Forest (and) primates: Conservation and ecology of the endemic primates of Java and Borneo
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CHAPTER 1

FOREST AND PRIMATES, A GENERAL INTRODUCTION TO
THE CONSERVATION OF ENDEMIC PRIMATES IN THE
SUNDAIC REGION

INTRODUCTION

The Sundaic region, also known as Sundaland, Malesia, or the Indo-Malayan region, and defined as Thai-Malay peninsula south of the isthmus of Kra, Sumatra, Borneo, Java and Bali, has been identified as one of the hottest biodiversity hotspots on earth (Meyers et al., 2000). The area ranks second in number of endemic plants, fifth in number of endemic vertebrates (excluding fishes), tenth for endemic plants / area ratio and endemic vertebrate / area ratio, and ranks seventh in having the least amount of primary vegetation remaining as percentage of the original extent. With the Philippines and Madagascar, the Sundaic region is the only area to appear in the top ten of all the above listed factors (Meyers et al., 2000).

During interpluvial periods the region was originally covered by and large in rain forest of different types, depending on, among other things, altitude and soil type (Park, 1994). Interpluvial periods correspond with the 'glacial' periods in temperate regions and during such times so much of the northern and southern latitudes was covered in ice that sea levels were reduced by as much as 100 m. Along the south eastern edge of the Sunda Shelf, i.e. eastern Java and parts of Bali, drier forest types could be found including deciduous forest. Especially over the last decades, but much earlier in the lowlands of Java, due to rapid deforestation, large areas, are now converted into agricultural land, plantations, and, increasingly 'wastelands', i.e. virtually unoccupied land covered in e.g., alang-alang Imperata grassland and other depauperate vegetation types (e.g., Myers, 1989).

The once large continuous areas of forest of the Sundaic region are home to a large variety of non-human primate species (hereafter 'primates'). Depending on the taxonomy followed 26-28 species can be found in the region. This includes four of the eleven families commonly recognised (Corbet & Hill, 1992; Mittermeier & Konstant, 1996/1997): Loridae (one species), Tarsidae (one species), Cercopithecidae (17-18 species, including the bear macaque Macaca arctoides which occurs marginal in northern part of the Thai-Malay peninsula), Hylobatidae (six species), Hominidae (one or two species depending on whether the two orangutan taxa from Sumatra and Borneo are given the species rank, see below). From a

\[1\] Biologically and taxonomically humans are included in the order primates, for practical reasons however, in the present thesis, 'primates' unless specified otherwise normally denotes 'non-human primates'.

1
broad geographic perspective the region is important as it harbours a
disproportionately large number of primate species and primate endemics
(Mittermeier & Konstant, 1996/1997).

With the exception of a few, most notably the long-tailed macaque *M.
fascicularis*, most species are confined to natural forest. Some species are able to
survive in certain man-made habitats, most notably certain forest plantations, but
most of them will not survive for any length of time in these habitats.

In this thesis I will present data on the ecology and conservation of the endemic
primates of Java and Borneo. Combined, these two islands, and their smaller
neighbouring islands, comprise more than half of the land surface of the Sundaic
region. In this first chapter I will briefly introduce the islands of Java and Borneo
(geology, climate, vegetation, human population etc.), the endemic primate species
occurring on them and their conservation status. The main causes of the decline of
the populations of the endemic primates on Java and Borneo are presented, after
which a brief overview of primate conservation studies that have been conducted on
the islands will be given. The chapter ends with a concise summary of the history of
the present study, its aims, and an outline of the thesis.

**BACKGROUND ON THE STUDY ISLANDS**

Java is an island of about 130,000 km$^2$ and politically includes the island of Madura
(5,620 km$^2$) which lies just north of the east Javan province. It is administratively
divided in six areas, viz. West Java (at the end of 2000 this was split in two smaller
provinces Banten and West Java), DKI Jakarta (the nation's capital), Central Java,
DI Yogyakarta, and East Java (which includes Madura). As Indonesia's political and
industrial centre, it is one of the most densely populated areas in the World. The
very fertile soils which lend themselves to terracing for irrigated rice, sustain about
115 million people, at an average population density of 862 people km$^{-2}$ (Whitten et
al., 1996). Geologically Java is dominated by its backbone of (active) volcanoes,
running over the central axis of the island. Eleven volcanoes reach over 3000 m and
with 3676 m Mt Semeru is Java's tallest mountain. Rivers are relatively short and
run mostly from the central axis of the island straight to either the Java Sea or the
Indian Ocean.

