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Distribution of the Javan Slow Loris (*Nycticebus javanicus*): assessing the presence in East Java, Indonesia.

Jonna Lehtinen
MSc Primate Conservation
Dissertation

Abstract

Primates are amongst the most studied mammal species, but little is known of the Javan slow loris (*Nycticebus javanicus*), a highly threatened nocturnal primate endemic to Java, Indonesia. Its distribution is highly fragmented due to habitat loss, and it is found in very low densities in primary and secondary forests, but also in disturbed agricultural areas. Known distribution of the Javan slow loris is restricted to Western and Central Java, mainly because lack of research in the east. We surveyed areas around East Java using line transects to confirm the presence/absence of the lorises and other nocturnal small mammals in these areas. Previously done ecological niche modelling (Maxent) determined the selection of the survey areas, which included Meru Betiri and Alas Purwo National Parks as well as areas around Ijen Plateau.

We encountered five Javan slow lorises, all in Meru Betiri National Park. An overall encounter rate for the loris was 0.09/km (n=5). Other nocturnal small mammal species encountered in various survey areas were: common (or red) giant flying squirrel *Petaurista petaurista* (0.10-0.17/km), common palm civet *Paradoxurus hermaphrodites* (0.10/km), small-toothed palm civet *Arctogalidia trivirgata* (0.12/km), Sunda colugo *Galeopterus variegatus* (0.05/km) and Javan chevrotain *Tragulus javanicus* (0.03/km).

We also conducted unstructured interviews with people and visited wildlife markets around survey areas. Data from these indicated possible loris presence in various locations and existing trade on lorises as well. Further surveys are needed to clarify the status of Javan slow loris and other nocturnal small mammal populations in East Java.

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First, I would like to thank my supervisor Prof. Anna Nekaris as well as Prof. Vincent Nijman, not just for their help with this project, but for the whole amazing year I had at Oxford Brookes. This goes to other staff and all my fellow students as well. What an amazing group of dedicated and caring people I am privileged to be part of.

Thank you to everyone from Little Fireface Project, Johanna Roda and the field guides for taking me to see my first ever wild loris in Cipaganti, West Java and teaching me how to do night surveys. Also, Johanna as well as Hendra Margono and Eja Hafiz from Lautan Hutan Adventure for helping me with my research permit process.

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I could not have done this without my assistants in the field, Heri Beahaqi and Puveanthan Nagappan Govendan. Heri, who reminded how young we are and Pu, who carried my heavy bags when needed the most. These young men make me believe there is a brighter future for Indonesian wildlife. Merci beaucoup to my friend Guillaume Douay for coming to visit me all the way from France. Thank you for the photos as well.

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Abbreviations

CITES	Convention on International Trade for Endangered Species of Wild Flora and Fauna
IUCN	International Union for Conservation of Nature
LEK	Local Ecological Knowledge
MAXENT	Maximum Entropy Modeling
NP	National Park

Cover photo: Little Fireface Project

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1 Introduction

Indonesia is home to varied biodiversity with 44 primate species present. One of them is the Javan slow loris (*Nycticebus javanicus*), a small, nocturnal primate, which is endemic to the island of Java. Slow lorises are strepsirrhine primates, closely related to pottos, false pottos, galagos and angwantibos of Africa as well as slender lorises of India and Sri Lanka (Sussman, 1999).

Slow lorises are native to South and Southeast Asia, with eight species currently recognized: Bengal or northern slow loris (*N. bengalensis*), Pygmy or lesser slow loris (*N. pygmaeus*), Sunda or greater slow loris (*N. coucang*), Philippine slow loris (*N. menagensis*), Javan slow loris (*N. javanicus*), Sodhi's slow loris (*N. bancanus*), Bornean slow loris (*N. borneanus*), and Kayan slow loris (*N. kayan*) (Figure 1). Of these, *N. bengalensis* and *N. pygmaeus* are found only on mainland Asia, but the other six species reside in Indonesia (Munds et al., 2013).

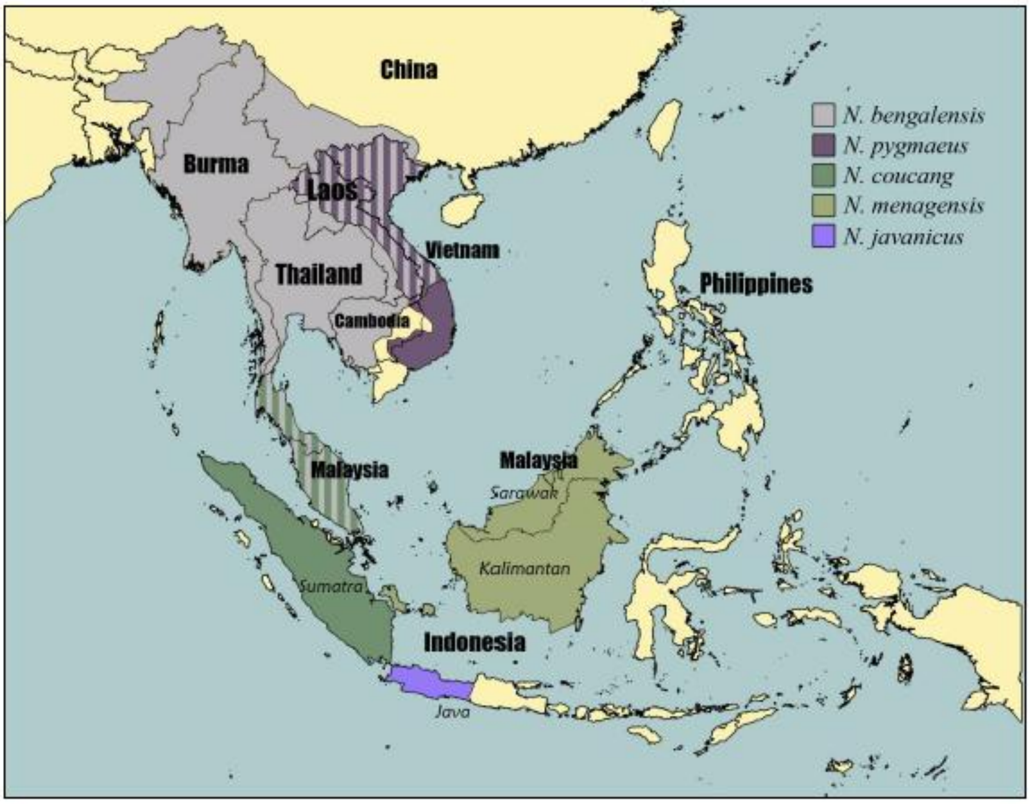

Figure 1. Distribution map of *Nycticebus* species (Moore, 2012).

Nocturnal strepsirrhines have been extensively studied only for a few decades and new species are still being ‘found’ and recognised. Because many morphological differences between species are subtle, separation of species can be difficult with these taxa (Sussman, 1999). However, for *Nycticebus* species, diversity in terms of cranial morphology, genetic variation, body size, facial markings, dentition, and pelage colouration has recently led to a major taxonomic revision (Nekaris et al., 2008). Most recently four species of Bornean lorises were recognised: *N. menagensis*, *N. bancanus*, *N. borneanus*, and *N. kayan;* based on a study of variation in facemask patterns (Munds et al., 2013).

Discovery of a new species is exciting and might bring good publicity for poorly known taxa, but at the same time, changes in taxonomy can be problematic regarding their conservation. When a species is divided into new distinct species, each of the new ones has a smaller range and faces a higher risk of extinction. Continuously changing taxonomy should not take the focus away from conservation of these increasingly threatened species. As Brandon-Jones (2006) argues, confirming the recognisability of a taxon is more crucial than debating its status as a species or subspecies.

Javan slow loris, like so many other species in Southeast Asia, is threatened by habitat loss, illegal wildlife trade for pets as well as traditional medicine. It is one of the World’s 25 Most Endangered Primates (Mittermeier et al., 2012), listed in Appendix I by CITES (Nekaris et al., 2010a) and classified as Endangered by IUCN Red List (Nekaris & Shekelle, 2008). Due to increased pressure on this species survival, a proposal to move Javan slow loris to Critically Endangered category has been put forward recently (Nekaris et al., unpubl.).

Unfortunately, many species in greatest need of conservation are the least known. *N. javanicus* has one of the smallest geographical ranges of all slow loris species and until recently it has also been the least studied. The known geographic distribution of this highly enigmatic species is restricted to western and central Java (Nekaris & Shekelle, 2008). However, ecological niche modelling by Thorn et al. (2009) predicted a potential distribution in the eastern parts of Java as well. This is supported by recently exposed supply routes from East Java to wildlife markets in

Bali (Nekaris et al., in review). In order to clarify the unknown status of the Javan slow loris, there is an urgent need to survey areas of its potential habitat in East Java. Finding any remaining populations in these fragments would extend the currently known range of this highly threatened species and provide possibilities for its future conservation.

To assess the potential presence of *N. javanicus* in East Java, I chose to carry out surveys using distance sampling with transects in two national parks; Meru Betiri and Alas Purwo as well as areas around Ijen Plateau. Because very little is known about presence or distribution of any nocturnal small mammal species in East Java, chance sightings of colugos, giant flying squirrels, civets and chevrotains were also recorded. We also opportunistically recorded sightings of two diurnal primate species present in the survey areas; Javan lutung (*Trachypithecus auratus*) and long-tailed macaque (*Macaca fascicularis*).

2 Survey methods

2.1 Selection of study areas

Thorn et al. (2009) used ecological niche modelling (Maxent 3.1.0) to predict potential distributions for *N. javanicus* by generating statistically significant models of occurrence based on their ecological niche requirements. Temperature, precipitation and altitude were some of the 20 environmental variable layers used, along with species locality data. Data on remaining habitat (forest cover) and altitudinal limits were used to predict remnant distributions. Maxent produces distribution maps with a defined threshold to indicate whether a species is likely to be present or absent in a given area (Baldwin, 2009). According to the results the loris could be present in various locations around eastern Java (Figure 2).

Meru Betiri National Park (MBNP) was recommended as one of the priority survey sites. Areas around southern Ijen Plateau were also predicted as potential habitat for *N. javanicus* as well as small parts of Alas Purwo National Park (APNP). Voskamp et al. (2012) further modelled the habitat suitability based on species presence (Maxent 3.3.3.k). Their results included all of Alas Purwo as suitable habitat for *N. javanicus*.

During a transect survey they also confirmed the presence of the species for one location in Meru Betiri, which is the easternmost sighting of *N. javanicus* until now. The aim of this study was to first survey areas in Meru Betiri, and to continue further east to confirm the presence/absence of this enigmatic species in the chosen survey areas.

Figure 2. Maxent modelling for *N. javanicus* in Meru Betiri NP (A), Ijen Plateau (B) and Alas Purwo NP (C). Predicted distributions (grey) represent the output before clipping to the altitude and vegetation layers. Remnant distributions (black) represent the predicted distribution clipped to the altitude and vegetation layers (Thorn et al., 2009).

2.1.1.1 Meru Betiri National Park

Meru Betiri National Park (MBNP) is a 50,000 ha area located in Jember and Banyuwangi districts (8°20′S to 8°34′S and 113°37′E to 113°59′E) ranging from sea level to 1223 m a.s.l. It was declared as a reserve in 1972 and was made a national park only in 1982. There are two plantation enclaves within the park, Bandealit in the west and Sukamade in the east (Whitten et al., 1997), and few other small villages inside the park borders.

