38 |
| Ngoc Lay | 223 | 0 | 68 | 155 | 15 | 120 | 20 |
| Total | 2,714 | 50 | 1,598 | 1,066 | 205 | 433 | 428 |

As the local population's current survival is dependent upon forest resources, a concerted effort has to be made to effectively establish and protect the nature reserve. As part of this effort, a community development programme in the buffer zone including agriculture, forestry, education and health care, must be implemented; in particular prioritising the communes suffering from food shortages. Living conditions and standards must be gradually improved and illegal forest exploitation reduced in order to conserve the biodiversity of Ngoc Linh Nature Reserve.

Table 23: Land-Use in the Buffer Zone

| District/ Commune | Total Land Area (ha) | Land-Use (ha) | | | |
|------------------------|----------------------------|----------------------|------------------|------------------------|----------------|
| | | Agricultural Land | Forested Land | Planned Agriculture | Other Lands |
| Dac Glei district | 72,842 | 1,298 | 67,102 | 3,468 | 873 |
| Dac Plo/Dac Man* | 29,220 | 365 | 27,373 | 1,066 | 316 |
| Dac Choong | 26,512 | 286 | 24,800 | 1,093 | 333 |
| Muong Hoong | 8,776 | 349 | 7,654 | 645 | 128 |
| Ngoc Linh | 8,334 | 298 | 7,275 | 664 | 96 |
| Dac To district | 27,297 | 817 | 21,919 | 4,372 | 189 |
| Dac Na | 8,126 | 270 | 6,249 | 1,528 | 79 |
| Mang Xang | 8,878 | 318 | 6,640 | 1,866 | 54 |
| Ngoc Lay | 10,293 | 229 | 9,030 | 978 | 56 |
| Total | 100,139 | 2,115 | 89,021 | 7,840 | 1,062 |

* Dac Plo and Dac Man were administratively divided in 1997 and share data.

Secondary crops grown in the region include cassava, corn and potato; beans and peanuts are grown to a lesser degree. Cassava and corn are the most common secondary crops (Table 24). Secondary crops are used to replace rice during times of shortage but are rarely used as commodities in the region.

Animal Husbandry

In general, the local area is favourable for animal husbandry and a developed cattle industry exists. Many households have two or three cows or buffaloes but some households are too poor to purchase livestock. On average, 60% of households own livestock; except in Ngoc Linh and Muong Hoong communes where 100% of households own livestock.



Table 24: Agricultural Production in the Buffer Zone

| District/ Commune | Total Area (ha) | Rice Cultivation (ha) | | | | Other Crops (ha) | | | |
|----------------------|-----------------------|-----------------------|-------------|-------------|--------------|------------------|------|--------|---------|
| | | Total | 1st Crop | 2nd Crop | Hill Rice | Total | Corn | Potato | Cassava |
| Dac Glei district | 1,177 | 962 | 626 | 135 | 201 | 210 | 138 | 1 | 71 |
| Dac Plo | 236 | 136 | 30 | 0 | 106 | 100 | 65 | 0 | 35 |
| Dac Man | 83 | 43 | 3 | 0 | 40 | 20 | 5 | 0 | 15 |
| Dac Choong | 359 | 310 | 135 | 120 | 55 | 49 | 43 | 0 | 6 |
| Muong Hoong | 283 | 273 | 258 | 15 | 0 | 25 | 15 | 0 | 10 |
| Ngoc Linh | 216 | 200 | 200 | 0 | 0 | 16 | 10 | 1 | 5 |
| Dac To district | 674 | 391 | 238 | 34 | 119 | 282 | 103 | 13 | 166 |
| Dac Na | 305 | 175 | 95 | 30 | 50 | 130 | 50 | 0 | 80 |
| Mang Xang | 259 | 135 | 91 | 4 | 40 | 124 | 44 | 13 | 67 |
| Ngoc Lay | 110 | 81 | 53 | 0 | 29 | 28 | 9 | 0 | 19 |
| Total | 1,851 | 1,353 | 865 | 171 | 320 | 492 | 241 | 14 | 237 |

Forest Production

The exploitation of forest products is the major economic activity in the region. The people of the buffer zone of Ngoc Linh Nature Reserve can only receive assigned forestry lands under an agroforestry tenure agreement. The average family receives responsibility for 10 to 15 ha of land under their protection (Table 25). Most households have not acquired enough land to establish production forest. Although there are extensive areas of forest under the administration of the communes, most forest is managed by forest enterprises.

Table 25: Agroforestry Land-Use in the Buffer Zone

| District/ Commune | Total Area (ha) | Production Forest (ha) | | | |
|----------------------|--------------------|------------------------|--------------------------|-----------------------|-------------|
| | | Coffee plants | <i>Litsea monopetala</i> | <i>Cinnamomum</i> sp. | Fruit Trees |
| Dac Glei district | 356 | 257 | 32 | 34 | 34 |
| Dac Plo | 42 | 29 | 0 | 1 | 13 |
| Dac Man | 48 | 15 | 25 | 3 | 5 |
| Dac Choong | 97 | 89 | 2 | 0 | 6 |
| Muong Hoong | 102 | 72 | 5 | 15 | 10 |
| Ngoc Linh | 67 | 52 | 0 | 15 | 0 |
| Dac To district | 94 | 25 | 23 | 1 | 45 |
| Dac Na | 0 | 0 | 0 | 0 | 0 |
| Mang Xang | 93 | 25 | 22 | 1 | 45 |
| Ngoc Lay | 1 | — | 1 | 0 | — |
| Total | 450 | 282 | 55 | 35 | 79 |

The potential for agroforestry in the production forest of the buffer zone communes is still very high. To date, most of these lands have not been used to plant economically valuable trees. Those areas which have been planted have not been protected, and many areas have been destroyed by grazing cattle.

There is a dire need to implement policies and measures which will encourage local people to become involved in agroforestry. At the very least, production forest in the buffer zone and outside of the nature reserve area should be encouraged to produce firewood to meet local needs.

Although the inhabitants of the buffer zone are not legally permitted to cut trees, exploitation of timber and other forest products occurs outside and inside the nature reserve. Most timber is exploited for domestic uses, such as building material and firewood, whilst some is sold locally.

The forest both inside and outside Ngoc Linh Nature Reserve has been heavily exploited (Table 26). Forest exploitation ranges from timber extraction, hunting and rattan collecting to collecting forest products that have already been over-exploited such as Ngoc Linh Ginseng and *Litsea monopetala*.

Table 26: Exploitation of Forest in the Buffer Zone

| District/ Commune | Timber (m ³) | Firewood (no. of stems) | Ngoc Linh Ginseng (kg) | <i>Litsea monopetala</i> (kg) | Honey (kg) |
|------------------------|-----------------------------|----------------------------|---------------------------|-----------------------------------|---------------|
| Dac Glei district | 200 | 40,190 | 200 | 1,800 | 3,375 |
| Dac Plo | 20 | 5,250 | 0 | 200 | 100 |
| Dac Man | 53 | 6,070 | 0 | 200 | 65 |
| Dac Choong | 68 | 10,190 | — | 500 | 820 |
| Muong Hoong | 35 | 14,440 | 100 | 500 | 390 |
| Ngoc Linh | 24 | 4,240 | 100 | 400 | 2,000 |
| Dac To district | 138 | 19,782 | 60 | 4,000 | 960 |
| Dac Na | 35 | 9,670 | 50 | 1,000 | 50 |
| Mang Xang | 53 | 4,760 | 10 | 2,000 | 650 |
| Ngoc Lay | 50 | 5,352 | 0 | 1,000 | 260 |
| Total | 338 | 59,972 | 260 | 5,800 | 4,335 |

Management of all forestry activities is the responsibility of the board of forestry in each commune. This board includes a chairman and three to four board members. They employ local people in forest protection and management, and oversee the agroforestry programme. However, with a lack of human resources coupled with low local incomes, widespread forest exploitation is inevitable.

Forest Enterprises

There are five state-run forest enterprises operating in the area; all fall within the management of the Provincial Department of Agriculture and Rural Development. All of these forest enterprises holdings are either partly or totally within the nature reserve area.

The main activities of the forest enterprises are reforestation and forest exploitation. Once Ngoc Linh Nature Reserve is officially registered, these forest enterprises will function in an official capacity to protect and manage the nature reserve and implement the agroforestry programme. Currently, Rung Thong Forest Enterprise is the only company still exploiting the forest, felling 6,000 m³ of timber per year, collecting 30 tonnes of pine resin per year and actively planting forests as part of the agroforestry programme.

The agroforestry programme is administered under the state-run forest enterprises, also known as the 327 Programme. This programme actively encourages farmers to develop forest plantations and protect natural forest. The forest enterprises have also constructed some roads, schools and health stations as part of this programme. For example, a television station, hydropower station and health care centre have been constructed, and roads have been developed as part of a forestry settlement programme in Muong Hoong and Ngoc Linh communes.



3. Evaluation

3.1 Evaluation Criteria

Establishing a set of criteria for assessing a nature reserve's global biogeographic coverage is a useful means of evaluating the overall importance and value of a site. Ngoc Linh Nature Reserve satisfies virtually all of the main criteria for an area to be considered to be of extremely high conservation value (Table 27).

Table 27: Conservation Criteria and Evaluation of Ngoc Linh Nature Reserve

| Conservation Criteria | Site Evaluation |
|---|--|
| <p>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.</p> | The area is representative of the Kontum Plateau EBA. Viable animal populations exist and should be preserved with comprehensive management efforts. |
| <p>Richness And Diversity: Usually linked with the diversity of habitat types; ecological gradients or ecotones should be represented because they support transitional communities.</p> | The area is as species diverse as other protected areas and is a biodiversity hotspot. Ecological gradients are present between four major habitat types and eight subtypes. An altitudinal gradient also exists. |
| <p>Naturalness: Assessment of the extent of primary habitats.</p> | The nature reserve area is almost pristine with little modification, and large contiguous areas of great biodiversity importance are unaltered. Small modified areas can be restored. |
| <p>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.</p> | There are 58 red-listed vertebrate species and 45 red-listed plant species. Two mammal species, two bird species and 12 bird subspecies are newly discovered. |
| <p>Uniqueness: Areas which exhibit particular natural processes or which are poorly represented in the national protection system.</p> | The study area is an EBA and contains unique upper montane habitat types. The two newly discovered bird species are not known from any other protected area. |
| <p>Typicalness: It is important to represent typical areas of common habitats and typical communities of a biome.</p> | Because of the wide altitudinal range, the study area contains all the major habitat types of the Kontum Plateau. |
| <p>Fragility: A measure of an area's susceptibility to change through either natural or man-made processes.</p> | Montane habitats and their associated fauna and flora are fragile, sensitive, easily modified and very slow to recover. |
| <p>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.</p> | To the north, the study area is contiguous with extensive forest areas in the proposed Song Thanh-Dakpring and Ngoc Linh (Quang Nam) Nature Reserves. Song Thanh-Dakpring is, in turn, linked to forest areas in Laos. |
| <p>Economic Value: An area may protect a valuable water catchment or a higher level of biogeographic subdivision.</p> | Area protects several important water catchments. |
| <p>Conservation Opportunity: Socio-political climate is highly determinate in the success of any conservation area's future objectives and priorities.</p> | One of 12 prioritised areas identified for expansion in the Biodiversity Action Plan for Vietnam in order to protect regional biodiversity. |

Conservation criteria follow Ratcliffe (1977)



Ngoc Linh Nature Reserve satisfies all of the evaluation criteria used to assess the overall importance and value of a conservation area. Moreover, Ngoc Linh Nature Reserve easily meets all of the criteria normally reserved for national parks and is recommended for upgrading to national park status.

3.2 Evaluation of Physical Features

The conservation coverage of Ngoc Linh Nature Reserve in Kon Tum province is planned to be 41,420 ha. The conservation area of Ngoc Linh Nature Reserve is comparable to that of seven other protected areas in the Western Highlands: Mon Ray (48,600 ha), Kon Ka Kinh (28,000 ha), Yok Don (58,000 ha), Chu Yang Sin (32,300 ha), Nam Ca (24,500 ha), Chu Hoa (17,000 ha), and Nui Bi Doup/Nui Ba (74,000 ha). The coverage of Ngoc Linh Nature Reserve includes 23,631 ha (57% of the total area) of “rich” and “medium” broadleaf forest.

The majority of the conservation coverage is over 1,000 m in elevation: this ensures significant inclusion of key montane habitats for endemic and newly discovered species. Combined with the conservation coverage of the proposed Ngoc Linh (Quang Nam) and Song Thang-Dakpring Nature Reserves in Quang Nam province, the conservation coverage would increase to approximately 170,000 ha and would become one of the largest conservation areas in Vietnam. This area would also be linked to a large block of forest in Laos, which would help to ensure the survival of a large area of one of Vietnam’s more unique, rare and interesting high montane forest ecosystems.

3.3 Evaluation of Flora and Fauna

Findings of the preliminary survey of Ngoc Linh Nature Reserve included 190 bird species, 52 mammal species, 41 reptile species, 23 amphibian species, 236 butterfly species and 878 plant species.

The shortcomings of this survey were that it was a quick assessment and did not focus on nocturnal species or freshwater fauna and flora. Thus invertebrates (except for butterflies), rodents and bats were excluded from the survey. Future faunal surveys could be anticipated to reveal additional species records for the area.

The vegetation of Ngoc Linh Nature Reserve is diverse and includes four main forest types and eight vegetation subtypes, ranging from an altitude of 900 m to the summit of Mount

Table 28: Flora Diversity in the Kontum Plateau and Da Lat Plateau EBAs, and the Fan Si Pan and Northern Laos Secondary EBA

| Protected Area | Area (ha) | Families | Genera | Species |
|----------------------------|-----------|----------|--------|---------|
| Hill 1978 (Thuong Da Nhim) | — | 74 | 113 | 170 |
| Nui Bi Doup / Nui Ra Rich | 73,912 | 126 | 288 | 425 |
| Chu Yang Sin | 32,328 | 142 | 475 | 876 |
| Hoang Lien | 29,845 | 119 | 322 | 497 |
| Ngoc Linh | 41,420 | 152 | 539 | 878 |

Ngoc Linh at 2,598 m. A total of 878 plant species have been identified to date, and Ngoc Linh is extremely diverse in flora when compared to other montane protected areas in Vietnam (Table 28).

The flora and fauna of Ngoc Linh Nature Reserve have large Sino-Himalayan components. The nature reserve has great floral and faunal similarities with the high mountains of north-west Vietnam but also has affinities with the highest peaks further south in the Da Lat Plateau EBA. Mammal and bird species diversity are comparable to those of other montane nature reserves in Vietnam (Table 29).

Table 29: Comparison of Mammal and Bird Diversity with other Montane Nature Reserves

| Area | Mammals | Birds |
|--------------|---------|-------|
| Ngoc Linh | 52 | 190 |
| Mom Ray | 76 | 208 |
| Chu Yang Sin | 46 | 203 |
| Nui Bi Doup | — | 154 |
| Hoang Lien | 33 | 208 |

Conservation of Red-listed Species

At 104, the number of red-listed species found in Ngoc Linh Nature Reserve is high; 19% of vertebrate species recorded are red-listed (Table 30). Mammals, reptiles and amphibians show high proportions of red-listed species; and 2% of the flora is listed by IUCN (1997), a high proportion for plant species. The total number of red-listed bird species is also relatively high, and is composed primarily of extremely niche-specialised species, and includes important indicator species for these fragile montane habitats.

Table 30: Number of Total, Globally and Vietnam Red-Listed Species

| Group | Total No. of Species | Total Red-listed Species | IUCN Listed Species | Vietnam Listed Species | % of Total Species Red-Listed |
|-------------|----------------------|--------------------------|---------------------|------------------------|-------------------------------|
| Mammals | 52 | 20 | 14 | 16 | 39 |
| Birds | 190 | 17 | 10 | 13 | 9 |
| Reptiles | 41 | 16 | 6 | 15 | 39 |
| Amphibians | 23 | 5 | 0 | 5 | 26 |
| Butterflies | 236 | 1 | 1 | 0 | <1 |
| Plants | 878 | 45 | 19 | 34 | 5 |
| Total | 1,420 | 104 | 50 | 83 | 7 |

As per IUCN (1996 and 1997), Collar *et al.* (1994) and Anon. (1992 and 1996).

Ngoc Linh Nature Reserve has 14 mammal species listed by IUCN (1996) and 16 mammal species listed in the Red Data Book of Vietnam (Anon. 1992). Of particular conservation concern is the endangered Tiger. Several mammals listed as vulnerable are also of conservation significance, namely Dhole *Cuon alpinus*, Asiatic Black Bear and Clouded Leopard. Two newly described mammal species are found within the nature reserve: Giant Muntjac and Truong Son Muntjac. Truong Son Muntjac is a locally common, restricted-range endemic with a currently known range of approximately 300 km².

There are also 17 red-listed bird species, 10 of which are listed by Collar *et al.* (1994) and 13 of which are listed in the Red Data Book of Vietnam (Anon. 1992). The 10 species listed by Collar *et al.* are Siamese Fireback *Lophura diardi*, Crested Argus, Brown Hornbill *Anorrhinus tickelli*, White-winged Magpie *Urocissa whiteheadi*, Indochinese Green Magpie *Cissa hypoleuca*, Green Cochoa *Cochoa viridis*, Yellow-billed Nuthatch, Red-tailed Laughingthrush *Garrulax milnei*, Black-hooded Laughingthrush and Short-tailed Scimitar Babbler.

Among the butterflies, *Teinopalpus imperialis* is listed in Appendix II of CITES (1994) and in the IUCN Red List of Threatened Animals (IUCN 1996). This species was previously known for Vietnam only from Sa Pa in the far north, and this represents the first record for central Vietnam. At present, no butterfly species are included in the Red Data Book of Vietnam (Anon. 1992) but this situation probably reflects a lack of study of this group rather than the true status of Vietnamese butterfly species.

Discovery of New Bird Species and Subspecies

The higher elevations of Ngoc Linh Nature Reserve have a large component of altitudinally restricted species that have been isolated for periods long enough to allow speciation. During the course of this survey, two species of bird new to science were discovered along with 12 new subspecies (see Section 2.12 for more details).

Conservation of Restricted-Range Endemic Species

Ngoc Linh Nature Reserve has a high degree of endemism; this mountain isolate includes both lowland and montane restricted-range species. Nine plant species endemic to Vietnam are found in the nature reserve, one of which, Ngoc Linh Ginseng, is famous for its purported medicinal qualities.

There are 34 species of butterfly with ranges restricted to the eastern Himalayas, southern China and



northern Indochina. The ranges of another 42 butterfly species are restricted to Indochina, and nine species are endemic to central Vietnam. Two butterfly species are new species records for the Oriental Region.

Ngoc Linh Nature Reserve represents the only known range of many butterfly species either in central Vietnam, Vietnam as a whole or the world. Therefore, despite the current lack of information on the distribution of many butterfly species within Vietnam, Ngoc Linh should be considered a priority site for the conservation of butterfly diversity.

Three endemic reptiles and amphibians are found in the nature reserve; these Vietnam endemics include two reptiles, *Scincella rufocaudata* and *Cistoclemmys galbinifrons*, and one amphibian, *Rana verrucospinosa*. Three mammal species endemic to Vietnam or to Vietnam and Laos are found in the nature reserve: Truong Son Muntjac, Giant Muntjac and Buff-cheeked Gibbon.

Seven restricted-range bird species are found in Ngoc Linh Nature Reserve:

- Crested Argus. Vulnerable; restricted to the Annamese Lowlands and the Da Lat and Kontum Plateaus of Vietnam, Laos, and peninsular Malaysia;
- Yellow-billed Nuthatch. Vulnerable; restricted to Mount Fan Si Pan and the Da Lat and Kontum Plateaus of Vietnam, northern Laos, and Hainan Island, China;
- White-cheeked Laughingthrush. Least Concern; restricted to the Annamese Lowlands and the Da Lat and Kontum Plateaus of Vietnam and southern Laos;
- Black-hooded Laughingthrush. Vulnerable; restricted to the Da Lat and Kontum Plateaus of Vietnam and adjacent areas in Laos;
- Short-tailed Scimitar Babbler. Vulnerable; restricted to the Annamese Lowlands and the Da Lat and Kontum Plateaus of Vietnam and adjacent areas in Laos;
- Golden-winged Laughingthrush. Not Evaluated; restricted to the Kontum Plateau of Vietnam; and
- Black-crowned Barwing. Not Evaluated; restricted to the Kontum Plateau of Vietnam, and adjacent areas in Laos.

The level of endemism in the bird fauna of Ngoc Linh can be ranked for comparison with that of other montane nature reserves. A scoring method allows five points per genus, one point per species, 20 points per restricted-range species, and 10 points per red-listed species (Table 31). Ranking results indicate that Ngoc Linh Nature Reserve has higher levels of endemism than other montane nature reserves in Vietnam.

Table 31: Bird Endemism Ranking for Vietnam's Montane Nature Reserves

| Nature Reserve | Genera | Species | RRS | Red-Listed | Score | Rank |
|----------------------------|--------|---------|-----|------------|-------|------|
| Ngoc Linh | 125 | 190 | 7 | 17 | 1,125 | 1 |
| Chu Yang Sin | 120 | 203 | 6 | 7 | 993 | 2 |
| Cong Troi (Lam Dong) | 111 | 154 | 7 | 7 | 919 | 3 |
| Hoang Lien | 110 | 208 | 4 | 7 | 908 | 4 |
| Hill 1978 (Thuong Da Nhim) | 74 | 93 | 5 | 7 | 633 | 5 |
| Nui Bi Doup/ Nui Ra Rich | 61 | 84 | 5 | 4 | 529 | 6 |
| Nui Ba | 53 | 63 | 3 | 3 | 418 | 7 |

Note: RRS = Restricted-Range Species (restricted to within 50,000 km² (ICBP 1992)). Red-listed as per Collar *et al.* (1994) and Anon. (1992).

Indicator Species

Several butterfly species collected in Ngoc Linh are indicators of habitat type. A high proportion of species in the Satyridae and Amathusiidae are forest understorey species, such as species in the following



genera: *Stichopthalma*, *Faunis*, *Aemone*, *Thaumantis*, *Neope* and *Lethe*. A number of species, including *Teinopalpus imperialis*, *Dodona adonira*, *D. deodata*, *D. ouida*, *D. egeon*, *Polyura dolon*, *Parantica sita*, *Capila pauripuneteta*, etc. are restricted to montane forest habitats where their food plants are distributed. The larvae of *T. imperialis*, for instance, feed only on species in the Magnoliaceae.

The abundance of rare and endemic species such as *Aemona amathusia*, *Orinoma damaris* and *Enispe cygnus* is relatively high in habitats at high elevations. This fact, coupled with the high overall butterfly species diversity and the large number of species with specific habitat requirements, indicates the presence of a wide variety of habitat types, including undisturbed montane forest habitats.

Biodiversity Comparison with Vietnam's National Parks

When the total known biodiversity of Ngoc Linh Nature Reserve is compared with that of Vietnam's national parks, it is ranked second behind Cuc Phuong National Park (Table 32).

Table 32: Biodiversity Comparison of Ngoc Linh Nature Reserve with Vietnam's National Parks

| Protected Area | Mammal Species | Bird Species | Reptile Species | Amphibian Species | Plant Species | Rank by No. of Species |
|--------------------------|----------------|--------------|-----------------|-------------------|---------------|------------------------|
| Cuc Phuong National Park | 64 | 137 | 36 | 17 | 1,967 | 1 |
| Ngoc Linh Nature Reserve | 52 | 190 | 41 | 23 | 878 | 2 |
| Ba Vi National Park | 38 | 113 | 41 | 27 | 812 | 3 |
| Ben En National Park | 41 | 82 | 3 | 27 | 737 | 4 |
| Cat Tien National Park | 62 | 121 | 22 | 14 | 632 | 5 |
| Yok Don National Park | 62 | 196 | — | 13 | 464 | 6 |
| Bach Ma National Park | 55 | 158 | — | — | 501 | 7 |
| Ba Be National Park | 38 | 111 | 18 | 6 | 354 | 8 |
| Con Dao National Park | 18 | 62 | 19 | 6 | 361 | 9 |
| Cat Ba National Park | 28 | 37 | 20 | — | — | 10 |

The biodiversity of Cuc Phuong is much better studied than that of Ngoc Linh, especially with respect to flora, so it is not surprising that it should be ranked higher. However, it is probable that, given further study, the level of known biodiversity for Ngoc Linh will equal or even surpass that for Cuc Phuong. Based on the area's high biodiversity and favourable conservation evaluation, Ngoc Linh Nature Reserve deserves conservation coverage comparable to that of a national park.

3.4 Evaluation of Socio-Economic and Socio-Cultural Benefits

The demand for immediately available resources rapidly increases in developing countries with high population growth. Protected areas are increasingly required to provide justification on both biological and socio-economic grounds.

Flood and Erosion Control

In general, river systems in Ngoc Linh Nature Reserve are narrow, high energy, montane rivers which are undergoing extensive grading and erosion. These rivers include the Dac Mek, Dac Po Ko, Thu Bon and Dac Plo Rivers and all are graded into sharp sloped, "V" shaped valleys that experience sudden floods and extensive erosion during the rainy seasons. Flood damage to lower lying areas is common, particularly to agricultural areas and irrigation projects. Groundwater run-off occurs at high rates for the alluvial soils in the region. Furthermore, during the dry season, rivers and streams at higher elevations and in open areas without forest cover are temporal. Available water can be limited, making irrigation very difficult in the lowlands.

Increases in river-flow volume can be higher than one-hundred-and-fifty-fold for typical lowland rivers

in this region. Guaranteeing further protection of these watersheds in Ngoc Linh Nature Reserve is highly recommended for the prevention and reduction of flash-floods and erosion. Additionally, the large area of forest cover maintains a thick humus layer that can regulate and preserve groundwater, and has an invaluable function in rainwater intrainment and internment.