Java is largely deforested and most of the remaining forest fragments cover
(parts of) the numerous volcanoes; human pressure on the remaining forests is very
high. Less than 10% of the original forest remains: 54% of the mountain forest, 19%
of the hill forest, and only 2% of the lowland forest (Smiet 1992). The last
mentioned forest type is now almost exclusively found scattered along the southern
coast and in the easternmost part of the island. Once the island was probably
completely covered by tropical forest (MacKinnon et al., 1982), but its destruction
already commenced in the 15th century (Whitten et al., 1996). An estimated total
area of 10 million ha of natural forest was present in the 17th century. Some hundred
years ago four million were left, which was reduced to about one million in the first half of the 20th century. During the past 50 years no further significant change in forest cover has taken place (Smiet, 1990). At present deforestation has slowed down, but fragmentation and forest degradation continues (Smiet, 1992). Forest has been replaced by cities and villages, agricultural land, estate crop plantations (coffee *Coffea* sp., quinine *Cinchona calisaya*, sugar cane *Saccharum* sp.), forest plantations (teak *Tectona grandis*, pine *Pinus* sp., rubber *Hevea brasiliensis*), leaving the natural forest areas as habitat islands. Less than 25% of the remaining forest on Java is included in the protected area network (RePPProTT, 1990).

The climate on Java differs greatly from the west to the east. The eastern part of Java and the north coast have a pronounced dry season, while in the western half it is weak and nowhere marked. In general, the wettest vegetation types (mixed lowland and hill rain forest and everwet montane forest) only occur in areas with at least 30 rainy days during the driest four consecutive months (van Steenis & Schippers-Lammertse, 1965), and hence is mostly found in the west and central part of Java. Rain forest is also found throughout the otherwise seasonally dry east in the wet 'islands' which arise as a result of stowage on the southern and south-eastern slopes of the higher mountains (van Steenis, 1972). In the drier areas rain-forest is replaced by moist forest and deciduous forest.

The island of Bali (5560 km²), situated east of Java, is politically a separate entity, but bio-geographically it is included in the Javan faunal province. Bali has a population of some three million people at an average population density of 520 per km². Most humans live in the fertile southern part of the island (Whitten et al., 1996). Less than one fifth of the island remains under forest cover, most of which is situated in the central mountain range and in the northern part of the island (MacKinnon et al., 1982). Large-scale deforestation on Bali is more recent than on Java, and around the turn of the 20th century most of the northern half of the island was still covered with forest. The loss of forest during the 20th century has been largely due to the introduction of coffee, clove *Syzygium aromaticum* and coconut *Cocos nucifera* plantations, and use of fuel-wood (see maps in Whitten et al., 1996: 335). The climate of Bali is comparable to the eastern part of Java, with a long dry season along the north coast and a negligible dry season on some of the higher volcanoes (RePPProT, 1990).

Borneo is much larger than Java, in fact with a size of 746,305 km² it is the third largest island in the world (after Greenland and New Guinea). Administratively it is divided into the four Indonesian provinces of West, Central, East and South Kalimantan, the two autonomous Malaysian states Sabah and Sarawak and the Brunei Sultanate. The Indonesian part of Borneo covers some three quarters of the total land area of Borneo. Borneo mainly consists of relatively low lying areas and over half of the island lies below 150 m a.s.l. In the centre of the island lies a chain of higher hills and mountains, running from south-west to the north-east. Borneo's highest mountain is Mt. Kinabalu in Sabah, which is, with its 4101 m, the highest peak between the Himalayas and the mountains of New Guinea. Other than Java,
Borneo is dissected by a large number of great rivers; the Kapuas river (1143 km in length) to the west, the Barito River (900 km) to the south, and the Mahakam River (775 km) to the east. High levels of weathering and leaching are characteristic of many Bornean soils (Burnham, 1984), and the soils on Borneo are generally much less fertile than the volcanic rich soils of Java.