Meru Betiri is dominated by lowland tropical rainforest. Most of the forest is moist deciduous type with dense undergrowth. The vegetation in Meru Betiri is closer to the habitat types of West and Central Java than to the other parts in East Java (Whitten et al., 1997). It is considered a "wet island" in an area otherwise dominated by monsoon climate vegetation. The mountains influence the climate of Meru Betiri resulting in both an increase in total yearly rainfall and a reduction of the severity of the dry periods that so strongly influence the surrounding area. The average annual rainfall in the park is between 2,000 and 6,000 mm with 4 dry months and 7 wet months in average (IUCN, 1980).

2.1.1.2 Alas Purwo National Park

Alas Purwo National Park (APNP) is located in Southeast Banyuwangi (8°26′S to 8°46’S and 114°20′E to 114°36′E) on Blambangan peninsula. The area is quite flat with the highest point reaching only 375 m a.s.l. Alas Purwo was declared a national park in 1990, although before that it was partly protected as a game reserve (Whitten et al., 1997).

The park covers about 42,000 ha of lowland forest and savannah. The annual rainfall is lower than in Meru Betiri, and the whole area has only one permanent stream (Whitten et al., 1997). Alas Purwo is also dominated by moist deciduous forest, which prevails under 4–6 dry months. The forest is dominated by teak (*Tectona grandis*), which may actually not be indigenous to Java, but introduced by Hindu migrants, probably as early as 200 A.D. (Smiet, 1990). Other species include *Bombax*, *Duabanga* and *Tetrameles* (Lavigne & Gunnell, 2006). Teak and mahogany plantations cover areas near the borders.

2.1.1.3 Ijen Plateau

Ijen plateau is an active volcano complex with its highest volcano, Raung, standing at 3,332 m a.s.l (8°7'S, 114°3'E). The plateau is located north of Meru Betiri and covers an area of over 130,000 ha (Whitten et al., 1997). It has lesser conservation value as the neighbouring national parks as almost the whole central plateau has been converted to coffee plantations. Outer slopes are still covered with some forest, but inadequate management has led to progressive degradation and deforestation and destroyed much of the original *Casuarina* (*C. junghuhniana*) forests (Whitten et al., 1997; Nijman, pers.comm.).

2.2 Data collection

The data were collected using distance sampling with line transects. Existing tracks and paths were used as transects (Buckland et al., 2010). Distance sampling counts as many animals as possible from a point or line within an area, assuming that only a proportion will be seen. This is then used to calculate an estimate of the total number of animals present (Ross & Reeve, 2011). To get a reliable density estimate, a sample size needs to be between 60-80 sightings (Buckland et al., 2001). Based on previous encounter rate data or a pilot study, it is possible to estimate a satisfactory total line length (Buckland et al., 2001) by equation:

$$L = \left(\frac{b}{\{cv_t(\hat{D})\}^2}\right)\left(\frac{L_0}{n_0}\right)$$

Where

$$b \simeq \left\{\frac{var(n)}{n} + \frac{n \cdot var\{\hat{f}(0)\}}{\{\hat{f}(0)\}^2}\right\}$$

L_0 = line length
n_0= animals spotted
b = 3 (from Buckland et al., 2001)
$(cv_t\ (D))^2 = 0.1$ (for 10% precision)
(from Buckland et al., 2001)

Because of the great variety of encounter rates (0.02-0.68 animals/km) in the few previous surveys of *N. javanicus*, a median (0.35 animals/km) was used (Nekaris et al. 2008; Voskamp, 2012). The result showed that the total length for transects should be 105 km.

Transects can be cut in the forest, but using existing paths or roads allow more extensive surveys to be completed for the same available effort (Hiby & Khrishna,

2001) and provides better visibility (Duckworth, 1998). However, there can be no guarantee that densities along trails are representative. To avoid bias, transects should be randomly placed in the survey area and adequately repeated. Random placement ensures that they pass through areas with representative densities and allows reliable extrapolation to the whole survey region (Buckland et al., 2010).

For nocturnal loris surveys Nekaris et al. (2008) suggest using red lights, small research team and a speed of <500 m per hour when surveying. Red lights are said to be less disturbing to lorises, yielding more and lengthier sightings and increasing the chance of recording an animal on the line transect (Nekaris, unpubl. data). The locations of each transect and sightings were recorded using GPS (Garmin 62s & Suunto Ambit). The animals can be detected by their orange-red ‘eye-shine’, light reflected by *tapetum lucidum*, a layer of tissue behind the retina in many nocturnal animals. Lorises can also be detected by their distinctive call, a high frequency whistle (Nekaris et al., 2008).

Perpendicular distance of the animal from transect, number of individuals, height of the animal in the tree and height of tree and tree species (if known) were recorded for each sighting (Nekaris et al., 2008). Other data recorded included survey time, transect length, forest type and density, presence of bamboo, altitude, path type and possible human disturbance. Moonrise and phase, temperature and weather conditions were also recorded, as these have been noticed to have an effect on loris behaviour and thus can affect the number of sightings (Nekaris & Jayewardene, 2004). The data on the lunar phase was obtained from the Moon Phase Calculator (www.timeanddate.com) using Surabaya as a point of reference. Temperature was measured by Suunto Ambit.

As human pressures on environments continue to increase and primate habitats become smaller and more fragmented, the need for a primatology that considers the impact of human attitudes and behaviour on all aspects of primates and their survival becomes more important (Fuentes & Hockings, 2010). We conducted unstructured interviews with local people and rangers of forestry department. This was done to find out if people are aware of the presence of *N. javanicus* in the survey areas, and to record peoples’ attitudes as well as possible myths and stories about this secretive animal. People were asked if they know what a slow loris is and shown a picture of a Javan slow loris to see if they recognised the species. If they recognised the loris, they were further asked if they've seen any in the area and how long ago. We also visited wildlife markets in the biggest towns near the survey areas to see whether they had any lorises or other nocturnal small mammals for sale.

2.3 Data analysis

The problem with distance sampling is that it requires a reasonably large sample size to yield reliable estimates. This is a problem when dealing with low-density populations, such as lorises (Duckworth, 1998). Because we did not encounter enough lorises during the surveys to provide a density estimate, other methods for analysis were reviewed. According to Duckworth (1998) information from nocturnal transect surveys is best presented as contact frequencies accompanied by some contextual information. As such, linear animal encounter rates (sightings per km) were calculated for all species (Sutherland, 2002). This gives an index of the population size and can be reliably estimated even from small samples (Buckland et al., 2001).

Environmental and habitat variables of East Java were considered in analysis of reasons for the possible absence of lorises in most of the survey areas. Data from the interviews and market visits were used to assess further the presence/absence of Javan slow loris in the study areas.

3 Results

The study was conducted over a 6 week period between May-July 2013. Nocturnal surveys were done on 28 nights. 40 transects were walked for 76 hours covering 58.25 kilometres. Transects were between 0.1 km and 4.2 km in length, with average transect length of 1.49 km. Two strategies regarding survey speed were used, transects in western side of Meru Betiri and Alas Purwo were walked at a speed of 180-800 m per hour. Due to time limitations of this study and in order to cover longer distances, walking speed was increased for the remainder of the survey. Thus areas around Ijen Plateau and eastern side of Meru Betiri were walked at 970 m - 2.05 km per hour.

Each transect was walked by a team of 2-5 people using a combination of red and white lights. All surveys were conducted between 17:45 and 00:00. Each transect was walked only once as recommended by Duckworth (1998). Survey areas were located between altitudes of 12 to 1731 m. We were able to confirm the presence of slow lorises in two locations, both in western part of Meru Betiri NP. Three individuals were encountered in Bandealit and two in Sumber Salak. We failed to observe lorises in any other location.

A total of five lorises were seen with an overall encounter rate of 0.09/km. For Meru Betiri NP, where all the lorises were seen, the rate was 0.38/km. All lorises were seen along transects walked at a speed of 800 m/h or less (range 0.18 – 0.8 km/h). Three individuals were seen alone and two together. Single individuals were all seen in dense primary forest with bamboo. Two others were seen next to a corn plantation by a small river, with bamboo present as well. The median distance of a loris from a transect line was 7.5 m (range 3–15 m). All animals were seen in trees at heights of 10–34 m (Median = 20 m). All loris sightings occurred on nights between third quarter and new moon with no or very little illumination (0.3 – 27.6%; www.timeanddate.com). One sighting occurred during the rain, while others were seen during clear sky.

Other nocturnal mammal species encountered during the surveys were: common (or red) giant flying squirrel (*Petaurista petaurista*), common palm civet (*Paradoxurus hermaphrodites*), small-toothed palm civet (*Arctogalidia trivirgata*), Sunda colugo (*Galeopterus variegatus*) and Javan chevrotain (*Tragulus javanicus*). Both civet species were present in Meru Betiri and Alas Purwo, but not in Ijen. In total we encountered six common palm civets and seven small-toothed palm civets during our surveys. We observed two further civets off-transects, one small-toothed palm civet and one unidentified individual in Alas Purwo. Colugos and giant flying squirrels were seen in Meru Betiri and Ijen, but not in Alas Purwo. In addition, we recorded two diurnal primate species *M. fascicularis* and *T. auratus* in both Meru Betiri and Alas Purwo NPs as well as in Ijen. Macaques were present at seven and lutungs at nine different locations.

All sightings and their locations are listed in Table 1 and shown on map (Figure 3).

Table 1. Localities of all species encountered during the surveys.

Species/location	Meru Betiri				Alas Purwo			Ijen plateau		
	Bandealit	Sumber Salak	Rajegwesi	Sukamade	Rowobendo	Sadengan	Sumurtrong	Kawah Ijen	Kalisat	Sidomulyo
Javan slow loris	X	X								
Common palm civet	X		X				X			
Small-toothed palm civet			X	X	X		X			
Sunda colugo	X									X
Red giant flying squirrel				X					X	
Javan chevrotain				X						
Javan lutung	X	X		X	X	X	X	X	X	
Long-tailed macaque	X	X		X	X	X	X		X	

Figure 3. Map of all sightings in the survey areas.

Encounter rates for each species were calculated as well as an average distance from transect and average height in tree when encountered (Table 2).

Table 2. Sighting data for all encountered nocturnal small mammals.

	Javan slow loris	Common palm civet	Small toothed palm civet	Sunda colugo	Giant flying squirrel	Javan chevrotain
No of sighting	4	6	7	2	6	2
No of animals	5	6	7	3	6-10	2
Overall encounter rate (km)	0.09	0.10	0.12	0.05	0.10-0.17	0.03
Average distance from transect	3-15 m	4-20 m	5-30 m	5-6 m	-	-
Average height in tree	10-35 m	0-4 m	4-31 m	8-10 m	-	-

We visited three small bird markets in Jember, Banyuwangi and Bondowoso, the biggest towns in the area. We did not see any lorises or other primate species for sale during our visits, but were told that trade in primates does occur. This was supported by the data from the interviews. The interviews produced few data on loris presence, but revealed the overall lack of knowledge on nocturnal small mammals and species identification.

4 Discussion

The aim of this study was to assess possible presence of the Javan slow loris in the chosen survey areas around East Java. In this Discussion, I try to analyse why we only encountered five lorises and only in Meru Betiri NP. First I do an overview to previous loris studies and their range and densities as well as habitat variables. I then discuss presence/absence as a survey method, ecological niche modelling and detectability. Other nocturnal small mammal species are considered and finally an ethnoprimatological aspect is included with Local Ecological Knowledge and wildlife trade. I conclude the Discussion with conservation implications and recommendations for future studies.