Water Supply

The forest of Ngoc Linh Nature Reserve has an equally important role in upstream watershed protection for several of the large rivers in Quang Nam and Kon Tum provinces. These rivers are used to irrigate thousands of hectares of agricultural lands, as sources of potable water, and to supply the Yaly Hydropower Station. These rivers and the areas they service include:

- (a) **Dac Mek River.** Provides irrigation and potable water for Ngoc Linh, Dac Choong, Muong Hoong and Dac Man communes in the vicinity of the nature reserve. This river merges with the Dac Se River, which flows into the South China Sea at Da Nang city;
- (b) **Dac Po Ko River.** Provides irrigation and potable water for the Dac Man and Dac Nhong communes, and travels south to Dac Glei and Kon Tum towns. Several tributaries merge with this river from the nature reserve such as Dac Na, Dac Ka Tan, Dac Psi and Dac Glei Rivers. This river flows to Dac Pla, then merges with the Krong Po Ko River at Kon Tum town. The Dac Po Ko River is the most important water source for the Yaly Hydropower Station;
- (c) **Thu Bon River.** Provides irrigation and potable waters for the communities between the nature reserve and where it reaches the South China Sea, supplying freshwater to the fisheries at the Hoi An estuary; and
- (d) **Dac Plo River.** Secondary rivers flow into the Dac Plo River which travels through Laos and joins the Mekong River; it is an important irrigation and potable water supply for the communities and rice fields in the Dac Plo district communes on the Vietnam-Laos border.

Forestry and Agroforestry

Ngoc Linh Nature Reserve contains 236 commercially valuable timber species and extensive areas of potentially exploitable forest which are economically valuable and largely inaccessible. Primary broadleaf forest classified as “rich” or “medium” covers 57% of the total area of the nature reserve and contains a standing timber volume estimated at 5,346,876 m³. Inaccessible terrain renders many areas too costly to exploit by constructing logging roads.

The only active logging company in the nature reserve is Rung Thong Forest Enterprise, whose activities would have to be transformed to an official capacity in forest protection and management. Despite this, continued small-scale extraction of timber can be anticipated, especially of the more commercially valuable species. Conservation measures to curtail these activities would have to be implemented.

Exhausted, degraded and abandoned agricultural lands surrounding the nature reserve are of great importance as buffer zones. Funds allocated for reforestation of buffer zones under the current agroforestry programme would improve the living standards of the local people and help to prevent migration of people into the nature reserve in the future. Inclusion of these areas in the agroforestry programme would not only provide income for local people but would decrease the current reliance on forest resources. As part of this programme, emphasis should be placed on planting commercially valuable, native tree species.

In implementing the agroforestry programme, it is advisable that indigenous tree species are used for

reforestation. Current silviculture practices commonly replant with non-native *Casuarina equisetifolia* and *Eucalyptus* spp., both of which produce highly flammable alkaloids and growth-inhibiting hormones, thereby increasing the risk of fire, deterring seed germination and restricting the growth of other plant species.

Medicinal and Ornamental Plants

Ngoc Linh Nature Reserve's forest contains 78 ornamental plant species and 169 medicinal plant species. Medicinal plants are valuable, widely sought and easily depleted. The efficacy of wild medicinal plants is well understood in Asia and they are regularly used for various ailments but their potential western pharmaceutical value remains largely unresearched. Some chemical compounds isolated from these plants could provide valuable pharmaceutical drugs.

Other medicinal plant species could be cultivated locally for commercial purposes. A case in point is the endemic, endangered and heavily over-exploited Ngoc Linh Ginseng. This plant is now restricted to altitudes over 1,700 m but could be polycultured as part of an agroforestry programme.

Genetic Resources

Tropical forests are increasingly regarded as valuable genetic reservoirs with many possible agricultural and husbandry applications. They represent not only many potentially untapped commercially exploitable animal resources but a source for valuable strains with increased production, hardiness and disease resistance.

Tourism

Ecotourism. Ngoc Linh Nature Reserve covers a large area of pristine and beautiful primary forest, with altitudinal zonation of four distinct vegetation types and eight subtypes. The nature reserve includes the second highest mountain in Vietnam in a scenic setting with prominent landscape features, such as broad vistas, complex terrain, unbroken forest and deep river gorges. At least five ethnic minority groups reside within the immediate vicinity of the nature reserve.

The nearest centres of developed tourism are Hoi An, Da Nang and Hue cities. Ngoc Linh Nature Reserve is an ideal location for potential recreational activities such as hiking, climbing, camping, white-water rafting, kayaking and birdwatching. Road access is provided by National Highway 14 which bisects the nature reserve.

Birdwatching. Ornithological tours are increasingly popular in western countries and Ngoc Linh Nature Reserve shows promise as a desirable destination to be included in ornithological tour itineraries. One potential drawback is that the newly discovered species and subspecies, as well as the most endangered and visually stunning species, can be especially difficult to observe.

Ethnotourism. Another area of tourism potential is ethnotourism: tours that emphasise the ethnology of the region. These tours, which educate participants about the lifestyles and culture of the local ethnic groups, are becoming popular in Vietnam. Tours that respect and recognise the intrinsic value of local customs can help to preserve these cultures and their respective customs. The specific minorities found in the study area and some of their historic ethnographic characteristics of potential tourist interest (Nghiem Van Dang *et al.* 1993) are:

- (a) **The Xe Dang (Sedang) and the Chau.** The Xe Dang people belong to the Mon-Khmer language group; these are the most populous ethnic minority in the area with 8,992 people or 64% of the local population. Another 95 people are members of the Chau, a subclan of the Xe Dang. These people construct complex and aesthetically appealing terraced rice fields with intricate irrigation systems. Some Xe Dang and Chau villages have blacksmiths



that forge iron implements. Traditional celebrations often involve a buffalo sacrifice and exhibiting jars, gongs and livestock. The Xe Dang have rich spiritual beliefs based on agricultural cycles. Some of their oral traditions, songs and dance have been popularised on stage in Vietnam.

- (b) **The De or E-de (Zay or Ee-zay).** The De people are members of the Indo-Malay language group and are the second most populous ethnic minority with 3,658 people or 26% of the local population. Traditionally, these people lived in large longhouses divided into family compartments. Men wear turbans, long decorated loincloths and vests. Women wear their hair tied into a chignon. De people often forge farming tools, weave durable cloths and baskets, and carve wood; some make pottery. Both sexes wear copper bracelets, symbolic of marriage and oaths. Puberty is heralded by rites including bleaching the incisors and piercing the earlobes, which are then stretched for cosmetic purposes. De women propose marriage to the men, men reside in the wife's house, children adopt the mother's family name and a surname from the mother's family ancestors. Polytheism is practised where both spirits and kings of the elements are worshiped and venerated. Their popular literature, arts and music are rich and unique; myths, legends, epics, stories and folk songs relate to their customs and history.
- (c) **The Gie-Trieng, known locally as the Trieng-Re (Chee-ing Zay).** The Trieng-Re people are another member of the Mon-Khmer language group and are the third most populous ethnic minority with 1,032 people or 7% of the local population. These nomadic and semi-nomadic people traditionally practised human sacrifices of enemies as a religious rite and lived in houses arranged on a four-level caste system within the village. Their swidden cultivation practices are meagre and rely heavily on gathering and hunting. Men wear loincloths and women wear necklaces and ornaments made of copper, silver, glass beads and sometimes ivory. Women's hairstyles denote their marital status; a girl's hair is worn shoulder length until married, when it is plaited and tied into a knot on the top of the head. Children's ears are pierced and puberty is marked by the filing of teeth for both boys and girls. Trieng-Re people weave bamboo, rattan, cotton and jute. Metal forging is increasingly uncommon but pottery is specialised in certain villages. Religious activities are based on agricultural cycles, fertility rites, sorcery with many taboos and prohibitions, and vestiges of totemism that are different for men and women. Their material and social culture, particularly musical instruments, story telling, folk singing, popular art and literature, are rich and varied.

The amount of ethnographically unique characteristics that have been retained by these ethnic minorities remains undetermined. If local ethnic minorities have not retained some of their more unique characteristics, then ethnotourism may have potential.

The Xe Dang people have altered the landscape into interesting terraced rice fields that are unique to this part of Vietnam. The areas of greater interest are readily accessible on National Highway 14 from Dac Glei district to Da Nang and on National Highway 14B from Dac Man to Cong Troi and Dac Plo. This area of Vietnam is implicitly as anthropologically and culturally rich as other areas in Vietnam of high ethnotourist interest, such as Mai Chau and Sa Pa in northern Vietnam.

Agricultural Self-sufficiency and Agroforestry

The staple food for people in this region is rice, which is produced from low-yielding strains. Other food crops are corn and cassava, whilst green beans and potatoes are grown to a lesser degree.

Forest resources are still rich, and the area of primary forest cover is the highest in the region. Ngoc



Linh, Muong Hoong and Dac Man communes have a population of 4,636 people, and the other five communes in the buffer zone have a population of 9,240 people. Ethnic minorities make up more than 95% of the local population, and 97% of the population relies on agricultural production. The agroforestry programme has begun planting trees in family forest plots and forest gardens, emphasising coffee, cinnamon and *Litsea monopetala*. The living conditions of local people are difficult: 39% of households suffer from famine for at least one month a year. Forest resources account for as much as 20 to 25% of household income. Forest products include animals, edible tubers, leaves and fruits, traditional medicines, scented wood and resins, mints, gums, tannins, ornamental plants, medicinal plants, bamboo, rattan, construction materials and timber products.

Incorporating the villages in the nature reserve's buffer zone into the agroforestry programme could potentially realise several benefits. Training local people in more productive agricultural methods and the sustainable exploitation of forest products will have immediate and measurable benefits for them. The obvious benefit to conservation will be a reduced dependence on natural resources.

The main objectives should be to economically empower local people by producing a surplus of food beyond their immediate needs, provide a more readily available source of forest products, and alleviate the hunting and collecting pressure on Ngoc Linh Nature Reserve.

Research and Local Stewardship

Understanding the dynamic nature of the fragile montane habitats and forest types within this unique biogeographical isolate is crucial for proposing land-use alternatives ultimately aimed at minimising the loss of the region's and Vietnam's biodiversity. Ngoc Linh Nature Reserve provides an opportunity for studies to understand altitudinal zonation of tropical montane forests and the standards required to manage these primary montane forest habitats.

Studies of the primary forest of this nature reserve can provide baseline data for comparative studies elsewhere in Vietnam, and lead to a better understanding of immigration and emigration in a biological isolate. The opportunity to determine population dynamics of new, rare and endangered plants and animals in various undisturbed habitats is also a feature of Ngoc Linh Nature Reserve. The area also caters to applied socio-anthropological studies. The Xe Dang people's method of terraced wet-rice cultivation could potentially be expanded to other communes in the buffer zone and the region.

The scientific value of Ngoc Linh Nature Reserve should be emphasised in schools, universities and colleges in Vietnam, as well as the benefits of forest management and biodiversity conservation in the country.

3.5 Evaluation of Managerial Role of Communes, Government and NGOs

Vietnam's system of 'Special-Use Forests' is unlikely to succeed in its objectives without the assistance and support of local communities, various government agencies, and Non-Governmental Organisations (NGOs). These bodies and organisations are particularly important in terms of defining and prioritising long-term objectives.

The Ministry of Agriculture and Rural Development (MARD) is the management body responsible for Vietnam's national parks. Management of nature reserves falls under the responsibility of provincial people's committees. However, limited resources are available to the government bodies responsible for development and management of protected areas; the European Union has a treaty agreement with Vietnam to subsidise these costs over a five-year interim period. This interim period should be devoted to determining which government agencies, NGOs and international donors can best serve the objectives of protection areas now and in the future. Numerous opportunities and benefits exist for local



communities, provincial authorities, government agencies and NGOs in assuming management responsibilities. NGOs should have a particularly active role not only in management and conservation training, sustainable development, tourism training, and educational awareness but also in developing assistance and coordinating multilateral efforts.

NGOs are often in a position to coordinate the collaboration of various governmental branches with the activities of local communities, donor organisations, research bodies, other NGOs and international governments.

The general scope of activities for NGOs includes to:

- conduct environmental and social awareness programmes;
- perform environmental and conservation education programmes;
- assist in professional management training programmes;
- devise and implement management and conservation plans;
- conduct environmental assessment, management and monitoring;
- supervise sustainable resource and forestry management;
- identify economic, biodiversity and conservation priorities;
- monitor environmental law compliance;
- protect genetic variability and resources;
- oversee on-going research and long-term monitoring studies;
- recommend expansion, linkage and corridor prospects;
- supervise policies regarding threatened species and habitats; and
- acquire funds and grants for long-term management.

3.6 Summary of Ngoc Linh Nature Reserve Evaluation

Ranking the overall evaluation features of Ngoc Linh Nature Reserve shows that the area is of high conservation, economic and socio-cultural value. Virtually all of the site features fulfil the conservation criteria at the local and regional level. The biological and scientific values of the study area are unquestionably of international importance.

Ecotourism, ornithological tourism and ethnotourism are all of potential value in regard to economic benefits at the local and regional level. Ngoc Linh Nature Reserve fulfils all of the evaluation criteria normally reserved for national parks.

4. Management Planning

4.1 Administrative Areas

Ngoc Linh Nature Reserve in Kon Tum province will fall within the management of the Kon Tum Provincial People's Committee. The nature reserve will be administered by the provincial Forest Protection Department under MARD. Administrative duties include the management and protection of the nature reserve, as well as the implementation of projects and the nature reserve's investment programme.

Districts and Communes in the Administrative Area

Ngoc Linh Nature Reserve is located at 15°04'20"N 107°58'30"E, in northern Kon Tum province, on the border with Quang Nam province. Ngoc Linh Nature Reserve's boundary includes conservation coverage of 41,420 ha, located within four communes and including 42 compartments. These communes and compartments are:

- Dac Man commune: compartments 16 to 25, excluding part of compartment 23;
- Dac Choong commune: compartments 53 to 55, 59, 60 and 64 to 77, excluding parts of compartments 54, 66 and 69 but including part of compartment 83; and
- Muong Hoong and Ngoc Linh communes: compartments 78 to 82, 94 and 95 are included; as are parts of compartments 86, 87, 89 and 91 to 93.

Eight communes in Dac Glei and Dac To districts are included in the buffer zone of the nature reserve. The total administrative area of these eight communes is 100,139 ha.

Ngoc Linh Nature Reserve Boundary

The administrative boundary of Ngoc Linh Nature Reserve in Kon Tum province is based on:

- a biodiversity assessment of the area;
- the inclusion of all habitat types and their associated fauna and flora, especially endemic and critically-threatened species; and
- the necessity for boundary increases in the future.

The nature reserve's northern boundary follows the border between Kon Tum and Quang Nam provinces. This starts at Ngoc Peng Pek peak (1,728 m) and follows a stream bed until it crosses National Highway 14 at Lo Xo Pass (15°03'48"N 107°44'18"E). It then proceeds east then south-west, crossing the summit of Mount Ngoc Linh (2,598 m), to Ngoc Hu peak (2,383 m) on the border between Dac To and Dac Glei districts.

The southern boundary follows the border between Dac Glei and Dac To districts, from Ngoc Hu peak to Ngoc Poong peak (1,729 m).

The south-western boundary starts at Ngoc Poong peak and heads north along the western boundaries of compartments 77, 73 and 69 until it reaches the peak of Ngoc Moc (1,500 m), where it heads east, cutting across compartment 69 to the confluence of the Dac Choong and Dac Nol Rivers. At this point, the boundary follows the Dac Nol River until it meets the northern boundary of compartment 70. The boundary then cuts across compartment 66 in a north-easterly direction to the western boundary of compartment 67. From here, the boundary follows the northern boundaries of compartments 64 and 65 until it reaches the border between Dac Choong and Muong Hoong communes.

The north-western boundary starts at the border between Dac Choong and Muong Hoong communes.



It cuts across compartment 83 then heads west along the southern boundaries of compartments 60, 59, 55 and 54. The boundary cuts across the south-west corner of compartment 54, and then follows the southern boundaries of compartments 53 and 23, until reaching National Highway 14 at the 12 km marker. Following National Highway 14 to the Dac Man bridge, it then follows the Dac Man Stream to the southern boundary of compartment 22. It then follows the southern boundaries of compartments 24 and 25 in Dac Man commune, and the western boundary of compartments 20, 21, 19, 18, 17 and 16 in Dac Plo commune. The northern end of the western boundary is Ngoc Peng peak.

The boundary of Ngoc Linh Nature Reserve, as described, includes the villages and agricultural lands of Ngoc Linh and Muong Hoong communes. Therefore, the nature reserve's boundary is further defined so as to exclude compartments 84, 85, 88 and 90, and those parts of compartments 86, 87, 89 and 91 to 93 that include agricultural land or habitation.

Strict Protection and Forest Regeneration Areas

The conservation coverage of Ngoc Linh Nature Reserve is divided into two management categories: a Strict Protection Area and a Forest Regeneration Area. Because the Strict Protection Area is very large, it is divided into five sub-areas (SP I to SP V) in order to help make management and protection efforts more convenient. There is only one Forest Regeneration Area (FR I) (Table 33).

Table 33: Strict Protection Sub-Areas and Forest Regeneration Area

| Area/ Sub-area | Forestry Classified Areas (ha) | | | | | | | | | Total |
|-------------------|--------------------------------|-------|-------|-------|-------|-------|-----|-------|-----|--------|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | |
| SP I | 3,161 | 2,007 | 71 | 2,826 | 377 | 576 | 249 | 1,055 | 0 | 10,322 |
| SP II | 123 | 1,577 | 0 | 594 | 483 | 252 | 28 | 748 | 61 | 3,866 |
| SP III | 1,191 | 3,280 | 924 | 1,267 | 370 | 376 | 21 | 1,095 | 23 | 8,547 |
| SP IV | 2,669 | 239 | 39 | 626 | 0 | 99 | 20 | 896 | 0 | 4,588 |
| SP V | 6,440 | 2,001 | 0 | 395 | 1,083 | 790 | 165 | 409 | 0 | 11,283 |
| FR I | 248 | 695 | 0 | 355 | 601 | 131 | 34 | 750 | 0 | 2,814 |
| Total | 13,832 | 9,799 | 1,034 | 6,063 | 2,914 | 2,224 | 517 | 4,953 | 84 | 41,420 |

SP = Strict Protection Sub-area; FR = Forest Regeneration Area. 1 = Rich forest, 2 = Medium forest, 3 = Poor forest, 4 = Regeneration forest, 5 = Coniferous forest, 6 = Bamboo forest, 7 = Scattered trees, 8 = Scrub and Grassland, 9 = Waterways.

Strict Protection Area. This area is free from exploitation or being compromised in any way. This is to ensure that an area exists where wildlife populations can live and reproduce unhindered. The Strict Protection Area includes 38,606 ha or 93% of the nature reserve's total area. Management requirements for the Strict Protection Area are very restrictive of activities allowed in the area (Table 34).

- (a) **Strict Protection Sub-Area I.** An area of 10,322 ha in the west and north-west of the nature reserve, including parts of nine compartments in Dac Man commune; forest covers 9,018 ha or 87% of the sub-area, of which 3,161 ha is rich forest. Biodiversity is high, with Truong Son Muntjac, Giant Muntjac and Tiger present, particularly in the Cong Troi and Lo Xo Pass areas. Endemic birds found in this sub-area are Black-crowned Barwing, Black-hooded Laughingthrush and Short-tailed Scimitar Babbler.
- (b) **Strict Protection Sub-Area II.** An area of 3,866 ha on the northern boundary of the nature reserve, which comprises compartments 53 to 55, bordering Phuoc Son district in Quang Nam province to the north. The forest is moderately disturbed and there are some areas of scattered trees, grasslands and scrub in an area of 1,000 ha. Most forest is classified as "medium", with some areas of regenerating and poor forest. This area contains the lowest diversity of bird and mammal species in the nature reserve.
- (c) **Strict Protection Sub-area III.** An area of 8,547 ha in the north and north-east of the

nature reserve, which includes compartments 59 and 60 in Dac Choong commune, and compartments 78 to 82 and parts of compartments 86 and 87 in Muong Hoong commune. Forest covers 7,392 ha or 87% of the sub-area, and is moderately disturbed but still in good condition.

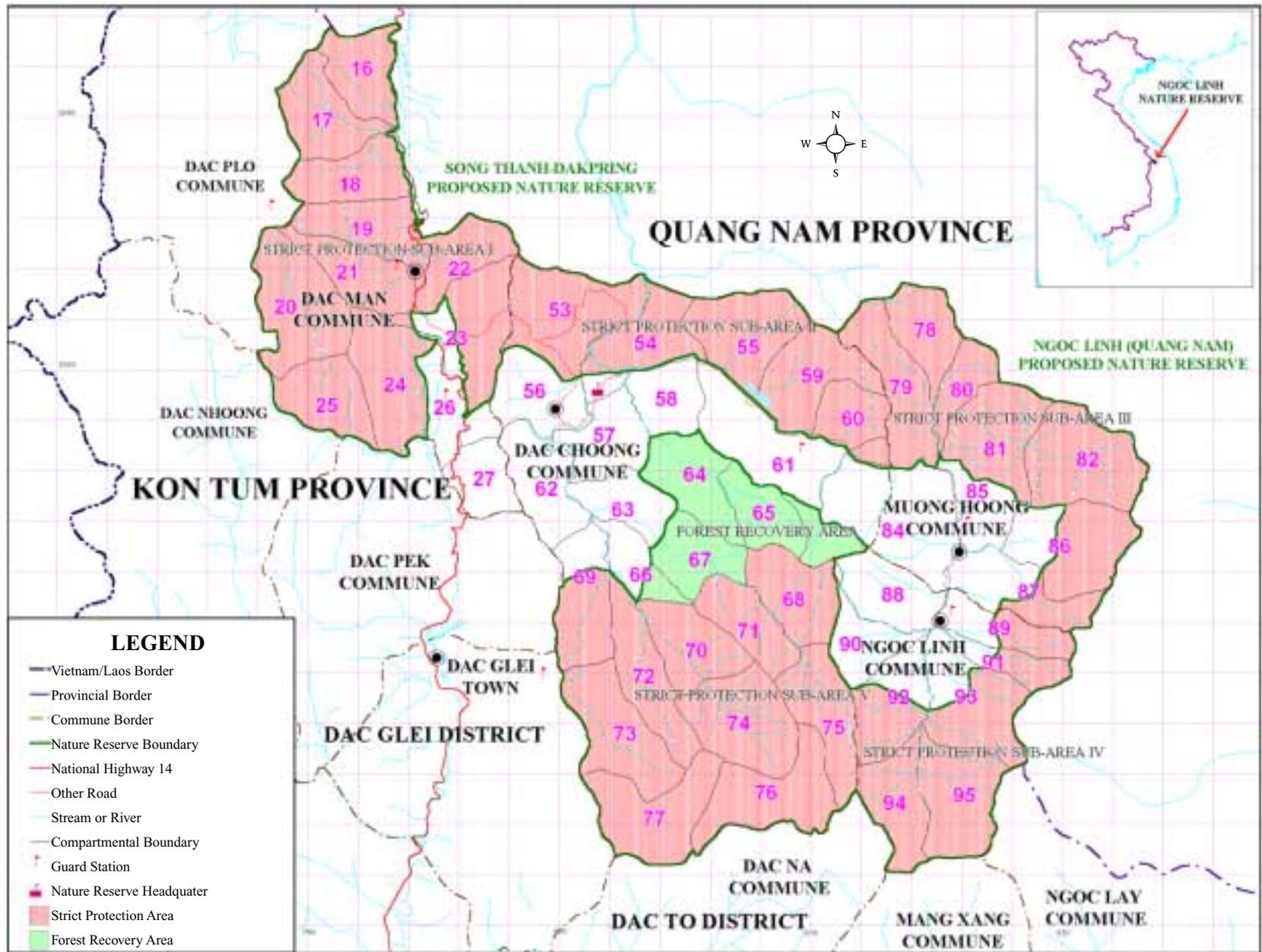
- (d) **Strict Protection Sub-area IV.** An area of 4,588 ha which comprises the forest in Ngoc Linh commune and includes all or part of compartments 89, and 91 to 95 in the south-east of the nature reserve. Forest extends from 1,400 m to the summit of Mount Ngoc Linh. The area of forest cover is 3,672 ha or 80% of the sub-area, of which 2,669 ha comprises rich forest. This is the primary area where Ngoc Linh Ginseng is found. This is also an area where large stands of *Pinus dalatensis* occur. Bird and butterfly communities in this sub-area are similar to those of northern and north-western Vietnam. The two newly described bird species, two endemic species and several endemic sub-species are found in this sub-area. Large mammals such as Tiger, Clouded Leopard, Sun Bear, Asiatic Black Bear, Buff-cheeked Gibbon, Truong Son Muntjac and Dhole are also found in this sub-area.
- (e) **Strict Protection Sub-area V.** This sub-area covers an area of 11,283 ha, including nine compartments 68, 69, 70, 72, 73, 74, 75, 76 and 77, of which 10,709 ha or 95% comprises forest. The sub-area includes undisturbed primary forest in the upstream catchments of the Dac Mek and Dak Po Ko Rivers in the south-west of the nature reserve, which cover an area of 6,500 ha. Ngoc Linh Ginseng is found in some locations. Stands of *Pinus dalatensis*, endemic bird species, and Truong Son Muntjac are also found in this sub-area.

Table 34: Management Regime for the Strict Protection Area

| Activity | Impacts | Management |
|--|--|---------------------|
| Logging | Forest fragmentation, forest habitat destruction, loss of animal and plant species | Strictly prohibited |
| Charcoal production | Forest fragmentation, loss of habitat and species, air and ground pollution | Strictly prohibited |
| Fragrant wood/oil distilling | Forest degradation, habitat destruction, loss of plant species, regeneration disturbance | Strictly prohibited |
| Mining | Forest and habitat destruction, pollution, loss of animal and plant species | Strictly prohibited |
| Construction of roads, houses and other infrastructure | Forest and habitat destruction, wildlife disturbance, pollution | Strictly prohibited |
| Ngoc Linh Ginseng collecting | Loss of genetic and economic resources | Strictly prohibited |
| Hunting with guns | Loss of animal species, wildlife disturbance | Strictly prohibited |
| Trapping | Loss of animal species, wildlife disturbance | Strictly prohibited |
| Poison and dynamite fishing | Habitat destruction, loss of animal species, pollution | Strictly prohibited |
| Fishing | Loss of species | Strictly prohibited |
| Ornamental plant collecting | Unknown but can endanger local species | Strictly prohibited |
| Livestock grazing | Natural regeneration, habitat and wildlife disturbance | Strictly prohibited |
| Fires | Forest and habitat destruction | Strictly prohibited |
| Firewood collecting | Forest fragmentation, natural regeneration disturbance | Limited |
| Rattan cane collecting | Habitat destruction, wildlife disturbance | Limited |
| Medicinal plant collecting | Loss of plant species, potential habitat disturbance | Limited |
| Honey collecting | Possible fire hazard | Limited |

Forest Regeneration Area. The Forest Regeneration Area includes 2,814 ha or 7% of the nature reserve's total area, within which limited human activities are permitted (Table 35). The management regime is

Map 6: Proposed Boundary of Ngoc Linh Nature Reserve



Grid: UTM, zone 48
Horizontal Datum: India 1960

SCALE 1:200,000

Produced by the Forest Resources and Environment Centre of FIPI

primarily aimed at allowing degraded forest to regenerate and increasing the total area available for viable wildlife populations in the nature reserve. The forest is moderately disturbed and situated adjacent to cultivated lands in Dac Choong commune. However, there are also 900 ha of grassland and scattered trees. This area would be part of the agroforestry programme in the future. There is suitable habitat for birds and animals below 1,000 m. Animals recorded in this area include civets, bovids, Siamese Fireback, Crested Argus and hornbills.