Borneo has a much smaller human population than Java (some 12.5 million in 1990: MacKinnon et al., 1996), and an average population density of less than 17 people km\(^{-2}\). All major cities are located near the coast, and population densities in large part of Borneo's interior are less than one person per km\(^2\). Within large parts of the island the infrastructure is poorly developed and boats are the main mode of transportation. Settlements are also concentrated along waterways.

Borneo supports the largest expanse of lowland evergreen rain forest in the Sundaic region, with some 60% of the land surface still under natural forest (MacKinnon et al., 1996; Collins 1991: this figure may be as low as 45% due to deforestation over the last decades, E. Meijaard, in litt.). The forests are characterised by a high diversity of dipterocarps, the most important timber species in the region (Whitmore, 1984). Timber is a major source of revenue for the Malaysian states and for Kalimantan; oil-rich Brunei has less need to exploit its forest for timber. Large scale exploitation of forest for timber began at the end of the 1960s; in 1967 all Indonesian forests were declared property of the state. Some 90% of all forest (excluding conservation areas) in Sarawak is under concession (MacKinnon et al., 1996) whereas the total are of forest under concession in Kalimantan is actually larger than the total area of remaining forest (Rijksen & Meijaard, 1999). Besides for timber production, every year vast areas are cleared for agriculture, plantations, human settlements and transmigration. Lowland forests in particular are directly threatened by these practises due to their accessibility and their higher soil fertility than higher altitude forests. The last few decades forest fires have taken an immense toll on the remaining forest areas. During the 1982-1983 fires an area of some 50,000 km\(^2\) was affected (Goldammer et al., 1999), and, although figures vary widely, the 1997 fires affected an area significantly larger than this. Less than 10% of the forest on Borneo are formally protected as conservation forest, and most of this is concentrated in the mountains (Sujatnika et al., 1995; MacKinnon et al., 1996).

Most parts of Borneo have few months with rainfall less than 100 mm. Most of the hilly inland areas receive between 2000 and 4000 mm per year. West and Central Borneo are the wettest parts of the island, whereas certain parts of east Borneo have a longer dry season with several months receiving less than 100 mm of rain. However, nowhere is the dry season as pronounced as it is in eastern Java or Bali.

THE ENDEMIC PRIMATES OF JAVA AND BORNEO

On Java and Borneo a large proportion of the non-human diurnal primates are endemic, viz. three out of four and five out of 13 respectively. Six of these eight
species are leaf monkeys (Cercopithecidae, subfamily Colobinae), whereas the other two are gibbons (Hylobatidae) (Oates et al., 1994; Geissmann, 1995) (see Table 1.1). In the other diurnal primate families present on Java and Borneo, viz. the macaques (Cercopithecidae, subfamily Cercopithecinae) and orang-utan (Pongonidae), endemism is absent (although consistent differences between the orang-utan from Borneo and Sumatra in mtDNA [e.g., Karesh et al., 1997], karyotype [Seuanez et al., 1979], habitus [e.g., Markham 1980] and morphology [e.g., MacKinnon 1973] suggest that the two are perhaps best treated as distinct species).

Table 1.1 Endemic primates on Borneo and Java and their IUCN threat status

<table>
<thead>
<tr>
<th>Sub(family)</th>
<th>IUCN status</th>
<th>Islands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cercopithecidae, subfamily Colobinae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grizzled leaf monkey <em>Presbytis comata</em></td>
<td>Endangered</td>
<td>Java</td>
</tr>
<tr>
<td>Bornean leaf monkey <em>Presbytis hosei</em></td>
<td>Lower Risk</td>
<td>Borneo</td>
</tr>
<tr>
<td>White-fronted leaf monkey <em>Presbytis frontata</em></td>
<td>Data Deficient</td>
<td>Borneo</td>
</tr>
<tr>
<td>Red leaf monkey <em>Presbytis rubicunda</em></td>
<td>Lower Risk</td>
<td>Borneo</td>
</tr>
<tr>
<td>Ebony leaf monkey <em>Trachypithecus auratus</em></td>
<td>Vulnerable</td>
<td>Java, Bali, Lombok</td>
</tr>
<tr>
<td>Proboscis monkey <em>Nasalis larvatus</em></td>
<td>Vulnerable</td>
<td>Borneo</td>
</tr>
<tr>
<td>Hylobatidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Javan gibbon <em>Hylobates moloch</em></td>
<td>Critically Endangered</td>
<td>Java</td>
</tr>
<tr>
<td>Bornean gibbon <em>Hylobates muelleri</em></td>
<td>Lower Risk</td>
<td>Borneo</td>
</tr>
</tbody>
</table>