4.1 Slow loris ranges, encounter rates and densities

Nijman (2000) states that the geographic distribution of a species is perhaps the fundamental unit of ecology and biogeography affecting probability of extinction. Geographical range and the occurrence within its range, determines the distribution of a species, and with population size, structure and trend the threat of extinction can be assessed (IUCN, 2012). Until recently, the range of Javan slow loris was thought to be restricted to western and central Java with confirmed sightings at Dieng Mountains and Gunung Sawa in central and at Gunung Gede Pangrango National Park, Ujung Kulon, Gunung Tilu, Gunung Simpang as well as in Ciamis and Tasikmalaya regencies in West Java (Nekaris & Munds, 2010; Voskamp, 2012).

Only a few surveys have been done for *N. javanicus* in West Java, where animals have been recorded at very low densities of 0.02-0.20 animals/km (Nekaris et al. 2008). Voskamp (2012) reported an encounter rate of 0.68/km, but the results are likely affected by the fact she was surveying areas with previously known loris distribution. Other authors have also indicated that they have surveyed areas specifically chosen for their high loris abundance (Nekaris & Nijman, 2007). Our encounter rate for this study was 0.09/km (n=5), which fits into the previously recorded range. If we take into consideration only Meru Betiri, where all our sightings occurred the encounter rate increases to 0.38/km.

To have an overview of median encounter rates for *Nycticebus* species, Nekaris & Nijman (2007) and Nekaris et al. (2008) combined data from various surveys conducted between 1981 and 2007. Data from other loris surveys since then by other authors was added and can be seen in Table 3.

Table 3. Encounter rates for *Nycticebus* species.

Species	From Nekaris & Nijman (2007)	From Nekaris et al. (2008)	Others
N. coucang	**0.66-0.74/km**, n=142-183 (Malaysia)	**0.80/km**, n=15 (Malaysia)	-
N. bengalensis	**0.10-0.13/km**, n=35 (India, Laos, Vietnam)	**0.26/km**, n=12 (India & Laos)	**0.03-0.33/km**, n=10 (India, Radhakrishna et al., 2006) **0.57/km**, n=93 (Thailand, Pliosungnoen et al., 2010) **0.45/km**, n=9 (Cambodia, Coudrat et al., 2011) **0.22/km**, n=9 (India, Swapna et al., 2011)
N. menagensis	**0.12/km**, n=13 (Malaysia, Kalimantan)	**0.19-0-33/km**, n=12 (Kalimantan) **0.02/km**, n=3 (Malaysia)	-
N. pygmaeus	**0.05-0.08/km**, n=12 (Laos, Vietnam)	**0.13/km**, n=4 (Laos & Vietnam)	**0.10-0.40/km** n=26 (Cambodia, Starr et al., 2010) **0.33/km** (Cambodia, Starr et al., 2012)
N. javanicus	-	**0.11/km**, n=2	**0.68/km,** n=52 (Voskamp, 2012) **0.09/km**, n=5 (This study)

For further comparison the linear encounter rates in Sri Lanka for red slender lorises (*Loris tardigradus tardigradus*) were 0.1–1.1 lorises/km (n=44) (Nekaris et al., 2013) while surveys in 2001 and 2002 produced rates for *L. t. tardigradus* (0.86–13/km, n=69) and *L. lydekkerianus nordicus* (0.33–5.3/km, n=111) (Nekaris & Jayewardene, 2004; Nekaris & Bearder, 2011). In India, encounter rates of *L. l. lydekkerianus* and

L. l. malabaricus have been recorded as 0.41/km (n=90) and 0.21/km (n=63), respectively (Kumara et al., 2006).

We did not have enough sightings to estimate the loris density in our survey areas, but the low encounter rate suggests low abundance. Due to time limitation and other challenges during our study, we covered just 55% of the recommended length of transects. Even with all 105 km it would have been nearly impossible to reach the recommended 60–80 sightings for reliable estimation of density. But as can be seen from the comparison only very few studies produce enough sightings. Often the studies are not long enough. With the typical encounter rates, thousands of hours would be needed for adequate samples (Duckworth, 1998).

Like in this study, many other loris surveys have used line transects with existing paths and roads as transects (Kumara et al., 2006; Radhakrishna et al., 2006; Pliosungnoen et al., 2010; Voskamp, 2012). This violates the principle of randomisation, one of two basic principles of density studies. Single transect along a road or path may pass through areas with atypical densities. This will lead to biased estimates of density which cannot be extrapolated reliably to the whole survey region (Buckland et al., 2010).

Abundance along routes might also be very different from ‘core areas’, as these are easier accessed by hunters or poachers, there is more disturbance along the routes, i.e. connectivity might be disturbed and habitats can be different compared to the core areas (Buckland et al., 2001). Laurance et al. (2008) report that relative to forest transects, road margins had significantly depressed species richness of nocturnal primates, gliding rodents, and small ungulates, extending approximately 30 m on either side of road edges. On the contrary, Johns (1986) encountered *N. coucang* significantly more frequently in forest-edge habitat than in the forest interior. This has also been observed with many radio tracking studies in various locations (Nekaris, pers.comm.). Whether using existing trails affects the encounter rates and density estimates of loris species, is beyond the scope of this study, but should be considered in future studies.

4.2 Habitat variables

All species have their requirements for suitable habitat. Identifying the principal habitat characteristics which influence species presence and abundance requires studies of species ecology and behaviour. Slow lorises are known to inhabit a variety of habitats including ever-wet rainforests, seasonal forests, plantations, evergreen lowland and montane forests, mangrove forests and even peat swamp forests (Nekaris et al., 2008; Thorn et al., 2009), showing adaptability to their environment. The exact altitudinal limit for slow lorises is not known, but on Java they have been found at nearly 1500 m (Nekaris et al., 2008) and on Borneo at 1000 m (Thorn et al., 2009). We made three of our sightings in lowland deciduous forest and two in a plantation between forest patches. Two of our slow loris observations were at c. 360 m a.s.l. and others at less than 70 m a.s.l.

4.2.1 Diet and habitat types

All *Nycticebus* species feed regularly on exudates that they obtain through active gouging and they have been identified as a main food source for *N. javanicus* (Nekaris et al., 2010b). Tree species lorises have been seen in include *Toona siensis*, *Acacia decurrens,* and *Eucalyptus* spp., which are all gum producing trees as well as *Gigantochlora ater*, which is a species of bamboo (Albers, 2012). Arecaceae and Moraceae are used as well (Moore, 2012). *Acacia* spp. belong to the family Fabaceae which is most commonly exploited by slow lorises for exudates (Nekaris et al., 2010b). Unfortunately we did not have a specialist who could identify the species of trees in which we saw the lorises during our surveys, but one was tentatively identified as *Drypetes* spp., which are evergreen flowering trees (The Angiosperm Phylogeny Group, 2009).

Study on reintroduced Javan slow lorises found them feeding mainly on nectar and pollen from flowers, observed on almost 90% of feeding bouts. Amongst the flower species, *Calliandra calothyrsus*, which belongs to *Fabaceae* as well, was the preferred (80.79%) food item (Moore, 2012). However, *Calliandra* is native to Mexico, Central and South America, and it was first introduced to Indonesia from Guatemala as late as in 1936. *Calliandra* is said to grow in Meru Betiri, but we were unable to find out whether it does in rest of the survey areas. Due to lack of studies, it is impossible to know what native species the loris is replacing in its diet with *Calliandra* and whether this has any significance to its abundance or higher densities in disturbed habitats. The lorises in Cipaganti, West Java have been observed to feed on *Calliandra* as well, although there they rely more on gum (Albers, 2012).

The amount of bamboo on transect had a positive effect on the presence of Javan slow lorises (Voskamp, 2012) as well as pygmy slow lorises in Cambodia (Starr et al., 2010). Starr et al. (2010) also interviewed local informants, who all believed lorises occur in thick forests that have bamboo. We also made all our five sightings in areas with bamboo nearby. Lorises are known to use bamboo as sleeping sites, but they are used for feeding as well. Starr et al. (2010) observed lorises licking and breaking open dead bamboo culms full of insects and termites, while in Sri Lanka presence of slender lorises was positively associated with insect presence (Nekaris & Jayewardene, 2004).

During our survey, the encountered lorises were seen relatively high in trees (range 10–34 m, Median = 20 m) compared to other studies (Nekaris & Jayewardene, 2004; Radhakrishna et al., 2006; Starr & Nekaris, 2010; Nekaris & Munds, 2011; Rogers & Nekaris, 2011). This can be an effect of habitat type as primary and secondary forests are likely to have higher trees than disturbed habitats. However, Voskamp (2012) found that while there was significant difference between the average tree heights in different habitat types, there was no difference in the average height of lorises in trees between them.

Animal densities vary across habitat type. In Sri Lanka, the highest density of slender lorises occurs in the dry zone in monsoon forests, while the presence of lorises is negatively associated with primary forest with little undergrowth (Nekaris & Jayewardene, 2004). Contrary to this in Thailand, Pliosungnoen et al. (2010) report nearly identical *N. bengalensis* densities in regenerating forest plantations and primary forest, while mean density estimate for the younger plantations was only one-third of them. In Cambodia more sightings of *N. bengalensis* occurred in dry dipterocarp forest than in lowland evergreen forest (Coudrat et al., 2011; Rogers & Nekaris, 2011).

4.2.2 Habitat disturbance

Anthropogenic forest disturbance is detrimental to ecological health of forests and biodiversity, with mammals being the most sensitive group (Sodhi et al., 2009). Species richness and abundance/density of forest-dependent taxa generally decline in disturbed habitats compared to mature forests. Species with restricted ranges and those with habitat and foraging specialization are particularly vulnerable (Sodhi et al., 2010). However, species also differ in their ability to thrive at the edge of human habitations (Johns, 1986).

All of our five sightings were inside a national park but very near human-influenced areas. Many studies on lorises have recorded substantially less sightings in protected areas (with presumably less human activities) than outside of them, including two slender loris species in Sri Lanka (Nekaris & Jayewardene, 2004) and India (Kumara et a., 2006) and *N. javanicus* in Java (Voskamp, 2012). In Voskamp's (2012) study, 86% of all sightings were made in agricultural areas and forest plantations, with high levels of human disturbance. However, this can be a result of detectability, which will be discussed in detail in chapter 4.4.

While Javan slow loris is currently facing more pressure from illegal trade than habitat loss, its remaining habitat is highly fragmented. Population fragmentation plays an important part in the long-term survival of a species (Turner, 1996). For arboreal primate species, such as slow loris, habitat fragments can be defined as suitable forest remnants, isolated from each other by a matrix of inappropriate environment, e.g., human and agricultural settlement. Studies of primates in fragments frequently conclude that fragmentation negatively affects some aspect of their biology or ecology, i.e. diet, distribution, home range size, population size or social organization (Arroyo-Rodríguez & Mandujano, 2009). Animals trapped in fragments have varying capabilities and skills to adapt to new ecological conditions. Some species require intact primary forests to survive, but others, including lorises are able to adapt to secondary forests as well as agricultural plantations (Schwitzer et al., 2011).

Fragments, which might not exhibit characteristics required for a species' long-term persistence, may function as sinks, while larger neighbouring forest reserves may act as a source of individuals (Arroyo-Rodríguez & Mandujano, 2009). If fragmented habitats limit dispersal capacity, these fragments might temporarily harbour unnaturally large populations with significant differences in population sizes between fragments (Das et al., 2011). In theory, a small fragment will support a smaller population of a species than a larger one. As a fragment gets very small, populations will fall below viable levels (Turner, 1996). Small fragments often have fewer species recorded for the same survey effort than large fragments or areas of continuous forest. Size of patch where a species is able to persist also varies between primate species (Schwitzer et al., 2011). For *L. t. tardigradus* the patch size heavily influenced encounter rate, with the largest patches containing more lorises (Nekaris et al., 2013). On the other hand, edge habitat characteristically has a larger number of supports per unit volume of vegetation. This may increase the efficiency of foraging, particularly for insect prey (Johns, 1986). As mentioned before, insect presence has been positively associated with presence of slender lorises (Nekaris & Jayewardene, 2004), while less is known about other loris species.