Table 35: Management Regime for the Forest Regeneration Area

| Activity | Impacts | Management |
|---|--|-----------------------|
| Logging | Forest and habitat destruction, loss of animal and plant species | Strictly prohibited |
| Fragrant wood/oil distilling | Forest degradation, habitat destruction, loss of species, regeneration disturbance | Strictly prohibited |
| Reforestation with alien species | Loss of habitat, loss of plant and animal species | Strictly prohibited |
| Hunting and trapping | Loss of animal species, habitat disturbance | Strictly prohibited |
| Mining | Forest and habitat destruction, pollution, loss of animal and plant species | Strictly prohibited |
| Construction of roads, houses and public facilities | Forest and habitat destruction, wildlife disturbance, pollution | Strictly prohibited |
| Livestock grazing | Natural regeneration, habitat and wildlife disturbance | Strictly prohibited |
| Fire | Forest and habitat destruction | Strictly prohibited |
| Converting forest to cultivation | Forest and habitat destruction, loss of animal and plant species | Strictly prohibited |
| Honey Exploitation | Possible fire hazard | Permitted |
| Exploitation of non-timber forest products | Loss of plant species and habitat | Limited and regulated |
| Reforestation with local indigenous tree species | Habitat expansion, maintenance of biodiversity | Encouraged |
| Family forest plots | Reforestation, reduction of pressures on forest, habitat expansion | Encouraged |

Buffer Zone

Buffer zones are areas adjacent to protected areas in which land-use is partially restricted, giving an added degree of protection to the nature reserve while providing valuable benefits to local communities. Buffer zones can serve two functions (adapted from MacKinnon *et al.* 1986):

- (a) **Extension Buffering** which extends the area of habitats contained within the protected area and supports larger breeding populations than could survive within the nature reserve area alone. These areas can have limited socio-cultural use; and
- (b) **Socio-Buffering** where wildlife use is of secondary importance and management is primarily aimed at providing products for local use but land-use does not conflict with the nature reserve's objectives.

Table 36: Commune Areas in the Nature Reserve and Buffer Zone

| District/ Commune | Area in Nature Reserve (ha) | Area in Buffer Zone (ha) |
|--------------------------|-----------------------------|--------------------------|
| Dac Glei district | 41,420 | 32,470 |
| Dac Plo | 0 | 14,620 |
| Dac Man | 10,321 | 4,179 |
| Dac Choong | 19,766 | 6,874 |
| Muong Hoong | 6,745 | 3,715 |
| Ngoc Linh | 4,588 | 3,082 |
| Dac To district | 0 | 27,297 |
| Dac Na | 0 | 8,126 |
| Mang Xang | 0 | 8,878 |
| Ngoc Lay | 0 | 10,293 |
| Total | 41,420 | 59,767 |

An area of 59,767 ha is included in the buffer zone; this area is outside of the designated Ngoc Linh Nature Reserve and does not include Dac Nhoong and Dac Pek communes nor Dac Glei town.

The communes of Dac Choong, Dac Man, Dac Plo, Muong Hoong and Ngoc Linh in Dac Glei district are included in the buffer zone. In Dac To district, there are three communes included in the buffer zone, these are Dac Na, Mang Xang and Ngoc Lay (Table 36).

The inhabitants of Dac Man, Dac Choong, Muong Hoong and Ngoc Linh communes can be expected to have the greatest impact on the nature reserve. The total area of these four communes is 59,270 ha, of which the nature reserve area comprises 41,420 ha or 70% the total area.

4.2 Management Development

Nature Reserve Management Personnel

Initial personnel requirements for the nature reserve include the following:

- (a) **Nature Reserve Director.** Responsible for managing all nature reserve staff, and coordinating government bodies, institutions, consultants and NGOs. Supports, coordinates and presents all activities and programmes that aim to address the nature reserve's objectives;
- (b) **Vice-Director (Administrative).** Responsible for overall operational aspects of the nature reserve regarding management and development plans. Reports to manager on progress of physical, institutional and personnel activities, as well as the budgetary status;
- (c) **Vice-Director (Technical).** Responsible for coordinating scientific specialists in investigating specific aspects of the nature reserve necessary for management and interpretative programmes. Must be aware of any occurring impacts and responsible for technical support and maintenance; and
- (d) **Head of Forest Protection.** As head guard, responsibilities include working with scientists to design and implement necessary resource management activities. Interacts with visitors, controls and monitors resources, applies forest protection laws and policies, and coordinates the activities of forest guards.

Management Hierarchy and Recruitment

The chain of managerial responsibility should be clear and precise with well-established hierarchical reporting and duty allocation. Direct communications are required between each department and its subordinates. The hierarchical allocation of duties should be clearly delineated. The minimum staffing requirements are shown in Figure 2.

Forest Protection Personnel

Ultimate responsibility for the performance of protection personnel falls on the head of forest protection, who should be in regular contact with and involved in the selection of personnel. Guards may be recruited locally or appointed to the area from outside the region; distinct disadvantages and advantages exist for both options (Table 37).

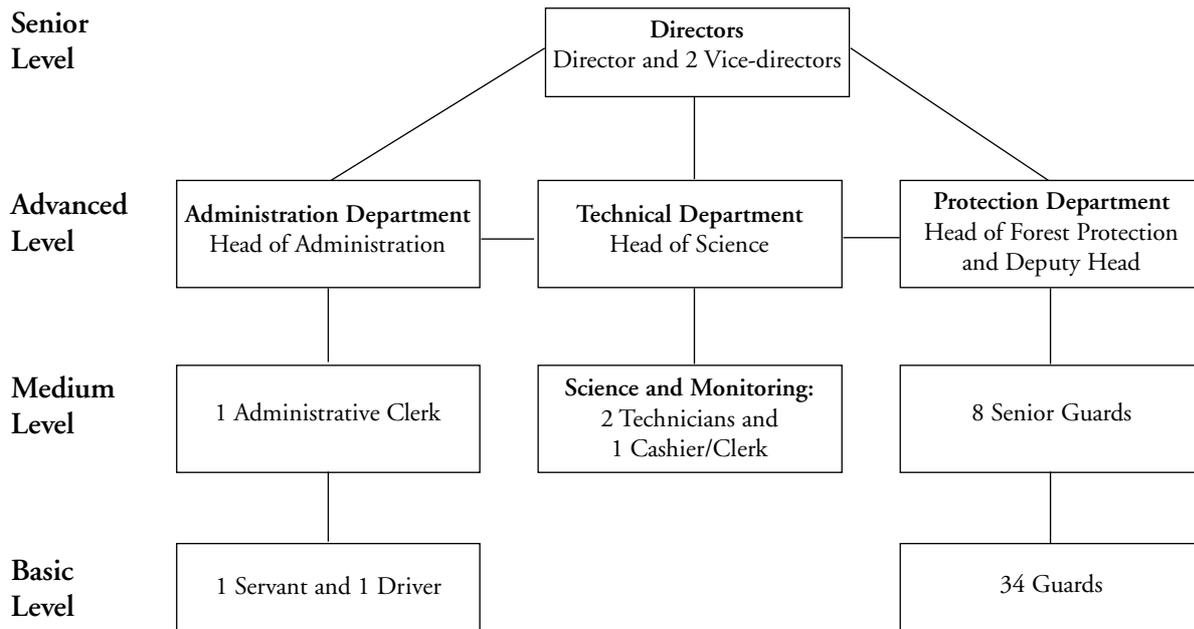


Figure 2: Schematic Diagram of Nature Reserve Staff Hierarchy

Local recruitment of protection personnel would be more desirable than hiring regionally; with training and education, local recruits can fulfil all but the highest levels of conservation protection positions. With local recruits, the benefits in both local knowledge and social goodwill outweigh the disadvantages and can be of long-term benefit in meeting management objectives.

Table 37: Locally versus Regionally Recruited Protection Personnel

| Local Recruitment | | Regional Recruitment | |
|--|---|--|---|
| Advantages | Disadvantages | Advantages | Disadvantages |
| Can select most able and best members of the local community. | Locals often have low education levels and are poorly qualified. | Regional searches offer a much wider pool of potential employees. | May have little empathy for locals or their customs and traditions. |
| Locals are familiar with conservation area and have local knowledge. | Locals may be more lenient on infringements by other locals. | Regional employment can select more highly educated personnel. | May be reluctant to explore and provide cover of unknown areas. |
| Locally employed work force generates goodwill amongst the local communities. | Locals may be involved in long-standing local divisions, feuds or clan conflicts. | Regional staff can be posted where no previous loyalties or relationships exist. | May be unsuitable for work in remote areas or feel they are upper management level. |
| Locals are more likely to maintain their posts if families are either nearby or accompany. | Loyalties may be stronger towards family or local clans, creating resentments. | Regionally hired staff can be moved in the event of local problems or serious trouble. | May be of poor qualification or standard as applicants for lower paying jobs. |

Management Development Infrastructure

Ngoc Linh Nature Reserve is currently poorly administered and lacks appropriate facilities for carrying out protection activities. There are no support vehicles or communication equipment, nor are there programmes for forest-fire prevention or the protection of forest resources. Salaries and living standards of forest protection personnel are low, and, consequently, incentive to work is often lacking. However, five forest enterprises are located in the area, and there is potential for the conversion of their personnel to a forest-protection role.

Visitor Access and Restrictions

It is highly recommended that visitor access be restricted to National Highway 14, which passes through



the west of the nature reserve. Prohibiting vehicular traffic to the inner communities of Ngoc Linh and Muong Hoong communes is advisable until these access roads are better developed.

Access to the higher and more fragile montane forest types and habitats should be limited and restricted to existing trails. Nevertheless, visitor access should pass through as many of the representative forest and vegetation types as possible, and visitors should be routed to any areas with impressive vistas.

Ngoc Linh Nature Reserve Headquarters

The location of Ngoc Linh Nature Reserve headquarters was discussed at a workshop with the relevant provincial authorities, where it was decided that the headquarters should be constructed at Be Re village in Dac Choong commune.

Guard Stations and Forest Protection Personnel

Recommended locations for guard stations to maximise the protection coverage of Ngoc Linh Nature Reserve are given in Table 38. Protection coverage includes creating perimeters around the most pristine forest areas, controlling access routes, and establishing guard stations between the more heavily populated areas and the forest.

Manpower requirements for protection coverage include eight forest protection teams, totalling eight senior guards and 34 guards, and the establishment of seven guard stations; one team is a mobile unit which constantly relocates within the nature reserve. All protection teams are required to conduct regular patrols and maintain diaries of useful information: wildlife sightings, human disturbance, etc. The most important objective of the protection teams is the strict enforcement of the nature reserve's regulations.

Table 38: Recommendations for Guard Stations, Staffing Requirements, and Coverage

| Location | Guard Staff | Coverage | Location |
|-----------------------------------|-----------------------------|------------------------|---|
| Ngoc Linh commune | 1 Senior Guard and 4 Guards | SP IV and FR I | In village that is nearly surrounded by the nature reserve. |
| Muong Hoong commune | 1 Senior Guard and 4 Guards | SP III and FR I | Good monitoring area between north end of Muong Hoong village and the nature reserve. |
| Dac Choong commune | 1 Senior Guard and 4 Guards | SP II, SP III and FR I | Situated on main access trail, in centre of area encircled by nature reserve. |
| Dac Man commune (at 12 km marker) | 1 Senior Guard and 4 Guards | SP I and SP II | Located at junction between National Highway 14 and road leading to three communes encircled by nature reserve. |
| Dac Man commune (at 26 km marker) | 1 Senior Guard and 4 Guards | SP I | Located on National Highway 14, 26 km from Dac Glei town. Existing building and communications. |
| Dac Plo commune | 1 Senior Guard and 4 Guards | SP I | Controls access to nature reserve from Phuoc Son district, Quang Nam province. |
| Dac Glei town | 1 Senior Guard and 4 Guards | SP V | Access provided by Rung Thong Forest Enterprise road. |
| Mobile unit | 1 Senior Guard and 6 Guards | Not applicable | Mobile team that constantly relocates to check station-based conservation coverage. |

5. Management Policy, Objectives, Development and Reporting

5.1 Management Policy

Devising a comprehensive management policy for Ngoc Linh Nature Reserve is determined by site-specific requirements. The nature reserve's management requirements are a function of three factors addressed in the following sections, namely:

- (a) classifying the features which require protection;
- (b) determining appropriate management actions; and
- (c) establishing compatible utilisation with limited disturbance.

Protected Area Classification

Classifying the protection area establishes the major features that require protection; these specific protection features are the basis for devising a site-specific management policy (Table 39).

Table 39: Classifying the Protection Features of Ngoc Linh Nature Reserve

| Protection Features | Site Considerations |
|---|---|
| Characteristic or unique ecosystems | Montane forest isolate with eight habitats |
| Special species of interest, value, rarity or under conservation threat | 19% of vertebrate species red-listed, including 20 mammals, 17 birds and 21 herpetiles |
| Sites of unusual species diversity | High montane area with key habitat types |
| Landscapes or geophysical features of aesthetic or scientific value | Very aesthetic area of mountains, valleys, rivers, forest and terraced rice cultivation |
| Hydrological protective functions | Watershed, flood control, and irrigation |
| Nature recreation and tourism facilities | Recreation and tourism potential very high |
| Sites of special scientific interest | Montane forest of high scientific value |
| Cultural sites | Not applicable |

The primary features for protection in Ngoc Linh Nature Reserve under this classificatory scheme are the unique and vulnerable high montane forest habitats that have associated high species diversity; and the newly discovered, endemic and threatened species of great conservation value. The nature reserve is aesthetically very appealing and promises to be an area of high recreational and tourist interest. Furthermore, the area is important for its various hydrological benefits and is of scientific value for on-going research into dynamic tropical montane forest systems that are poorly understood at present.

Compatible Utilisation

Conservation areas are increasingly required to realise benefits for local inhabitants whose livelihoods have been affected by establishing the area. Unfortunately, if immediate benefits are not realised by the local inhabitants, at least to some extent, the conservation area may fail to meet its objectives.

Visitors should be able to witness firsthand the areas, habitats and species which have been targeted for conservation efforts. Habitats and species which are threatened should be accessible to a limited extent as a means of promoting awareness of the conservation area but contact should be as non-interventionist as possible. Therefore, a concerted effort should be made to predetermine which target species are intolerant of human contact. Also, the extent of access increases the need for regulatory enforcement. Furthermore, the benefits of visitor access versus the effects on threatened species should be considered.

Scientific research is essential for understanding poorly studied areas, particularly threatened animal populations and unique habitat dynamics. The potential benefits from research in the areas of ecology, ethology, conservation, ethnology, and sociology within the tropical montane forests of the Western



Highlands of Vietnam are great and should be promoted.

Recommendations for compatible utilisation of Ngoc Linh Nature Reserve should take into consideration the potential impacts on key habitats and threatened species. Any utilisation with potential for causing disturbance is not recommended for this nature reserve on several grounds: available refuge is limited and patchily distributed; habitats are already heavily degraded and unstable; and the viability of existing wildlife populations has not been determined.

The most highly recommended compatible utilisation for Ngoc Linh Nature Reserve is that users have access to most habitat types without compromising the more fragile habitats.

Incompatible Utilisation, Exploitation and Unsustainable Use

Most common forms of exploitation of natural resources in Vietnam are incompatible with the management objectives of ‘Special-Use Forest’ areas. These activities must be regulated and controlled to ensure the sustainable use, management and maintenance of Vietnam’s biodiversity and natural resources.

Legal and Illegal Timber Extraction. The timber resources in the study area are largely unprotected: small-scale timber extraction currently operates unhindered, and Rung Thong Forest Enterprise holds concessions within the nature reserve for large-scale extraction. Currently, this is the only forest enterprise still legally exploiting the forest. However, the timber cutting activities of this company must be stopped to ensure the survival of the fragile montane forest habitats in Ngoc Linh Nature Reserve.

Trapping and Hunting. The local ethnic minority people living at subsistence level must supplement their protein intake, therefore trapping and hunting are widespread in Ngoc Linh Nature Reserve. Large birds and mammals are particularly vulnerable to hunting and trapping pressure; to ensure their survival, these activities would have to be prohibited within the nature reserve’s boundaries.

Other Incompatible Uses. Several other forms of exploitation are probably common but highly incompatible with any conservation effort in the nature reserve, most notable are activities such as forest burning, agriculture, plant collecting and animal trading.

Livestock grazing takes place around Ngoc Linh Nature Reserve and its effects on the flora and fauna would have to be determined before allowing continued grazing within the nature reserve’s boundaries.

Management Actions

At some point, extensive human impact will reduce the naturalness of the area, thereby increasing the costs of management efforts. Therefore, it is essential that a management regime encouraging only compatible utilisation of the nature reserve is implemented (Table 40).

Table 40: Recommended Compatible and Incompatible Utilisation of the Nature Reserve

| Utilisation | Management Recommendations |
|---|--|
| Collecting firewood and forest products | Not for recovering or damaged habitats |
| Traditional hunting, trapping and fishing | Not for depleted or threatened populations |
| Villages | None currently located within boundary |
| Grazing of domestic stocks | Not if this competes with wild animal populations or inhibits seral succession |
| Limited agricultural use | Not permitted |
| Selective logging | Not permitted |
| Clear felling with reforestation | Not permitted |
| Silviculture | Not permitted |
| Agroforestry/polyculture | Only if polyculturing species |
| Mining or quarrying | Not permitted |

5.2 Management Objectives

Site-specific management objectives for Ngoc Linh Nature Reserve should be based on the protection features, the extent of management actions contemplated for the area, and the range of compatible utilisation that can be accommodated with limited disturbance. The management objectives for Ngoc Linh Nature Reserve should be to:

- (a) conserve the representative tropical montane forest habitats;
- (b) protect and maintain the area's rich biodiversity;
- (c) protect the populations of threatened, restricted-range and endemic species; especially the newly described species;
- (d) conserve the potential genetic resources of the area;
- (e) promote the creation of buffer zones in the conservation coverage;
- (f) safeguard the watershed-protection value of the area in order to reduce soil erosion, siltation, drought, saltwater intrusion and flooding;
- (g) maintain a source for fresh water and irrigation supply for downstream users;
- (h) improve local knowledge and practice of responsible land stewardship, sustainable land-use and tourism;
- (i) accommodate visitors while increasing awareness and ensuring preservation of the nature reserve's biological uniqueness and aesthetic appeal;
- (j) promote the on-going management of the nature reserve, and the cooperation of the local community, government and NGOs in achieving the nature reserve's goals;
- (k) promote and facilitate research, particularly on conservation of endangered animal populations and on dynamics of tropical montane forest; and
- (l) demonstrate the ability to manage and sustainably utilise forest resources while maintaining a comprehensive conservation protection area, and to do this without over-exploiting the inherently limited resources of adjacent areas.

5.3 Management and Development

As part of the management plan for Ngoc Linh Nature Reserve, programmes outlining the necessary development stages are required. Development of the nature reserve will require baseline studies, construction and protection efforts, as well as parallel socio-economic development programmes for the communities that reside in the buffer zone of Ngoc Linh Nature Reserve. These development programmes must adhere to the nature reserve's objectives while also addressing development needs of the local communities. The management and development programmes should be:

- (a) infrastructure development programme;
 - (i) demarcation workshops
 - (ii) headquarters construction
 - (iii) guard station construction
 - (iv) road and trail upgrading
- (b) conservation and protection programme;
 - (i) protection coverage
 - (ii) natural and assisted forest regeneration
 - (iii) agroforestry
- (c) scientific research programme;
- (d) education and awareness programme; and
- (e) administrative management programme.



The management and development programmes should aim to:

- clearly delineate the nature reserve's administrative areas and ensure public awareness of the rules and regulations of the nature reserve;
- describe and evaluate the forest and forest resources in Ngoc Linh Nature Reserve including flora, invertebrate and vertebrate fauna communities. This baseline work should focus on locally and regionally threatened, and restricted-range endemic species, including their role and importance in both the local ecosystem and the local economy;
- evaluate the potential genetic, economic and hydrological values of the nature reserve;
- evaluate the dependence on forest resources of the local community, and the pressure that they exert on the forest resources of the nature reserve;
- propose a proper management plan within the scope of conservation in the nature reserve for promoting the sustainable development of local communities;
- propose a five-year plan for construction, management and protection of Ngoc Linh Nature Reserve;
- propose investment and disbursements for Ngoc Linh Nature Reserve; and
- evaluate the effectiveness of management and investment in Ngoc Linh Nature Reserve.

Infrastructure Development Programme

(a) Demarcation Workshops

Objectives. To announce the establishment of Ngoc Linh Nature Reserve. To clearly establish the nature reserve and buffer zone boundaries. To provide notice of the nature reserve's rules and regulations.

Activities. Upon approval for investment and establishment of Ngoc Linh Nature Reserve in Kon Tum province by MARD, the Kon Tum People's Committee will be requested to make decisions regarding the organisation(s) and personnel to be assigned to Ngoc Linh Nature Reserve. The management board of Ngoc Linh Nature Reserve should then hold a series of demarcation workshops to seek agreement on the zoning plan of the nature reserve from the leaders of the relevant districts, communes and forest enterprises. During these workshops, the nature reserve's management board should announce the establishment of the nature reserve, the objectives of the nature reserve and the contents of the management plan, and should carry out the following activities:

- (i) *Setting Boundary Pillars.* Demarcation of the nature reserve requires the setting of boundary pillars to mark the nature reserve's boundary. These boundary pillars should be made of concrete and set at a spacing of every 100 to 150 m along the boundary in Ngoc Linh and Muong Hoong communes; this includes the boundaries of compartments 86, 87, 89, 91 and 93. In the areas of clearly divided terrain that separates the nature reserve, boundary pillars should only be placed at the ends of the boundary and at the entrance of trails leading into the nature reserve.

Estimated total number of boundary pillars: 150.

- (ii) *Setting Regulation Boards.* Rules and regulation boards should be posted at the nature reserve headquarters, guard stations, villages, communes and at the entrance of trails leading into the nature reserve.

Estimated number of regulation boards: 15.
Size: 1.5 x 2 x 0.05 metres.

(b) Ngoc Linh Nature Reserve Headquarters

Objectives. To construct of a nature reserve headquarters. The nature reserve headquarters should be large enough to accommodate workshops, conferences and various departmental functions. This structure must include a lobby, offices for the director and vice-directors, and rooms for the protection, technical and administration departments. Also in this facility, or adjacent to this facility, there should be accommodations which include guest rooms, directors and officers living quarters, staff quarters, and washrooms

Activities. Selection of a suitable location, design of the headquarters and approval of the design, and finally construction of the facility.

Estimated constructed area: 500 m² (on a plot of 2,000 to 3,000 m²).

(c) Guard Stations

Objective. To provide suitable lodgings and work place for guards, whose responsibilities will be to enforce rules and regulations, to manage and protect the nature reserve from exploitation activities, and to conduct regular patrols of the nature reserve area.

Activities. Construction of seven guard stations.

Estimated area: 60 m² for each guard station and including lodgings, work place and washrooms, within a plot of 300 m².

Total construction area: 7 x 60 = 420 m².

- (i) *Ngoc Linh Guard Station.* Location: centre of Ngoc Linh commune; 15°05'N 107°55'E.

Duties: to protect and manage Strict Protection Sub-area IV; and to cooperate with Ngoc Linh commune in the implementation of forest protection and reforestation in the Forest Regeneration Area.

- (ii) *Muong Hoong Guard Station.* Location: centre of Muong Hoong commune.

Duties: to protect and manage Strict Protection Sub-areas II and III; and to cooperate with Kon Rieng Guard Station and Muong Hoong commune in the implementation of forest protection and reforestation in the Forest Regeneration Area.

- (iii) *Kon Rieng Guard Station.* Location: Kon Rieng village, Dac Choong commune; 15°09'N 107°52'E.

Duties: to protect and manage Strict Protection Sub-areas II and III; cooperate with Muong Hoong guard station and Kon Rieng village in the implementation of forest protection and reforestation in the Forest Regeneration Area.

- (iv) *Kilometre 12 Guard Station.* Location: 12 km marker on National Highway 14 (12 km from Dac Glei district centre), at the T-junction of the road to Ngoc Linh commune.

Duties: to protect and manage Strict Protection Sub-areas I and II.



(v) *Dac Man Guard Station*. Location: Dac Man commune forestry station

Duties: to protect and manage Strict Protection Sub-area I.

(vi) *Dac Plo Guard Station*. Location: Dac Plo commune.

Duties: to protect and manage Strict Protection Sub-area I.

(vii) *Dac Glei Guard Station*. Location: west of Dac Glei town, near Rung Thong Forest Enterprise.

Duties: to protect and manage of Strict Protection Sub-area V.

(d) Road and Trail Upgrading

Objectives. To improve access for implementing protection and management programmes, and to increase user access to the nature reserve. To reduce erosion of heavily used but unsurfaced roads.

Activities

- construction of 15 km of road. The road to Ngoc Linh from National Highway 14, which will be repaired as part of the Ngoc Linh-Muong Hoong Centre project, should not be included in this project. However, 15 km of National Highway 14b, between Dac Man and Dac Plo communes, should be upgraded, including the access road to Border Army Station 662 (accounted for in the buffer zone investment);
- repair of two drainage areas and four small underpasses;
- upgrading of 7 km of road from Ngoc Linh Forest Enterprise to Long Hy village, Mang Xang commune;
- reconstruction of five bridges (accounted for in buffer zone investment); and
- repair of two trails for guard-station access. This includes 10 km of trail from Long Nang village, Ngoc Linh commune to Long Hy village, Mang Xang commune, and 15 km of trail from Long Nang village to Dac Choong commune.