Note that fuscous leaf monkey *Presbytis fredericae* is not included in this listing, as it is considered synonymous with *P. comata* (chapter 5). Based on Eudey, 1996/1997, Geissmann 1993, Oates & Davies, 1994.

Without exception, all of the endemic primates of Java and Borneo are found only in forested areas. For most species this originally consisted of everwet forest only (including riverine, swamp, and montane forest), apart from the ebony leaf monkey which is also found in deciduous forest. A number of species, in particular some of the leaf monkeys, can also be found in forest plantations; but mostly only if more natural forest is present nearby. Since large areas on Java and Borneo are deforested or are under severe threat of being deforested in the near future, and because of increasing human pressure on populations, most if not all endemic species are threatened with extinction. Half of them are included in the IUCN (1996) list of threatened species (see also Chapter 13 for a more detailed assessment of IUCN threat criteria). Two species of leaf monkey, i.e. red leaf monkey *Presbytis rubicunda* and Bornean leaf monkey *P. hosei* are listed as Lower Risk (least concern), whereas the Bornean gibbon is listed as Lower Risk (near threatened). White-fronted leaf monkey *P. frontata* is listed as Data Deficient, i.e. there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on distribution and / or population status (Table 1.1).
MAIN CAUSES OF DECLINE

Over the last few decades the interest in non-human primates in the Sundaic region has increased substantially, and researchers from many disciplines and from various countries have focused their attention on this diverse order. Ironically enough these years have also seen serious declines in primate populations. For an increasing number of species these declines threaten their survival. The major threats to wild populations of primates in the Sundaic region fall into three broad categories: habitat destruction (including total loss and fragmentation), hunting, and capture for local trade.

It is important to understand the threats an endangered species is subjected to in order to make recommendations that could positively influence its survival. This is all the more important as the effects of different threats are cumulative.

1. Habitat destruction
The main threat to the endemic primates of the Sundaic region is habitat destruction (e.g., MacKinnon, 1987; Eudey, 1996/1997). This includes not only the total loss of forest and its replacement by forest plantations, pasture, or other forms of cultivated land, but also the degradation of the forest. The continuous fragmentation of primary forests and the intensification of land use in the areas between the remaining forest patches result in isolation of the populations trapped in these forest remnants. Many species of primates are completely arboreal and will not cross open land of any width, which makes them especially susceptible to the effects of forest fragmentation. In the long run, gaps between populations may soon become unbridgeable due to further habitat loss and fragmentation may result in loss of variability due to genetic drift and inbreeding depression. In practise, however, small population will often never reach this stage of the extinction vortex as they are wiped out by hunters, are captured for the pet-trade, or further habitat destruction will results in the death of the last remaining individuals. Thus, in all likelihood, the reduction and the fragmentation of the forests result in populations too small and too widely separated to persist in the long term.

Another immediate threat to many of the endemic primates is encroachment by humans along the edges of the forested areas. As the infrastructure is being improved the accessibility is increasing and primate and man are getting more and more in conflict. This usually turns out to be unfavourable for the former species.

2. Hunting
The greater accessibility may also increase hunting activities. More on Borneo than on Java and Bali, primates are hunted for food and sport, as crop pest and for medicine. Many rural people depend on wildlife meat for their protein and primates are frequently eaten. Hunting is deeply ingrained into almost all cultures on Borneo (Bennett et al., 1994). With little traditional controls and the almost universal availability of shotguns and cartridges (more so in the Malaysian States than in
Kalimantan), the effect on primate populations is devastating. Although largely protected by law, in practise the only safeguard for most species is inaccessibility. With the spread of logging roads, and improved river transport no areas are anymore safe (Bennett et al., 1994).