Canopy continuity is especially important for arboreal species which avoid crossing open areas, such as lorises. They usually move with slow, deliberate, hand-over-hand movements. They are able to move fast, but do not leap or jump, thus having limited ability to move over gaps (Sussman, 1999). If a species is unlikely to utilize fragmented habitats, the conservation value of isolated forest patches will diminish (Turner, 1996). Canopy continuity has been proposed as an important factor in determining loris and other arboreal mammal abundance. Several studies have found that when forest canopy becomes more open, proportionally less small mammal abundance and biomass is comprised of arboreal species (Malcolm, 2004). It has been identified as crucial for slender lorises by other authors, but was not significantly associated with *L. t. tardigradus* abundance (Nekaris et al., 2013). Canopy cover has been positively associated with the abundances of the galagos, pottos, and scaly-tails and negatively associated with palm civet abundance (Laurance et al., 2008).

If travel routes are lacking in the upper canopy, arboreal primates are forced to descend to lower levels, or even to the ground, in order to cross gaps (Johns, 1986). On the other hand, disturbed habitats, i.e. plantations with fences and interspersed with trees, along with trees along roads, can be used as corridors between unconnected forest patches. Lorises are known to utilise various substrates in disturbed habitats and even coming to the ground to cross between trees (Singh et al., 1999; Nekaris & Jayewardene, 2004; Kumara et al., 2006; Rogers & Nekaris, 2011).

4.3 Challenges with methodology

4.3.1 Presence/Absence

Because reliable population density estimates require more sightings than is often feasible with short-term surveys, surveys recording presence or absence data of species are commonly used instead to help establish the geographic range or habitat requirements of species (Ross & Reeve, 2011). Presence of a species can be confirmed when it has been observed and reliably identified in an area. To be certain of species' absence is more challenging. It can be more easily determined if the species is conspicuous and easily identified (Sutherland, 2002), but low encounter rates make it difficult to confirm absence of lorises as well as other rare and cryptic taxa. Many nocturnal primates are not spaced evenly across a habitat due to habitat selectivity or sensitivity to disturbance. It is common to see an animal, and then walk for hours or days without encountering another individual (Duckworth, 1998; Nekaris et al., 2008).

Collecting presence/absence data is usually less expensive and time consuming than abundance studies (Wintle et al., 2005), but presence/absence surveys should not be used alone to confirm a species absence from a survey location. There is always a possibility that the species being surveyed for was not detected and not genuinely absent creating a false absence (MacKenzie, 2005). Misidentification of species can lead to a false absence or to a false positive observation as well. Quantifying the rate of false absences can help in estimating the required survey effort to assert that a species is absent from a certain area (Wintle et al., 2005).

4.3.2 Ecological niche modelling

We chose the survey locations based on ecological niche modelling (Maxent 3.1.0) by Thorn et al. (2009). Maxent is designed to make predictions from incomplete data and can be used for modelling species geographic distributions with presence-only data (Baldwin, 2009). In habitat as well as ecological niche modelling, the intent is to build a species distribution model related to certain habitat characteristics, particular habitat preferences or identify other possibly suitable habitats (MacKenzie, 2005).

Voskamp (2012) found Javan slow lorises in 75 % of the priority areas based on niche modelling. All our loris sightings were done in Meru Betiri NP, which was recommended as a priority survey location by the same modelling. We failed to record any lorises in Ijen Plateau and Alas Purwo, both which were also predicted as suitable habitat. On the other hand, due to accessibility many of the locations we ended up surveying were not inside the predicted distribution.

There are many uncertainties that need to be investigated in order to increase confidence in species distribution modelling (Araujo & Guisan, 2006). Because the composition of environmental variables often varies across a species occupied range, the ability to transfer findings from within a sampled area to unsampled areas is important. If a species’ entire range is not sampled, constructed models may inadequately define this range. As such it is important to adequately define which variables are important to the species of interest (Baldwin, 2009). Another problem is that niche theory does not take species dispersal into account. Limited dispersal can cause species to be absent from significant portions of the fundamental niche.

Thorn et al. (2009) used data gathered from museum and other natural history collections, which are often incomplete with relatively general location data. Thus the data can be biased in relation to the true spatial or environmental distributions of species. This taxonomic uncertainty can contribute to decreased modelling accuracy (Araujo & Guisan, 2006; Baldwin, 2009). However, maybe the biggest challenge with modelling in fast-changing environments is the lack of recent land-cover data. Because it is necessary for species localities and environmental layers to correspond temporally, land-cover data cannot be incorporated in modelling (Thorn et al., 2009). Especially with non-protected areas and areas of rapid deforestation, the reality might be very different, even when compared with relatively recent data.

4.4 Detectability

Detectability which means the number of individuals detected per unit of survey effort (distance or time) is considered to be one of major challenges of nocturnal surveys. Small nocturnal mammals are difficult to survey as they are hard to detect, especially in dense tropical rainforests (Duckworth, 1998). In distance sampling, perpendicular (i.e. shortest) distances from the transect line can be used to estimate a detection function. This is the probability that an animal is detected, as a function of distance from the line. It is assumed that this probability is one at 0 distance from the line, meaning that animals on the line are seen with certainty (Buckand et al., 2010). A distance *w* from the line on either side (strip width) is used to estimate the proportion of animals detected within a strip. The furthest we observed a loris was 15 m from a transect midline. This is in accordance with Pliosungnoen et al. (2010) who measured maximum effective distances for detecting lorises. These were 15 m for primary forest, 20 m for older plantations, and 30 m for younger plantations. In comparison, out of 185 slender loris sightings only on seven occasions were lorises detected at distances >20 m (Nekaris & Jayewardene, 2004).

As mentioned before, many loris surveys have resulted in more sightings in agricultural and plantation areas. This is likely a factor of better visibility and thus detectability in these areas compared to often half-open or dense rainforest with almost totally closed understory. Especially the very dense bamboo forests we surveyed in Alas Purwo had barely any visibility past the bamboo. The bamboo had grown tall and bended creating ‘arch-shaped’ corridors, which restricted visibility up to any tall trees in the area.

Laurance et al. (2008) report that the mean horizontal distances at which nocturnal primates and other mammals could be detected was significantly greater along road margins than in forest-interior transects. Seasonality and forest type may also bias estimations of animal densities as visibility is greater in dry forests (Nekaris & Jayewardene, 2004). Pliosungnoen et al. (2010) state that encounter rates for Bengal slow loris (*N. bengalensis*) were three times higher in plantations probably owing to the lower detection probability in the more complex vegetation of the primary forest.

Experience of the researcher does not necessarily affect the probability of detection, but technique has an important role in surveying lorises (Nekaris et al., 2008). Lorises move almost silently in their habitat and are commonly detected only by their eye-shine. Hunting pressure is thought to lead to torch-shyness and if animals are hidden by vegetation or do not look towards the torch, they can easily be overlooked (Duckworth, 1998). The speed at which transects are walked strongly influences loris detectability (Nekaris et al., 2008). When observing for other species as well, the balance of species recorded may change with speed. According to Duckworth (1998) walking faster produced more mouse-deer and fewer flying squirrels records in Borneo.

All our loris sightings were recorded on transects which were walked at a speed of 800m/h or less (range 0.18 – 0.8km/h). All other animal sightings (n=21) occurred when walking at speeds between 0.34 and 1.41km/h (Table 4). Out of these, 14 sightings were done when walking > 800 m/h and 7 when walking slower, supporting the previous observations of the changing balance of species detected. Transects walked any faster than this (up to 2.05km/h) failed to produce any sightings.

Table 4. Walking speed for species detection.

Species	Median	Range
Javan slow loris	0.30 km/h (n=4)	0.18 – 0.8 km/h
Common palm civet	0.88 km/h (n=6)	0.34 – 1.41 km/h
Small toothed palm civet	0.52 km/h (n=7)	0.34 – 1.12 km/h
Sunda colugo	1.34 km/h (n=3)	1.26 – 1.41 km/h
Common giant flying squirrel	1.18 km/h (n=6)	0.97 – 1.36 km/h

Temperature and rainfall influence detectability of most species (Wintle et al., 2005), and the amount of moonlight has an effect on detectability of nocturnal mammals. On clear, bright nights the surveyors are able to see more. On the other hand, the moonlight affects the behaviour of these animals, making some more active (lunar philic) and others to decrease their activity (lunar phobic). Starr et al. (2012) observed that the mean activity of *N. pygmaeus* was significantly affected by moonlight. The interaction between moonlight and temperature was also significant: on bright nights, lorises were increasingly more active with higher temperature; and on dark nights they were consistently active regardless of temperature. *N. bengalensis* becomes more active during dark moon phase (Rogers & Nekaris, 2011), while *L. t. lydekkerianus* significantly decreases foraging and traveling between trees (Bearder et al., 2002).

Obvious differences in Javan slow loris behaviour and moonlight have not been recorded. Also their detectability does not appear to be affected by the amount of lunar lights (Nekaris et al., unpubl.). The duration of this study and the amount of sightings were not enough to analyse the effect of the moon to detectability of the Javan slow loris, but all our sightings did occur between the third quarter and new moon, when there is very little moonlight.

Previously slow lorises were thought to be solitary, but this is not the case. When surveying for lorises, researchers should pay attention for other group members in order to estimate densities more accurately (Nekaris et al., 2008). Nekaris et al. (2010b) also suggest searching for characteristic marks left behind by gouging to help determine the presence of *Nycticebus* in a forest, which we did in a few plantations around Ijen.

If a species is not detected at a survey site, either the target species does not occupy the site or the investigator fails to detect the species at an occupied site (MacKenzie, 2005). Unless the probability of detecting a species is equal to 1 false absence will occur (Wintle et al., 2005). In reality this is often the case. Detection probability is also affected by random chance or differing abundances of the species at different sites: usually (but not always) the species is more detectable at sites with a higher abundance (MacKenzie, 2005). When surveying a species with small home range, increasing the duration of the survey might improve the probability of detecting the species, while with a species with a large home range, an increase in frequency of visits to the site is required (Wintle et al., 2005).

Estimating detectability of a species is important when designing future surveys, because it provides an estimate how many repeat visits are needed to confidently confirm a species' presence (Wintle et al., 2005). If Nekaris & Jayewardene (2004) did not see a loris in an area on one night, they continued to a new site. They argue, that the probability is high that lorises are absent from these areas, because in almost all areas where they did observe lorises, they were heard or seen again on subsequent nights. Field et al. (2005) suggest that 2 to 3 visits to each site would be sufficient for most species. However, if species occupancy and detectability rates are uncertain, more visits to more sites are preferred.

4.5 Identification of species

Identification of species can be problematic when surveying nocturnal small mammals, because the animals are spotted mostly by their eye-shine and patterns of movement. Footprints and other signs can be used, but are often not identifiable to species as similar species occupy same areas (Duckworth, 1998). Starr et al. (2012) used arboreal track plates with bait for footprints of *N. pygmaeus*, but failed to detect any loris prints. There were often too many footprints to correctly identify species correctly, but they were able to get reliable prints of two civet species (*P. hermaphrodites* and *Paguma larvata*), yellow-throated marten, giant squirrels and small cats. Many nocturnal animals use unique calls and vocalisations for communication (Duckworth, 1998). These can be used for detection and identification of species as well, but it can take months of field work to be able to clearly recognise e.g. slow loris calls (Starr et al., 2010). Due to lack of expertise, detection of vocalisations weren't used for species recognition in this study.