Conservation and Protection Programme

(a) Protection Coverage

This programme is aimed at resource protection and resource management in the nature reserve, and should be implemented by the nature reserve headquarters and protection teams.

Objectives. To protect the nature reserve's forest resources, to implement and enforce the nature reserve's rules and regulations, to maintain a record of field activities and findings, and to coordinate activities in the Strict Protection and Forest Regeneration Areas.

Activities

- establishment of 'Standard Operating Procedures' for each guard station which outline in detail the scope, objectives and activities for each protection team;
- preparation of weekly, monthly and annual guard schedules for each guard station protection team and the mobile protection team;
- enforcement of the rules and regulations regarding forest exploitation activities, particularly regarding hunting, trapping, plant collecting and logging;



- regular inspections and interviews with households taking part in the forest regeneration, forest protection and agroforestry programmes; and
- establishment of a forest fire prevention and fighting plan to be implemented during the dry season, with particular attention to areas of coniferous forest.

(b) Natural and Assisted Forest Regeneration

A forest regeneration programme should be implemented as part of a process to restore areas of degraded forest to their natural condition.

Objectives. To increase the forest cover of the nature reserve, to expand habitats for wildlife, and to generate incomes for local people.

Activities

- design of a detailed forest regeneration programme;
- selection of indigenous trees and plants, and collecting seedlings of local trees;
- design and establishment of nurseries to provide young trees for the forest regeneration and agroforestry programmes;
- establishment of guidelines for nursery, planting and post-planting care; and
- plan of the diversity, density and distribution of indigenous trees to be planted in the Forest Regeneration Area of Ngoc Linh Nature Reserve.

In order to carry out the forest regeneration programme, the project proposes the establishment of two nurseries, each of two hectares: one near Muong Hoong guard station and the other near the nature reserve headquarters in Be Re village, Dac Choong commune.

Areas of scrub, grassland and scattered trees totalling 3,972 ha should be allocated to individual households for the purpose of natural regeneration. Households allocated land for natural regeneration should receive VND90,000 in the first year and VND80,000 in subsequent years.

Areas of bare land and scrub that are unable to regenerate naturally should be replanted with native tree species. These areas are mostly within the Forest Regeneration Area and have a total area of 784 ha. Preference should be given to indigenous species, such as *Litsea verticillata*, *L. monopetala*, *Dacrycarpus imbricatus*, *Michelia* spp., *Pinus kesiya*, and others. Mixed planting is emphasised in order to create a forest ecosystem with different botanical species.

VND7 million per hectare per year should be allocated for the first five years of the replantation programme.

(c) Forest Protection

Objectives. To protect the nature reserve's forest, and to involve local communities in nature conservation by allocating forest land to individual households for the purposes of protection.

Activities. A total of 12,235 ha of forest, including coniferous forest, regeneration forest, poor forest and bamboo forest should be allocated on protection contracts to households living in the nature reserve's buffer zone. Households allocated forest land should receive VND70,000 per hectare for the first year and VND50,000 per hectare in subsequent years.

(d) Agroforestry

This socio-economic development project should be designed and implemented separately from

Ngoc Linh Nature Reserve's development and management programmes. Participation of the local people is crucial to the implementation of the agroforestry project.

Objective. Improve local people's living conditions, particularly those that are more dependent on the forest products from the nature reserve, and to reduce their dependence on the nature reserve's forest. Promote local participation in forest protection and polyculture development.

Activities

- inventory of present land-use in the communes in the nature reserve's buffer zones;
- assignment of forest to be protected and reforested in the buffer zone;
- implementation of programmes through the forestry departments of Dac Glei and Dac To and the related forest enterprises; and
- coordination of the agroforestry project with the forest regeneration project, particularly the nursery activities, and species to be collected and planted.

Buffer zone land-use areas of the four communes of Ngoc Linh Nature Reserve are listed in Table 41. The agroforestry project for the four buffer zone communes should assign 8,712 ha of forest for protection; this includes categories 1 to 6 in Table 41. Most of the assigned areas of forest should be

Table 41: Buffer Zone Land-Use Areas of Four Communes

| Commune | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|-------------|-----|-------|----|-------|-------|-------|-------|-------|--------|
| Ngoc Linh | 44 | 759 | 0 | 321 | 53 | 474 | 648 | 783 | 3,082 |
| Muong Hoong | 0 | 794 | 0 | 290 | 706 | 295 | 587 | 1,043 | 3,715 |
| Dac Choong | 644 | 453 | 15 | 27 | 248 | 117 | 155 | 2,520 | 4,179 |
| Dac Man | 156 | 382 | 0 | 998 | 1,523 | 413 | 741 | 2,661 | 6,874 |
| Total | 844 | 2,388 | 15 | 1,636 | 2,530 | 1,299 | 2,131 | 7,007 | 17,850 |

Note: 1 = rich forest; 2 = medium forest; 3 = poor forest; 4 = regenerated forest; 5 = coniferous forest; 6 = bamboo forest; 7 = agricultural lands; 8 = scrub and grasslands

located near villages or existing agricultural land. Land assigned for agroforestry should also include scrub and grasslands (category 8 in Table 41) which cover 7,007 ha. Preference should be given to indigenous tree species, such as *Litsea* spp. and *Michelia* spp., as well as to economically valuable ones such as cinnamon and coffee.

Scientific Research Programme

Objective. To increase understanding of the ecology of the nature reserve in order to assist in formulating both long and short-term protection and management plans. To promote and increase the capacity of conservation personnel's knowledge of forestry, biology and natural resources.

Activities

- establishment of a plan for research studies including study outlines, proposal for any interventionist measures, period of study, cooperating agencies and training;
- comprehensive baseline assessment of the fauna and flora systems in the nature reserve;
- on-going evaluation of forest regeneration;
- on-going observation of the distribution and numbers of mammals in the nature reserve, particularly endangered and threatened species;
- on-going studies of the range, habits and ecology of endemic restricted-range birds; and
- studies of Ngoc Linh Ginseng, with cultivation under different forest types.

The above research studies will include as part of the programme, collaboration with nature reserve staff, training centres, colleges and NGOs (i.e. BirdLife and WWF). Cooperation with government agencies such as FIPI, the Institute for Ecology and Biological Resources, Xuan Mai Forestry College,



and the Institute of Forestry Science.

Education and Awareness Programme

Objective. Promote local knowledge in nature and resource protection and conservation and how it applies to Ngoc Linh Nature Reserve. Education is important for the community and visitors to understand Ngoc Linh Nature Reserve's significant role in water catchment, potable water, agriculture, irrigation, hydropower and ecology.

Activities

- distribution of materials introducing the role of Ngoc Linh Nature Reserve;
- courses on forest protection and community development, in particular for the buffer zone communities;
- distribution of materials on forest and environmental protection for course lessons in schools in the buffer zone; and
- films and exhibitions on environmental and forest-resource protection in communities and schools in the buffer zone.

Administrative Management Programme

Objective. Establish the administrative structure for the implementation of the management, protection and development of Ngoc Linh Nature Reserve.

Activities. Establish a directorate with three personnel, which oversees three departments: a protection department with 44 personnel; a technical department with four personnel; and an administration department with four personnel.

(a) Directorate

Personnel. One director and two vice-directors.

Function. The director is the highest-ranking officer in the nature reserve, who is properly qualified in forestry, biology and/or nature conservation. The director is responsible for organisation and management of the nature reserve, supervision of the board of management, and planning and monitoring the programmes proposed in the project. Vice-directors assist the director or act on behalf of the director to deal with management, activities and programmes.

(b) Protection Department

Personnel. 44 officers, equivalent to a forest department branch. Of which, there is one head of department, one deputy head, five personnel for each of seven guard stations, and seven personnel for one mobile team to be stationed at the nature reserve headquarters.

Functions

- implement protection and management measures for forest resources and the forest regeneration programme;
- cooperate with local authorities to allocate forest to households for protection and replanting;
- execute the rules and regulations on protection and management of 'Special-Use Forests';
- educate the local populous in forest fire prevention, conservation, and rules and regulations regarding the nature reserve; and
- guard stations should directly organise and fulfil duties including patrolling and inspection of forest in assigned areas; maintenance of regular contact with other guard station heads and the head of the protection department, and collaboration with the mobile team that



will assist the guard stations in forest protection.

(c) Technical Department

Personnel. One head of department, two technical experts and one cashier/clerk.

Functions

- assist the directorate in consulting, planning and supervision;
- propose long-term plans for the protection and management programme; and
- provide the technical support for the forest regeneration programme, primary baseline assessment and on-going scientific studies.

(d) Administration Department

Personnel. One head of department, one administrative clerk, one servant and one driver.

Functions. Assisting the directorate and other departments in the implementation of programmes, financial management and payrolls, disbursement for locally-hired staff, and acquisition of necessary goods and equipment.

5.4 Management Progress Reporting

Evaluating Management Effectiveness

Periodic independent evaluations of management effectiveness are recommended to determine whether the nature reserve's conservation objectives are being met. Evaluations are further recommended as a component of all routine reports and should be conducted as internal audits as well as external audits. Four areas of management importance should be included in evaluations:

| EVALUATIONS | INTERNAL AUDITS | EXTERNAL AUDITS |
|-----------------------------|--------------------------|--------------------------|
| Expenditures and Budgets | Self Evaluations | Independent Experts |
| Progress and Time Schedules | Headquarters Assessments | Local Advisory Committee |
| Goals and Objectives | | Visitors' Responses |
| Cost-effectiveness | | |

A set of evaluation criteria have been devised by IUCN's Commission on National Parks and Protected Areas:

- | | |
|---|---|
| (1) Clearly defined specific written objectives to guide management; | (h) Geomorphology Maps |
| (2) Compatible legislation fully protected at national or provincial level; | (i) Pedology Maps |
| (3) Basic resources information including: | (j) Meteorology Data Sets |
| (a) Mammal Inventory | (k) Hydrological Data Sets |
| (b) Bird inventory | (l) Topographic Maps |
| (c) Herpetile Inventory | (m) Aerial Photographs |
| (d) Terrestrial Invertebrate Inventory | (n) Full Bibliography of Publications |
| (e) Freshwater Vertebrate and Invertebrate Inventory | (4) Basic ecological information including: |
| (f) Plant Inventory | (a) Studies of wildlife population dynamics |
| (g) Vegetation Maps | (b) Studies of population status and trends of key target species |
| | (c) Information on wildlife and habitat relationships |

- | | |
|---|---|
| (d) Studies of predator-prey relationships | (14) Informal education with the following facilities: |
| (e) Information on the carrying capacity of key habitat types | (a) Leaflets |
| (f) Information on disease reservoirs among wildlife | (b) Maps |
| (g) Studies on seral succession | (c) Marked Trails |
| (h) Information on fires and their effects | (d) Signs |
| (5) Watershed management that protects: | (e) Guide Services |
| (a) Welfare of downstream inhabitants | (f) Information Centre |
| (b) Welfare of downstream ecological processes (e.g. estuaries) | (g) Audio-Visual Programmes |
| (c) Engineering works for irrigation dams | (h) Observation Areas |
| (6) Managed to protect potential genetic resources | (15) Tourism is promoted and facilities are provided |
| (7) Management plan approved, implemented and monitored | (16) Political support of the central government for the nature reserve's conservation objectives |
| (8) Zoning plan which controls human impacts and includes development relative carrying capacity | (17) Local Advisory Committee involves local people in decision making processes |
| (9) Boundaries are clearly demarcated and effectively define the area | (18) Benefits to local people are real economic, agricultural and development opportunities |
| (10) Ecological boundaries which enclose an entire self-sufficient ecosystem | (19) Budget is sufficient to meet the conservation objectives in the management plan |
| (11) Natural resources are fully and effectively protected from exploitation | (20) Maintenance is budgeted for and equipment/facilities are in working order |
| (12) Research programmes are well integrated and applied research provides support to management objectives | (21) Personnel and training are sufficient to attain specified management objectives |
| (13) Formal education with adequate facilities, extension programmes for local and national institutions | (22) Equipment is sufficient and well maintained to meet management objectives |
| | (23) External support is acquired, budgeted for and well utilised |

Regional Management Units

Ngoc Linh Nature Reserve will come under the management jurisdiction of the Kon Tum Provincial People's Committee. The administration of the nature reserve will be through the Kon Tum Provincial Forest Protection Department. Collaboration between the nature reserve and the Kon Tum Provincial People's Committee will be coordinated by Ngoc Linh Nature Reserve's management board

The provincial Forest Protection Department will be responsible for the staffing and expenditures, approaching potential funding sources and the technical studies as an addendum to the nature reserve's management plan. It is highly recommended that coordination of these functions is supported and guided by Ngoc Linh Nature Reserve's management board.

Ngoc Linh Nature Reserve's management board's responsibilities and duties should be:

- (a) coordination with the provincial Forest Protection Department;
- (b) participation with and inputs from the local communities;
- (c) development and management of the nature reserve;
- (d) collaboration with the agroforestry programme;
- (e) mediation of socio-cultural and economic impacts of the nature reserve;



Section 5 - Management Policy, Objectives, Development and Reporting

- (f) mitigation or litigation issues associated with the nature reserve;
- (g) collaboration with NGOs and institutions work and research;
- (h) establishment and maintenance of the buffer zones; and
- (i) potential extension of conservation coverage.

6. Finance

6.1 Financial Management

The responsibility for financial management of Ngoc Linh Nature Reserve will be largely the duty of the management board of Ngoc Linh Nature Reserve. This board is the acting project coordinator between the provincial administration and the nature reserve's management personnel.

The investment programme to develop Ngoc Linh Nature Reserve covers the management and development programmes as discussed in Section 5 (Table 42).

Table 42: Investment Programme for Ngoc Linh Nature Reserve (in VND million)

| Category | Total | 1999 | 2000 | 2001-2003 |
|---------------------------|--------|-------|-------|-----------|
| 1. Protection programme | 2,669 | 1,613 | 761 | 295 |
| 2. Regeneration programme | 10,883 | 1,282 | 2,450 | 7,151 |
| 3. Research programme | 2,600 | 100 | 300 | 2,200 |
| 4. Education programme | 165 | 20 | 55 | 90 |
| Total | 16,317 | 3,015 | 3,566 | 9,736 |

6.2 Investment Capital

Investment capital should be apportioned for the management and development of Ngoc Linh Nature Reserve with the following provisos:

- investment capital for protection and management programmes in the nature reserve should be accounted for in a five-year plan, from 1999 to 2003;
- feasibility studies should be conducted for the construction projects, and protection, management and development programmes outlined in Section 5; and
- investment capital for construction should be based on completing the necessary legal documents.

The investment capital that has been appointed for the management and development of Ngoc Linh Nature Reserve is VND13,477 million. Cost estimates for the nature reserve total VND16,317 million (Table 43). The estimated cost for each of the programmes includes construction and equipment investment, and personnel payrolls. In order to meet the shortfall of VND2,840 million, the nature reserve will have to obtain additional sources of funding, such as low interest loans or foreign assistance. Annual disbursements of the nature reserve's investment capital will begin in fiscal year 1999 and end in fiscal year 2003 (Table 44).

Table 43: Cost Estimates for the Nature Reserve's Programmes (in VND million)

| Category | Quantity | Unit price | Price |
|--|--------------------|------------|---------------|
| 1. Infrastructure Development Programme | | | 2,669 |
| Demarcation workshops | 3 | 15 | 45 |
| Boundary pillars | 150 | 0.5 | 75 |
| Regulation boards | 15 | 2 | 30 |
| Headquarters | 500 m ² | 1.5 | 750 |
| Guard stations | 420 m ² | 1.2 | 504 |
| Road repairs | 25 km | 2.5 | 62.5 |
| Car | 1 | 350 | 350 |
| Motorbikes | 10 | 15 | 150 |
| Vehicle registration and maintenance | — | — | 150 |
| Petrol and oil | — | — | 150 |
| Generator for headquarters | 1 | 15 | 15 |
| Generators for guard stations | 7 | 7.5 | 52.5 |
| 15W mobile phone | 1 | 10 | 10 |
| 6W mobile phones | 10 | 5 | 50 |
| Binoculars | 10 | 5 | 50 |
| Compasses | 10 | 0.5 | 5 |
| Cameras | 2 | 10 | 20 |
| Office equipment | — | — | 200 |
| 2. Conservation Protection Programme | | | 10,883 |
| Land allocation for protection | 13,213 ha | 0.27 | 3,567 |
| Land allocation for regeneration | 3,972 ha | 0.41 | 1,628 |
| Reforestation with native species | 784 ha | 7 | 5,488 |
| Nurseries | 4 ha | 50 | 200 |
| 3. Science and Research Programme | | | 2,600 |
| Primary assessment | 3 yrs | 200 | 600 |
| Studies of Ngoc Linh Ginseng | 3 yrs | 200 | 600 |
| Studies of regeneration | 3 yrs | 100 | 300 |
| Studies of mammals | 3 yrs | 100 | 300 |
| Studies of restricted-range birds | 3 yrs | 100 | 300 |
| Training | 5 yrs | 100 | 500 |
| 4. Education and Awareness Programme | | | 165 |
| Materials | — | — | 100 |
| Camera | 1 | 15 | 15 |
| TVs | 2 | 5 | 10 |
| Video recorders | 2 | 5 | 10 |
| Slide projector | 1 | 15 | 15 |
| Overhead projector | 1 | 15 | 15 |
| Total | | | 16,317 |

Table 44: Disbursement Schedule for Ngoc Linh Nature Reserve

| Category | Total | 1999 | 2000 | 2001—2003 |
|--|---------------|--------------|--------------|--------------|
| 1. Infrastructure Development Programme | 2,669 | 1,613 | 761 | 295 |
| Demarcation workshops | 45 | 45 | — | — |
| Boundary pillars | 75 | 75 | — | — |
| Regulation boards | 30 | 30 | — | — |
| Headquarters | 750 | 450 | 300 | — |
| Guard stations | 504 | 288 | 216 | — |
| Road repairs | 62.5 | 25 | 37.5 | — |
| Car | 350 | 350 | — | — |
| Motorbikes | 150 | 100 | 50 | — |
| Vehicle registration and maintenance | 150 | 10 | 35 | 105 |
| Petrol and oil | 150 | 30 | 30 | 90 |
| Generator for headquarter | 15 | 15 | — | — |
| Generators for guard stations | 52.5 | 30 | 22.5 | — |
| 15W mobile phone | 10 | 10 | — | — |
| 6W mobile phone | 50 | 50 | — | — |
| Binoculars | 50 | 30 | 20 | — |
| Compasses | 5 | 5 | — | — |
| Cameras | 20 | 20 | — | — |
| Office equipment | 200 | 50 | 50 | 100 |
| 2. Conservation Protection Programme | 10,883 | 1,282 | 2,450 | 7,151 |
| Land allocation for protection | 3,567 | 925 | 660 | 1,982 |
| Land allocation for regeneration | 1,628 | 357 | 318 | 953 |
| Reforestation with native species | 5,488 | — | 1,372 | 4,116 |
| Nurseries | 200 | — | 100 | 100 |
| 3. Science and Research Programme | 2,600 | 100 | 300 | 2,200 |
| Primary assessment | 600 | — | — | 600 |
| Studies of Ngoc Linh Ginseng | 600 | — | 200 | 400 |
| Studies of regeneration | 300 | — | — | 300 |
| Studies of mammals | 300 | — | — | 300 |
| Studies of restricted—range birds | 300 | — | — | 300 |
| Training | 500 | 100 | 100 | 300 |
| 4. Education and Awrns. Programme | 165 | 20 | 55 | 60 |
| Materials | 50 | 20 | 20 | 30 |
| Equipment | 65 | — | 35 | 30 |
| Total Investment | 16,317 | 3,015 | 3,566 | 9,736 |

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Appendix 1: Flora Recorded in Ngoc Linh Nature Reserve

| Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes |
|--|-------|----------------------------------|----------------|-------------------------------------|---------|
| Psilotophyta | | <i>C. glabra</i> | 1,2 | <i>Manglietia blaoensis</i> | W,1 |
| Psilotaceae | | Thyrsopteridaceae | | <i>M. chevalieri</i> | W,1 |
| <i>Psilotum nudum</i> | R,1 | <i>Cybotium barometz</i> | M,R,1,2 | <i>M. sp1</i> | W,1 |
| Lycopodiophyta | | Dennstaedtiaceae | | <i>M. sp2</i> | W,1,2 |
| Lycopodiaceae | | <i>Pteridium aquilinum</i> | 1,2 | <i>Michelia foveolata</i> | W,1,2 |
| <i>Huberia phlegmaria</i> | O,1,2 | <i>Lindsaea lobata</i> | 1,2 | <i>Parakmeria aff. yunnanensis</i> | W,1 |
| <i>Lycopodium cernuum</i> | O,1,2 | <i>L. longipes</i> | 1 | <i>Paramichelia baillonii</i> | W,1,2 |
| Selaginellaceae | | Thelypteridaceae | | Annonaceae | |
| <i>Selaginella dodderleinii</i> | 1,2 | <i>Pneumatopteris truncatus</i> | 1,2 | <i>Alphonsea boniana</i> | W,1 |
| <i>S. involvens</i> | 2 | <i>Thelypteris triphylla</i> | 1,2 | <i>Cyathocalyx annamensis</i> | W,1 |
| Equisetophyta | | Aspleniaceae | | <i>Desmos chinensis</i> | O,1 |
| Equisetaceae | | <i>Asplenium crinicaule</i> | O,1,2 | <i>Enicosanthellum plagioneurum</i> | W,1 |
| <i>Equisetum debile</i> | M,1,2 | <i>A. scortechinii</i> | 1,2 | <i>Fissistigma oldhamii</i> | 1 |
| Polypodiophyta | | <i>Diplazium platyklamys</i> | 1,2 | <i>F. polyanthoides</i> | 1 |
| Ophioglossaceae | | Dryopteridaceae | | <i>F. thorelii</i> | M,1 |
| <i>Helminthostachys zeylanica</i> | M,1,2 | <i>Dryopteris assamensis</i> | 1,2 | <i>Polyalthia cerasoides</i> | W,1,2 |
| Angiopteridaceae | | Davalliaceae | | <i>Uvaria dac</i> | 1,2 |
| <i>Angiopteris annamensis</i> | O,1,2 | <i>Nephrolepis cordifolia</i> | M1,2 | <i>Xylopiavielana</i> | M,1,2 |
| <i>A. cochinchinensis</i> | O,1,2 | Blechnaceae | | Myristicaceae | |
| Schizeaceae | | <i>Blechnum orientale</i> | 1,2 | <i>Horsfieldia amygdalina</i> | W,1,2 |
| <i>Lygodium conforme</i> | M,1,2 | <i>Brainea insignis</i> | 1,2 | <i>Knema conferta</i> | W,M,1,2 |
| <i>L. flexuosum</i> | M,1,2 | <i>Woodwardia japonica</i> | M,1,2 | Chloranthaceae | |
| <i>L. japonicum</i> | M,1,2 | Pinophyta | | <i>Sarcandra glabra</i> | 1 |
| Adiantaceae | | Gnetaceae | | Saururaceae | |
| <i>Adiantum capillus-veneris</i> | O,1,2 | <i>Gnetum latifolium</i> | M,1,2 | <i>Houttuynia cordata</i> | M,1,2 |
| <i>A. flabellulatum</i> | O,1,2 | Cycadaceae | | Piperaceae | |
| <i>A. philippense</i> | O,1,2 | <i>Cycas immersa</i> | O,1 | <i>Peperomia tetraphylla</i> | 1,2 |
| <i>Pteris biaurita</i> | 1,2 | Pinaceae | | <i>Piper boehmeriaefolium</i> | 1,2 |
| <i>P. ensiformis</i> | 1,2 | <i>Keteleeria evelyniana</i> | W,R,1 | <i>P. chaudocanum</i> | 1,2 |
| <i>P. grevilleana</i> | 1,2 | <i>Pinus dalatensis</i> | W,M, EV,R,1 | <i>P. harmandii</i> | 1,2 |
| <i>P. semipinnata</i> | 1,2 | <i>P. kesiya</i> | W,1,2 | <i>P. cf. maclurei</i> | 1 |
| <i>Vittaria flexuosa</i> var. <i>filipes</i> | 1,2 | Podocarpaceae | | <i>P. hainanense</i> | 1,2 |
| Gleicheniaceae | | <i>Dacrycarpus imbricatus</i> | W,1,2 | <i>Zippelia begoniifolia</i> | 1 |
| <i>Dicranopteris linearis</i> | 1,2 | <i>Dacrydium elatum</i> | W,R,1,2 | Illiciaceae | |
| Polypodiaceae | | <i>Nageia aff. fleuryi</i> | W,O,R,1 | <i>Illicium griffithii</i> | M,1 |
| <i>Drynaria fortunei</i> | R,M,1 | <i>N. aff. wallichiana</i> | W,O,R,1 | Ranunculaceae | |
| <i>D. quercifolia</i> | O,1,2 | <i>Podocarpus neriifolius</i> | W,1,2 | <i>Anemone poilanei</i> | 1,2 |
| <i>Microsorium brachylepis</i> | 2 | Cephalotaxaceae | | <i>Ranunculus cantoniensis</i> | 1 |
| <i>M. fortunei</i> | 1,2 | <i>Cephalotaxus mannii</i> | W,R,1,2 | Menispermaceae | |
| <i>Phymatodes scolopendra</i> | 1,2 | Amentotaxaceae | | <i>Cosciniun fenestratum</i> | M,1,2 |
| <i>Platyserium coronarium</i> | O,1,2 | <i>Amentotaxus poilanei</i> | W,EV,R1,2 | <i>Cissampelos pereira</i> | M,1 |
| <i>P. grande</i> | O,1 | Magnoliophyta | | <i>Limacia scandens</i> | 1 |
| <i>Pseudodrynaria coronans</i> | O,1,2 | Magnoliopsida | | <i>Pericampylus ineanus</i> | M,1,2 |
| <i>Pyrrosia acrostichoides</i> | 1,2 | Magnoliaceae | | <i>Stephania pierrei</i> | 1,2 |
| <i>P. lingua</i> var. <i>heteracta</i> | 1,2 | <i>Kmeria aff. duperreana</i> | W,1 | Lauraceae | |
| Cyatheaceae | | <i>Magnolia annamensis</i> | W,O,1,2 | <i>Aseodaphne andersonii</i> | W,1,2 |
| <i>Cyathea latebrosa</i> | 2 | | | <i>Beilschmiedia percoriacea</i> | W,1,2 |