With respect to the success of the conservation of primates, it is relevant to note that human attitudes towards primates differ greatly between religious groups, and that the distribution of religious groups differs between Borneo and Java (and Bali). For Hindus primates are often considered sacred and in certain areas and at certain times offerings are brought to primates (Wheatly, 1999). Primates are not considered sacred by Muslims, but religious restriction permits the consumption of primates. This is in contrast to Christianity where few dietary restrictions prevail.

The human population on Java is predominately Muslim and only a small proportion is Christian or of another religion. Concentrations of Hindus on Java are only found in a few remote highland areas. Bali however, is predominately Hindu. The coastal regions of Borneo are mostly inhabited by people with a Malayan origin who have adopted Islam as their main religion. Most of Borneo's interior is inhabited by people of the Dayak and Punan tribes, many of which have been converted to Christianity, although animistic beliefs are still widespread (Cleary & Eaton, 1992). Over the last hundred years there has been a heavy migration from the interior towards the coastal areas, generally as a result of better health facilities, better education and better living conditions (Sirait et al., 1994) bringing people from different cultural and religious backgrounds in closer contact. At a different scale transmigration (in the present context mostly involving people from Java, Sumatra and Sulawesi migrating to (rural) Borneo) has done the same.

In general, hunting of primates is rare or absent in most areas on Java and Bali (although in certain areas long-tailed macaques are hunted as crop pest, and sometimes for sport), whereas it is widespread on Borneo, especially in the interior. On Borneo all primates that constitute more than a mouthful of meat (involving all species with the exception of the nocturnal slow loris and the tarsier) are frequently eaten (Caldecott, 1992).

3. Trade
In the Sundaic region, the human attitude towards keeping primates as pets differ greatly from those in the western world and seems to differ little between religious groups. Capturing of primates for pets is widespread throughout western Indonesia, with trade routes mostly running from the 'outer islands' (Sumatra, Borneo, and Sulawesi) to Java, and within Java, from east to west (Nursaid & Astuti, 1996; Nursaid, 1998; R. Nursaid, pers. comm.). The trade in primates is a profitable business and although many species protected by law (both in Indonesia and Malaysia) they are frequently offered for sale at bird markets. Few quantified data are available, but it must be feared that trade in primates has increased, especially after the economic depression of the late 1990's (R. Sözer, pers. comm.; R. Nursaid, pers. comm.). Zoos and safari parks, just as some 'animal lovers', see primates, and preferably the rarer ones, as status symbols and important assets for their collections.
It is beyond doubt that zoos and birdparks play an important role in education as well as in conservation of many animal species, but prudence is called for keeping some of the rarest species.

Table 1.2  Selected study sites on Borneo and Java where long-term studies (> one year or several shorter studies) on endemic primates have been conducted.

<table>
<thead>
<tr>
<th>Country State, Province</th>
<th>Study site</th>
<th>Altitudinal range</th>
<th>Study species</th>
<th>Principal researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia Sarawak</td>
<td>Samunsam</td>
<td>0-50</td>
<td><em>N. larvatus</em></td>
<td>E.L. Bennett,</td>
</tr>
<tr>
<td>Sabah</td>
<td>Danum valley</td>
<td>200-300</td>
<td><em>P. hosei, H. muelleri</em></td>
<td>A.D. (Grieser)-Johns</td>
</tr>
<tr>
<td></td>
<td>Sepilok</td>
<td>50-100</td>
<td><em>P. rubicunda</em></td>
<td>A G. Davies</td>
</tr>
<tr>
<td></td>
<td>Kinabatang</td>
<td>0-100</td>
<td><em>N. larvatus</em></td>
<td>R. Boonratana</td>
</tr>
<tr>
<td>Brunei Indonesia</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>West Kalimantan</td>
<td>Gunung Ulun</td>
<td>0-100</td>
<td><em>P. rubicunda</em></td>
<td>M. Leighton, N. Salafski</td>
</tr>
<tr>
<td>Central Kalimantan</td>
<td>Tanjung Puting</td>
<td>0-50</td>
<td><em>N. larvatus</em></td>
<td>C P. Yeager</td>
</tr>
<tr>
<td></td>
<td>Barito Ulu</td>
<td>150-350</td>
<td><em>H. muelleri x H. agilis</em></td>
<td>D. Chivers, R. Mather</td>
</tr>
<tr>
<td>South Kalimantan</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>East Kalimantan</td>
<td>Kutaiah</td>
<td>100-300</td>
<td><em>H. muelleri</em></td>
<td>D. Leighton, J.C. Mitani,</td>
</tr>
<tr>
<td></td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>P.S. Rodman, A Suzuki</td>
</tr>
<tr>
<td>West Java</td>
<td>Ujung Kulon</td>
<td>0-100</td>
<td><em>H. moloch</em></td>
<td>M. Kappeler, Rinjani</td>
</tr>
<tr>
<td></td>
<td>Telaga Patengan</td>
<td>1600-1800</td>
<td><em>P. comata</em></td>
<td>Y. Ruhiyat, I.M. Wedana</td>
</tr>
<tr>
<td></td>
<td>Pangandaran</td>
<td>0-50</td>
<td><em>T. auratus</em></td>
<td>E. Brotsisworo, K. Kool,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E. Megantara, K. Watanabe</td>
</tr>
<tr>
<td>Central Java</td>
<td>Dieng</td>
<td>300-800</td>
<td><em>P. comata, H. moloch, T. auratus</em></td>
<td>V. Nijman</td>
</tr>
<tr>
<td></td>
<td>Cepu</td>
<td>0-100</td>
<td><em>T. auratus</em></td>
<td>Djuwantoko</td>
</tr>
<tr>
<td>East Java</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Bali</td>
<td>Bali Barat</td>
<td>0-50</td>
<td><em>T. auratus</em></td>
<td>T. Voght</td>
</tr>
<tr>
<td>Lombok</td>
<td>--</td>
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</table>

Altitudinal ranges are approximate and refer to the main study areas; often higher parts are in the vicinity.

FIELD STUDIES ON THE ENDEMIC PRIMATES OF BORNEO AND JAVA

Most long-term primatological studies in Indonesia, and indeed in most of Southeast Asia have been concentrated at a limited number of field stations. These stations are mostly situated in relatively pristine habitat, in areas with limited or no hunting pressure, and almost without exception in the lowlands (Table 1.2). At these field stations different aspects of the synecology of tropical rain forests and their inhabitants have been studied, including primates. Borneo seems to follow this pattern, but on Java few long-term studies have been conducted and many primatological studies have been conducted in isolation. From a conservation perspective the data collected at field stations (habitat preferences, densities, group
sizes, and other population parameters) are often the only ones available. Examples of studies on the endemic primates of Borneo and Java are listed in Table 1.2.

Of the endemics on Borneo the gibbons are relatively well-studied, with long-term studies conducted in Kutai National Park (e.g., Mitani 1984, 1985ab; Leighton, 1987; Rodman, 1978, 1988), Danum valley (Johns, 1992; Grieser-Johns, 1997), and Barito Ulu (Chivers, 1992, including studies on the hybrid zone between H. muelleri and H. agilis: Mather, 1992). Of the colobines, only the proboscis monkey has been studied in detail at a number of localities throughout its range (e.g., Yeager, 1989, 1990, 1991, 1993; Bennett, 1988; Bennett & Sebastian, 1986; Boonrata, 2000). Red leaf monkey has been studied in detail in Sabah (Davies, 1987, 1991; Davies & Baillie, 1988) and to a lesser extent Central Kalimantan (Supriatna et al., 1986). Data on the other colobines is scant and often collected during short studies. Hardly any published studies are available on white-fronted leaf monkey (Blouch, 1997) or Bornean leaf monkey.

Of the Javan endemics the Javan gibbon has been studied in detail in Ujung Kulon only (Kappeler, 1981, 1984 abc; Rinaldi, 1999), although some base-line surveys have been conducted in other parts of the island (Kappeler, 1981, 1984c; Asquith, 1995; Asquith et al., 1995; Nijman, 1995). The grizzled leaf monkey has been studied mostly in montane habitats (Ruhiyat, 1983, 1991; Sujatnika, 1992; Wedana, 1993), whereas this species is probably more common at lower elevations (Nijman, 1997b; chapter 6; Whitten et al., 1996). The ebony leaf monkey has a wider niche breadth than the other endemics and occurs in a large variety of forest types. This species has been studied mostly in the more open forest types, including teak plantations (Brotoisworo, 1983; Brotoisworo & Dirgayusa, 1991; Kool, 1993; Kool & Croft, 1992; Djuwantoko, 1991) and deciduous forest (e.g., Kartikasari, 1986; T. Voght, pers. comm.). No long-term studies on this species have been conducted in the rain forest, although it can be found in all wet forest types on Java.

Most studies are selectively conducted in those areas where the study species are present at relatively high densities. This may introduce a bias for assessing the conservation status of primates. For example for estimation of total population sizes of primates often rely heavily on published density estimates and hence over-estimation of true population sizes is likely to occur. Only recently have studies begun to evaluate the effects of habitat disturbance. However most factors of disturbance (selective logging, hunting, and fire) have been studied in isolation (e.g., Suzuki, 1984; Caldecott, 1992; Johns, 1985, 1992). In reality disturbances do not occur in isolation but seem to be tightly linked. As an example, it is not uncommon for a forest area to be selectively logged (during which the rules for proper forest management may or may not be followed), during and after which it is frequently visited by hunters. Parts of the concessions are subsequently invaded by opportunistic farmers and settlers, who take out some additional timber and 'non-timber products', including animals. During a extended dry season the forest is set alight, after which the remaining large trees are felled, and the last animals hunted out. Hence, for primates to persist in under the current management regime, it is
necessary to assess the conservation status of these primates based on data collected over a variety of habitats in different stadia of re- and degeneration, facing different threats (human pressure, encroachment, logging, hunting etc.).

AIMS OF THE STUDY

There is a lack of base line knowledge concerning the ecology of most, if not all, endemic primates in Indonesia. The precise geographical distribution of many species has not been documented. The types of habitats preferred and the densities at which individual species occur in different land use types remains largely unknown. The likely impacts of current factors such as hunting, capturing, habitat alteration and habitat fragmentation are unknown for many of the primates concerned. The islands of Java and Borneo are excellent locations to study the effects of human interference on the survival and conservation of primates. On both islands similar endemic primates are found but the pressures facing these species are quite different. Java represents an area where little forest remains, where the pressure on the remaining populations of primates dates back several centuries, and where many people are no longer dependent on the forest, whereas Borneo represents an area in transition. Although still largely covered in forest, rapid changes in land-use and changing human attitudes will greatly alter the pressures that wildlife populations are facing. The history of deforestation on Java will most likely repeat itself on the other Sundaic islands, e.g., Sumatra and Borneo and possibly other parts of Southeast Asia. These areas have a much higher number of primate species. The findings and conclusions of the present study will therefore aim at presenting a framework for the conservation of South-east Asian primates.

In order to gain greater understanding in the conservation status of the endemic primates of Java and Borneo, this study set out to collect relevant ecological data and to document the pressures facing the different species. Specific aims of the research are:

(i) To assess the geographical distribution of individual species on Java and Borneo (Chapters 6, 7, 9 and 11).
(ii) To develop, test and evaluate census methods by which primate populations can be assessed and monitored (Chapters 2, 3 and 4).
(iii) To determine the type and magnitude of the threats facing the individual species and habitats on the islands (Chapters 8, 9, 10 and 11).
(iv) Using data collected under (i), (ii) and (iii), to re-assess the conservation status of the endemic primates of Java and Borneo using the IUCN threat criteria (Chapter 12), and subsequently
(v) To identify key areas for conservation based on densities of particular primate species, the co-existence of a disproportional large subset of primate species and management feasibility (Chapters 8 and 11).
(vi) To discuss the results of the present study into greater perspective and formulate further research priorities (Chapter 13).
Forest and Primates, a General Introduction

SETTING OF THE PROJECT

The Zoological Museum of the University of Amsterdam has several decades of practical experience with conservation related studies in the tropics, including the Sundaic and Wallacean regions. During the decades prior to Indonesia gaining independence most studies were focused on descriptive taxonomy, although part the studies of among others Prof. Dr. L.F. de Beaufort, director of the museum during 1922-1949, would nowadays be classified as biodiversity conservation research. Later Prof. Dr. K.H. Voous, curator of birds from 1940-1964, worked on the ornithology of the region and published some influential studies on the birds of Java and Sumatra (Voous, 1950; van Marle & Voous, 1988).

In the years after Voous' superannuation the number of projects increased due to the activities of the former heads of the department of birds, Dr. J. Wattel, and mammals, Dr P.J.H. van Bree. For vertebrates studies include: seabirds (de Korte, 1989, 1991; de Korte & Silvius, 1994; Argeloo, 1993; Argeloo & Dekker, 1996), megapodes (Dekker, 1990ab; Argeloo, 1992; Jones et al., 1995), pheasants (Sözer, 1997; Sözer et al., 2000, in press; Nijman & Sözer, 1997), birds of prey (van Balen et al., 2000; Sözer et al., 1998), woodpeckers (Lammertink, 1998, 2001), bats (Bergmans & Rozendaal, 1982, 1988; Bergmans & van Bree, 1986), and marine mammals (de Jongh et al., 1997; Kreb, 1999).

The present project was initiated in 1996 and stems from an agreement between the Zoological Museum Amsterdam and the Zoological Museum Bogor with ongoing projects concerning woodpeckers, birds of prey, pheasants, primates and dolphins.

OUTLINE OF THIS THESIS

After the general introduction of primate conservation studies in the Sundaic region, in the following twelve chapters the results of field studies on Javan and Bornean primates which were carried out between 1994 and 2001 will be described, interpreted, and their implications discussed.

Section I (Chapter 2-5) presents some background information on survey methodology, behaviour, and morphology. In Chapter 2 a comparison is made between three commonly used methods for estimating densities and biomass of rain forest vertebrates. Chapter 3 deals with the effects that behavioural changes in rain forest vertebrates due to habitat disturbance have on estimation of densities. Both chapters use data from the Bornean gibbon and Javan gibbon, but the results and conclusions are likely to be applicable to other animal groups as well. Chapter 4 deals with the calling behaviour of Javan gibbons. It presents data on the frequency of calling in both sexes, and explores the use of bio-acoustics in conservation studies. Chapter 5 describes the geographical variation in pelage of grizzled leaf monkeys, one of the three endemic primates of Java. Contrary to previous studies it
argues that a number of morphological and behavioural characteristics of individuals of the western populations of this species are not diagnosably different from those in the eastern part of the species' range. It is therefore argued that the grizzled leaf monkey on Java comprises only one species; for conservation purposes the populations on Java should be treated as one single unit.

The following two sections deal with the geographical distribution, conservation status and conservation of the endemic primates of Java and Borneo; section II deals with the Javan species, whereas Section III deals with those from Borneo.

Section II (Chapter 6-9) begins with addressing the geographical distribution of the two endemic colobines on Java. Chapter 6 deals with the grizzled leaf monkey and chapter 7 deals with the ebony leaf monkey. Chapter 8 presents data on the conservation status and distribution of the endemic primates in the Dieng mountains.

Section III begins with presenting data on the distribution and conservation of proboscis monkeys on Borneo (chapter 9), and chapter 10 tells the story of the local extinction of this species from the Pulau Kaget Nature Reserve. Both chapters demonstrate the in-effectiveness of species conservation on Kalimantan. Chapter 11 attempts to assess the patterns of primate diversity on Borneo, and the implications of these patterns for the selection of priority sites for conservation.

Section IV starts with a re-assessment of the conservation status of the endemic primates of Java and Borneo based on the present IUCN threat criteria (Chapter 12), incorporating data from the previous three sections. Finally an overall discussion and an integration of the different themes is presented (chapter 13). This chapter also provides some suggestions for further research on primates and their forest in Java and Borneo.

Most chapters have been published in scientific journals, with a number of different co-authors. In order to increase readability as much as possible a single style is adopted. Nomenclature and English names for the different species follows Geissmann (1993) for the gibbons, and Oates & Davies (1994) for the colobines (see Table 1.1); these may differ from the ones used in the original publication.