Knowledge of local people can be used in identifying species. The challenge is that local people might not define a species the same way as scientists do. Often what taxonomy considers as separate species, local people might have one name for them all, as with civets in Indonesia, where they are collectively called "musang" or "luwak". In Indochina, in regions where *N. pygmaeus* occur sympatrically with *N. bengalensis*, they are often reported together as 'slow loris', because of confusion in species identification (Starr et al., 2010). On the other hand, for one animal there can be as many local names as there are local languages (Boomgaard, 1999). For example, there are 36 local names used by various ethnic groups to describe the Sunda colugo in Malaysia (Dzulhelmi & Abdullah, 2010).

We encountered this challenge with lorises. The local name for a slow loris in Java is *kukang* or *malu-malu*, “the shy one” (Nekaris & Munds, 2010), but in the east it is also known as *tukang*. When interviewing people it became evident that slow loris is often confused with civets or flying squirrels. Many times when the name (kukang/tukang/malu-malu) was mentioned or after a photo of a loris was shown, people would say they recognise the species and sometimes told us they had also seen one. However, when further discussed, it became evident that they were not talking about a loris, but possibly a civet species, i.e. animals were seen on the ground or they had a tail. Sometimes people mentioned the face mask, but when asked about details, they would describe a mask like that of the common palm civet. For future studies, it would be recommended having a species list in the local language (bahasa Indonesia), supported with drawings or photos of look-alike species to test the reliability of identification skills of people.

We were able to collect a variety of names related to slow lorises (Table 5). Whether all these relate to slow lorises is unlikely. For example, *tukang burung* (‘bird loris’) is likely a giant flying squirrel. At Sumber Salak, a local teacher told us about two types of lorises, one “white” and one “brown”. Also at Rajegwesi, *kukang batu* was said to be a loris “like in the sticker”, while *kukang kayu* is “smaller, lighter and yellow”. Indeed, if not confused with any other species, this could support the existence of two forms of lorises on Java as suggested by Nekaris & Jaffe (2007) as *N. ornatus* is slightly smaller and generally light brown compared to brown to reddish fur of *N. javanicus*. The two forms have been distinguished mainly on hair length, which might also indicate altitudinal differences. As the four Bornean slow loris species are significantly clustered together by geographic regions, separated by notable geographic boundaries (Munds et al., 2013), it would not be surprising if Java had two separate species considering the previously discussed biogeography of Java.

Table 5. Examples of local names for lorises.

Examples of local names with description
Kukang batu (batu=stone) => “like in the sticker” (when shown Little Fireface Project sticker with a Javan slow loris photo)
Kukang kayu (kayu=wood) => smaller, lighter, “yellow”

Tukang lare (lare=“child”)
Tukang burung (burung=bird) => possibly a flying squirrel
Tukang cina (cina=China) => white
Tukang arab => black, “like in the sticker” (when shown Little Fireface Project sticker with a Javan slow loris photo)
Tukang tani => “farmer”

4.6 Characteristics of East Java

Java is a large island with ecologically distinct areas. Java’s flora and fauna is less rich than that of other Greater Sunda islands, but the level of endemism is relatively high (Whitten et al., 1997). The climate varies from slightly seasonal in the west to strongly seasonal in the east; only the south-western tip of Java has an everwet climate resembling that of the Sunda Shelf (van Welzen et al., 2011). Many species are confined to the wetter, western part of the island. Eastern Java is much drier with less species, and the montane forest is highly susceptible to burning in the dry season (Smiet, 1990). East Java has a long distinct dry period during the south-easterly monsoon from June to September, and a rainy period during the northwest monsoon from November to March (IUCN, 1980).

Historically, the land masses of Sundaland were connected to the mainland Asia through land bridges. Slow lorises are thought to have reached the islands of Sundaland when the Sunda Shelf was exposed at times of low sea level, creating one of these land bridges (Groves, 1971). During the early Pleistocene, about 1.25 ± 0.12 mya, a land bridge, a ‘savanna corridor’ connected the Malaysian peninsula with eastern Java, but not with Sumatra and Borneo. This connectivity allowed opportunities for species dispersal throughout the region. Support for this dispersal route is also indicated by the fact that a similar fauna is found on Java and on mainland Asia, which is absent from Sumatra and Borneo (Roos et al., 2008, Cannon, 2012).

The succession of mammalian fauna recorded from Java provides a perspective of the evolution of vegetation. The diverse fauna, similar to that of mainland Asia, was mainly adapted to open woodland vegetation. On the other hand, there is no botanical evidence for a continuous seasonal climate corridor from north to south. Also, compared with Asian fossil fauna, the Javanese fauna is depauperate, and lacks the ‘open savanna’ elements found in other time-equivalent fauna in India. This might indicate that the main open habitats were open woodland and riverine grassland (Cannon, 2012).

About 0.96 ± 0.09 mya, a land bridge connected eastern and western Java, allowing species to invade the western part of the island. About 0.8 mya however, this land connection was interrupted by rising sea levels, resulting in an allopatric speciation process on the island (Roos et al., 2008). Major river systems that originated in the highlands of Java transected the lowland areas. These river systems probably represented significant zoogeographic barriers to mammals, and may have contributed to increased population isolation and speciation (Harrison et al., 2006).

There is fossil evidence that forest-dependent primates such as orangutans (*Pongo*) and siamangs (*Symphalangus*) once existed in Java (Harcourt & Schwartz, 2001). This also provides evidence that a continuous belt of forest existed through the region, which was replaced by a more open vegetation type due to reduction or increased seasonality in rainfall. Rainforest-dependent species either became extinct, or were forced into refugia in Western Java, Sumatra and Borneo (Bird et al., 2005; Harrison et al., 2006).

Today, Southeast Asia experiences one of the highest rates of deforestation in the tropics due to agricultural expansion, logging, habitat fragmentation and urbanization (Sodhi et al., 2010). Java has been densely populated for centuries and has a long history of forests converted to plantations. Deforestation of mountain slopes began to be perceived as a problem around 1850, and still in the 1940s 24% of Java was under forest cover (Boomgaard, 1999). Now, less than 7% of original forests are left and they are highly fragmented, with less than 2.5% of the original lowland forest remaining (Smiet, 1990; Lavigne & Gunnell, 2006).

Forests have been replaced by commercial plantation forests, where agricultural crops, including sugar cane, rubber and coconut, are grown as monocultures (Whitten et al., 1997). The remaining fragments are mainly found in the mountain areas. Most of these remaining forests are legally protected to some extent, but are still extensively used by local people, whose livelihood depends on forest products, such as firewood, timber and fodder. These human activities alter species composition and modify forest structure. Large areas of degraded forest are replaced by woodland or shrubland (Smiet, 1992). In East Java all major mountains, including Ijen, are subjected to frequent burning and tree cutting. Repeated burning drastically modifies the original vegetation. Selective tree cutting has less of an impact and depends largely on accessibility. However, tree cutting in accessible areas is less selective and results in more drastic modifications (Smiet, 1992).

4.6.1 Survey areas

The surveys were conducted in parts of Meru Betiri and Alas Purwo National Parks as well as areas around Ijen Plateau. The survey areas were still connected and mostly forested in the beginning of the 20th century (Whitten et al., 1997). Meru Betiri and Ijen are separated from each other by a relatively narrow area of plantations, secondary forest and a road. While Meru Betiri and Alas Purwo are still largely intact, areas around Ijen Plateau are highly degraded and fragmented.

As a recommended priority survey site with a habitat similar to West Java and with one confirmed sighting, Meru Betiri was considered our best chance of encountering lorises during our study. We surveyed four locations in Meru Betiri NP: Bandealit, Sumber Salak, Rajegwesi and Sukamade. We were able to confirm the presence of lorises at two locations (Bandealit and Sumber Salak) in the western side of the park. We failed to observe any lorises in the eastern side of the park. This could be due to the survey effort (3 nights at Sukamade and 2 nights at Rajegwesi) as reports from local people indicate the presence of lorises in the area. However, even rangers at Sukamade told us sightings to be rare, the latest being over a month ago. What is interesting that we made three of our sightings in Bandealit. This area is said to be subject to a severe dry season, typical of the dry monsoon climate of rest of East Java (IUCN, 1980), which indicates that the Javan slow loris possibly inhabits these drier areas as well.

There are clear signs of poaching around Rajegwesi on the east border of Meru Betiri with one local telling us that the selling price for a loris is as high as for a pangolin (*Manis javanicus*), which are also highly sought after for traditional medicine trade. We surveyed some of the most easily accessible areas on this side of the park. Due to easy access and little patrolling, these locations seem to be under heavy poaching. Another interviewee indicated that there are no more lorises in the area, because all of them have been taken for trade. This combined with little survey effort are likely to be the reasons why we failed to encounter any lorises in this area. All the other species we observed during this study were all present in Meru Betiri.

In Alas Purwo NP we mainly surveyed areas in the northeast corner of the park. Four types of habitat were surveyed; primary forest, secondary forest, bamboo forest and plantations. We failed to observe any lorises. Of the nocturnal mammals we only encountered civets. Because the survey effort was similar to that in Meru Betiri, we felt that the absence of lorises was more likely to be related to the habitat variables than failed detection.

We surveyed five locations around Ijen Plateau, but did not encounter any lorises or civets. Survey effort here was less than in the two national parks with new location every night, which naturally lowers the detection probability. Personal observations by Prof. Nekaris also confirmed the lack of suitable habitat in most survey areas. One location, Kalisat, seemed most promising with a small protected forest with bamboo with good visibility. We observed giant flying squirrels, a group of macaques and a group of lutungs in this locality. We also saw colugos in Sidomulyo, on the south side of Ijen. The location was only c. 5 km from the northern border of Meru Betiri, and seemed to more suitable habitat also for lorises. The fact that we observed both gliding mammals in Ijen, and because the ecological niche modelling predicted remnant distribution for lorises in these areas it is possible that we failed to observe any lorises only due to survey effort.

4.6.2 Other primates of Java

Non-human primate fauna of Java is slightly impoverished compared to the other Sunda Islands. There are 5 species, compared to 13 species on Borneo and 12-13 on mainland Sumatra. However, a high proportion of them are endemic (Nijman, 2000). In addition to Javan slow loris, four other species present in Java include: long-tailed macaque (*Macaca fascicularis*), Javan lutung (*Trachypithecus auratus*), Javan surili (*Presbytis comata*) and Javan gibbon (*Hylobates moloch)*. Of these, the macaque and the lutung are distributed all around the island, while the surili and the gibbon are restricted to the western and central parts of Java (Nijman, 2004).

4.6.2.1 Javan lutung (Trachypithecus auratus)

Javan lutung (*Trachypithecus auratus*), also called Javan langur or Ebony leaf monkey is a colobine primate endemic to Indonesia (Figure 4). It is found on Java, Bali and Java. Taxonomy of this species is highly debated with two subspecies recognized based on coat colour: *T. a. mauritius* from SW. Java and *T. a. auratus* from Bali, Lombok and the rest of Java (Brandon-Jones et al., 2004). However, Roos et al. (2008) argue that based on genetic data *T. a. mauritius* should be recognized as a distinct species*.*

Figure 4. A Javan lutung (*Trachypithecus auratus*) in Meru Betiri NP. Photo: Guillaume Douay.

Javan lutung is listed as Vulnerable by IUCN Red List. It is threatened by habitat loss, fragmentation and pet trade as the loris, but on top of this it is also hunted for food (Nijman & Supriatna, 2008). Is spite of this, Javan lutung has been the most commonly observed primate in many part of central Java (Nijman & van Balen, 1998).