Appendices

| Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes |
|---|----------|-------------------------------------|---------|---|---------|
| <i>Caryodaphnopsis poilanei</i> | W,1 | <i>G. multiflora</i> | W,M,1,2 | <i>Rorippa nasturtium-aquaticum</i> | M,1 |
| <i>Cinnamomum balansae</i> | W,R,EV,1 | <i>G. scheffleri</i> | W,1 | Clethraceae | |
| <i>C. cassia</i> | W,M,1 | <i>Hypericum javanica</i> | M,1 | <i>Clethra faberi</i> | 1 |
| <i>C. iners</i> | W,1,1 | Elaeocarpaceae | | Ericaceae | |
| <i>Cryptocarya metcalfiana</i> | W,1,2 | <i>Elaeocarpus daclacensis</i> | W,1 | <i>Craibiodendron stellatum</i> | R,1 |
| <i>Lindera spicata</i> | M,1,2 | <i>E. griffithii</i> | W,1,2 | <i>Diphycosia semi-infera</i> | 1 |
| <i>Litsea cambodiana</i> | W,2 | <i>E. laceifolius</i> | W,1 | <i>Enkianthus quinqueflorus</i> | R,1 |
| <i>L. cubeba</i> | M,1,2 | <i>E. nitentifolius</i> | W,1,2 | <i>Gaultheria fragrantissima</i> | M,1 |
| <i>L. glutinosa</i> | W,M,1,2 | <i>E. tectorius</i> | W,1,2 | <i>Leucothoe griffithiana</i> | 1 |
| <i>L. verticillata</i> | W,1,2 | <i>E. varunua</i> | W,1,2 | <i>Lyonia ovalifolia</i> | W,1,2 |
| <i>Machilus bombycina</i> | W,1,2 | <i>E. sp</i> | W,2 | <i>L. ovalifolia</i> var. <i>rubrovenia</i> | 1,2 |
| <i>Neolitsea cambodiana</i> | W,1,2 | <i>Sloanea sinensis</i> | W,1,2 | <i>Rhododendron excelsum</i> | O,1,2 |
| <i>Phoebe lanceolata</i> | W,1 | Tiliaceae | | <i>R. fleuryi</i> | O,1,2 |
| <i>P. tavoyana</i> | W,1,2 | <i>Grewia abutilifolia</i> | 1 | <i>R. irroratum</i> subsp. <i>kontumense</i> | O,1 |
| Hernandiaceae | | <i>G. sessilifolia</i> | 1,2 | <i>R. lyi</i> | O,1,2 |
| <i>Illigeria parviflora</i> | M,1 | Sterculiaceae | | <i>Vaccinium dunalianum</i> | 1 |
| <i>I. pierrei</i> | 1 | <i>Pterocymbium tinctorium</i> | W,1 | <i>V. nummulari</i> | 1 |
| Dilleniaceae | | <i>Pterospermum lanceaefolium</i> | W,1,2 | <i>V. sperengelii</i> | 1,2 |
| <i>Dillenia ovata</i> | W,2 | <i>Reevesia gagnepainiana</i> | W,1 | Sapotaceae | |
| <i>Tetracera sarmentosa</i> | M,1,2 | <i>Sterculia hyposticta</i> | W,1,2 | <i>Donella lanceolata</i> | W,1,2 |
| Actinidiaceae | | <i>S. lanceolata</i> | W,1,2 | <i>Madhuca alpina</i> | W,1 |
| <i>Actinidia aff. latifolia</i> | | Bombacaceae | | <i>M. floribunda</i> | W,2 |
| <i>Saurauja fasciculata</i> | 1,2 | <i>Bombax ceiba</i> | W,1,2 | <i>M. pasquieri</i> | W,R,2 |
| <i>S. nepaulensis</i> | 1,2 | Malvaceae | | <i>Sarcosperma kachinense</i> | W,2 |
| <i>S. roxburghii</i> | 1,2 | <i>Abelmoschus moschatus</i> | M,1,2 | <i>S. kontumensis</i> | W,1,2 |
| Theaceae | | <i>Sida rhomboidea</i> | 1,2 | Ebenaceae | |
| <i>Anneslea fragrans</i> | W,1 | <i>Urena lobata</i> | M,1 | <i>Diospyros apiculata</i> | W,1,2 |
| <i>Camellia caudata</i> | 1 | Flacourtiaceae | | <i>D. hayatae</i> | W,2 |
| <i>C. dormoyana</i> | 1,2 | <i>Casearia glomerata</i> | 1,2 | <i>D. pilocella</i> | W,1,2 |
| <i>C. kissi</i> | W,1,2 | <i>Osmelia philippinense</i> | W,1,2 | <i>D. vaccinioides</i> | W,1 |
| <i>Eurya japonica</i> | 1,2 | <i>Xylosma contronversum</i> | W,2 | Styracaceae | |
| <i>E. muricata</i> | 1,2 | Violaceae | | <i>Alniphyllum fortunei</i> | W,1,2 |
| <i>E. sinensis</i> var. <i>glabra</i> | 1,2 | <i>Viola arcuata</i> | O,1,2 | <i>Rehderodendron macrocarpon</i> | W,1,2 |
| <i>E. trichocarpa</i> | 1,2 | <i>V. curvistylis</i> | 1,2 | <i>Styrax benjoin</i> | W,1,2 |
| <i>Gordonia intricata</i> | W,1 | <i>V. inconspicua</i> | 1,2 | <i>S. tonkinensis</i> | W,2 |
| <i>G. gigantiflora</i> | W,1,2 | Passifloraceae | | Symplocaceae | |
| <i>Pyrenaria jonquieriana</i> | 1,2 | <i>Passiflora heterophylla</i> | M,2 | <i>Symplocos adenophylla</i> | W,1,2 |
| <i>P. oblongicarpa</i> | W,1 | <i>P. siamea</i> | M,1,2 | <i>S. cambodiana</i> | 1,2 |
| <i>Schima wallichii</i> ssp. <i>norronhae</i> | W,1,2 | Cucurbitaceae | | <i>S. cochinchinensis</i> var. <i>laurina</i> | W,M,1,2 |
| <i>Ternstroemia japonica</i> | W,1,2 | <i>Gymnopetalum cochinchinensis</i> | M,1,2 | <i>S. glomerata</i> subsp. <i>congesta</i> | W,1,2 |
| Pentaphylaceae | | <i>Hodgsonia macrocarpa</i> | 1,2 | <i>S. racemosa</i> | M,1 |
| <i>Pentaphylax spicata</i> | W,1,2 | <i>Solena heterophylla</i> | M,1 | <i>S. ramosissima</i> | 1,2 |
| Guttiferae | | Begoniaceae | | Myrsinaceae | |
| <i>Calophyllum dryobalanoides</i> | W,2 | <i>Begonia aptera</i> | 1,2 | <i>Ardisia aciphylla</i> | 1,2 |
| <i>Cratoxylum maingayi</i> | 2 | <i>B. lanciniata</i> | M,1,2 | <i>A. cambodiana</i> | 1,2 |
| <i>C. formosum</i> var. <i>prunifolium</i> | W,1,2 | <i>B. palmata</i> | 1 | <i>A. corymbifera</i> | 1,2 |
| <i>Garcinia kyddia</i> | 1 | <i>B. siamensis</i> | 1,2 | <i>A. depressa</i> | 1,2 |
| <i>G. merguensis</i> var. <i>truncata</i> | W,1,2 | Brassicaceae | | <i>A. elegans</i> | 1,2 |
| | | <i>Capsella bursa-pastoris</i> | M,1,2 | | |



| Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes |
|---|---------|---|---------|---------------------------------------|-------|
| <i>A. florida</i> | 1,2 | <i>Sorbus granulosa</i> | M,1,2 | Myrtaceae | |
| <i>A. gigantifolia</i> | M,1 | <i>S. wattii</i> | 1 | <i>Cleistocalyx consperipunctatus</i> | W,1 |
| <i>A. hypargyrea</i> | 1 | Saxifragaceae | | <i>Decaspermum montanum</i> | W,1,2 |
| <i>A. lecomte</i> | 1,2 | <i>Astilbe rivularis</i> | M,1 | <i>Syzygium albiflorum</i> | 1 |
| <i>A. vestita</i> | 2 | <i>Dichroa febrifuga</i> | M,1 | <i>S. cumini</i> | W,1,2 |
| <i>A. villosa</i> | 1,2 | <i>Itea chinensis</i> | W,1,2 | <i>S. oblatum</i> | W,1 |
| <i>A. villosoides</i> | 1 | Mimosaceae | | <i>S. syzygioides</i> | W,1 |
| <i>Embelia aberran</i> | 1,2 | <i>Acacia pennata</i> | 1,2 | <i>S. zeylanicum</i> | W,1,2 |
| <i>E. laeta</i> | M,1 | <i>Albizia chinensis</i> | W,1,2 | <i>Tristanopsis burmanica</i> | W,1,2 |
| <i>E. ribes</i> | M,1,2 | <i>A. lucidior</i> | W,1,2 | Onagraceae | |
| <i>Maesa balansae</i> | 1 | <i>A. odoratissima</i> | W,1,2 | <i>Ludwigia octovalvis</i> | 1,2 |
| <i>M. laxiflora</i> | 1,2 | <i>Archidendron clypearia</i> | W,1,2 | Melastomataceae | |
| <i>M. montana</i> | 1,2 | <i>A. pellitum</i> | W,1,2 | <i>Allomorpha sulcata</i> | 1,2 |
| Primulaceae | | <i>A. turgidum</i> | W,1,2 | <i>Medinilla honbaensis</i> | 1,2 |
| <i>Lysimachia clethroides</i> | 1 | <i>Entada glandulosa</i> | 1,2 | <i>M. scortechinii</i> | 1 |
| <i>L. siamensis</i> | 1 | <i>Mimosa diplotricha</i> | 1,2 | <i>Melastoma chevalieri</i> | 1,2 |
| Amaranthaceae | | <i>M. pudica</i> | M,1,2 | <i>M. normale</i> | 1,2 |
| <i>Achyranthes aspera</i> | M,1,2 | Caesalpiniaceae | | <i>Memecylon fruticosum</i> | 1 |
| <i>Alternanthera sessilis</i> | 1,2 | <i>Bauhinia bracteata</i> | 1,2 | <i>Osbeckia crinita</i> | 1 |
| <i>Amaranthus spinosus</i> | M,1,2 | <i>Cassia alata</i> | M,1,2 | <i>Sonerila annamica</i> | 1,2 |
| <i>Cyathula prostrata</i> | M,1 | <i>C. siamea</i> | W,1,2 | <i>S. quadrangularis</i> | 1 |
| <i>Ptilotrichum ferrugineum</i> | 1,2 | <i>Sindora laotica</i> | W,1,2 | <i>S. rivularis</i> | 1,2 |
| Portulacaceae | | Fabaceae | | Rhizophoraceae | |
| <i>Portulaca oleracea</i> | M,1,2 | <i>Dalbergia pinnata</i> | 1,2 | <i>Carallia brachiata</i> | W,1,2 |
| Caryophyllaceae | | <i>D. rimosa</i> | 1 | Alangiaceae | |
| <i>Drymaria diandra</i> | 1,2 | <i>Desmodium heterocarpum</i> | 1,2 | <i>Alangium kurzii</i> | W,1,2 |
| Polygonaceae | | <i>D. triquetrum</i> | M,1 | Nyssaceae | |
| <i>Cephalophilon perfoliatum</i> | M,1,2 | <i>Dunbaria circinalis</i> | 1 | <i>Nyssa japonica</i> | 1 |
| <i>C. caespitosum</i> | 1 | <i>D. ferruginea</i> | 1,2 | Cornaceae | |
| <i>C. chinense</i> | M,1,2 | <i>Lespedeza juncea</i> var. <i>sericea</i> | 1,2 | <i>Cornus controversa</i> | W,1 |
| <i>C. hydropiper</i> | M,1,2 | <i>Milletia pachyloba</i> | 1,2 | <i>Mastixia arborea</i> | 1,2 |
| Pittosporaceae | | <i>M. cf. spireana</i> | 1 | <i>M. poilanei</i> | 1,2 |
| <i>Pittosporum floribundum</i> | 1 | <i>Ormosia balansae</i> | W,1,2 | Olacaceae | |
| Rosaceae | | <i>O. pinnata</i> | W,1,2 | <i>Anacolosa moiorum</i> | W,1 |
| <i>Eriobotrya bengalensis</i> | W,1,2 | <i>Phaseolus minimus</i> | 1 | <i>Harmandia mekongensis</i> | W,1 |
| <i>E. poilanei</i> | W,M,1,2 | <i>Pueraria montana</i> | 1,2 | Santalaceae | |
| <i>Malus doumeri</i> | W,M,1,2 | <i>Shuteria suffulta</i> | 1 | <i>Dendrotrophe buxifolia</i> | 2 |
| <i>Photinia benthamiana</i> var. <i>glabrescens</i> | 1 | Elaeagnaceae | | Loranthaceae | |
| <i>Prunus arborea</i> var. <i>montana</i> | W,1,2 | <i>Elaeagnus</i> aff. <i>conferta</i> | 1 | <i>Elytranthe alpida</i> | 1,2 |
| <i>Rubus alcaefolius</i> | M,1,2 | Proteaceae | | <i>Macrosolen bibracteolatus</i> | 1,2 |
| <i>R. asper</i> | 1,2 | <i>Helicia cochinchinensis</i> | W,1,2 | <i>Taxillus chinensis</i> | 1,2 |
| <i>R. chevalieri</i> var. <i>anghae</i> | M,1,2 | <i>H. obovatifolia</i> | W,1 | <i>T. parasitica</i> | 1,2 |
| <i>R. cochinchinensis</i> var. <i>glabrescens</i> | 1,2 | Sonneratiaceae | | <i>Viscum ovalifolium</i> | 1 |
| <i>R. leucanthus</i> | 1,2 | <i>Duabanga grandiflora</i> | W,2 | Balanophoraceae | |
| <i>R. niveus</i> | 1,2 | Thymeleaceae | | <i>Balanophora fungosa</i> | M,1 |
| <i>R. obcordatus</i> | 1,2 | <i>Aquilaria crassna</i> | M,R,1,2 | <i>B. laxiflora</i> | M,1 |
| <i>R. rugosus</i> | 1,2 | <i>Daphne composita</i> | 1 | <i>Rhopalocnemis phalloides</i> | R,1 |
| | | <i>Wikstroemia meyeniana</i> | 1 | Celastraceae | |
| | | | | <i>Celastrus monosperma</i> | M,1,2 |



Appendices

| Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes |
|-----------------------------------|---------|---|---------|---|---------|
| <i>Euonymus grandiflorus</i> | 1 | <i>A. oblongum</i> | W,1,2 | <i>E. meliaefolia</i> | M,1,2 |
| <i>Maytenus hookeri</i> | 1,2 | <i>A. tonkinensis</i> var. <i>fenzelianum</i> | W,O,1,2 | <i>Glycosmis pentaphylla</i> | 1 |
| Aquifoliaceae | | Sabiaceae | | <i>G. craibii</i> | 1 |
| <i>Ilex fabrilis</i> | W,1,2 | <i>Meliosma lepidota</i> subsp. <i>dumicola</i> | W,1 | <i>Micromelum minutum</i> | 1,2 |
| <i>I. micrococca</i> | 1,2 | <i>M. simplicifolia</i> | 1,2 | <i>Skimmia arborescens</i> | 1,2 |
| <i>I. rotunda</i> | W,1,2 | <i>Sabia fasciculata</i> | 1,2 | <i>Toddalia tonkinensis</i> | 1,2 |
| Euphorbiaceae | | Malpighiaceae | | <i>Zanthoxylum acanthopodium</i> | 1 |
| <i>Alchornea annamica</i> | EV,1,2 | <i>Hiptage bengalensis</i> | 1,2 | <i>Z. avicenniae</i> | 1,2 |
| <i>Antidesma bunius</i> | W,1,2 | Polygalaceae | | Rhamnaceae | |
| <i>A. velutinosum</i> | 1,2 | <i>Polygala karensium</i> | M,1,2 | <i>Alphitonia philippinensis</i> | W,1,2 |
| <i>Aporusa microcalyx</i> | W,1,2 | <i>P. luteo-alba</i> | M,1,2 | <i>Berchemia floribunda</i> | M,1,2 |
| <i>Baccaurea oxycarpa</i> | W,1,2 | Burseraceae | | <i>Zizyphus incurva</i> | 1 |
| <i>B. silvestris</i> | W,EN,2 | <i>Canarium littorale</i> var. <i>rufum</i> | W,M,1,2 | Leeaceae | |
| <i>Bischofia javanica</i> | W,1,2 | <i>Dacryodes dungii</i> | W,1,2 | <i>Leea rugosa</i> | M,1,2 |
| <i>Breynia fruticosa</i> | 1,2 | Anacardiaceae | | Vitaceae | |
| <i>Claoxylon indicum</i> | M,1 | <i>Buchanania reticulata</i> | W,1 | <i>Cayratia japonica</i> | M,1,2 |
| <i>Croton poilanei</i> | 1,2 | <i>Choerospondias axillaris</i> | W,1,2 | <i>Cissus adnata</i> | 2 |
| <i>Delechampia bidentata</i> | 1 | <i>Mangifera</i> sp. | W,1,2 | <i>C. javanica</i> | 1,2 |
| <i>Endospermum chinense</i> | W,1,2 | <i>Protium serratum</i> | W,1,2 | <i>C. subtetragona</i> | 2 |
| <i>Glochidion eriocarpum</i> | M,1,2 | <i>Rhus chinensis</i> | M,1,2 | <i>Tetrastigma erubescens</i> | 1 |
| <i>Homonoia riparia</i> | 1,2 | <i>Semecarpus annamensis</i> | 1 | <i>T. laoticum</i> | 2 |
| <i>Macaranga denticulata</i> | W,1,2 | <i>S. caudata</i> | 1 | <i>Vitis balansaeana</i> | 2 |
| <i>M. kurzii</i> | W,1,2 | <i>S. humilis</i> | 1,2 | Apiaceae | |
| <i>Mallotus apelta</i> | W,1,2 | <i>S. reticulata</i> | W,1,2 | <i>Centella asiatica</i> | M,1,2 |
| <i>Microdesmis caseariaefolia</i> | W,M,1,2 | <i>Spondias pinnata</i> | W,1,2 | <i>Eryngium foetidum</i> | M,1,2 |
| <i>Phyllanthus embrica</i> | W,1,2 | <i>Toxicodendron succedana</i> | W,1,2 | <i>Hydrocotyle chinensis</i> | 1,2 |
| <i>Sapium discolor</i> | W,1,2 | Simaroubaceae | | <i>H. petelotii</i> | 1,2 |
| <i>S. rotundifolium</i> | W,1,2 | <i>Ailanthus triphysa</i> | W,M,1,2 | <i>Oenanthe javanica</i> | 1,2 |
| <i>Securinega vinosa</i> | 1,2 | <i>Brucea javanica</i> | M,1,2 | <i>Pimpinella divercifolia</i> | 2 |
| <i>Suregada multiflora</i> | 1,2 | <i>B. mollis</i> | M,1,2 | <i>Sanicula elata</i> | 1 |
| Oxalidaceae | | <i>Picrasma javanica</i> | W,1 | Araliaceae | |
| <i>Oxalis corniculata</i> | 1,2 | Meliaceae | | <i>Aralia armata</i> | M,1,2 |
| Balsaminaceae | | <i>Aglaia andamanica</i> | W,1,2 | <i>Brassaiopsis acuminata</i> | 1 |
| <i>Impatiens rara</i> | O,1,2 | <i>A. cambodiana</i> | W,1,2 | <i>B. glomerulata</i> | M,1 |
| Sapindaceae | | <i>A. gigantea</i> | W,1,2 | <i>Dendropanax stachyanthus</i> | W,1,2 |
| <i>Cardiospermum halicacabum</i> | 1,2 | <i>A. taynguyenensis</i> | 1,2 | <i>Macropanax grushvitzkii</i> | 1 |
| <i>Mischocarpus sundaicus</i> | W,2 | <i>A. roxburghiana</i> | W,1,2 | <i>M. undulatus</i> var. <i>simplex</i> | 1 |
| <i>Nephelium lappaceum</i> | W,1,2 | <i>Chisocheton paniculatus</i> | W,1,2 | <i>Panax vietnamensis</i> | M,E,R,1 |
| <i>Paranephelium spirei</i> | W,2 | <i>Chukrasia tabularis</i> | W,R,1,2 | <i>Schefflera</i> cf. <i>aromatica</i> | 1 |
| <i>Pometia pinnata</i> | W,1 | <i>Cipadessa baccifera</i> | 1 | <i>S. alongensis</i> | M,1 |
| <i>Sapindus mukorossi</i> | W,1,2 | <i>Dysoxylum cochinchinensis</i> | W,1,2 | <i>S. delavayi</i> | M,1 |
| <i>Xerospermum laoticum</i> | W,2 | <i>Melia azedazach</i> | W,1,2 | <i>S. fasciculifoliata</i> | M,1 |
| Staphyleaceae | | <i>Toona</i> aff. <i>sinensis</i> | W,2 | <i>S. hypoleuca</i> | M,1 |
| <i>Turpinia montana</i> | W,1,2 | Rutaceae | | <i>S. incisa</i> | M,1 |
| <i>T. cochinchinensis</i> | W,1,2 | <i>Acronychia pedunculata</i> | W,M,1,2 | <i>S. kontumensis</i> | M,1 |
| <i>T. pomifera</i> | W,1,2 | <i>Clausena excavata</i> | 1,2 | <i>S. lucescens</i> | M,1 |
| Aceraceae | | <i>Euodia calophylla</i> | M,1,2 | <i>S. octophylla</i> | W,M,1,2 |
| <i>Acer heptaphlebium</i> | W,O,1,2 | <i>E. leptia</i> | M,1,2 | <i>Scheffleropsis angkae</i> | 1,2 |
| <i>A. laurinum</i> | W,O,1,2 | | | <i>Trevesia palmata</i> | M,1,2 |



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|---|---------|---|---------|------------------------------------|---------|
| Hamamelidaceae | | <i>E. roxburghiana</i> | W,1,2 | <i>Melodinus spireanus</i> | 1,2 |
| <i>Exbucklandia populnea</i> | W,1,2 | <i>E. serrata</i> var. <i>cambodiana</i> | W,1,2 | <i>Pottsia laxiflora</i> | 1,2 |
| <i>E. tonkinensis</i> | W,1,2 | <i>E. spicata</i> var. <i>spicata</i> | W,1,2 | <i>Rauwolfia cambodiana</i> | M,R,1,2 |
| <i>Rhodoleia championii</i> | W,R,2 | <i>E. wallichiana</i> | W,1,2 | <i>Strophanthus kontumensis</i> | 1 |
| Ulmaceae | | Myricaceae | | <i>Wrightia pubescens</i> | W,1,2 |
| <i>Celtis orientalis</i> | W,1,2 | <i>Myrica esculenta</i> var. <i>chevalier</i> | W,1,2 | Asclepiadaceae | |
| <i>Gironniera nervosa</i> | W,2 | <i>M. esculenta</i> var. <i>tonkinensis</i> | W,1,2 | <i>Dischidia alboflava</i> | 1,2 |
| <i>G. subaequalis</i> | W,1,2 | Fagaceae | | <i>D. hirsuta</i> | 1 |
| <i>Trema orientalis</i> | W,1,2 | <i>Castanopsis ceratocantha</i> | W,1 | <i>Gymnema silvestre</i> | 1,2 |
| <i>Ulmus lanceaeifolia</i> | W,1 | <i>C. echinophora</i> | W,1,2 | <i>Streptocaulon griffithii</i> | M,1,2 |
| Salicaceae | | <i>C. harmandii</i> | W,1,2 | Solanaceae | |
| <i>Salix tetrasperma</i> var. <i>nilagirica</i> | W,1 | <i>C. hystrix</i> | W,1,2 | <i>Physalis angulata</i> | 1,2 |
| <i>S. thorelii</i> | W,1 | <i>C. indica</i> | W,1,2 | <i>Solanum americanum</i> | 1,2 |
| Moraceae | | <i>Lithocarpus aggregatus</i> | W,1,2 | <i>S. torvum</i> | W,1,2 |
| <i>Artocarpus lakoocha</i> | W,M,1 | <i>L. blaensis</i> | W,1,2 | <i>S. virgianium</i> | 2 |
| <i>A. nitidus</i> | W,M,1 | <i>L. corneus</i> | W,1,2 | Convolvulaceae | |
| <i>Broussonetia papyrifera</i> | M,1,2 | <i>L. dealbatus</i> | W,1 | <i>Argyria lanceolata</i> | M,O,1 |
| <i>Ficus abelii</i> | 1,2 | <i>L. dinbensis</i> | W,1 | <i>Ipomoea involucrata</i> | 1,2 |
| <i>F. altissima</i> | W,1,2 | <i>L. elegans</i> | W,1 | <i>Lepistemon bielechtariferum</i> | 1,2 |
| <i>F. auriculata</i> | W,M,1,2 | <i>L. fissa</i> | W,1,2 | <i>Merremia umbellata</i> | 1,2 |
| <i>F. chartacea</i> | 1,2 | <i>L. krempfii</i> | W,1,2 | <i>Xenostegia tridentata</i> | 1,2 |
| <i>F. fulva</i> | 1,2 | <i>L. sylvicularum</i> | W,1,2 | <i>Porana racemosa</i> | 1,2 |
| <i>F. fulva</i> var. <i>minor</i> | 1,2 | <i>Quercus augustinii</i> | W,1,2 | Boraginaceae | |
| <i>F. glaberrima</i> | W,1 | <i>Q. fructisepta</i> | W,2 | <i>Heliotropium indicum</i> | M,1,2 |
| <i>F. heterophylla</i> var. <i>heterophylla</i> | 1,2 | <i>Q. helferiana</i> | W,1,2 | <i>Tournefortia montana</i> | 1,2 |
| <i>F. hirta</i> var. <i>roxburghii</i> | 1,2 | <i>Q. kerrii</i> | W,1,2 | Verbenaceae | |
| <i>F. hispida</i> var. <i>hispida</i> | 1,2 | <i>Q. langbianensis</i> | W,1 | <i>Callicarpa alpida</i> | 1,2 |
| <i>F. oligodon</i> | W,M,1 | <i>Q. leucotrichophora</i> | W,1 | <i>C. arborea</i> | 1,2 |
| <i>F. pumila</i> | M,1 | <i>Q. macrocalyx</i> | W,1,2 | <i>Clerodendrum erioclona</i> | M,1,2 |
| <i>F. racemosa</i> | W,1,2 | <i>Q. poilanei</i> | W,1 | <i>C. rubella</i> | 1 |
| <i>F. sagittata</i> | W,1 | Betulaceae | | <i>Gmelina arborea</i> | W,1,2 |
| <i>F. saxophila</i> | W,1,2 | <i>Betula alnoides</i> | W,1,2 | <i>Premna balansae</i> | 1,2 |
| <i>Maclura nadamanica</i> | M,1 | <i>Carpinus poilanei</i> | W,1,2 | <i>P. flavescens</i> | 1,2 |
| <i>M. cochinchinensis</i> | M,1,2 | Loganiaceae | | <i>Verbena officinalis</i> | M,1,2 |
| <i>Morus wittiorum</i> | W,1 | <i>Fagraea auriculata</i> | 1,2 | <i>Vitex sumatrana</i> | W,1,2 |
| Urticaceae | | <i>Gelsemium elegans</i> | 1,2 | <i>V. trifolia</i> | W,1,2 |
| <i>Boehmeria diffusa</i> | 1,2 | Gentiniaceae | | Lamiaceae | |
| <i>B. tonkinensis</i> | 2 | <i>Crawfordia campanulacea</i> | 1,2 | <i>Anisomeles indica</i> | M,1,2 |
| <i>Debregeasia velutina</i> | 1,2 | <i>Gentiana rigrescens</i> | 1 | <i>Ceratanthus annamensis</i> | 1,2 |
| <i>Elatostema acuminata</i> | 1 | Apocynaceae | | <i>C. ocimoides</i> | 1,2 |
| <i>Poikilospermum mollis</i> | 1,2 | <i>Alstonia scholaris</i> | W,M,1,2 | <i>Colquhounia elegans</i> | 1 |
| <i>P. suaveolens</i> | M,1,2 | <i>Alyxia pisiformis</i> | 1,2 | <i>Elsholtzia blanda</i> | 1,2 |
| <i>Pouzolzia hirta</i> | 2 | <i>A. kontumensis</i> | 1,2 | <i>E. winitina</i> | 1 |
| <i>P. sanguinea</i> | 1,2 | <i>A. poilanei</i> | 1,2 | <i>Gomphostemma lucidum</i> | 1,2 |
| <i>Villebrunea tonkinensis</i> | 2 | <i>A. pseudosinensis</i> | 1,2 | <i>Leonurus sibiricus</i> | M,1 |
| Juglandaceae | | <i>Bousignonia mekongensis</i> | 1,2 | <i>Leucas mollissima</i> | 1,2 |
| <i>Engelhardtia colebrookeana</i> | W,1,2 | <i>Ervatamia pierrei</i> | 1,2 | <i>Melissa axillaris</i> | M,1 |
| | | <i>Ixodonerium annamense</i> | 1,2 | <i>Plectranthus dakglayensis</i> | 1 |
| | | <i>Kopsia lancibracteolata</i> | W,1 | | |