The species is diurnal, arboreal primate and mainly folivorous. It can be found in a large variety of forest types, including mangrove, beach, and freshwater swamp forest; everwet lowland and hill forest; dry deciduous forest and montane forest up to 3,000 - 3,500 m. It can even survive in plantations adjacent to natural forests (Nijman, 2000). We encountered groups of lutungs in various locations at all our survey areas including mangrove forest, lowland deciduous forest, montane forest (at c. 2,000 m a.s.l.) and teak forest.

4.6.2.2 Long-tailed macaque (Macaca fascicularis)

Long-tailed macaque (*Macaca fascicularis*) is one of the most widespread primate species with at least ten subspecies around Southeast Asia (Figure 5). It is extremely tolerant of variety of habitats and often thrives near human settlements (Gumert et al., 2011).

Figure 5. A long-tailed macaque (*Macaca fascicularis*) in Alas Purwo National Park.

IUCN Red List status for long-tailed macaque is Least Concern, because it is often abundant (Ong & Richardson, 2008). However, recent studies indicate that many populations are actually declining. They are hunted for consumption and for sport, and due to increasing human-wildlife conflict, persecuted as pests. Macaques are also victims of pet trade and they are used extensively in medical research (Gumert et al., 2011).

As with lutungs, we encountered groups of macaque at all survey areas. We also observed groups of macaques and lutungs living in vicinity of each other and even using same trees for feeding. *T. cristatus* and *T. obscurus* are known to be sympatric with long-tailed macaque in peninsular Malaysia feeding in same trees (Harding, 2010). The species might tolerate each other, because while lutungs are mainly folivorous, macaques are generally frugivorous (Corlett, 1998).

4.7 Other nocturnal small mammals

Many nocturnal small mammals have only been recorded by researchers in western Java, including Sunda colugos (Boeadi & Steinmetz, 2008) and small-toothed palm civets (Duckworth et al., 2008b). The assertion that these animals only occur in the east might be because eastern Java has not been surveyed for these animals, not because they are not present. We were able to confirm the presence of Sunda colugos and small-toothed palm civets in various survey locations. Encounter for all encountered nocturnal small mammals can be seen in Table 6.

Table 6. Encounter rates for other nocturnal small mammals.

Species	Density estimates	Encounter rates (mean)
Sunda colugo (*G. variegatus*)	**0.535 (± 0.104) ind/ha,** n=34 (Singapore, Lim & Ng, 2010)	**0.96/km,** n=30 (Singapore, Lim et al., 2013)
Common palm civet (*P. hermaphrodites*)		**0.07 – 0.15/km**, n=18 (Thailand, Pliosungnoen et al., 2010) **0.35 – 0.39/km**, n=14 (Cambodia, Iseborn et al., 2012) **0.50/km** (Cambodia, Starr et al., 2012)

Small-toothed palm civet (*A. trivirgata*)		**0.22/km,** n=11 (Java, Moore, 2011)
Red giant flying squirrel (*P. petaurista*)	**0.26 – 2.23 ind/10 ha,** n=35 (Taiwan, Lee et al., 1993b)	**0.10 – 0.77/km**, n=23 (India, Radhakrishna et al., 2006) **0.36/km,** n=25 (Thailand, Pliosungnoen et al., 2010) **0.85/km,** n=78 (India, Ray et al., 2012) **0.33/km** (Cambodia, Starr et al., 2012)
Lesser Oriental chevrotain (*T. kanchil*)		**0.33/km** (Cambodia, Starr et al., 2012)

4.7.1 Sunda Colugo (*Galeopterus variegatus*)

Sunda colugo (*Galeopterus variegatus*) is one of two species of colugos. They are nocturnal, arboreal folivores, endemic to Southeast Asia. Colugos are also called flying lemurs and recent genetic studies show, that they are the closest living relatives of primates (Janečka et al., 2007). Four sub-species are currently recognised, but DNA studies by Janečka et al. (2008) indicate that the mainland (*G. v. peninsulae*), Javan (*G. v. variegatus*), and Bornean (*G. v. borneanus*) subspecies could be better recognized as distinct species.

These gliding mammals have rarely been studied and are often confused with giant flying squirrels. The species occurs in Indochina (including parts of Vietnam, Laos and Cambodia), south through Thailand, eastern Myanmar and peninsular Malaysia. It is also found on the islands of Borneo, Sumatra and Java, where it is thought to reside only in the western parts (Boeadi & Steinmetz, 2008). We observed colugos at two different locations during our surveys, one individual in Bandealit in Meru Betiri NP and two in Sidomulyo, south of Ijen.

Due to its arboreal nature colugo is a forest-dependent species, but it can be found in secondary habitats close to human populations as well. It has been observed sleeping in coconut trees during the day, feeding on young fruits of the surrounding trees (Boeadi & Steinmetz, 2008). This is supported by our sightings as we detected one of the colugos on a coconut tree trunk on a maize plantation bordering a forest (Figure 6). The other sighting was in a disturbed habitat by a road as well with access to a more intact forest.

Figure 6. A Sunda colugo (*Galeopterus variegatus*) on a coconut tree in Meru Betiri NP. Photo: Guillaume Douay.

Colugos' dependence on forest habitats and limited dispersal abilities through open areas make them susceptible to local population extinctions in highly fragmented habitats. They are also hunted for consumption in western Java and populations are declining (Boeadi & Steinmetz, 2008). Currently, Sunda colugo is listed by IUCN as Least Concern, but if the isolated populations are in fact distinct species, this would warrant a need for a reassessment of conservation status along with revised taxonomy (Janečka et al., 2008).

4.7.2 Common giant flying squirrel (*Petaurista petaurista*)

Petaurista is a genus of large nocturnal flying squirrels found in Asia. Common (or red) giant flying squirrel (*P. petaurista*) is a widespread species found all over Java while spotted giant flying squirrel (*P. elegans*) has only been recorded in the west. *P. elegans* is smaller of the two and lives at higher altitudes (Walston et al., 2008). As with colugos, the giant flying squirrels are listed by IUCN as Least Concern as they seem to be very abundant in suitable habitats. Because they need tall trees, giant flying squirrels are primarily found in hills and mountains. Thus they are above the range of widespread habitat conversion and populations are considered stable (Walston et al., 2008). They can also adapt to habitat disturbance and have been observed in secondary conifer plantations and fragmented rainforest (Lee et al., 1993a).

Giant flying squirrels are often active just around dusk (Francis, 2008). We observed *P. petaurista* in two different locations, Kalisat in Ijen and Sukamade in Meru Betiri. Some authors (Lee et al., 1993a) report this species to be solitary, but we observed multiple individuals at close vicinity to each other. Due to their fast movement (gliding from tree to tree) it is difficult to tell the exact number of individuals observed when surveying, but we estimated that we saw groups of 2-4 individuals at both locations.

In Taiwan *P. petaurista* lives sympatrically with *P. alborufus* in mountain forests with *P. alborufus* being more common at higher altitudes (Lee et al., 1993b). Whether this is true for *P. petaurista* and *P. elegans* in Java has not been studied. Also, further research would be required to assess whether *P. elegans* is truly absent from East Java or whether it just has not been recorded there as is the case with Sunda colugos. Interestingly, *P. elegans* is also said to lack the distinctive white spots on Java (Francis, 2008), making identification between the two species more difficult (Figure 7).

Figure 7. A red giant flying squirrel (*Petaurista petaurista*) and spotted giant flying squirrel (*Petaurista elegans*). Photos: Yu-hui Ding, ARKive & Celine Low, Cicada Tree.

Pliosungnoen et al. (2010) speculate on possible competition between slow lorises and giant flying squirrels based on the two taxa not been sighted in the same survey areas at the same time (Radhakrishna et al., 2006).

4.7.3 Civet species

Civets are mostly nocturnal mammal species native to tropical Asia and Africa with most species diversity found in Southeast Asia (Nowak, 1999). The Asian palm civets, the Hemigalinae and Paradoxurinae, are two subfamilies confined to South and Southeast Asia. They are generally nocturnal, arboreal and frugivorous, with possibly an important role in seed dispersal (Corlett, 1998; Patou et al., 2008).

Indonesia is home to 11 species of civets, of which at least three are found on Java; binturong (*Arctictis binturong*), common palm civet (*Paradoxurus hermaphrodites*) and small-toothed palm civet (*Arctogalidia trivirgata*). Their distribution and abundance on Java are very poorly known. Because of the unknown status of many species, Java has been defined as the third most important global priority area for mustelid and viverrid conservation (Schreiber et al. 1989). Small Indian civet (*Viverricula indica*) has been historically recorded on Java (Duckworth et al., 2008a), while possible existence of Malay civet (*Viverra tangalunga*) is based on two museum specimen (Meiri, 2005). Brooks & Dutson (1994) report observing a Masked palm civet (*Paguma larvata*) on Java. They argue that it is feasible that the species occurs naturally on Java, but the more probable explanation is an introduction.

4.7.3.1 Common palm civet (Paradoxurus hermaphrodites)

Common palm civet (*P. hermaphrodites*) (Figure 8) has a large range all through South and Southeast Asia. It is listed by IUCN as Least Concern, but increasingly caught from the wild. They are hunted as a pest and for consumption and captured for pet trade as well as for the growing civet coffee ‘kopi luwak’ production (Shepherd, 2012).

Figure 8. A common palm civet. Photo: Daniel Heuclin, ARKive.

Common palm civet is so variable in pelage that numerous invalid taxa have been named (Eaton et al., 2010). At least 30 subspecies have been described (Schreiber et al.,1989) and their taxonomic status needs clarification (Patou et al., 2008). This is true also for the Javan form (*P. h. javanicus*). Patou et al. (2010) found no genetic evidence to distinguish populations of Sumatra and Java and do not agree with the definition of these two subspecies.

Very few studies have been conducted on palm civet ecology, but *P. hermaphrodites* is tolerant of human impact, as long as they are not actively hunted, and appear to thrive in degraded landscapes (Corlett, 1998). Our encounter rate of 0.10 animals/km is relatively low compared to Iseborn et al. (2012), who reported mean linear encounter rates of 0.35 animals/km (SE ± 0.17) and 0.39 animals/km (SE ± 0.21) for the species in two surveys areas in Cambodia.

4.7.3.2 Small-toothed palm civet (Arctogalidia trivirgata)

Small-toothed palm civet (*Arctogalidia trivirgata*) ranges from northern South-east Asia down to the islands of Sumatra, Borneo and Java (Figure 9). Three sub-species are recognised, *A. t. leucotis* from mainland areas north of the Isthmus of Kra; *A. t. trivirgata* from Malaya, Sumatra, and Borneo; and *A. t. trilineata* from Java. The

Javan taxon (*A.t. trilineata*) is clearly distinct from the ones on Borneo and Sumatra, which could indicate that it may be a distinct species (Duckworth et al., 2008b; Eaton et al., 2010). The species is listed by IUCN as Least Concern and it is widespread and often locally common in mainland South-east Asia, Borneo and Sumatra. The status of the Javan taxon is poorly known (Eaton et al., 2010; Moore, 2011). Already in the early 1900s, the small-toothed palm civet was considered to be one of the rarest mammals of Java (Schreiber et al., 1989).

Figure 9. A small-toothed palm civet (*Arctogalidia trivirgata*). Photo: Ch'ien C. Lee.

As with colugos, small-toothed palm civets have been reported only from western Java in the Gunung Halimun NP (Eaton et al., 2010; Moore, 2011). However, the lack of other recent records does not prove that the species is rare and its range may be much underestimated as it hasn't been surveyed in other areas (Eaton et al., 2010). Our observations of six individuals in Meru Betiri and Alas Purwo national parks would indicate that the species could be present all over Java.

4.7.3.3 Identification of civets

Identification between the two palm civet species can be challenging, especially due to varying pelage colour and patterns, but there are some distinct differences. The cheeks and face of a common palm civet are usually black forming a face mask

(Francis, 2008). Small-toothed palm civet has very distinctive head structure and its tail, which at 48-66 cm is very long even for a palm civet, looks tubular and woolly (Eaton et al., 2010). As the tail of *P. hermaphrodites* is shorter (33-42cm), we considered the length of tail as a key factor to identification.

The two species also have very different styles of movement. Both are arboreal, *A. trivirgata* strictly so (Francis, 2008). Moore (2011) reported seeing *A. trivigata* always in a tree (height 1–12 m), never on the ground. Our observations support this with no sightings on the ground with median height of 14.5 m (range 4-31 m). *P. hermaphrodites* seems to have more semi-arboreal nature (median height 3 m, range 0-4 m) with two individuals encountered on ground.

The third civet species on Java, binturong is easily recognisable, because of its larger size and bushy tail (Nowak, 1999). Malay civet and small Indian civet are mostly terrestrial and both have spotted pelage and banded tails (Francis, 2008). If these two species are indeed present on Java, identification is surely more difficult and misidentification between civet species is likely to happen. Indeed, the unidentified individual in Alas Purwo, we observed on a feeding ground and it clearly had a banded tail, which would indicate it was not a palm civet.

4.7.4 Other species

In addition to the other sightings, we also encountered two Javan chevrotains (*Tragulus javanicus*) in Meru Betiri (Figure 10). Chevrotain is an even-toed ungulate in the Tragulidae family, and after the recent taxonomic revision it is endemic to Java, although it might exist in Bali. Little is known about this species and there might even be two distinct chevrotain taxa on Java (Meijaard & Groves, 2004).

Figure 10. A Javan chevrotain (*Tragulus javanicus*) in Meru Betiri NP.

In Meru Betiri we also saw two small Asian (or Javan) mongoose (*Herpestes javanicus javanicus*) and a black giant squirrel (*Ratufa bicolor*) (Figure 11).

Figure 11. A small Asian mongoose (*H. j. javanicus*) and a black giant squirrel (*Ratufa bicolor*) in Meru Betiri NP. Photos: Guillaume Douay.

4.8 Anthropological aspects

As our results show, short-term surveys can be useful for assessing the presence of species, but estimating abundance or absence requires longer survey effort. However, even short-term survey data can be supplemented by collecting information from local people. This can be done by conducting interviews as well as visiting local animal markets.

4.8.1 Local Ecological Knowledge (LEK)

East Java has been much less studied than the west, maybe because it hasn’t been expected to have much biodiversity. Overall during our surveys we encountered many species with unknown status and some even outside their recorded geographical range. However, many local rangers did not consider our sightings unusual. People who live in or near these areas and regularly go into the forest, have large amounts of information which could be used for assessing presence or even distribution and abundance of various species. This knowledge is called Local Ecological Knowledge (LEK). It is largely orally transmitted, is cumulative, is typically local in scale, and builds on the experiences of past and present generations through mentoring, storytelling, and cooperative work (Brook & McLachlan, 2008). LEK is increasingly being used in wildlife monitoring and management, understanding historical and on-going processes and even in obtaining distribution and abundance data (Anadón et al., 2009).

Interviews are one method of collecting Local Ecological Knowledge (Anadón et al., 2009). Interview-based surveys have not traditionally been regarded as reliable with conservation scientists, but increasingly they are used to complement ecological survey methods (Meijaard et al., 2011). They are especially useful when large survey areas need to covered or dealing with rare and cryptic species, and has been successfully done with Bornean orangutans (Meijaard et al., 2011) and pygmy slow lorises in Cambodia (Starr et al., 2010).

Meijaard et al. (2011) compared interview-based surveys to traditional ecological survey methods and found out that using interviews can be very cost-effective. Conventional ecological research cannot always be conducted quickly enough and over large enough areas (Brook & McLachlan, 2008). Interview-based surveys provide reasonably reliable estimates of relative presence and relative encounter rates of poorly known species. They are also very useful at defining and quantifying the main threat factors.

Finding an individual or a group of “experts” is fundamental when exploring LEK. Reliability of local knowledge depends strongly on characteristics of the target taxa as well as the people being interviewed (Anadón et al., 2009). In order to get reliable results, the species should be relatively easily identified and its detection should not need any particular skills. Naturally, when the difficulty of identifying and detecting a species increases, the number of potential interviewees will decrease. This will increase the sampling error, and lead to possible biases and poor data quality (Anadón et al., 2009; Meijaard et al., 2011).

So called social-desirability bias occurs when interviewees want to answer in a positive manner, even if giving dishonest answers (Meijaard et al., 2011). This is especially true in Southeast Asia, where ‘loosing face’ is considered unacceptable. We conducted the interviews in bahasa Indonesia as it is important to use the local language and understand the cultural connotations in order to pick up when someone is telling the truth and not trying to please you.

In addition, sometimes people might not be honest or they are reluctant to share their knowledge. Especially if the species has an economic value or because they believe the information may be used against them, e.g., declaring protected areas (Anadón et al., 2009). This became evident during our interviews as well. People clearly know the market value of slow lorises and other wildlife, and seem to be aware of illegal nature of the trade. While some individuals openly talked about their knowledge, others were clearly secretive and even suspicious. Since LEK research necessarily includes humans as research participants, a careful consideration of implications of the entire research process is needed (Brook & McLachlan, 2008).

Overall data from our interviews support the presence of lorises in Meru Betiri. Most people we talked to recognised the species and had either seen one or at least heard of other people seeing lorises at all our survey locations in the national park.

On the contrary, in Alas Purwo people were rarely aware of lorises and even fewer recognised one. We heard of no confirmed sightings, but were told a few times that they might exist further in the forest, where 'nobody ever goes'. These places are called *angker*, meaning haunted, sacred or forbidden. An area that is *angker* cannot be inhabited, or sometimes cannot even be entered by humans. Often they are mountains, and regarded as 'the 'land of the souls', where the spirits of the ancestors dwell (Boomgaard, 1999). Alas Purwo especially still retains these forests with ancient tombs and temples. While it makes surveying these areas challenging, it might also provide much needed refuges for wildlife in East Java.

Around Ijen people seemed to be aware of lorises. However, no one could indicate exact locations for sightings and any possible sightings were years if not decades ago. The remaining forest fragments around Ijen are easily accessible by good roads and have been under heavy poaching since the 1980s.

4.8.2 Myths and stories

Interview might also reveal myth and stories. Lorises are traditionally used in medicine but they are also used in religious practices and considered to be spiritual animals. For many Asian cultures animals are seen as objects to serve human needs, and the concept of wildlife conservation and prohibition of the use of natural resources can be alien to people (Alves et al., 2010). Paluga (2006) summarizes well the attitude to primates:

> "*The complex and ambivalent ways in which Southeast Asians relate to animals can readily be observed in the case of monkeys. Monkeys are variously feared, venerated, hated, displayed, disciplined, respected, made as resources for moralizing, given a sacred space, plus a host of more ambivalent emotions*."

Lorises are a source of myths and stories in all over their range. In Indonesia beliefs range from burying lorises under the foundations of a house to bring luck to using body parts of lorises to curse enemies (Nekaris et al., 2010a). We were told that lorises are illegitimate children thrown to the forest. This might reflect their distinct vocalisation, which is described as a child's cry-like (Bearder et al., 2002) and hence one of the local names, *tukang lare, lare* meaning child. We also heard of a belief that if you see a loris you will become rich. Different parts of lorises are used for various ailments. We were informed that sometimes their collarbones are buried in front of houses to bring good luck.

4.8.3 Wildlife trade

Slow lorises are one of the most commonly found endangered primates in Indonesian animal markets (Malone et al., 2003; Shepherd, 2010). They are used for traditional medicine all over Southeast Asia, but the trade in Indonesia is mainly for pets, both for local and international trade (Nekaris et al., 2010a). The level of harvest is thought to be unsustainable (Nekaris & Nijman, 2007), confirmed by hunters in West Java, who revealed that if they see a slow loris in the forest, they will always catch it, even it is a non-target species (Nekaris et al., 2010a). This is known to happen in other countries as well (Starr et al., 2010).

Poaching of all wildlife has increased, because new roads allow better access to forests, internet creates more demand and it is profitable with a very small risk of being punished. It is even possible that we failed to detect any lorises in most of our survey areas, because they've been poached to local extinction in these areas. This was the likely the case in Mondulkiri Province, Cambodia, where in late 2008 and 2009 three transects with previously high encounter rates in early 2008 were surveyed and no lorises were detected (Starr et al., 2010).

Bali, Java and Sumatra are central to the regional trade of primates in Indonesia (Malone, 2003; Shepherd, 2010). Over a 10-year period (1997 – 2008), in 66 surveys at a market in Medan, North Sumatra, 714 individual greater slow lorises (*N. coucang*) were encountered. It was one the most commonly traded primate species with long-tailed macaque (*M. fascicularis*) and pig-tailed macaque (*M. nemestrina*) while Javan lutung was the only non-Sumatran species on sale. The same species are most prevalent also at markets in Bali and Java, and there are clear links between animal traders in Java and Sumatra (Shepherd, 2010). Some of the slow lorises for sale could have actually been *N. javanicus*, because at the time it was only known as a sub-species of *N. coucang*.

Trade in high-profile, charismatic species such as orangutans and gibbons has become more discreet, but the trade in lower-profile, although totally protected species, such as the slow loris, continues to be carried out openly in the markets (Shepherd, 2010). Vendors speak freely about how they obtain animals, and discuss usages, prices and numbers of sold animals (Nekaris et al., 2010a). In some big cities of Java, for example Malang and Surabaya and also Denpasar in Bali, people travel around selling traditional medicine with parts of slow loris bodies (Alves et al., 2010).

We visited three small bird markets in Jember, Banyuwangi and Bondowoso. No slow lorises or other primates were observed on sale, but at both Jember and Banyuwangi markets we were told that they have had lorises for sale. We were told by a ranger from Meru Betiri, that a price for a slow loris at the market in Jember is 300.000 IDR. Both Jember and Bondowoso market had very young leopard cats for sale and we also saw a civet at Bondowoso, but could not identify the species (Figure 12). A civet could be purchased for 75.000 IDR in Banyuwangi, although none were for sale, when we visited the market.

Figure 12. An unidentified young civet at a market in Bondowoso.

Civets are sold for food and as pets, but more recently they have been taken from the wild for production of civet coffee, ‘kopi luwak’. Shepherd (2012) reported three species of civets at markets in four markets in Jakarta with the common palm civet being the most common species for sale. While we stayed at Jampit in Ijen, we talked with a local farmer who told us that civets are rarely seen in the coffee plantations anymore and if one is seen it is sold to the local coffee production plant. We surveyed the area for one night and failed to observe any mammals in the area. We were able to confirm that up to 80 civets were being kept in captivity at the plant for ‘kopi luwak’ production (Figure 13).