Appendices

| Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes |
|---|---------|---|---------|--|--------|
| Plantaginaceae | | <i>H. corymbosa</i> | 1,2 | <i>B. balsamifera</i> | M,1,2 |
| <i>Plantago asiatica</i> | M,1,2 | <i>H. diffusa</i> | 1,2 | <i>B. eberhardtii</i> | 1 |
| Buddleiaceae | | <i>H. ovatifolia</i> | 1 | <i>B. hieracifolia</i> | 1 |
| <i>Buddleia paniculata</i> | 1 | <i>H. uncinella</i> | 1,2 | <i>B. lacera</i> | M,1 |
| Oleaceae | | <i>Ixora dolichophylla</i> | 1,2 | <i>B. laciniata</i> | M,1,2 |
| <i>Fraxinus chinensis</i> | W,R,1,2 | <i>I. henryi</i> | 1 | <i>B. lanceolaria</i> | M,1 |
| <i>F. floribunda</i> | W,1 | <i>Lasianthus annamicus</i> | 1,2 | <i>B. membranacea</i> var. | 1 |
| <i>F. insularis</i> | W,1,2 | <i>L. baviensis</i> | 1 | <i>membranacea</i> | |
| <i>Olea dentata</i> | 1,2 | <i>L. cyanocarpus</i> | 1,2 | <i>B. procera</i> | 1 |
| Scrophulariaceae | | <i>L. cyanocarpus</i> var. <i>asperatus</i> | 1 | <i>B. riparia</i> | 1 |
| <i>Alectra avense</i> | M,1 | <i>L. dinhensis</i> | 1 | <i>B. virens</i> | 1,2 |
| <i>Lindernia ciliata</i> | M,1 | <i>L. hoaensis</i> | M,R,1,2 | <i>Centipeda minima</i> | M,1 |
| <i>Torenia alboviolacea</i> | 1 | <i>L. poilanei</i> | 1 | <i>Cirsium lineare</i> | M,1,2 |
| <i>T. concolor</i> | 1,2 | <i>Morinda cochinchinensis</i> | M,1,2 | <i>Conyza japonica</i> | 1,2 |
| Gesneriaceae | | <i>Mussaenda erosa</i> | M,1,2 | <i>Crossostephium crepidioides</i> | M,1,2 |
| <i>Beccarinda tonkinensis</i> | 1 | <i>M. pubescens</i> | 1,2 | <i>Dichrocephala integrifolia</i> | 1 |
| Acanthaceae | | <i>Ophiorrhiza baviensis</i> | 1,2 | <i>Eclipta prostrata</i> | M,1,2 |
| <i>Andrographis laxiflora</i> | 1,2 | <i>Paederia scandens</i> | M,1,2 | <i>Elephantopus mollis</i> | 1,2 |
| <i>Asystasia chelonoides</i> | 1,2 | <i>Pavetta indica</i> | M,1,2 | <i>Emilia sonchifolia</i> | M,1 |
| <i>Justicia multinodis</i> | 1,2 | <i>Psychotria cephalophora</i> | M,1 | <i>Erechtites hieracifolia</i> | 1,2 |
| <i>Strobilanthes boerhavioides</i> | M,1 | <i>P. mekongensis</i> | 1 | <i>E. valerianifolia</i> | 1,2 |
| <i>S. dalzielii</i> | 1,2 | <i>P. morindoides</i> | 1,2 | <i>Erigeron crispus</i> | 1,2 |
| <i>S. echinata</i> | 1 | <i>P. rubra</i> | M,1 | <i>Eupatorium odoratum</i> | M,1,2 |
| <i>S. pateriformis</i> | 1,2 | <i>Randia acuminatissima</i> | W,2 | <i>E. fortunei</i> | M,2 |
| <i>S. pentstemonoides</i> | 1,2 | <i>R. lanceolata</i> | W,1,2 | <i>Galinsoga parviflorum</i> | 1,2 |
| Bignoniaceae | | <i>Tarenna latifolia</i> | 1,2 | <i>Gnaphalium affine</i> | 1,2 |
| <i>Oroxylum indicum</i> | M,1,2 | <i>Uncaria hirsuta</i> | 1,2 | <i>G. polycaulon</i> | 1,2 |
| <i>Stereospermum colais</i> | W,M,1,2 | <i>Wendlandia glabrata</i> | 1,2 | <i>Gynura barbaraefolia</i> | M,1 |
| Pentaphragmaceae | | <i>W. ferrugienea</i> | 1,2 | <i>G. nitida</i> | 1,2 |
| <i>Pentaphragma sinense</i> | 1,2 | <i>W. paniculata</i> | 1,2 | <i>G. procumbens</i> | 1 |
| Campanulaceae | | Caprifoliaceae | | <i>Inula cappa</i> | M, 1,2 |
| <i>Codonopsis javanica</i> | M,R,1,2 | <i>Lonicera dasystyla</i> | M,1,2 | <i>I. polygonata</i> | O,1,2 |
| <i>Lobelia zeylanica</i> | 1,2 | <i>Sambucus simpsonii</i> | 1 | <i>Ixeris gracilis</i> | 1 |
| <i>Pratia nummularia</i> | M,1 | <i>Viburnum coriaceum</i> | W,1,2 | <i>Lactuca indica</i> | M,1,2 |
| Rubiaceae | | <i>V. punctatum</i> | W,1,2 | <i>Laggera alata</i> | M,1,2 |
| <i>Adina polycephala</i> | W,M,1,2 | Valerianaceae | | <i>Microglossa pyrifolia</i> | M,1,2 |
| <i>Aidia cochinchinensis</i> | M,1,2 | <i>Valeriana hardwickii</i> | M,1 | <i>Piloselloides hirsuta</i> | M,1,2 |
| <i>A. oxydonta</i> | W,1,2 | Asteraceae | | <i>Rhynchospermum verticillatum</i> | 1 |
| <i>Anthocephalus chinensis</i> | W,1 | <i>Adenostemma laevinia</i> | M,1,2 | <i>Saussurea delloidea</i> var. <i>nivea</i> | 1 |
| <i>Borriera articularis</i> | 1,2 | <i>A. macrophyllum</i> | 1 | <i>Senecio scandens</i> | M,1 |
| <i>Canthium dicoccum</i> var. <i>rostratum</i> | W,1,2 | <i>Ageratum conyzoides</i> | M,1,2 | <i>Siegesbeckia orientalis</i> | M,1,2 |
| <i>Fagerlindia depauperata</i> | M,1,2 | <i>Ainsliaea latifolia</i> | 1,2 | <i>Sonchus oleraceus</i> | M,1,2 |
| <i>Galium rotundifolium</i> | 1 | <i>Anaphalis adnata</i> | 1,2 | <i>Tridax procumbens</i> | M,1,2 |
| <i>Gardnera philastreii</i> | 1 | <i>A. margaritacea</i> | O,1,2 | <i>Vernonia arborea</i> var. <i>javanica</i> | W,1,2 |
| <i>Hedyotis capitellata</i> var. <i>dactinensis</i> | 1 | <i>Artemisia japonica</i> | M,1,2 | <i>V. cinerea</i> | M,1,2 |
| <i>H. capitellata</i> var. <i>glabra</i> | 1,2 | <i>A. vulgaris</i> | M,1,2 | <i>V. cumingiana</i> | M,1 |
| <i>H. capitellata</i> var. <i>mollis</i> | M,1,2 | <i>Aster ageratooides</i> | M,1 | <i>V. solanifolia</i> | 1,2 |
| | | <i>Bidens bipinnata</i> | M,1 | <i>Vicoa auriculata</i> | 1 |
| | | <i>Blumea aromatica</i> | 1,2 | <i>Youngia japonica</i> | 1,2 |

| Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes | Class, Family, Genus and Species | Notes |
|----------------------------------|----------|--|---------|-----------------------------------|----------|
| Liliopsida | | Maranthaceae | | <i>Dinochloa</i> sp. | 1,2 |
| Pandanaceae | | <i>Phrynium dispernum</i> | M,1,2 | <i>Echinochloa colonum</i> | 1,2 |
| <i>Pandanus tonkinensis</i> | 1,2 | Pontederiaceae | | <i>Eleusine indica</i> | 1,2 |
| <i>P.</i> sp. | 1,2 | <i>Monochoria hastata</i> | 1,2 | <i>Eragrostis zeylanica</i> | 1,2 |
| Araceae | | <i>M. ovata</i> | 1,2 | <i>Erianthus arundinaceus</i> | 1,2 |
| <i>Acorus tatarinovii</i> | M,1 | Liliaceae | | <i>Gigantochloa nigro-ciliata</i> | 2 |
| <i>Aglaonema modestum</i> | 1,2 | <i>Dianella nemorosa</i> | 1,2 | <i>Hymenachne polymorpha</i> | 1,2 |
| <i>Alocasia macrorrhiza</i> | M,1,2 | <i>Disporum calcaratum</i> | 1 | <i>Imperata cylindrica</i> | 1,2 |
| <i>Arisoema hypoglaucaum</i> | 1,2 | <i>D. cantoniense</i> | M,1,2 | <i>Melocalamus compactiflorus</i> | 1,2 |
| <i>A. petiolulatum</i> | 1,2 | <i>D. cambodiana</i> | O,2 | <i>Miscanthus floridulus</i> | 1,2 |
| <i>Colocasia esculenta</i> | 1,2 | <i>D. gracilis</i> | O,1 | <i>Oxytenanthera albo-cyliata</i> | 1,2 |
| <i>Epipremnum giganteum</i> | O,1,2 | <i>Ophiopogon peliosanthoides</i> | O,1,2 | <i>O. poilanei</i> | 1,2 |
| <i>E. pinnatum</i> | O,1,2 | <i>Paris polyphylla</i> | M,R,1,2 | <i>Paspalum cojugatum</i> | 1,2 |
| <i>Homalomena occulta</i> | M,1,2 | <i>Polygonatum kingianum</i> | M,1 | <i>P. scrobiculatum</i> | 1,2 |
| <i>Lasia spinosa</i> | 1,2 | <i>P. punctatum</i> | M,1 | <i>Phragmites vallatoria</i> | 1,2 |
| <i>Pothos angustifolius</i> | 1,2 | Smilacaceae | | <i>Saccharum spontaneum</i> | 1,2 |
| <i>P. balansae</i> | O,1,2 | <i>Smilax annamensis</i> | 1,2 | <i>Setaria geniculata</i> | 1,2 |
| <i>P. cachcartii</i> | O,1,2 | <i>S. corbularia</i> | 1,2 | <i>S. palmifolia</i> | 1,2 |
| <i>Schismatoglottis cadieri</i> | M,1 | <i>S. glabra</i> | M,R,1 | <i>Sorghum nitidum</i> | 1,2 |
| Commelinaceae | | <i>S. megacarpa</i> | 1,2 | <i>Themeda caudata</i> | 1,2 |
| <i>Commelina diffusa</i> | 1,2 | <i>S. perfoliata</i> | 1,2 | <i>Thysanolaena maxima</i> | 1,2 |
| <i>Cyanotis vaga</i> | 1,2 | Cyperaceae | | Agavaceae | |
| Arecaceae | | <i>Carex anomocaria</i> | 1,2 | <i>Dracaena angustifolia</i> | O,2 |
| <i>Areca triandra</i> | O,M,1,2 | <i>C. cryptostachys</i> | 1,2 | Taccaceae | |
| <i>Arenga pinnata</i> | 1 | <i>C. filicina</i> | 1,2 | <i>Tacca integrifolia</i> | M,2 |
| <i>Calamus bousigonii</i> | 1,2 | <i>C. leucholora</i> | 1,2 | Dioscoreaceae | |
| <i>C. poilanei</i> | EV,R,1,2 | <i>Cyperus diffusus</i> | 1,2 | <i>Dioscorea cirrhosa</i> | 2 |
| <i>C. rudentum</i> | 1,2 | <i>C. flavidus</i> | 1,2 | <i>D. glabra</i> | M,1,2 |
| <i>C. tetradactylus</i> | 1,2 | <i>C. paniceus</i> var. <i>roxburghianus</i> | 1,2 | <i>D. intempestiva</i> | 1,2 |
| <i>Caryota mitis</i> | O,1,2 | <i>C. pumilus</i> | 1,2 | Orchidaceae | |
| <i>C. urens</i> | 1 | <i>C. rotundus</i> | 1,2 | <i>Aerides falcatum</i> | O,1,2 |
| <i>Daemonorops pierreanus</i> | 1,2 | <i>Fimbristylis complanata</i> | 1,2 | <i>A. multiflorum</i> | O,1,2 |
| <i>Korthalsia laciniosa</i> | 1,2 | <i>F. dichotoma</i> | 1,2 | <i>Anoectochilus lylei</i> | M,1,2 |
| <i>Licuala ternata</i> | 1,2 | <i>F. thomsonii</i> | 1,2 | <i>Arachnis labrosa</i> | 2 |
| <i>Livistona saribus</i> | 1,2 | <i>Kyllinga brevifolia</i> | 1,2 | <i>Arundina graminifolia</i> | O,1,2 |
| <i>Pinanga paradoxa</i> | 1,2 | <i>K. sesquiflorus</i> | 1,2 | <i>Bulbophyllum evrardii</i> | O,EV,R,1 |
| <i>Plectocomia elongata</i> | 1,2 | <i>Lipocarpa chinensis</i> | 1 | <i>B. retusiusculum</i> | O,1,2 |
| Musaceae | | <i>Scirpus ternatanus</i> | 1,2 | <i>B. semitereitifolium</i> | O,1,2 |
| <i>Musa bakeri</i> | 1,2 | <i>S. wichurai</i> | 2 | <i>B. tortuosum</i> | 1,2 |
| Zingiberaceae | | Poaceae | | <i>Calanthe triplicata</i> | O,1 |
| <i>Catimbium bracteatum</i> | M,1,2 | <i>Arundinaria pusilla</i> | 1,2 | <i>Coelogyne ovalis</i> | O,1,2 |
| <i>Costus speciosus</i> | M,1,2 | <i>A. vicina</i> | 1 | <i>C. stricta</i> | O,1,2 |
| <i>Curcuma aromatica</i> | M,2 | <i>Arthraxon hispidus</i> | 1,2 | <i>Cymbidium ensifolium</i> | O,1,2 |
| <i>Hedychium bousigonianum</i> | M,1,2 | <i>A. lancifolius</i> | 1,2 | <i>C. lowianum</i> | 1 |
| <i>H. coronarium</i> | M,O,1,2 | <i>Bambusa balcoa</i> | 1,2 | <i>Dendrobium bellatulum</i> | O,R,1 |
| <i>Zingiber purpureum</i> | M,1,2 | <i>Cephalostachyum langbianensis</i> | 1,2 | <i>D. christyanum</i> | O,1,2 |
| <i>Z. rubens</i> | M,1,2 | <i>Cynodon dactylon</i> | 1,2 | <i>D. crystallinum</i> | O,1,2 |
| <i>Z. zerumber</i> | 1,2 | <i>Dactyloctenium aegyptiacum</i> | 1,2 | <i>D. faulhaberianam</i> | O,1,2 |
| | | <i>Digitaria ciniaris</i> | 1,2 | <i>D. heterocarpum</i> | O,1,2 |



Appendices

| Class, Family, Genus and Species | Notes |
|-------------------------------------|----------|
| <i>D. lindleyi</i> | O,1,2 |
| <i>D. linguella</i> | 2 |
| <i>D. palpebrae</i> | O,2 |
| <i>D. parishii</i> | O,1,2 |
| <i>D. podagraria</i> | O,1 |
| <i>D. terminale</i> | O,1,2 |
| <i>D. thyrsiflorum</i> | O,2 |
| <i>Doritis pulcherrima</i> | 1,2 |
| <i>Eria amica</i> | 1,2 |
| <i>E. dacrydium</i> | O,1,2 |
| <i>E. floribunda</i> | O,1,2 |
| <i>E. globifera</i> | O,1,2 |
| <i>Eulophia nuda</i> | O,2 |
| <i>Flickingeria angustifolia</i> | 2 |
| <i>Goodyera schlechtendaliana</i> | M,O,1 |
| <i>Holcoglossum subulifolium</i> | O,1 |
| <i>Liparis mannii</i> | O,1 |
| <i>Luisia curtisii</i> | 2 |
| <i>Oberonia anceps</i> | O,1,2 |
| <i>O. rufilabris</i> | O,1,2 |
| <i>Otochilus fuscus</i> | O,EV,1,2 |
| <i>Phajus tankervilleae</i> | O,1,2 |
| <i>Pholidota articulata</i> | O,1,2 |
| <i>P. chinensis</i> | O,1,2 |
| <i>P. convallariae</i> | O,1,2 |
| <i>P. rubra</i> | O,1,2 |
| <i>Schoenorchis aff. gemmata</i> | O,2 |
| <i>Spiranthes sinensis</i> | M,1 |
| <i>Thecostele alata</i> | O,1,2 |
| <i>Thrixspermum pusillum</i> | 2 |
| <i>Zeuxine affinis</i> | 1 |

Follows Pham Hoang Ho (1991)

Notes:

- 1 = Recorded on Mount Ngoc Linh;
- 2 = Recorded in Cong Troi Area and Lo Xo Pass;
- EV = Endemic to Vietnam;
- M = Medicinal;
- W = Wood;
- O = Ornamental;
- E = Endangered;
- R = Rare

as per IUCN (1997) and Anon. (1996).



Appendix 2: Mammals Recorded in Ngoc Linh Nature Reserve (excluding Rodents and Bats)

| No. | Common Name | Order, Family, Genus and Species | IUCN 1996 | Anon. 1992 | Site | Data Source |
|-----|------------------------------|-----------------------------------|-----------|------------|-------|-------------|
| | Pangolins: | Pholidota: | | | | |
| | Pangolins | Manidae | | | | |
| 1 | Sunda Pangolin | <i>Manis javanica</i> | NT | | 1,2,4 | I,S |
| | Insectivores: | Insectivora: | | | | |
| | Moles | Talpidae | | | | |
| 2 | Himalayan Mole | <i>Talpa micrura</i> | | | 5 | S |
| | Shrews | Soricidae | | | | |
| 3 | House Shrew | <i>Suncus murinus</i> | | | 2 | O |
| 4 | SE Asian White-toothed Shrew | <i>Crocidura fuliginosa</i> | | | 5 | O |
| | Treeshrews: | Scandentia: | | | | |
| | Treeshrews | Tupaïidae | | | | |
| 5 | Northern Treeshrew | <i>Tupaia belangeri</i> | | | 1,2,5 | O |
| | Primates: | Primates: | | | | |
| | Lorises | Loridae | | | | |
| 6 | Slow Loris | <i>Nycticebus coucang</i> | | V | 5 | S |
| | Old-World Monkeys | Cercopithecidae | | | | |
| 7 | Pig-tailed Macaque | <i>Macaca nemestrina</i> | VU | V | 4 | S |
| 8 | Rhesus Macaque | <i>M. mulatta</i> | NT | | 2,4 | S |
| 9 | Bear Macaque | <i>M. arctoides</i> | VU | V | 2,4,5 | S |
| | Gibbons | Hylobatidae | | | | |
| 10 | Buff-cheeked Gibbon | <i>Hylobates gabriellae</i> | DD | | 2 | H |
| | Carnivores: | Carnivora: | | | | |
| | Dog and Foxes | Canidae | | | | |
| 11 | Indian Wild Dog or Dhole | <i>Cuon alpinus</i> | VU | E | 1,2 | H,I |
| | Bears | Ursidae | | | | |
| 12 | Asiatic Black Bear | <i>Ursus thibetanus</i> | VU | E | 2,4,5 | I |
| 13 | Sun Bear | <i>U. malayanus</i> | DD | E | 2,4,5 | I |
| | Weasels, etc. | Mustelidae | | | | |
| 14 | Yellow-throated Marten | <i>Martes flavigula</i> | | | 2 | S |
| 15 | Hog-Badger | <i>Arctonyx collaris</i> | | | 2,4,5 | I |
| 16 | Large-toothed Ferret-Badger | <i>Melogale personata</i> | | R | 2 | S |
| 17 | Eurasian Otter | <i>Lutra lutra</i> | | T | 2,4 | I,S |
| | Civets | Viverridae | | | | |
| 18 | Large Indian Civet | <i>Viverra zibetha</i> | | | 2 | S |
| 19 | Small Indian Civet | <i>Viverricula indica</i> | | | 2 | S |
| 20 | Spotted Linsang | <i>Prionodon pardicolor</i> | | | 2 | S |
| 21 | Common Palm Civet | <i>Paradoxurus hermaphroditus</i> | | | 2 | S |
| 22 | Masked Palm Civet | <i>Paguma larvata</i> | | | 2 | S |
| 23 | Binturong | <i>Arctictis binturong</i> | | V | 2 | S |
| 24 | Small-toothed Palm Civet | <i>Arctogalidia trivirgata</i> | | R | 2 | S |
| | Mongoose | Herpestidae | | | | |
| 25 | Small Asian Mongoose | <i>Herpestes javanicus</i> | | | 2 | O |



Appendices

| No. | Common Name | Order, Family, Genus and Species | IUCN 1996 | Anon. 1992 | Site | Data Source |
|-----|---------------------------------|-----------------------------------|-----------|------------|-----------|-------------|
| 26 | Crab-eating Mongoose | <i>H. urva</i> | | | 2 | S |
| | Cats | Felidae | | | | |
| 27 | Leopard Cat | <i>Prionailurus bengalensis</i> | | | | |
| 28 | Golden Cat | <i>Catopuma temminckii</i> | NT | V | 2 | I |
| 29 | Marbled Cat | <i>Pardofelis marmorata</i> | DD | V | 2,4 | I,S |
| 30 | Clouded Leopard | <i>P. nebulosa</i> | VU | V | 2 | I |
| 31 | Tiger | <i>Panthera tigris</i> | EN | E | 2,4 | I |
| | Even-toed ungulates: | Artiodactyla: | | | | |
| | Pigs | Suidae | | | | |
| 32 | Wild Boar | <i>Sus scrofa</i> | | | 2,4 | I,T |
| | Deer | Cervidae | | | | |
| 33 | Sambar Deer | <i>Cervus unicolor</i> | | | 2,4 | S,T |
| 34 | Giant Muntjac | <i>Megamuntiacus vuquangensis</i> | | | 2 | S |
| 35 | Truong Son Muntjac | <i>Muntiacus truongsongensis</i> | | | 2,4 | S |
| 36 | Barking Deer | <i>M. muntjak</i> | | | 1,2,3,4,5 | H,T |
| | Cattle, Antelopes, etc. | Bovidae | | | | |
| 37 | Southern Serow | <i>Naemorhedus sumatraensis</i> | VU | V | 2,4 | I |
| | Rodents: | Rodentia: | | | | |
| | Non-flying Squirrels | Sciuridae | | | | |
| 38 | Black Giant Squirrel | <i>Ratufa bicolor</i> | | | 2,5 | O,S |
| 39 | Pallas's Squirrel | <i>Callosciurus erythraeus</i> | | | 1,2,4 | O |
| 40 | Cambodian Striped Tree-squirrel | <i>Tamiops rodolphii</i> | | | 1,2,3,4,5 | O |
| 41 | Red-cheeked Squirrel | <i>Dremomys rufigenis</i> | | | 3,5 | O |
| 42 | Indochinese Ground Squirrel | <i>Menetes berdmorei</i> | | | 2,3,4,5 | O |
| | Flying Squirrels | Pteromyidae | | | | |
| 43 | Red Giant Flying Squirrel | <i>Petaurista philippensis</i> | | R | 2 | S |
| 44 | Red-cheeked Flying Squirrel | <i>Hylopetes spadiceus</i> | | | 2 | S |
| | Mice, Rats, etc. | Muridae | | | | |
| 45 | Sladen's Rat | <i>Rattus koratensis</i> | | | 2,5 | S,O |
| 46 | Polynesian Rat | <i>R. exulans</i> | | | | |
| 47 | Large Bandicoot-Rat | <i>Bandicota indica</i> | | | 3 | S,O |
| 48 | Fea's Tree Rat | <i>Chiromyscus chiropus</i> | | | 2 | S |
| | Bamboo Rats | Rhizomyidae | | | | 49 |
| 49 | Hoary Bamboo Rat | <i>Rhizomys pruinosus</i> | | | 2 | S |
| 50 | Large Bamboo Rat | <i>R. sumatrensis</i> | | | 2 | S |
| | Old-World Porcupines | Hystricidae | | | | |
| 51 | Malayan Porcupine | <i>Hystrix brachyura</i> | VU | | 2,4 | S |
| 52 | Asiatic Brush-tailed Porcupine | <i>Atherurus macrourus</i> | | | 2,3 | S,O |

Follows Corbet and Hill (1992)

Note: EN/E = Endangered; VU/V = Vulnerable; NT = Near Threatened; T = Threatened; R = Rare; DD = Data Deficient as per IUCN (1996) and Anon. (1992).

S = Specimen; O = Observed; I = Interview; H = Heard; T = Tracks.

Site: 1 = Ngoc Linh commune; 2 = Lo Xo Pass; 3 = Cong Troi Area; 4 = Dac Plo commune; 5 = Mang Xang commune.



Appendix 3: Birds Recorded in Ngoc Linh Nature Reserve

| No. | Common Name | Order, Family, Genus and Species | Notes | Collar <i>et al.</i> 1994 | Anon. 1992 |
|-----|------------------------------|----------------------------------|-------|---------------------------|------------|
| | | Galliformes | | | |
| | | Phasianidae | | | |
| 1 | Chinese Francolin | <i>Francolinus pintadeanus</i> | 1 | | |
| 2 | Rufous-throated Partridge | <i>Arborophila rufogularis</i> | 1 | | |
| 3 | Bar-backed Partridge | <i>A. brunneopectus</i> | 1 | | |
| 4 | Red Junglefowl | <i>Gallus gallus</i> | 1 | | |
| 5 | Silver Pheasant | <i>Lophura nycthemera</i> | 1 | | T |
| 6 | Siamese Fireback | <i>L. diardi</i> | V | VU | T |
| 7 | Crested Argus | <i>Rheinardia ocellata</i> | RRS | VU | T |
| | | Piciformes | | | |
| | | Picidae | | | |
| 8 | Speckled Piculet | <i>Picumnus innominatus</i> | 1 | | |
| 9 | White-browed Piculet | <i>Sasia ochracea</i> | 1 | | |
| 10 | Grey-capped Pygmy Woodpecker | <i>Dendrocopos canicapillus</i> | 1 | | |
| 11 | Stripe-breasted Woodpecker | <i>D. atratus</i> | * | | |
| 12 | Bay Woodpecker | <i>Blythipicus pyrrhotis</i> | 1 | | |
| | | Megalaimidae | | | |
| 13 | Green-eared Barbet | <i>Megalaima faiostricta</i> | 1 | | |
| 14 | Golden-throated Barbet | <i>M. franklinii</i> | 1 | | |
| 15 | Black-browed Barbet | <i>M. oorti</i> | * | | |
| 16 | Blue-throated Barbet | <i>M. asiatica</i> | * | | |
| | | Bucerotiformes | | | |
| | | Bucerotidae | | | |
| 17 | Great Hornbill | <i>Buceros bicornis</i> | 1 | | T |
| 18 | Brown Hornbill | <i>Anorrhinus tickelli</i> | 1 | NT | T |
| 19 | Wreathed Hornbill | <i>Aceros undulatus</i> | | | T |
| | | Trogoniformes | | | |
| | | Trogonidae | | | |
| 20 | Red-headed Trogon | <i>Harpactes erythrocephalus</i> | 1 | | |
| | | Coraciiformes | | | |
| | | Coraciidae | | | |
| 21 | Dollarbird | <i>Eurystomus orientalis</i> | | | |
| | | Alcedinidae | | | |
| 22 | Common Kingfisher | <i>Alcedo atthis</i> | 1 | | |
| | | Halcyonidae | | | |
| 23 | Ruddy Kingfisher | <i>Halcyon coromanda</i> | | | R |
| 24 | White-throated Kingfisher | <i>H. smyrnensis</i> | | | |
| | | Meropidae | | | |
| 25 | Blue-bearded Bee-eater | <i>Nyctyornis athertoni</i> | 1 | | |
| | | Cuculiformes | | | |
| | | Cuculidae | | | |
| 26 | Hodgson's Hawk Cuckoo | <i>Hierococcyx fugax</i> | | | |
| 27 | Indian Cuckoo | <i>Cuculus micropterus</i> | | | |
| 28 | Eurasian Cuckoo | <i>C. canorus</i> | | | |
| 29 | Asian Emerald Cuckoo | <i>Chrysococcyx maculatus</i> | 1 | | |
| 30 | Drongo Cuckoo | <i>Surniculus lugubris</i> | | | |



Appendices

| No. | Common Name | Order, Family, Genus and Species | Notes | Collar <i>et al.</i> 1994 | Anon. 1992 |
|-----|---------------------------|----------------------------------|-------|---------------------------|------------|
| 31 | Asian Koel | <i>Eudynamys scolopacea</i> | | | |
| 32 | Green-billed Malkoha | <i>Phaenicophaeus tristis</i> | 1 | | |
| | | Centropodidae | | | |
| 33 | Greater Coucal | <i>Centropus sinensis</i> | 1 | | |
| 34 | Lesser Coucal | <i>C. bengalensis</i> | 1 | | |
| | | Apodiformes | | | |
| | | Apodidae | | | |
| 35 | Swiftlet species | <i>Collocalia</i> sp. | | | |
| 36 | White-throated Needletail | <i>Hirundapus caudacutus</i> | | | |
| 37 | Asian Palm Swift | <i>Cypsiurus balasiensis</i> | | | |
| 38 | House Swift | <i>Apus affinis</i> | | | |
| | | Strigiformes | | | |
| | | Strigidae | | | |
| 39 | Mountain Scops Owl | <i>Otus spilocephalus</i> | 1 | | |
| 40 | Collared Scops Owl | <i>O. bakkamoena</i> | | | |
| 41 | Brown Wood Owl | <i>Strix leptogrammica</i> | 1 | | R |
| 42 | Collared Owlet | <i>Glaucidium brodiei</i> | 1 | | |
| 43 | Brown Hawk Owl | <i>Ninox scutulata</i> | | | |
| | | Caprimulgidae | | | |
| 44 | Grey Nightjar | <i>Caprimulgus indicus</i> | 1 | | |
| 45 | Large-tailed Nightjar | <i>C. macrurus</i> | 1 | | |
| | | Columbiformes | | | |
| | | Columbidae | | | |
| 46 | Oriental Turtle Dove | <i>Streptopelia orientalis</i> | 1 | | |
| 47 | Spotted Dove | <i>S. chinensis</i> | 1 | | |
| 48 | Barred Cuckoo Dove | <i>Macropygia unchall</i> | 1 | | |
| 49 | Emerald Dove | <i>Chalcophaps indica</i> | 1 | | |
| 50 | Thick-billed Green Pigeon | <i>Treron curvirostra</i> | 1 | | |
| 51 | Mountain Imperial Pigeon | <i>Ducula badia</i> | 1 | | |
| | | Ciconiiformes | | | |
| | | Accipitridae | | | |
| 52 | Black-shouldered Kite | <i>Elanus caeruleus</i> | 1 | | |
| 53 | Crested Serpent Eagle | <i>Spilornis cheela</i> | 1 | | |
| 54 | Crested Goshawk | <i>Accipiter trivirgatus</i> | 1 | | |
| 55 | Grey-faced Buzzard | <i>Butastur indicus</i> | 1 | | |
| 56 | Black Eagle | <i>Ictinaetus malayensis</i> | 1 | | |
| | | Ardeidae | | | |
| 57 | Little Egret | <i>Egretta garzetta</i> | 1 | | |
| 58 | Cattle Egret | <i>Bubulcus ibis</i> | 1 | | |
| 59 | Little Heron | <i>Butorides striatus</i> | 1 | | |
| 60 | Chinese Pond Heron | <i>Ardeola bacchus</i> | 1 | | |
| 61 | Cinnamon Bittern | <i>Ixobrychus cinnamomeus</i> | 1 | | |
| | | Passeriformes | | | |
| | | Pittidae | | | |
| 62 | Rusty-naped Pitta | <i>Pitta oatesi</i> | 1 | | |
| | | Eurylaimidae | | | |
| 63 | Long-tailed Broadbill | <i>Psarisomus dalhousiae</i> | 1 | | T |



| No. | Common Name | Order, Family, Genus and Species | Notes | Collar <i>et al.</i> 1994 | Anon. 1992 |
|-----|-------------------------------|----------------------------------|-------|---------------------------|------------|
| | | Irenidae | | | |
| 64 | Orange-bellied Leafbird | <i>Chloropsis hardwickii</i> | 1 | | |
| | | Laniidae | | | |
| 65 | Burmese Shrike | <i>Lanius colluriooides</i> | ** | | |
| 66 | Long-tailed Shrike | <i>L. schach</i> | 1 | | |
| | | Corvidae | | | |
| 67 | Red-billed Blue Magpie | <i>Urocissa erythrorhyncha</i> | 1 | | |
| 68 | White-winged Magpie | <i>U. whiteheadi</i> | 1 | NT | |
| 69 | Common Green Magpie | <i>Cissa chinensis</i> | 1 | | |
| 70 | Indochinese Green Magpie | <i>C. hypoleuca</i> | | NT | |
| 71 | Large-billed Crow | <i>Corvus macrorhynchos</i> | 1 | | |
| 72 | Ashy Woodswallow | <i>Artamus fuscus</i> | 1 | | |
| 73 | Maroon Oriole | <i>Oriolus traillii</i> | 1 | | |
| 74 | Large Cuckooshrike | <i>Coracina macei</i> | 1 | | |
| 75 | Indochinese Cuckooshrike | <i>C. polioptera</i> | | | |
| 76 | Black-winged Cuckooshrike | <i>C. melaschistos</i> | 1 | | |
| 77 | Long-tailed Minivet | <i>Pericrocotus ethologus</i> | 1 | | |
| 78 | Scarlet Minivet | <i>P. flammeus</i> | 1 | | |
| 79 | Bar-winged Flycatcher-shrike | <i>Hemipus picatus</i> | 1 | | |
| 80 | White-throated Fantail | <i>Rhipidura albicollis</i> | 1 | | |
| 81 | Black Drongo | <i>Dicrurus macrocercus</i> | 1 | | |
| 82 | Ashy Drongo | <i>D. leucophaeus</i> | 1 | | |
| 83 | Crow-billed Drongo | <i>D. annectans</i> | 1 | | |
| 84 | Bronzed Drongo | <i>D. aeneus</i> | 1 | | |
| 85 | Lesser Racket-tailed Drongo | <i>D. remifer</i> | 1 | | |
| 86 | Black-naped Monarch | <i>Hypothymis azurea</i> | 1 | | |
| | | Muscicapidae | | | |
| 87 | Blue Whistling Thrush | <i>Myophonus caeruleus</i> | 1 | | |
| 88 | Siberian Thrush | <i>Zoothera sibirica</i> | 1 | | |
| 89 | Scaly Thrush | <i>Z. dauma</i> | 1 | | |
| 90 | Lesser Shortwing | <i>Brachypteryx leucophrys</i> | 1 | | |
| 91 | White-browed Shortwing | <i>B. montana</i> | 1 | | |
| 92 | Asian Brown Flycatcher | <i>Muscicapa dauurica</i> | 1 | | |
| 93 | Ferruginous Flycatcher | <i>M. ferruginea</i> | | | |
| 94 | Narcissus Flycatcher | <i>Ficedula narcissina</i> | 1 | | |
| 95 | Slaty-backed Flycatcher | <i>F. hodgsonii</i> | | | |
| 96 | Rufous-gorgeted Flycatcher | <i>F. strophiatea</i> | 1 | | |
| 97 | White-gorgeted Flycatcher | <i>F. monileger</i> | 1 | | |
| 98 | Snowy-browed Flycatcher | <i>F. hyperythra</i> | 1 | | |
| 99 | Little Pied Flycatcher | <i>F. westermanni</i> | 1 | | |
| 100 | Verditer Flycatcher | <i>Eumyias thalassina</i> | 1 | | |
| 101 | Large Niltava | <i>Niltava grandis</i> | 1 | | |
| 102 | Small Niltava | <i>N. macgrigoriae</i> | 1 | | |
| 103 | Blue-throated Flycatcher | <i>Cyornis rubeculoides</i> | | | |
| 104 | Grey-headed Canary Flycatcher | <i>Culicicapa ceylonensis</i> | 1 | | |
| 105 | Oriental Magpie Robin | <i>Copsychus saularis</i> | 1 | | |
| 106 | Plumbeous Water Redstart | <i>Rhyacornis fuliginosus</i> | | | |
| 107 | White-tailed Robin | <i>Myiomela leucura</i> | 1 | | |



Appendices

| No. | Common Name | Order, Family, Genus and Species | Notes | Collar <i>et al.</i> 1994 | Anon. 1992 |
|-----|-------------------------------|----------------------------------|--------|---------------------------|------------|
| 108 | Slaty-backed Forktail | <i>Enicurus schistaceus</i> | 1 | | |
| 109 | Spotted Forktail | <i>E. maculatus</i> | | | |
| 110 | Green Cochoa | <i>Cochoa viridis</i> | 1 | NT | |
| | | Sturnidae | | | |
| 111 | Black-collared Starling | <i>Sturnus nigricollis</i> | 1 | | |
| | | Sittidae | | | |
| 112 | Chestnut-bellied Nuthatch | <i>Sitta castanea</i> | 1 | | |
| 113 | Velvet-fronted Nuthatch | <i>S. frontalis</i> | 1 | | |
| 114 | Yellow-billed Nuthatch | <i>S. solangiae</i> | *RRS | VU | T |
| | | Paridae | | | |
| 115 | Yellow-cheeked Tit | <i>Parus spilonotus</i> | 1 | | |
| 116 | Yellow-browed Tit | <i>Sylviparus modestus</i> | 1 | | |
| 117 | Sultan Tit | <i>Melanochloa sultanea</i> | ** | | |
| | | Aegithalidae | | | |
| 118 | Black-throated Tit | <i>Aegithalos concinnus</i> | 1 | | |
| | | Pycnonotidae | | | |
| 119 | Red-whiskered Bulbul | <i>Pycnonotus jocosus</i> | 1 | | |
| 120 | Flavescent Bulbul | <i>P. flavescentis</i> | 1 | | |
| 121 | Yellow-vented Bulbul | <i>P. goiavier</i> | *** | | |
| 122 | Puff-throated Bulbul | <i>Alophoixus pallidus</i> | 1 | | |
| 123 | Ashy Bulbul | <i>Hemixos flavala</i> | ** | | |
| 124 | Mountain Bulbul | <i>Hypsipetes mccllellandii</i> | 1 | | |
| 125 | Black Bulbul | <i>H. leucocephalus</i> | 1 | | |
| | | Cisticolidae | | | |
| 126 | Hill Prinia | <i>Prinia atrogularis</i> | 1 | | |
| | | Zosteropidae | | | |
| 127 | Oriental White-eye | <i>Zosterops palpebrosus</i> | | | |
| | | Sylviidae | | | |
| 128 | Grey-bellied Tesia | <i>Tesia cyaniventer</i> | 1 | | |
| 129 | Blyth's Reed Warbler | <i>Acrocephalus dumetorum</i> | ** | | |
| 130 | Mountain Tailorbird | <i>Orthotomus cuculatus</i> | 1** | | |
| 131 | Ashy-throated Warbler | <i>Phylloscopus maculipennis</i> | 1** | | |
| 132 | Pallas's Leaf Warbler | <i>P. proregulus</i> | 1** | | |
| 133 | Yellow-browed Warbler | <i>P. inornatus</i> | | | |
| 134 | Two-barred Greenish Warbler | <i>P. plumbeitarsus</i> | * | | |
| 135 | Pale-legged Leaf Warbler | <i>P. tenellipes</i> | | | |
| 136 | White-tailed Leaf Warbler | <i>P. davisoni</i> | 1 | | |
| 137 | Golden-spectacled Warbler | <i>Seicercus burkii</i> | | | |
| 138 | White-spectacled Warbler | <i>S. affinis</i> | ** | | |
| 139 | Grey-cheeked Warbler | <i>S. poliogenys</i> | 1** | | |
| 140 | Chestnut-crowned Warbler | <i>S. castaniceps</i> | 1** | | |
| 141 | Yellow-bellied Warbler | <i>Abroscopus superciliosus</i> | ** | | |
| 142 | Golden-winged Laughingthrush | <i>Garrulax ngoclinhensis</i> | NS,RRS | NE | NE |
| 143 | Black-hooded Laughingthrush | <i>G. milleti</i> | RRS | VU | R |
| 144 | Black-throated Laughingthrush | <i>G. chinensis</i> | 1 | | |
| 145 | White-cheeked Laughingthrush | <i>G. vassali</i> | RRS | | T |
| 146 | Red-tailed Laughingthrush | <i>G. milnei</i> | 1** | NT | |
| 147 | Buff-breasted Babbler | <i>Pellorneum tickelli</i> | 1 | | |
| 148 | Spot-throated Babbler | <i>P. albiventris</i> | 1 | | |



| No. | Common Name | Order, Family, Genus and Species | Notes | Collar <i>et al.</i> 1994 | Anon. 1992 |
|-----|---------------------------------|----------------------------------|--------|---------------------------|------------|
| 149 | Large Scimitar Babbler | <i>Pomatorhinus hypoleucos</i> | 1** | | |
| 150 | White-browed Scimitar Babbler | <i>P. schisticeps</i> | | | |
| 151 | Coral-billed Scimitar Babbler | <i>P. ferruginosus</i> | 1** | | |
| 152 | Short-tailed Scimitar Babbler | <i>Jabouilleia danjoui</i> | RRS | VU | T |
| 153 | Streaked Wren Babbler | <i>Napothera brevicaudata</i> | 1 | | |
| 154 | Eyebrowed Wren Babbler | <i>N. epilepidota</i> | 1 | | |
| 155 | Pygmy Wren Babbler | <i>Pnoepyga pusilla</i> | | | |
| 156 | Rufous-fronted Babbler | <i>Stachyris rufifrons</i> | * | | |
| 157 | Golden Babbler | <i>S. chrysaea</i> | 1 | | |
| 158 | Grey-throated Babbler | <i>S. nigriceps</i> | 1 | | |
| 159 | Spot-necked Babbler | <i>S. striolata</i> | 1** | | |
| 160 | Silver-eared Mesia | <i>Leiothrix argentauris</i> | 1** | | |
| 161 | Cutia | <i>Cutia nipalensis</i> | 1 | | |
| 162 | White-browed Shrike Babbler | <i>Pteruthius flaviscapis</i> | 1 | | |
| 163 | Black-eared Shrike Babbler | <i>P. melanotis</i> | 1** | | |
| 164 | Chestnut-fronted Shrike Babbler | <i>P. aenobarbus</i> | 1 | | |
| 165 | Black-crowned Barwing | <i>Actinodura sodangorum</i> | NS,RRS | NE | NE |
| 166 | Blue-winged Minla | <i>Minla cyanouroptera</i> | 1** | | |
| 167 | Chestnut-tailed Minla | <i>M. strigula</i> | 1** | | |
| 168 | Red-tailed Minla | <i>M. ignotincta</i> | 1** | | |
| 169 | Golden-breasted Fulvetta | <i>Alcippe chrysotis</i> | 1** | | |
| 170 | Rufous-winged Fulvetta | <i>A. castaneiceps</i> | 1** | | |
| 171 | Spectacled Fulvetta | <i>A. ruficapilla</i> | 1** | | |
| 172 | Streaked-throated Fulvetta | <i>A. cinereiceps</i> | 1** | | |
| 173 | Rusty-capped Fulvetta | <i>A. dubia</i> | 1** | | |
| 174 | Mountain Fulvetta | <i>A. peracensis</i> | | | |
| 175 | Rufous-backed Sibia | <i>Heterophasia annectans</i> | 1 | | |
| 176 | Black-headed Sibia | <i>H. melanoleuca</i> | 1 | | |
| 177 | Stripe-throated Yuhina | <i>Yuhina gularis</i> | 1** | | |
| 178 | Black-chinned Yuhina | <i>Y. nigrimenta</i> | 1** | | |
| 179 | White-bellied Yuhina | <i>Y. zantholeuca</i> | 1 | | |
| 180 | Black-throated Parrotbill | <i>Paradoxornis nipalensis</i> | 1** | | |
| | | Nectariniidae | | | |
| 181 | Fire-breasted Flowerpecker | <i>Dicaeum ignipectus</i> | 1 | | |
| 182 | Gould's Sunbird | <i>Aethopyga gouldiae</i> | 1 | | |
| 183 | Green-tailed Sunbird | <i>A. nipalensis</i> | 1 | | |
| 184 | Black-throated Sunbird | <i>A. saturata</i> | 1 | | |
| 185 | Little Spiderhunter | <i>Arachnothera longirostra</i> | 1 | | |
| 186 | Streaked Spiderhunter | <i>A. magna</i> | | | |
| | | Passeridae | | | |
| 187 | Forest Wagtail | <i>Dendronanthus indicus</i> | | | |
| 188 | Grey Wagtail | <i>Motacilla cinerea</i> | | | |
| 189 | Olive-backed Pipit | <i>Anthus hodgsoni</i> | | | |
| 190 | White-rumped Munia | <i>Lonchura striata</i> | | | |

Follows Inskipp *et al.* (1996)

Status: E = Endangered; VU/V = Vulnerable; NT = Near Threatened; T = Threatened; R = Rare as per Collar *et al.* (1994) and Anon. (1992). NE = Not Evaluated.

Notes: 1 : Also distributed in north or north-west Vietnam
 * : New record for Vietnam
 ** : New record for central Vietnam
 *** : Range extension
 NS : New species for science
 RRS : Restricted-Range Species



Appendix 4: Herpetiles Recorded in Ngoc Linh Nature Reserve

| No. | Class, Order, Family Genus and Species | Data Source | Endemic Species | IUCN 1996 | Anon. 1992 |
|-----|---|----------------|--------------------|--------------|---------------|
| | Reptilia | | | | |
| | Squamata: | | | | |
| | Gekkonidae | | | | |
| 1 | <i>Gekko gecko</i> | O | | | T |
| 2 | <i>Hemidactylus frenatus</i> | O | | | |
| | Agamidae | | | | |
| 3 | <i>Acanthosaura capra</i> | R | | | |
| 4 | <i>A. lepidogaster</i> | S | | | T |
| 5 | <i>Calotes emma</i> | R | | | |
| 6 | <i>C. mystaceus</i> | S | | | |
| 7 | <i>C. versicolor</i> | O | | | |
| 8 | <i>Draco maculatus</i> | R | | | |
| 9 | <i>Physignathus cocincinus</i> | O | | | V |
| | Scincidae | | | | |
| 10 | <i>Eumeces quadrilineatus</i> | R | | | |
| 11 | <i>Mabuya multifasciata</i> | O | | | |
| 12 | <i>M. sp.</i> | R | | | |
| 13 | <i>Scincella rufocaudata</i> | R | EV | | |
| 14 | <i>S. vittigerum</i> | R | | | |
| | Dibamidae | | | | |
| 15 | <i>Dibamus bourreti</i> | R | | | |
| | Lacertidae | | | | |
| 16 | <i>Takydromus sexlineatus</i> | R | | | |
| | Varanidae | | | | |
| 17 | <i>Varanus nebulosus</i> | R | | | V |
| 18 | <i>V. salvator</i> | I | | | V |
| | Boidae | | | | |
| 19 | <i>Python molurus</i> | I | | NT | V |
| 20 | <i>P. reticulatus</i> | R | | | V |
| | Colubridae | | | | |
| 21 | <i>Ahaetulla prasina</i> | O | | | |
| 22 | <i>Amphiesma stolata</i> | O | | | |
| 23 | <i>Calamaria septentrionalis</i> | S | | | |
| 24 | <i>Dinodon sp.</i> | S | | | |
| 25 | <i>Dipsas margaritophorus</i> | S | | | |
| 26 | <i>Elaphe radiata</i> | I | | | |
| 27 | <i>Enhydris plumbea</i> | R | | | |
| 28 | <i>Ptyas korros</i> | R | | | T |
| 29 | <i>Xenochrophis piscator</i> | R | | | |
| | Elapidae | | | | |
| 30 | <i>Bungarus candidus</i> | I | | | |
| 31 | <i>B. fasciatus</i> | I | | | T |
| 32 | <i>Naja naja</i> | I | | | T |
| 33 | <i>Ophiophagus hannah</i> | I | | | E |
| | Viperidae | | | | |
| 34 | <i>Trimeresurus albolabris</i> | | | | |



| No. | Class, Order, Family Genus and Species | Data Source | Endemic Species | IUCN 1996 | Anon. 1992 |
|-----|---|----------------|--------------------|--------------|---------------|
| | Testudinata: | | | | |
| | Platysternidae | | | | |
| 35 | <i>Platysternum megacephalum</i> | R | | DD | R |
| | Emydidae | | | | |
| 36 | <i>Cistoclemmys galbinifrons</i> | R | EV | NT | V |
| 37 | <i>Cuora trifasciata</i> | R | | EN | V |
| 38 | <i>Geoemyda spengleri</i> | R | | | |
| 39 | <i>Pyxidea mouhoti</i> | R | | | |
| | Testudinidae | | | | |
| 40 | <i>Indotestudo elongata</i> | R | | VU | V |
| | Trionychidae | | | | |
| 41 | <i>Palea steindachneri</i> | R | | NT | |
| | Amphibia | | | | |
| | Apoda: | | | | |
| | Coeciliidae | | | | |
| 1 | <i>Ichthyophis glutinosus</i> | R | | | V |
| | Anura: | | | | |
| | Megophryidae | | | | |
| 2 | <i>Leptobrachium hasselti</i> | S | | | |
| 3 | <i>Megophrys longipes</i> | S | | | T |
| 4 | <i>M. major</i> | S | | | |
| | Bufo | | | | |
| 5 | <i>Bufo galeatus</i> | R | | | R |
| 6 | <i>B. melanostictus</i> | O | | | |
| | Ranidae | | | | |
| 7 | <i>Occidozyga lima</i> | R | | | |
| 8 | <i>Phrynoglossus laevis</i> | O | | | |
| 9 | <i>Rana andersoni</i> | S | | | T |
| 10 | <i>R. guentheri</i> | O | | | |
| 11 | <i>R. kuhlii</i> | R | | | |
| 12 | <i>R. limmocharis</i> | S | | | |
| 13 | <i>R. nigrovittata</i> | S | | | |
| 14 | <i>R. ricketi</i> | S | | | |
| 15 | <i>R. rugulosa</i> | O | | | |
| 16 | <i>R. verrucospinosa</i> | R | EV | | |
| | Rhacophoridae | | | | |
| 17 | <i>Rhacophorus leucomystax</i> | S | | | |
| 18 | <i>R. nigropalmatus</i> | R | | | T |
| 19 | <i>Philautus</i> sp. | S | | | |
| | Microhylidae | | | | |
| 21 | <i>Microhyla berdmorei</i> | R | | | |
| 22 | <i>M. heymonsi</i> | S | | | |
| 23 | <i>M. ornata</i> | S | | | |

Follows Nguyen Van Sang and Ho Thu Cuc (1996).

Notes: EN/E = Endangered; VU/V = Vulnerable; NT = Near Threatened; R = Rare; DD = Data Deficient as per IUCN (1996) and Anon. (1992).

EV = Endemic to Vietnam.

Data Source: S = Specimen; O = Observed; I = Interview; R = Data from Previous Report.



Appendix 5: Butterflies Recorded in Ngoc Linh Nature Reserve

| No. | Family, Genus and Species | Range | S1 | S2 | S3 | S4 | S5 | S6 | S7 | Status |
|-----|---|-------|----|----|----|----|----|----|----|--------|
| | Papilionidae | | | | | | | | | |
| 1 | <i>Parides aidoneus</i> Doubleday | 2 | | | | | | r | | |
| 2 | <i>P. dasarada</i> Moore | 2 | | | | | r | | | |
| 3 | <i>Chilasa agestor</i> Gray | 3 | r | | | | | | | |
| 4 | <i>Papilio demoleus</i> | 4 | | | | | u | | | |
| 5 | <i>P. helenus</i> L. | 4 | r | | | | c | u | | |
| 6 | <i>P. alcmenor</i> Westwood | 2 | | | | | | r | | |
| 7 | <i>P. polytes</i> L. | 3 | r | | | | u | | c | |
| 8 | <i>P. dialis</i> Leech | 2 | | r | | | u | | | |
| 9 | <i>P. arcturus</i> Westwood | 1 | | | | | | r | | |
| 10 | <i>P. paris</i> L. | 3 | | | | | r | | | |
| 11 | <i>P. memnon</i> L. | 3 | | | | | u | | | |
| 12 | <i>Teinopalpus imperialis</i> Hop. | 1 | r | | | | | | | NT |
| 13 | <i>Meandrusa payeni</i> Boisd. | 2* | | | | | r | | | |
| 14 | <i>M. sciron</i> Leech | 2 | | | | | | r | | |
| 15 | <i>Pazala glycerion</i> Gray | 1 | c | | c | | | | | |
| 16 | <i>Graphium macareus</i> Godart | 3 | | | | | u | | | |
| 17 | <i>G. cloanthus</i> West. | 2* | | | | | r | | | |
| 18 | <i>G. chironides</i> Honr. | 3 | | | | | u | | | |
| 19 | <i>G. agamemnon</i> L. | 3 | | | | | c | | | |
| 20 | <i>G. sarpedon</i> L. | 4 | u | | | | | | c | |
| 21 | <i>Lamproptera curius</i> F. | 3 | | | | c | c | | | |
| 22 | <i>L. meges</i> Zinken | 3 | | | | c | | | | |
| | Pieridae | | | | | | | | | |
| 23 | <i>Delias belladonna</i> F. | 3 | c | | | | | | | |
| 24 | <i>D. agostina annamitica</i> Fruhstorfer | 0 | c | | | | | u | | |
| 25 | <i>Prioneris thestylis</i> Doubl. | 3 | | | r | | c | | | |
| 26 | <i>Artogeia canidia</i> Spar. | 2 | u | | | | u | | | |
| 27 | <i>Talbotia naganum</i> Moore | 1 | r | | | | c | | | |
| 28 | <i>Cepora nadina</i> Lucas | 3 | | | | | r | | | |
| 29 | <i>C. nerissa</i> F. | 3 | | | | | u | | | |
| 30 | <i>Appias lyncida</i> Cram. | 3 | | | | | u | | | |
| 31 | <i>A. indra</i> Moore | 3 | | | | | u | | | |
| 32 | <i>A. lalage</i> Doubl. | 3 | | | r | | | | | |
| 33 | <i>A. lalassis</i> G.-S. | 3 | | | | | u | | | |
| 34 | <i>A. albina</i> Boisd. | 3 | u | | | | c | | c | |
| 35 | <i>A. pandione</i> Greyer | 3 | | | | | r | | | |
| 36 | <i>Hebomoia glaucippe</i> L. | 3 | | | | | c | | | |
| 37 | <i>Dercas nina</i> Mell. | 1 | | | | | | u | | |
| 38 | <i>D. verhuelli</i> V.d.Hoeven | 2 | r | | | | r | | | |
| 39 | <i>Catopsilia pomona</i> F. | 5 | c | | | | c | | c | |
| 40 | <i>C. scylla cornelia</i> F. | 4 | | | | | c | | | |
| 41 | <i>Eurema brigitta hainana</i> Moore | 2* | r | | | | c | | c | |
| 42 | <i>E. hecabe</i> L. | 4 | u | | | u | c | | c | |
| 43 | <i>E. simulatrix</i> Semper | 3 | | | | | u | | | |
| 44 | <i>E. blanda silhetana</i> Wallace | 3 | u | | u | c | c | | u | |
| 45 | <i>E. ada iona</i> Talbot | 2* | r | | | r | | | | |



| No. | Family, Genus and Species | Range | S1 | S2 | S3 | S4 | S5 | S6 | S7 | Status |
|-----|--|-------|----|----|----|----|----|----|----|--------|
| | Danaidae | | | | | | | | | |
| 46 | <i>Danaus chrysippus</i> L. | 5 | | | | | | | c | |
| 47 | <i>D. genutia</i> Cram. | 4 | | | | | | | c | |
| 48 | <i>Parantica aglea melanooides</i> Moore | 3 | | | | | c | | c | |
| 49 | <i>P. sita</i> Kollar | 2* | c | c | c | | | | | |
| 50 | <i>P. melaneus plataniston</i> Fruhstorfer | 3 | r | | | | u | | | |
| 51 | <i>Ideopsis vulgaris</i> Butler | 3 | | | | | u | | | |
| 52 | <i>Euploea mulciber</i> Cram. | 3 | | | | | c | | | |
| 53 | <i>E. tulliolus</i> F. | 3 | | | | | c | | | |
| 54 | <i>E. radamanthus</i> F. | 3 | | | | | u | | | |
| | Satyridae | | | | | | | | | |
| 55 | <i>Melanitis leda</i> L. | 5 | | u | u | | | | u | |
| 56 | <i>M. phedima</i> Cramer | 3 | | | | | | r | | |
| 57 | <i>Elymnias hypermnestra</i> L. | 3 | | | | | | u | | |
| 58 | <i>E. patna</i> Westwood | 3 | | | | | | r | | |
| 59 | <i>E. malelas ivena</i> Fruhstorfer | 2 | r | | | | | r | | |
| 60 | <i>Lethe siderea</i> Marshall ssp? | 1 | | r | r | | | | | |
| 61 | <i>L. dura</i> Marshall | 2 | | | | | | r | | |
| 62 | <i>L. sura</i> Doubled | 1 | | r | | | | | | |
| 63 | <i>L. robria</i> F. | 3 | | | | | | r | | |
| 64 | <i>L. sinorix</i> Hew. | 2* | | r | | | | r | | |
| 65 | <i>L. verma stenopa</i> Fruhst. | 3 | | c | | | | c | | |
| 66 | <i>L. confusa</i> Aurivillius | 3 | | | | | | | c | |
| 67 | <i>L. chandica suvarna</i> Fruh. | 3 | | r | | | | r | | |
| 68 | <i>L. mekara crijnana</i> Fruh. | 3 | | r | | | | | | |
| 69 | <i>L. vinda</i> Felder | 3 | | r | u | | c | c | | |
| 70 | <i>L. latiaris perimele</i> Fruh. | 1 | | u | | | | | | |
| 71 | <i>L. philemon</i> | 2 | | | | | | r | | |
| 72 | <i>L. distans</i> Butl. | | | r | | | | | | |
| 73 | <i>Neope bhadra</i> Moore | 1 | | r | | | | u | | |
| 74 | <i>N. armandii</i> Oberthur | 1 | | u | u | | u | | | |
| 75 | <i>Mandarinia regalis baronesa</i> Fruhstorfer | 2 | r | | | | | | | |
| 76 | <i>Neorina</i> sp. (near <i>patria</i>) | 1 | r | | | | | | | |
| 77 | <i>Orinoma damaris</i> Gray | 1 | u | | | | | | | |
| 78 | <i>Penthema darlisa annamitica</i> Fruhstorfer | 0 | | | | r | r | | | |
| 79 | <i>Erites falcypennis</i> W.-M. and de Niceville | 2 | | r | | | | | | |
| 80 | <i>Ragadia critolaius</i> de Niceville | 2 | u | u | | | r | | | |
| 81 | <i>Mycalesis gotama</i> Moore | 3 | | | | | r | | | |
| 82 | <i>M. francisca</i> Fruhst. | 1 | | c | u | | c | | c | |
| 83 | <i>Ypthima baldus</i> Fabricius | 3 | | | | | u | | | |
| 84 | <i>Y. cerealis</i> Watson | 3 | | | | | r | | | |
| 85 | <i>Y. watsoni</i> Moore ? | 3 | | u | | | c | | u | |
| 86 | <i>Y. dobertyi</i> Moore | 3 | r | u | u | | | | | |
| 87 | <i>Callerebia narasingha</i> Moore | 1 | | r | | c | r | | | |
| | Amathusiidae | | | | | | | u | | |
| 88 | <i>Faunis arope</i> Leech | 0 | | | | | | | | |
| 89 | <i>F. canens arcesilas</i> Stich | 2 | | | | | | c | | |
| 90 | <i>F. eumeus incerta</i> Staudinger | 2 | | | | | | c | | |
| 91 | <i>Aemona amathusia</i> Hew. | 0 | | u | r | | | u | | |
| 92 | <i>Stichophthalma louisa</i> W.-M. ssp | 0 | | | | r | r | c | | |



Appendices

| No. | Family, Genus and Species | Range | S1 | S2 | S3 | S4 | S5 | S6 | S7 | Status |
|-----|---|-------|----|----|----|----|----|----|----|--------|
| 93 | <i>Thaumantis diores splendens</i> Tytler | 1 | | | | | | u | | |
| 94 | <i>Discophora deo</i> de Nicev. | 2 | | | | | | r | | |
| 95 | <i>Enispe euthymius sybaeus</i> (?) Brooks | 0 | | | | | | r | | |
| 96 | <i>E. cynus verbanus</i> Fruh. | 0 | | r | | | | | | |
| | Acraeidae | | | | | | | | | |
| 97 | <i>Acraea issoria vestalina</i> Fruh. | 0 | c | | | | | | c | |
| 98 | <i>A. viola</i> F. | 2 | | | | | ? | | | |
| | Nymphalidae | | | | | | | | | |
| 99 | <i>Cethosia biblis</i> Drury | 3 | r | | | u | u | u | | |
| 100 | <i>Argyreus hyperbius</i> L. | 5 | c | u | u | | c | | c | |
| 101 | <i>Phalanta phalantha</i> Drury | 4 | | | | | | u | | |
| 102 | <i>P. alcippe alcippoides</i> Moore | 3 | r | | | | | | | |
| 103 | <i>Vagrans egista</i> Cramer | 4 | | | | | u | | | |
| 104 | <i>Vindula erota</i> F. | 3 | r | | r | | c | c | | |
| 105 | <i>Vanessa cardui</i> L. | 6 | | | | | c | | c | |
| 106 | <i>Kanisca canace</i> L. | 3 | c | | | | r | | | |
| 107 | <i>Symbrenthia hypoclus</i> Cram. | 3 | u | | | u | u | | | |
| 108 | <i>S. hypselis</i> Godart | 3 | | | | r | u | | | |
| 109 | <i>Junonia iphita</i> Cramer | 3 | | | | | | r | | |
| 110 | <i>J. almana</i> L. | 3 | | | | | | | c | |
| 111 | <i>Junonia atlites</i> L. | 3 | | | | | u | | c | |
| 112 | <i>Kallima inachus</i> Doyere | 2 | r | | | | c | u | | |
| 113 | <i>Ariadne merione</i> Cramer | 3 | | | | | u | | | |
| 114 | <i>Cyrestis thyodamas</i> Doyere | 3 | | | | u | u | | | |
| 115 | <i>Chersonesia risa</i> Doubleday | 3 | | | | | r | | | |
| 116 | <i>Neptis clinia susruta</i> Moore | 3 | r | | | | | | | |
| 117 | <i>N. soma shania</i> Evans | 3 | c | | | c | c | | c | |
| 118 | <i>N. sappho astola</i> Moore | 2 | c | c | u | | c | | c | |
| 119 | <i>N. harita</i> Moore | 3 | | | | | r | | | |
| 120 | <i>N. sankara</i> Kollar | 1 | u | | r | | | | | |
| 121 | <i>N. zaida</i> Westwood | 2 | r | | | | | | | |
| 122 | <i>N. ananta</i> Moore | 1 | r | | | | | | | |
| 123 | <i>N. manasa</i> Moore | 1 | r | | | | | | | |
| 124 | <i>Pantoporia paraka</i> Butler | 3 | | | | | r | | | |
| 125 | <i>Athyma perius</i> L. | 3 | | | | | c | | ? | |
| 126 | <i>A. cama</i> Moore | 3 | | | | | c | | | |
| 127 | <i>A. ranga</i> Moore | 2 | | | | | r | | | |
| 128 | <i>A. asura</i> Moore | 2 | | | | | | r | | |
| 129 | <i>A. selenophora batilda</i> Fruhstorfer | 3 | r | | | | | | | |
| 130 | <i>Limenitis mimica</i> spp. | 1 | u | | | | | | | |
| 131 | <i>Sumalia daraxa</i> Doubleday | 3 | c | | | | | | | |
| 132 | <i>Auzakia danava</i> Moore | 1 | | r | | | | r | | |
| 133 | <i>Bhagadatta austenia</i> Moore | 1 | | | | | | r | | |
| 134 | <i>Tanaecia julii indochinensis</i> Fruhstorfer | 3 | u | | u | u | u | u | | |
| 135 | <i>Tanaecia lepidea</i> Butler | 3 | | | | | u | | | |
| 136 | <i>T. sp.</i> | ? | | | | | r | | | |
| 137 | <i>Euthalia monina sastra</i> Fruh. | 3 | | | | | r | | | |
| 138 | <i>E. sp.</i> | ? | | | | | | r | | |
| 139 | <i>E. lubentina</i> Cramer | 3 | | | | r | | | | |
| 140 | <i>Bassarona franciae</i> Gray | 1 | u | | | | | | | |



| No. | Family, Genus and Species | Range | S1 | S2 | S3 | S4 | S5 | S6 | S7 | Status |
|-----|--|-------|----|----|----|----|----|----|----|--------|
| 141 | <i>Apatura ambica</i> Kollar | 2 | | | | r | | | | |
| 142 | <i>Robana parisatis</i> Westw. | 3 | | | | | u | | | |
| 143 | <i>Hestina nama nama</i> Doubleday | 3 | r | | | | | | | |
| 144 | <i>Euripus nyctelius</i> Doubleday | 3 | | | | | u | u | | |
| 145 | <i>Pseudergolis wedah</i> Kollar | 2 | c | | | | u | | | |
| 146 | <i>Stibochiona nicea</i> Gray | 3 | | | | u | u | | | |
| 147 | <i>Dichorragia nesimachus</i> Doyere | 4 | | | | | | r | | |
| 148 | <i>Charaxes aristogiton</i> Felder | 2 | | | | | r | | | |
| 149 | <i>Polyura dolon</i> Westw. | 1 | u | | | | | r | | |
| | Libytheidae | | | | | | | | | |
| 150 | <i>Libythea myrrha sanguinalis</i> Fruhstorfer | 2 | | | | | u | | | |
| | Riodinidae | | | | | | | | | |
| 151 | <i>Zemeros flegyas annamensis</i> Fruhstorfer | 3 | c | u | u | c | c | c | c | |
| 152 | <i>Dodona ouida ouida</i> Moore | 1 | r | | r | | | | | |
| 153 | <i>D. adonira</i> Hew. | 2 | u | | u | | | | | |
| 154 | <i>D. deodata lecerfi</i> Fruh | 0 | | | | u | | | | |
| 155 | <i>D. sp.</i> | ? | r | | | | | | | |
| 156 | <i>D. egeon</i> Dbl. and Hew. | 3 | | | r | | | | | |
| 157 | <i>Abisara burnii</i> de Nicev. | 3 | | | | | | r | | |
| 158 | <i>A. echerius</i> Stoll. | 3 | | | | | u | | | |
| 159 | <i>A. neophron</i> Hew. | 2 | c | u | c | | | c | | |
| 160 | <i>A. fylla</i> Doubl. and Hew. | 1 | c | u | c | | | u | | |
| 161 | <i>Stiboges nymphidia elodinia</i> Fruhstorfer | 3 | c | u | | | | u | | |
| | Lycaenidae | | | | | | | | | |
| 162 | <i>Poritia phama regia</i> Evans | 2 | | | | | r | | | |
| 163 | <i>Allotinus drumila aphtonius</i> Fruhstorfer | 2 | | | | | u | | | |
| 164 | <i>Miletus mallus mallus</i> Fruhstorfer | ? | | | | | ? | | | |
| 165 | <i>Curetis bulis</i> Westw. | 3 | r | | | u | u | | | |
| 166 | <i>Discolampa ethion</i> West. | 3 | | | | | u | | | |
| 167 | <i>Taraka hamada</i> H.Druce | 3 | | | | | | r | | |
| 168 | <i>Caleta elna</i> Hewitson | 3 | | | | | u | | | |
| 169 | <i>Acytolepis puspa gisca</i> Fruhstorfer | 3 | | | | c | | | | |
| 170 | <i>Calenya lenya</i> Evans | 3 | | | | r | | | | |
| 171 | <i>Celastrina lavendularis limbata</i> Moore | | | | | | | | | |
| 172 | <i>C. argiolus iyntheana</i> de Niceville | | | | | | | | | |
| 173 | <i>Celatoxia marginata</i> Nicev. | 3 | u | | | | | | | |
| 174 | <i>Udara akasa sadenobui</i> Eliot & Kawazoe | 3 | c | | | | | | | |
| 175 | <i>U. dilecta</i> Moore | 3 | u | | | | | | | |
| 176 | <i>U placidula howarthi</i> Cantlie & Norman | | | | | | | | | |
| 177 | <i>Zizina otis sangra</i> Moore | 3 | | | | | c | | | |
| 178 | <i>Pseudozizeeria maha</i> Kollar | 2 | u | | | | | | c | |
| 179 | <i>Everes lacturnus rileyi</i> Fodfrey | 3 | | | | | | u | | |
| 180 | <i>Euchrysops cnejus</i> F. | 3 | | | | | | | c | |
| 181 | <i>Lampides boeticus</i> L | 5 | | | | | u | | | |
| 182 | <i>Jamides alecto alocina</i> Swinhoe | 3 | | | | | u | | | |
| 183 | <i>J. bochus</i> Stoll | 3 | u | | | | u | | | |
| 184 | <i>J. celeno</i> Cramer | 3 | | | | | u | | | |
| 185 | <i>Nacaduba angusta albida</i> Riley & Godfrey | 3 | | | | u | u | | | |
| 186 | <i>N. kurava</i> Moore | 3 | u | | | | | | | |
| 187 | <i>Prosotas nora ardates</i> Moore | 3 | | | | c | | | | |



Appendices

| No. | Family, Genus and Species | Range | S1 | S2 | S3 | S4 | S5 | S6 | S7 | Status |
|-----|--|-------|----|----|----|----|----|----|----|--------|
| 188 | <i>P. pia</i> Toxopeus | 3 | | | | c | | | | |
| 189 | <i>Anthene lycaninae</i> Felder | 3 | | | | c | | | | |
| 190 | <i>Una usta</i> Distant | 3 | r | | | | | | | |
| 191 | <i>Heliophorus ila pseudonexus</i> Eliot | 3 | r | | | | c | c | | |
| 192 | <i>H. tamu kala</i> Tytler | 1 | c | | | | | | | |
| 193 | <i>Arhopala oenea khamti</i> Doherty | ? | | | | | | r | | |
| 194 | <i>A. ace arata</i> Tytler | ? | | | | | | r | | |
| 195 | <i>Amblipodia anita</i> Hewitson | 3 | | | | u | | | | |
| 196 | <i>Spindasis syama latipicta</i> Fruhstorfer | 3 | | | | | c | | | |
| 197 | <i>Yasoda tripunctata</i> Hewitson | 2 | | | | | | u | | |
| 198 | <i>Pratapa icetas</i> Hewitson | 3 | r | | | | | | | |
| 199 | <i>Cheritrella truncipennis</i> de Niceville | 1 | | | r | | | | | |
| 200 | <i>Ancema ctesia</i> Hewitson | 3 | r | | | | | | | |
| 201 | <i>Hypolycaena kina</i> Hewitson | 3 | u | | | | | | | |
| 202 | <i>Zeltus amasa</i> Hewitson | 3 | | | | u | u | u | | |
| 203 | <i>Sinthusa chandrana</i> Moore | 1 | | | | r | | | | |
| 204 | <i>Neocheritra fabronia</i> Hew. | 1 | | | | r | | | | |
| 205 | <i>Tajuria diaeus</i> ssp | ? | | | | | | | | |
| 206 | <i>Deudorix epijarbas</i> Moore | 3 | r | | | | | r | | |
| 207 | <i>Rapala nissa</i> Kollar | 1 | | u | | | | | | |
| | Hesperiidae | | | | | | | | | |
| 208 | <i>Hasora vitta</i> Butler | 4 | r | | | | c | c | | |
| 209 | <i>H. danda</i> Evans | 3 | | | | | c | | | |
| 210 | <i>H. taminatus malayana</i> Felder & Felder | 3 | | | | | c | | | |
| 211 | <i>H. anura</i> de Niceville | 1 | r | | | | | | | |
| 212 | <i>Choaspes benjaminii formosana</i> Fruhstorfer | 3 | r | | | | | r | | |
| 213 | <i>Capila zennara</i> Moore | ? | | | | | | ? | | |
| 214 | <i>C. paupipunctata tamdaoensis</i> Devyatkin | 1 | | | | | | r | | |
| 215 | <i>C. lidderdali</i> Elwes | 1 | | | | | | r | | |
| 216 | <i>Celaenorrhinus putra</i> Moore | 3 | | r | | | | u | | |
| 217 | <i>C. sp. (near putra)</i> | | | | | | | | | |
| 218 | <i>C. aspersa</i> Leech | 2? | | | | | | r | | |
| 219 | <i>C. pyrha</i> de Niceville | 2 | c | | | ? | | | | |
| 220 | <i>Tagiades cohaerens cynthia</i> Evans | 3 | | | | | | r | | |
| 221 | <i>T. gana sangarava</i> Fruhstorfer | 3 | | | | | | r | | |
| 222 | <i>Aeromachus sp. (near jhora)</i> | ? | | | | | r | | | |
| 223 | <i>Thoressa fusca</i> ssp? | 1 | r | | | | | | | |
| 224 | <i>T. gupta</i> de Niceville | 3 | | | | | u | u | | |
| 225 | <i>T. sp. n. (near aina</i> de Niceville) | | | | | | | | | |
| 226 | <i>Astictopterus jama olivascens</i> Moore | 3 | | | | | u | u | | |
| 227 | <i>Darpa hanria</i> Moore | 1 | r | | | | | | | |
| 228 | <i>Gerosis phisara</i> Moore | 2 | r | | | | | | | |
| 229 | <i>Notocrypta feistameli alysos</i> Moore | 3 | u | | | | | u | | |
| 230 | <i>Gangara thyrasis</i> F. | 3 | | | | | r | | | |
| 231 | <i>Potanthus lydia</i> Evans | 3 | u | | | | c | c | | |
| 232 | <i>P. ganda ganda</i> Fruhstorfer | | | | | | | | | |
| 233 | <i>Polytremis discreta</i> Elw | 3 | c | | u | | | | | |
| 234 | <i>P. eltola</i> Hew. | 3 | c | | | | | | | |
| 235 | <i>Pelopidas assamensis</i> de Niceville | | | | | | | | | |
| 236 | <i>Caltoris cabira austeni</i> Moore | | | | | | | | | |

Global Range: 0 - Central Vietnam, Ngoc Linh Nature Reserve;
1 - East Himalayas (Nepal, Assam, Sikkim, N. Burma, Yunnan, S.W. China, N. Indochina);
2 - Indochina to India;
3 - Oriental region;
4 - Indo-Australian tropics;
5 - Palaeotropics; and
6 - Cosmopolitan.

Study Sites: S1 - Stream at 1,600 to 1,700 m a.s.l.;
S2 - Forest situated between stream and base camp at 1,600 to 1,750 m a.s.l.;
S3 - Primary and secondary forest fragments situated between 1,700 and 2200 m a.s.l.;
S4 - Forested section of road ~10 km from Ngoc Linh village at 900 m.;
S5 - Forest in the neighbourhood of Lo Xo Pass 1,000 to 1,100 m a.s.l.;
S6 - Forest trail at Lo Xo pass at 1,100 m a.s.l.; and
S7 - The neighbourhood of Ngoc Linh village at 1,000 to 1,300 m. a.s.l.

Species occurrence is divided into three categories:

- r - rare (single or two specimens encountered);
- u - uncommon (~10 specimens seen);
- c - common (up to 20 specimens seen);

Status: NT – Near Threatened as per IUCN 1996.

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 fulfill 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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