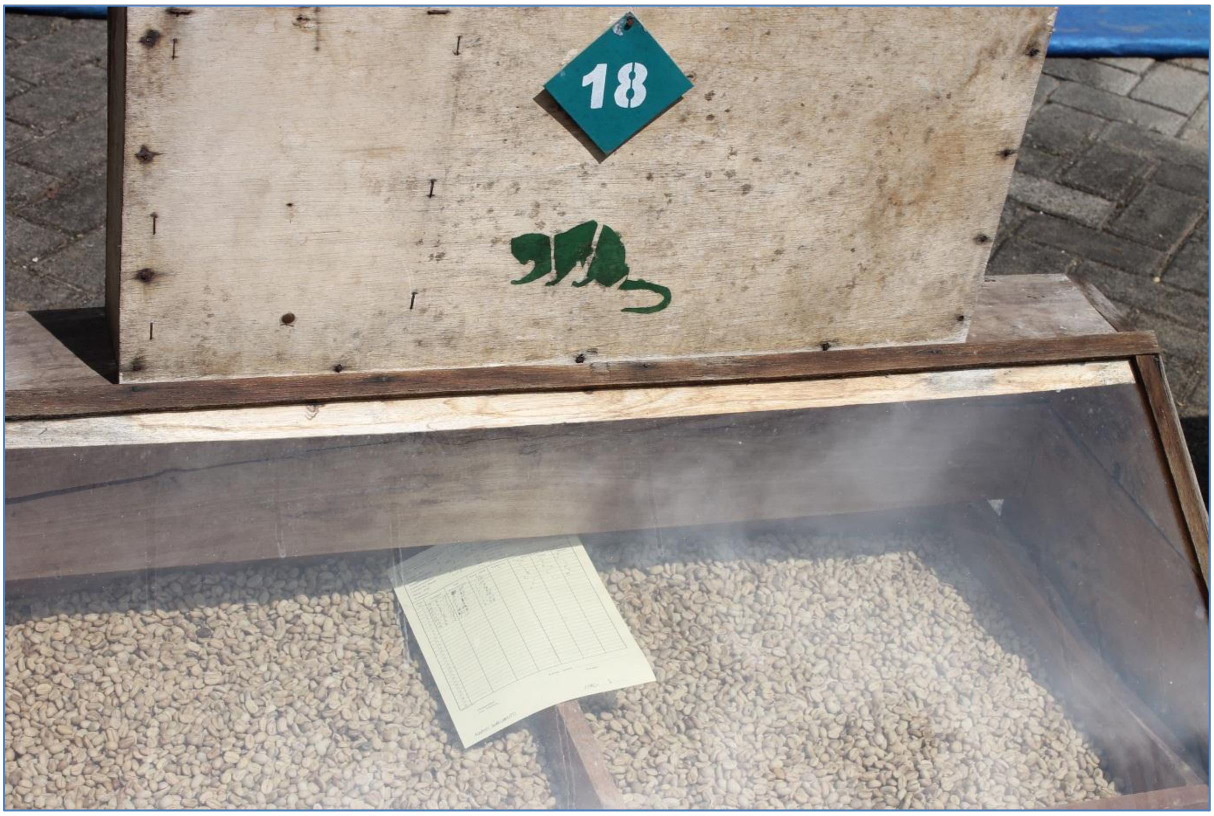

Figure 13. ‘Kopi luwak’ at coffee producing plant at Jampit, Ijen Plateau.

Indonesia is a signatory to many international conventions on biodiversity conservation, including the Convention on International Trade for Endangered Species of Wild Flora and Fauna (CITES) (Lee et al 2005). There is also sufficient national legislation in place to control and regulate the trade in primates and other wildlife, yet implementation and enforcement of these laws is lacking (Shepherd, 2010) and corruption is rampant. Nekaris et al. (2010) found during markets visit, that traders had no incentive to conceal their trade in slow lorises, even though the penalty according to law is up to 5 years of imprisonment and fines of up to USD 10,000. Enforcement officials often have limited knowledge of these regulations and laws, and are also unable to identify the species involved in trade (Lee et al 2005).

Also, according to Indonesian law, non-protected species may only be traded domestically or internationally following a harvest and export quota system. For example, thousands of long-tailed macaques are exported every year (Shepherd, 2010). Of five non-protected civet species, only common palm civet has a quota for capture and trade, of 270 individuals per year to be sold live as pets (Shepherd, 2012). Observations from wildlife markets around the country and increasing ‘kopi luwak’ production clearly indicate that the quota is not followed. Laws and regulations will not curb illegal wildlife trade alone. The collaboration and involvement of local people, NGOs and governmental organizations is essential (Malone et al., 2003).

Successful confiscations from the markets create a problem of placement of the confiscated animals. Most rescue centres in Java are full of animals or lacking financial assets to take in any more animals (pers.obs.). Thus the illegal wildlife trade not only contributes to the loss of wild populations, but can also lead to arbitrary release of animals (Nekaris & Jaffe, 2007). We were told by a ranger in Meru Betiri, that if he sees a loris at a market in Jember, he will buy it and release it to the forest. This is a good example of a release of an animal without any regard to their health status, their behavioural needs, or their geographic origin (Nekaris & Jaffe, 2007). Nekaris & Jaffe (2007) found that two loris species are clearly discernible in the Javan trade, *N. coucang* and *N. javanicus*, with nearly two thirds of the individual animals originating from Sumatra. On the other hand, a small market near a national park such as the one in Jember is likely to source its animals from the park.

4.8.4 Conservation implications

A first step in creating a meaningful conservation strategy involves understanding a species’ status, which is determined by both the distribution and the abundance of a species, and the rate at which they change over time (McGowan et al., 1998). Distribution and abundance of a species fluctuate due to natural ecological processes, but as discussed before they are increasingly influenced by human activities. The fact that the loris can survive in disturbed habitats is promising. On the other hand this is a possible conservation problem if most surviving populations are found outside protected areas (Voskamp, 2012). The trade especially has a devastating effect on the Javan slow loris. The remaining, apparently small populations are unlikely to sustain themselves as a consequence of the rampant poaching, especially in small habitat fragments. There is proof from repeated surveys from India (Kumara et al., 2006) and Cambodia (Starr et al., 2010), that over the years numbers of lorises have declined in the survey areas. Because Javan slow loris has been studied only recently, there is no long term data to make comparisons, but the low encounter rates would suggest a similar trend.

While habitat loss and wildlife trade are multifaceted problems which require co-operation of various parties and attitude changes, other strategies are used. Reintroductions and releases are used to reinforce diminished populations for many wildlife species and have been done with lorises as well (Streicher, 2004; Collins & Nekaris, 2008; Moore 2012). If not planned and implemented properly reintroductions have potential serious effects not only to the released individual, but to wild populations as well. Inability to identify species means that different species are housed together in rescue centres and non-native species released to the forests. Both cases may lead to hybridization (Nekaris & Jaffe, 2007). Animals released without proper health checks carry a risk of spreading diseases. Most rescued animals would not be suitable for release due to various health and behavioural problems, even after rehabilitation. This often leads to low survival rates of reintroduced lorises (Moore, 2012).

Whatever the strategy used for ensuring the long-term survival of the Javan slow loris and other species, surveys are needed to produce data for planning and monitoring of the conservation projects. Out of the survey sites, Meru Betiri NP has the most biodiversity and all the encountered species during this study were present there. As such we would recommend it to be a priority site for conservation of nocturnal small mammals in East Java.

5 Conclusions

The purpose of this study was to assess the potential presence and abundance of *N. javanicus* in East Java based on ecological niche modelling predictions. The results confirmed the presence of lorises in one of the recommended survey areas (Meru Betiri NP), but with the small sample size it was impossible to produce any meaningful abundance estimates. Interviews and market visits proved to be useful complimentary methods, and indicated possible loris presence in other areas. They also confirmed that poaching and trade on loris is happening also in East Java. Further research with adequate time to survey areas would be required.

On the other hand, many other species were encountered during the surveys producing useful presence data on nocturnal small mammals on East Java. As there are hardly any recent records on these species in the survey areas, any effort to bring new knowledge about these species is useful. Surveying for multiple species at the same time would be a cost effective strategy as other species will be encountered when looking for lorises. Surveys assessing presence/absence of a species should be done with enough time and effort as recording false absences can result in inadequate conservation measures and as such increase the risk of local extinctions. Surveyors should also have enough experience to make reliable identification of species.

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Appendix I Ethics form

Faculty Ethics form HSS.E2

Faculty of Humanities and Social Sciences

Application for ethics approval for a research project involving human participants

Undergraduates and Foundation Degree Students:

Before completing this form, the ethics review checklist (school form HSS.E1) should have been completed to establish whether this additional application for ethics approval is required. If ethics approval is required, you should complete this form, sign it and submit it to the Faculty Research Ethics Officer, Maggie Wilson at mvwilson@brookes.ac.uk. A decision form, E3 will then be returned to you by e-mail.

Master's Students:

You should complete this form before you start your project and submit it to your supervisor.

If he or she is unable to sign it at this stage, the form will be referred to the Faculty Research Ethics Officer, as above, who may seek further information and clarification from you. A decision form, E3, will then be returned to you by e-mail.

All students should refer to the University Code of Practice on Ethical Standards for Research involving Human Participants, available at www.brookes.ac.uk/res/ethics and Faculty guidelines, which are included in the relevant on-line module or course handbook. You should bind a copy of the approved form in your final project or dissertation submission.

1.	Name of Principal Investigator (Student):	Jonna Lehtinen	
	E-mail address:	12066351@brookes.ac.uk	
2.	Name of Supervisor and e-mail address:	Professor Anna Nekaris	
	E-mail address:	anekaris@brookes.ac.uk	
3.	Working Project Title:	Distribution of the Javan Slow Loris (*Nycticebus javanicus*): assessing the presence in East Java.	
4.	Project Type (please specify course and give module number):	Master's dissertation	MSc in Primate Conservation (SS85), P20107 Final Project
5.	Background to and rationale of proposed research:	The distribution of the Javan Slow Loris (*Nycticebus javanicus*) is only known in western parts of the island of Java. Hence research is needed to assess its distribution in the east.	

6.	‘Gatekeeper’ permission If you are conducting your research within an organisation external to Brookes, such as a school or company, has permission been obtained? Attach a copy of the letter or e-mail giving permission	Permit for foreign researcher in Indonesia applied from The Indonesian Institute of Sciences (LIPI)
7	Methods of data collection: Attach a copy of your draft questionnaire, interview schedule or observation guidelines	Field surveys using transects, unstructured interviews with local people.
8	Participants involved in the research: Include the target number, age range, source and method of recruitment and location of the research	1 Indonesian assistant throughout the project, local guides will be employed at survey sites. Randomly chosen local people will be interviewed.
9	Are participants in a dependent relationship) as an unequal power relationship) with the researcher? If yes, what steps will you take to ensure that participation is entirely voluntary and is not influenced by this relationship?	No. Participation is voluntary.
10.	Potential benefits of the proposed research:	Beneficial field experience for the assistant.
11	Potential adverse effects of the proposed research and steps to be taken to deal with them: These are defined as risks greater than those encountered during normal day to day interactions and could include possible psychological stress or anxiety	--
12.	Plan for obtaining informed consent: Please attach copy of your participant information sheet and consent form (Note consent forms are not needed for questionnaires)	--
13.	Steps to be taken to ensure confidentiality of data: Outline steps to be taken to ensure confidentiality, privacy and anonymity of data during collection and publication of data	No personal data will be stored. Dissertation and project report will be written in a way that any individual cannot be recognised from it.
14	Debriefing and/or feedback to participants What debriefing and support will participants receive after the research?	Interviewees will be told about the aims of the project.

	How will findings of the research be made available to them?	
15	Data storage and security How will you ensure safe data storage during fieldwork and after publication?	No personal data will be stored.

All materials submitted will be treated confidentially.

I have read and understood the University's Code of Practice on Ethical Standards for Research involving Human Participants

Signed: JONNA LEHTINEN Principal Investigator /Student

Signed: KAINEKARIS Supervisor

5/5/13

Date: