SUMMARY OF BIOLOGICAL AND SOCIOLOGICAL RESEARCH CARRIED OUT BY OPERATION WALLACEA IN THE FOREST OF CENTRAL BUTON

Edited by Adrian Seymour

Operation Wallacea 2006

Introduction

This report contains a summary of the biological and sociological research carried out on Buton Island by Operation Wallacea scientists, project students and volunteers in the 2006 field season. The field research by Operation Wallacea on the people, fauna and flora of central Buton is strongly geared towards biological conservation, and includes one of the largest biological monitoring schemes of its kind, both in terms of number of taxa monitored and the spatial extent of the sampling. Much of the research focusses on assessing the effectiveness of a 3-year rainforest conservation program funded by the World Bank's Global Environment Facility (GEF) which started in June 2005. This conservation program concentrates on the Lambusango Forest, an area of lowland rainforest covering around 650 square kilometres, divided into three principle managment blocks: the Lambusango Forest Reserve (~261 km^2) managed by the Natural Resource Conservation Agency (*BKSDA*) on behalf of the Minsitry of Forestry, and Limited Production Forest (~182 km^2) and Production Forest (~207 km^2) both managed by the Buton District Forestry Office (*Dinas Kehutanan Buton*).

The GEF rainforest conservation program is attempting to address the principle threats facing the forest and its fauna (e.g. illegal logging and hunting, forest clearance for settlements, agriculture and mining) using a variety of methods including the introduction of community forestry, economic incentives to reduce overexplotation of forest resources, promoting positive attitudes to conservation through education, and increased policing. To assess the effectiveness of these conservation initiatives Operation Wallacea scientists are monitoring both sociological changes related to forest use and the abundance of key taxanomic groups of plants and animals. These taxanomic groups include the anoa (*Bubalus depressicornis*) an IUCN red listed Sulawesi-endemic forest ungulate threatened by hunting; the Buton Macaque (*Macaca ochreata brunnescens*) a Buton endemic subspecies that frequently comes into conflict with local farmers; the forest bird community, a well-known group of species rich in Sulawesi endemics and containing a number of forest specialists (some of which are threatened by the pet trade); the rattans, an economically important group of climbing palms harvested for their canes used in furniture making; and timber trees, which are being illegally extracted throughout the forest.

In addition to those studies related to the GEF funded forest conservation project, there were a number of other ecological studies focussing on either single species or whole communities. Some of these studies have been running for a number of years and continue to contribute to unique long-term data sets on abundance and community composition (e.g. Malay civets *Viverra tangalunga*, bats, herpetofauna, murid rodents), others have focussed on human-wildlife conflict (e.g. Buton Macaques), and another study focussed on tree taxonomy and identification.

This report is divided into six sections: the first section describes the study sites including the location of sampling transects and study grids used by the majority of the biological studies. The second section presents the initial findings of the two botanical studies carried out this year. The third and fourth sections present the studies of Buton's fauna from single species and biological community perspectives respectively, and the fifth section outlines some qualitative findings of the social science studies carried out in 2006. The final section describes some of the conservation issues encountered by Opwall staff in 2006 and lists some broad conservation reccommendations.

This report has been compiled immediately following the field season, with very limited time for data synthesis and analysis as a requirement of the Indonesian Institute of Sciences (LIPI).

As a result, many of the summaries are necessarily brief and incomplete. However, the information in this report gives a good indication on the extent and direction of scientific research that has been carried out by Operation Wallacea staff, students and volunteers in 2006. More complete analyses of this work will be presented in peer-reviewed journals and as student dissertations, which, when complete, will be available from Operation Wallacea on request.

Study sites

All the research was carried out in central Buton in the districts of Lasalimu, Lasalimu Selatan, Kapontori and Pasarwajo. The sociological monitoring was carried out in seven communities around the Lambusango forest: Labundo-bundo and Watambo (Kapontori district), Lawele and Nambo (Lasalimu district), Harapan-Jayah (Lasalimu Selatan district), Wajah-Jaya, and Wining (Pasarwajo district). All the biological monitoring was carried out in the forests contained within the four districts. Most of the biological studies carried out in 2006 used one of two types of study site, the 'study grids', and the 'node camps'. There were three study grids, each consisting of a 1 km^2 grid with trails cut a 100m intervals (Fig. 1), and six node camps, each consisting of four parallel three kilometre transects seperated by 1 km (Fig. 2). The study grids have been established for a number of years, whilst the node camp transects were set up in 2004 (Lapago, Anoa, Wahalaka, Wabalamba & Bala) and 2005 (Lasolo) in response to the requirements of the GEF biological monitoring program. The node camps are distributed fairly evenly throughout the core of the proposed GEF Lambusango Forest Management Area (includes Forest Reserves and Limited Production Forest), so that the monitoring could assess changes in the composition and abundance of selected taxa in areas with different physical and socio-economic characteristics and different levels of anthropogenic disturbance.

Anthropogenic disturbance at sampling sites

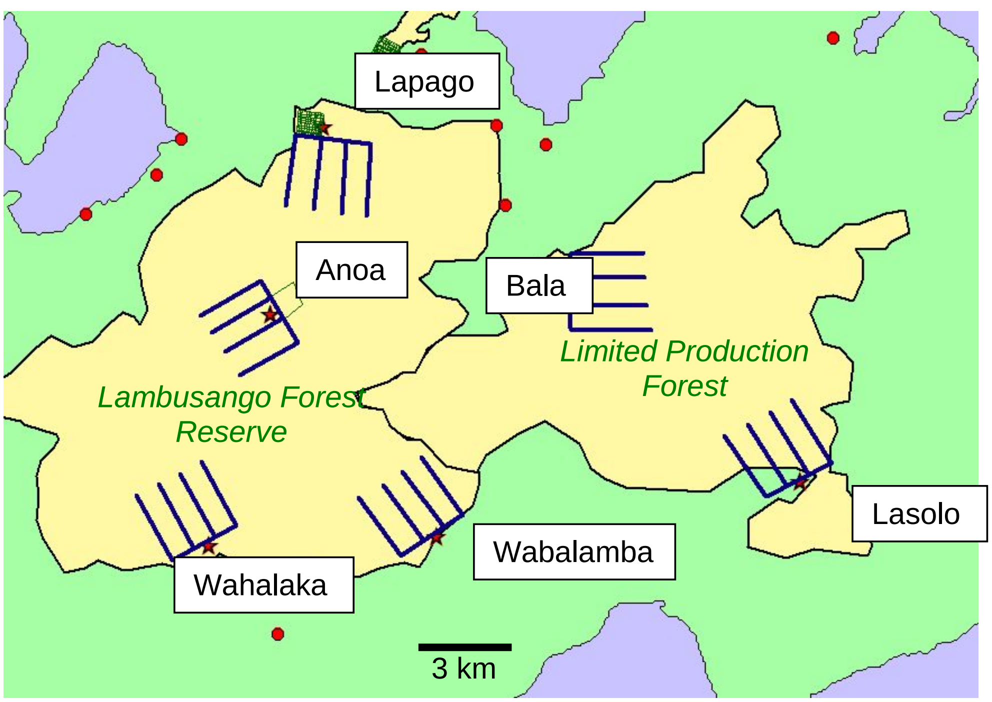
There are many different kinds of anthropogenic disturbance that can have very different effects on biota. In the context of forest conservation, disturbance usually refers to habitat alteration. On Buton this includes forest clearance, selective logging, mining, and rattan collecting. These activities alter the structure of the forest and change the identity and diversity of niches available. Because successional processes are typically slow in rainforests (in the order of decades), both historical and current habitat alteration are expected to have important effects on rainforest biota. Some study sites, such as Lapago and even Anoa (the remotest sampling site), show signs of long-abandoned farms such as old dry-stone walls and cultivated trees (e.g. coconut and banana trees). Levels of current habitat alteration are likely to be strongly correlated with accessibility from roads and villages, but historical disturbance may show weaker or even no correlation with current patterns of accessibility. In 2004 levels of on-going habitat alteration were very apparent along the node camp transects at Wahalaka and Wabalamba where notably high levels of rattan collecting and selective logging were observed. In 2005 there were signs of considerable illegal logging on and around the Lapago study grid, with more than 30 trees felled for timber.

In addition to habitat alteration, anthropogenic disturbance to the forest includes the removal of animals. This includes the hunting of anoa for meat, catching fish and crayfish from streams, trapping birds and monkeys for the pet trade, and killing perceived agricultural pests such as monkeys and pigs. Hunting and trapping occurs throughout most of the forest, but effort is likely to be correlated with accessibility.

Finally, the presence of people in the forest is likely to disturb the behaviour of many species regardless of whether they are altering the habitat or taking animals, simply because shy species will flee or show increased vigilence behaviour, which may result in increased stress levels or a reduction in the time available for feeding and other important activities.

Figure 1. The location of Operation Wallacea study grids in Central Buton. Green areas represent protected forest. Red lines are roads and dotted lines are trails.

Figure 2. Location of GEF sampling transects (solid blue lines).



Botanical Studies

Taxonomy of Trees and Growth Rates of Rattans in the Lambusango Forest

Andrew Powling

Introduction

The correct identification of forest plants is essential if the ecology of the forest is to be understood and repeatable science is to be done. Previously, taxonomic work has concentrated on rattans and ferns, but this year forest trees were also investigated. Ecological work on rattans has continued in order to measure the growth and survival of different species in forest conditions. The pH values and conductivities of soils in the forest have been investigated to assess the influence of underlying rocks (limestone and ultramafic) on the ecology of the plants.

Methods

Trees: Leaves were collected, and where available flowers and fruits, and comparisons made with published descriptions and drawings of SE Asian forest trees. This was greatly aided by the tree climbers Damien Seymour, Rio Kornel and Fifin.
Rattans: Parts of three rattan species were harvested from Production Forest and sent to the Herbarium Bogoriensis for identification. Measurement of heights of rattan stems was done either using a tape measure, or by estimation if the stem was too high to measure directly.
Soils: Soil samples were prepared by mixing equal volumes of soil and distilled water. Measurements of pH and conductivity were made using a portable pH meter.

Preliminary Results

Trees: A list of tree species that have been definitely or probably identified has been prepared and is presented in Table 1. The list draws on work done in this and previous years. It contains 62 species, however more work needs to be done in the UK to confirm or refute some of the probable identifications, particularly those of fig trees. A species of palm was found this year that had not previously been seen in the Lambusango Forest, this has been provisionally identified as *Oncosperma horridum*.
Rattans: The growth rates of rattan stems has been found to vary considerably and has previously been shown to depend on the amount of light received. Some of the stems being monitored have growth rates of 4 to 5 metres per year, and one *Calamus zollingeri* stem has reached the canopy at about 20 metres and has flowered. Other stems have not grown at all – some *C. ornatus* and *C. siphonospathus* stems have remained in the rosette stage (no growth) for 4 years. Some stems have been killed by falling trees.
Soils: Measurements of pH and conductivity of soils derived from limestone and ultramafic rocks show that the limestone soils generally have higher pH values (range 5.3 to 7.6) than ultramafic soils (range 4.5 to 5.9). Limestone soils also give higher conductivity measurements, which is taken to result from a higher content of mineral nutrients for plants. These differences presumably account for the very different assemblages of plant species found on the two soil types.

Conclusions

Work on botany and plant ecology is progressing but much still needs to be done. Most species of forest tree have not yet been identified. More work can be done following the fate of rattan stems in undisturbed forests. A range of chemical analyses of forest soils would aid in the understanding of how the soils influence plant growth and species composition.

Table 1. List of vernacular names and scientific names of tree species in the Lambusango forest.

Local Name	Latin	Family
Albitsia	Paraserianthes falcataria	Leguminosae
Ampo	Metrosideros petiolata	Myrtaceae
Areng	Arenga pinnata	Palmae
Bangkali Kuning	Anthocephalus chinensis	Rubiaceae
Baru	Caryota mitis	Palmae
Bau (Besar)	Pterospermum diversifolium	Sterculiaceae
Bau (Biasa)	Pterosperum celebensis	Sterculiaceae
Belimbing Hutan	Averrhoa carembola	Oxalidaceae
Benoa	Hermandia ovigera	Hernandinaceae
Beringin Merah	Ficus virens?	Moraceae
Beringin Putih (1)	Ficus altissima	Moraceae
Beringin Putih (2)	Ficus benjamina	Moraceae
Betau	Calophyllum soulattri	Guttiferae
Bigi	Dillenia ochreata	Dilleniaceae
Bolongita	Tetrameles nudiflora	Datiscaceae
Bucu	Cycas rumphii	Cycadaceae
Cendana, Cendrana	Pterocarpus indicus	Leguminosae
Damar Merah	Canarium balsamiferum?	Burseraceae
Damar Putih, Onoli	Canarium aspersum	Burseraceae
Davi Davi	Ficus sp. (variegata?)	Moraceae
Ewu Ewu	Planchonia valida	Leycithidaceae
Eya	Ficus sp.	Moraceae
Froda	Erythrina sp.	Leguminosae
Galanti	Hydrostele selibica	Palmae
Ipi	Intsia palembanica	Leguminosae
Jati Super	Tectona grandis	Verbenaceae
Ka Hembe Hembe	Tabernaemontana sphaerocarpa	Apocynaceae
Kakou	Ficus fistulosa?	Moraceae
Kalibuta	Macaranga sp.	Euphorbiaceae
Kambau, Kambawu	Barringtonia racemosa	Lecythidaceae
Kangkura	Alstonia spectabilis	Apocynaceae
Kapok Hutan, Kawa Kawa	Bombax ceiba	Bombacaceae
Kapolili, Kapoluli	Lithocarpus elegans	Fagaceae
Kaseh, Kasai	Pometia pinnata	Sapindaceae
Kawaja Waja	Ficus hispida	Moraceae
Kayu Lawang	Cinnamomum celebicum	Lauraceae
Kelapa	Cocos nucifera	Palmae
Kia Merah	Homalium foetidum	Flacourtiaceae
Kimboa	Artocarpus elasticus	Moraceae
Koba Hitam	Trema orientalis	Ulmaceae
Koda Hitam	Ficus semicordata?	Moraceae
Lambakara	Oncosperma horridum	Palmae
Lapi	Macaranga spp. (inc. M. gigantea?)	Euphorbiaceae
Libo	Ficus septica	Moraceae
Lolipo	Terminalia copelandii	Combretaceae
Mande Mandea	Arthrophyllum diversifolium	Araliaceae

Melinjo	Gnetum gnemon	Gnetaceae
Monggi Moneva	Albizia lebbeck	Leguminosae
Moniaga (Merah)	Anthocephalis macrophyllus	Rubiaceae
Nam Nam	Cynometra cauliflora	Leguminosae
Nenas Hutan	Phalaria capitata	Thymelaeaceae
Ngasa	Lithocarpus havilandii?	Fagaceae
Pa Rigi Rigi	Leea angulata	Vitaceae
Palem Kipas	Livistona rotundifolium	Palmae
Panggi	Pangium edule	Flacourtiaceae
Pinang (Kampong)	Areca catechu	Palmae
Rau	Dracontomelum dao	Anacardiaceae
Sahempa	Pterospermum acerifolium	Sterculiaceae
Sampu	Areca sp.	Palmae
Sulewe Merah	Madhuca betis	Sapotaceae
Tokulo	Kleinhovia hospita	Sterculiaceae
Wiuu	Licuala celebica	Palmae
Wola	Vitex cofassus	Verbenaceae
(unknown)	Castanopsis buruana	Fagaceae
(unknown)	Casuarina sumatrana	Casuarinaceae
(unknown)	Duabanga moluccana	Sonneratiaceae

Rattan community composition

Atiek Widayati & Georgina Robinson

Introduction

Rattan belongs to the palm family Palmae or Arecaceae and is part of a sub-family of palms; Calmoidae. Rattan exists in most old world tropical forests, and is considered as an ‘ open access’ resource so is therefore exploited in most areas where it exists. It is estimated that the global rattan industry is worth US $6.5 billion per annum (ITTO, 1997).

In the communities surrounding the Lambusango Forest, as in many other rattan-producing forest areas in developing tropical countries, livelihood depends, to various extents, on rattan collection. The economic importance of rattan in this area still needs to be evaluated, especially in recent years when rattan prices have declined tremendously. However, the social importance of rattan is still considered quite high as a source of income and building material at local level, as is also the case in other areas (Dransfield, 1994; Nur Supardi, 1999).

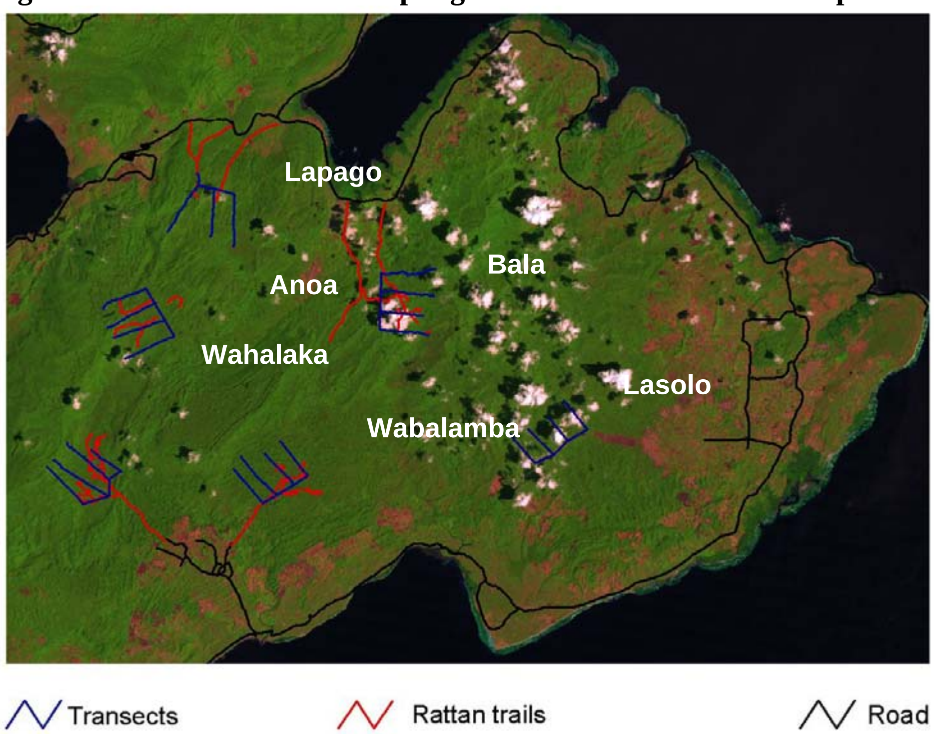
A better knowledge on the distribution, abundance and growth rates of different rattan species are needed to develop sustainable harvesting strageies for rattan to ensure continued long-term economic benefit from forest rattan and to promote conservation of rattan species. Preliminary observation to the rattan collection areas was conducted as part of the monitoring work of Lambusango Forest. The data collection was initiated in 2005, and this year, continuation and completion of the data collection was done in July-August 2006.

Method

Study area

Six node camps and the transects have been set at different locations in Lambusango forest, namely: Lasolo, Bala, Wahalaka, Anoa, Wabalamba and Lapago (Figure 3).

Figure 3. Rattan trails and sampling transects around 'node' camps



Rattan species distribution
Sampling was conducted in the areas indicated as target rattan clumps along the rattan trails in the vicinity of the node camps. At the site, local name identification was done by a local guide joining the survey. Species names were obtained from local names using lists based on previous research on rattan in the Lambusango Forest (A. Powling, pers. Comm.).

Tree characteristics in rattan harvesting areas
In rattan collection areas, tree characteristics were also recorded. Tree density, tree basal areas as well as tree species composition were obtained to show forest structure and condition in rattan collection areas. Measurements were done to the trees in the sampling plots and local names were identified. As the case with rattan, local names would later be 'translated' into tree species.

Plot for rattan and trees measurements
Both rattan inventory and tree inventory were done in the plots established in the sampling sites. As much as possible the positioning of the plots should be across slope and perpendicular to the trails.

Figure 4. Rattan and tree sampling plots

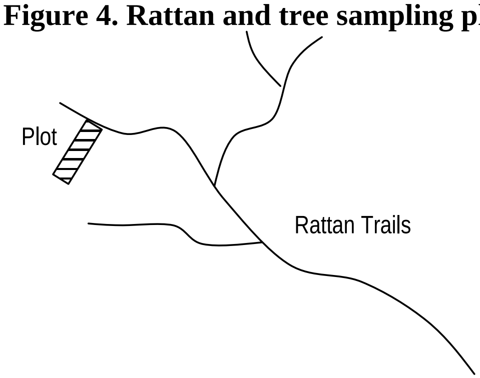
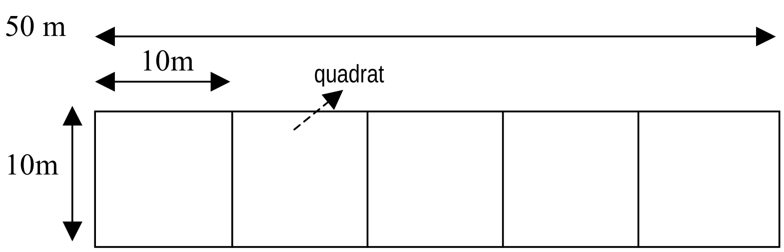


Fig 2. Position of plot



Measurements of rattan included: local rattan name (as proxy for species identification), cane length and diameter, and time elapsed since previous harvest. Measurements of tree characteristics included: local name and diameter at breast height (dbh). A number of other vegetation and physical characteristics were measured at each plot including: GPS position, altitude, slope, aspect, understorey light regime, soil, vegetation layers (Braun Blanquet approach).

Completion of Rattan Trail Mapping
Mapping of rattan trails in the vicinity of the node camps were mainly done last year (Widayati, 2005). However, in this year's data collection, whenever necessary trail mapping using a Garmin GPS Map 76 was still conducted to complete the gaps.

Results

The sampling effort at each site is shown in Table 2. Note that the following analyses do not include results from Lapago or Lasolo.

Table 2. Sampling effort at each site

Site	Number of plots
Wabalamba	9
Wahalaka	9
Anoa	7
Bala	8
Lapago	7
Lasolo	4

A total of 3857 rattan plants from 15 species were encountered during the study (data from Wabalamba, Wahalaka, Anoa and Bala only). The most commonly encountered species were Lambang *Calamus ornatus* (34%), Mombi *Calamus zollingeri* (33%) and Kabe *Calamus leiocaulis* (15%). The other species were encountered much less frequently, with any given species contributing less then 4.6% of all rattan plants enountered. The site with the greatest number of species was Bala with eleven species, but the site with the greatest diversity (according to Shannon's and Simpson's indices) was Wabalamba, followed by Wahalaka (Figure 5). The most commercially important big diameter rattans are Batang Asli (*Calamus zollingeri)*, Mombi (*Calamus sp. 13)*, Lambang (*Calamus ornatus)*, Umbul (*Calamus symphysipus)*, Torumpu (*Calamus koordersianus)*. Batang Asli usually has the highest market price, while the rest belong to the lower quality ones with lower prices.

Figure 5. Diversity indices of rattans in the region of four node camps (Wabalamba, Wahalaka, Anoa and Bala).

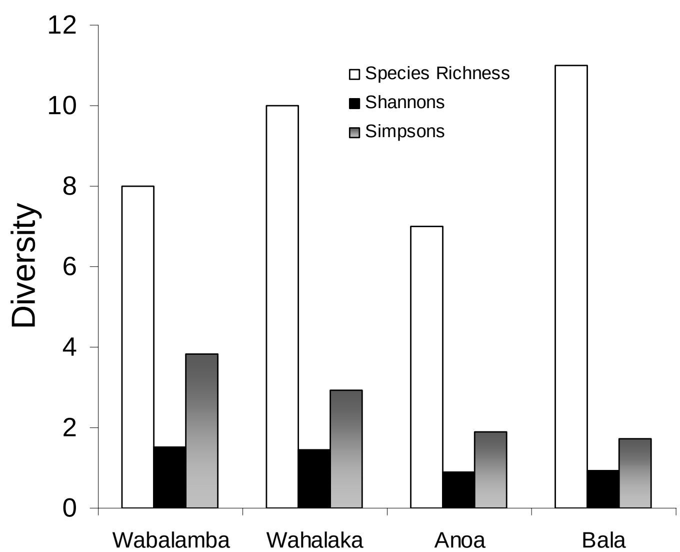


Figure 6. Rattan species abundance distributions at each site (vernacular names).

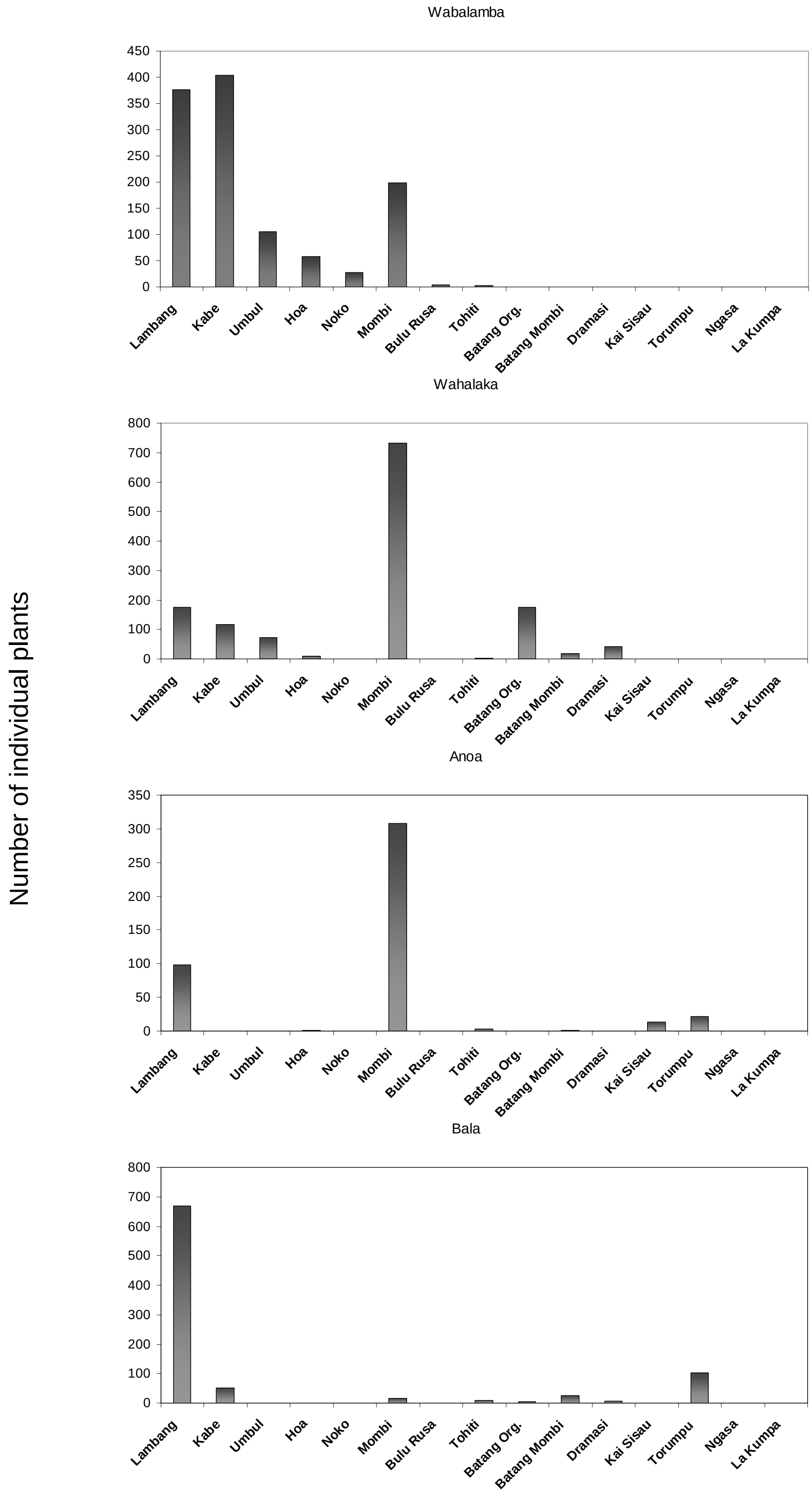
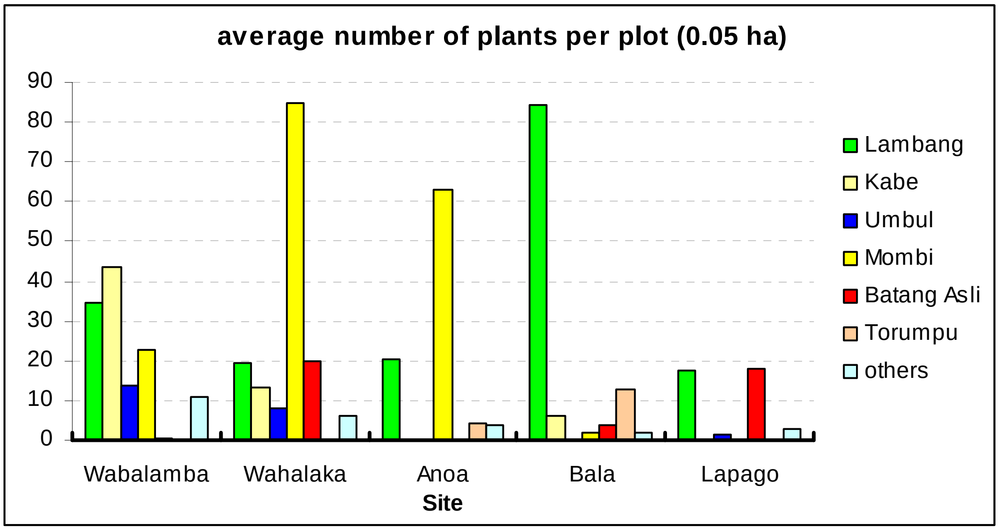


Figure 7. Rattan density per site



The low diversity indices for Anoa and Bala were due to highly skewed species abundance distributions (Figure 6 and Figure 7). Kabe and Lambang dominated the rattan flora in Wabalamba, whilst Mombi dominated in Wahalaka and Anoa, and Lambang alone dominated Bala (Figure 6). Most species were found in at least two sites, though Noko (*Daemonorops robusta*), Bulu Rusa (*Calamus* sp.), Ngasa (unknown species) and La Kumpa (unknown species) were unique to single sites.

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Fauna – Single Species Studies

Ecology of the Malay civet Viverra tangalunga *in the Lambusango Forest Reserve*

Adrian S. Seymour & Mark Tarrant

Introduction

The Malay civet *Viverra tangalunga* is one of 71 species of small to medium sized carnivores in the family Viverridae, which consists of mostly omnivorous forest-dwelling animals that are often the most numerous members of mammalian rainforest predator communities in Asia and Africa (Charles-Dominique 1978, Rabinowitz 1991, Heydon & Bulloh 1996, Ray 1997, Colón 2002). However, despite the diversity and abundance of rainforest Viverrids, very little is known about the population dynamics of this important group of predators. The Malay civet is a widespread and common species found in many parts of Malaysia and Indonesia. On Buton Island (Sulawesi) the Malay civet occurs in high densities and readily enters traps, making it a uniquely convenient model system for studying the behaviour and population ecology of a rainforest carnivore.

A population of Malay civets has been studied in the forests of central Buton since 2001. In the first two years, research concentrated on determining activity patterns and ranging behaviour of Malay civets using radio-tracking in the Kakenauwe Forest Reserve and adjacent farmland (Jennings, Seymour & Dunstone 2005). In 2003 a trapping grid consisiting of seventeen traps covering an area of approximately two square kilometres was established to monitor the annual abundance of civets and to help determine spatial organization (i.e. the position of home ranges relative to each other). Trapping grids can be used to carry out systematic capture mark recapture (CMR) studies which can yield data on both demography (i.e. abundance, age structure, survival) and spatial organization (i.e. relative position of captures).

It was not possible to estimate abundance from the 2003 CMR data set because trapping effort varied with time as the trapping grid was built up. The CMR was repeated in 2004 with constant trapping effort over time (i.e. grid already established), which yielded 101 capture events involving 21 individuals in a total of 865 trap nights (Seymour 2004). Although the capture rate was relatively high for a CMR study of carnivores, the sample size and capture probability was close to the minimum required to calculate abundance using closed population CMR models (Otis et al. 1978). Meaningful abundance estimates were obtained from the 2004 CMR data, though the confidence limits were fairly broad (Seymour in prep). For this reason, the trapping grid for the 2005 season was enlarged to 23 traps covering an area of 2.5 square kilometres in order to increase the sample size and encourage higher capture probabilities. Despite the increase in the number of traps in 2005, the capture rate in 2005 was much lower, with only 35 capture events involving 16 animals. The size of the trapping grid was not increased in 2006 due to logistical constraints, and was identical to the 2005 trapping grid.
In addition to the CMR trapping program, a radio-tracking study was carried out on the trapping grid to examine other aspects of Malay civet ecology such as diel activity patterns and spatial organization, and to contribute to our understanding of which factors influence the capture probability of civets on the trapping grid.
The objectives of the 2006 study season were to:

1) Estimate the abundance of Malay civets on the trapping grid.
2) Estimate between year survival rates.
3) Describe spatial organization of the Malay civet using trap-revealed and radio-tag revealed home ranges.
4) Determine home range size of Malay civets in a rainforest habitat.
6) Test whether there is intrasexual avoidance behaviour in neighbouring individuals.

Methods

Study site

Research was carried outside the northern border of the Lambasango Forest Reserves, central Buton Island (5˚ 10′ S, 122˚ 54′ E). The habitat consisted of lowland forest on karst coral limestone of quaternary age. Sulawesi forests are not dominated by any one tree family and there is a virtual absence of dipterocarp trees (Whitten *et al*., 2002). Within these reserves there was considerable variation in the major tree species and families found at different sites and there was some evidence of disturbance from local selective logging and rattan collection.

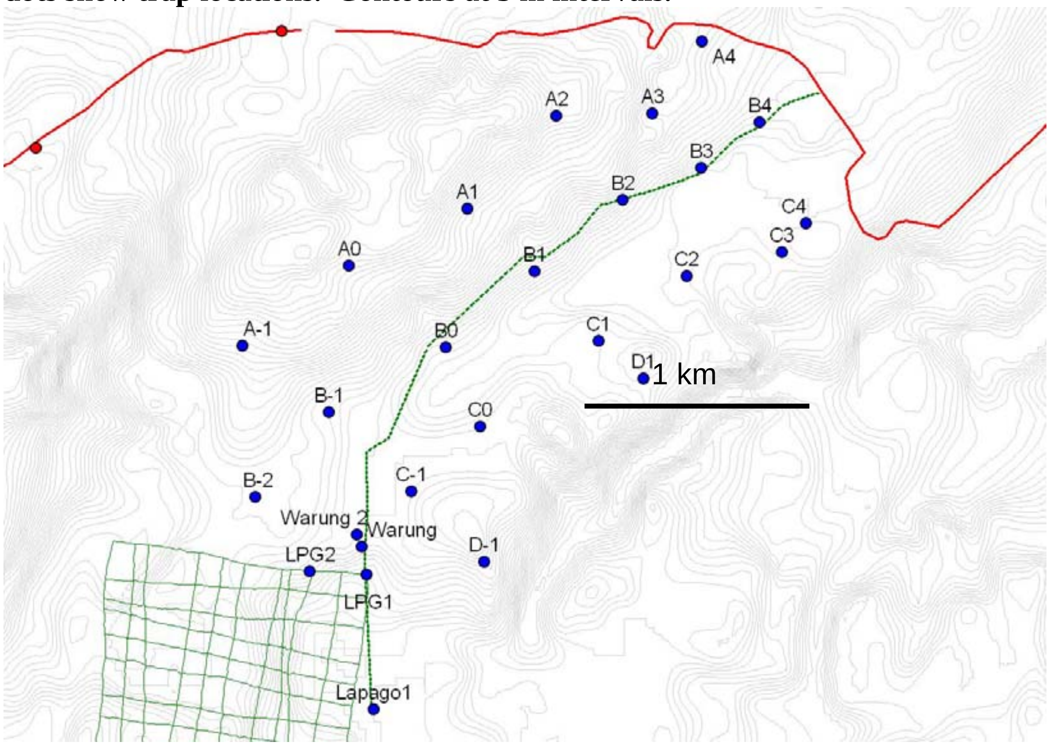
Trapping

A total of 25 cage traps (140 x 40 x 40cm) were set in 26 locations from June to August 2006 (Figure 8). Traps were baited with salt fish and checked daily in the mornings. In order to reduce trauma during immobilisation a "squeeze panel" was used to restrict the civet's movements inside the cage. When the animal was pressing against the cage it was injected intramuscularly with a mixture of Ketaset (Ketamine HCl, Parke, Davis & Co., Detroit, Mich.) and Rompum (Xylazine HCl, Bayer). Most civets were ataxic within 5 minutes and remained so for at least 20 minutes. While under anaesthetic the civets were weighed and measured. Each animal was sexed and aged based on body size and condition of the teeth. The age categories were: juvenile (< 2 kg, milk teeth present), subadult (usually < 3 kg and no signs of sexual maturity), young adult (sexually mature and teeth in very good condition), adult (sexually mature and teeth in fair condition) and old adult (showing signs of decline in weight and health and pronounced tooth wear). Reproductive status was determined by checking the condition of the nipples in females and testicles in males. The following body measurements were taken: head and body length, tail length, neck circumference, right ear length, right hind foot length, right fore-footpads (length and width), right canine length (upper and lower). Coloured plastic tags were clipped onto both ears. All animals were placed back into the trap and allowed to fully recover for 2-3 hours before being released.

Radio-tracking

Radio-tracking was carried out using three TRX-1000 receivers (Wildlife Materials Inc., USA) with collapsible 3-element Yagi antennae and collar mounted radio transmitters fitted with motion sensors (Wildlife Materials Inc., USA). A number of 'receiver stations' were identified along forest paths and marked with flagging tape and way-marked with Garmin 76 GPS units. At least ten GPS estimates with a minimum estimated position error of 20 m from at least four different GPS units were taken for each receiver station. A selection of civets were fitted with HLPM-3150A radio transmitters with activity sensors (Wildlife Materials Inc., USA). Once animals were collared we attempted to take three fixes per day (one during daylight and two at night) for each individual collared although this was not always possible. Night fixes were taken at least one hour apart. In addition, we opportunistically carried out continuous radio-tracking at night for up to eight hours, with fixes taken at 20 minute intervals. In order to reduce errors in estimated signal positions, receiver stations were selected to maximise the range of bearings to the estimated animal position. Bearings were taken simultaneously from each of the three receivers to obtain triangulation estimate for the civet position. For each fix, the bearing to the estimated signal position and the signal strength was taken for each receiver. Signal strength was classified into one of four categories (0: no signal, 1: weak signal that can only be detected when antennae pointing towards signal source, 2: strong signal that can be detected from all directions, and 3: very strong signal that can still be detected when the receiver attenuator is switched on). Signal strength gives an estimate of distance between transmitter and receiver.

Figure 8. Malay civet 2006 trapping grid. Red line represents road, dashed line represents principle access trail, solid green lines show the Lapago study grid trails, blue dots show trap locations. Contours at 5 m intervals.



Results

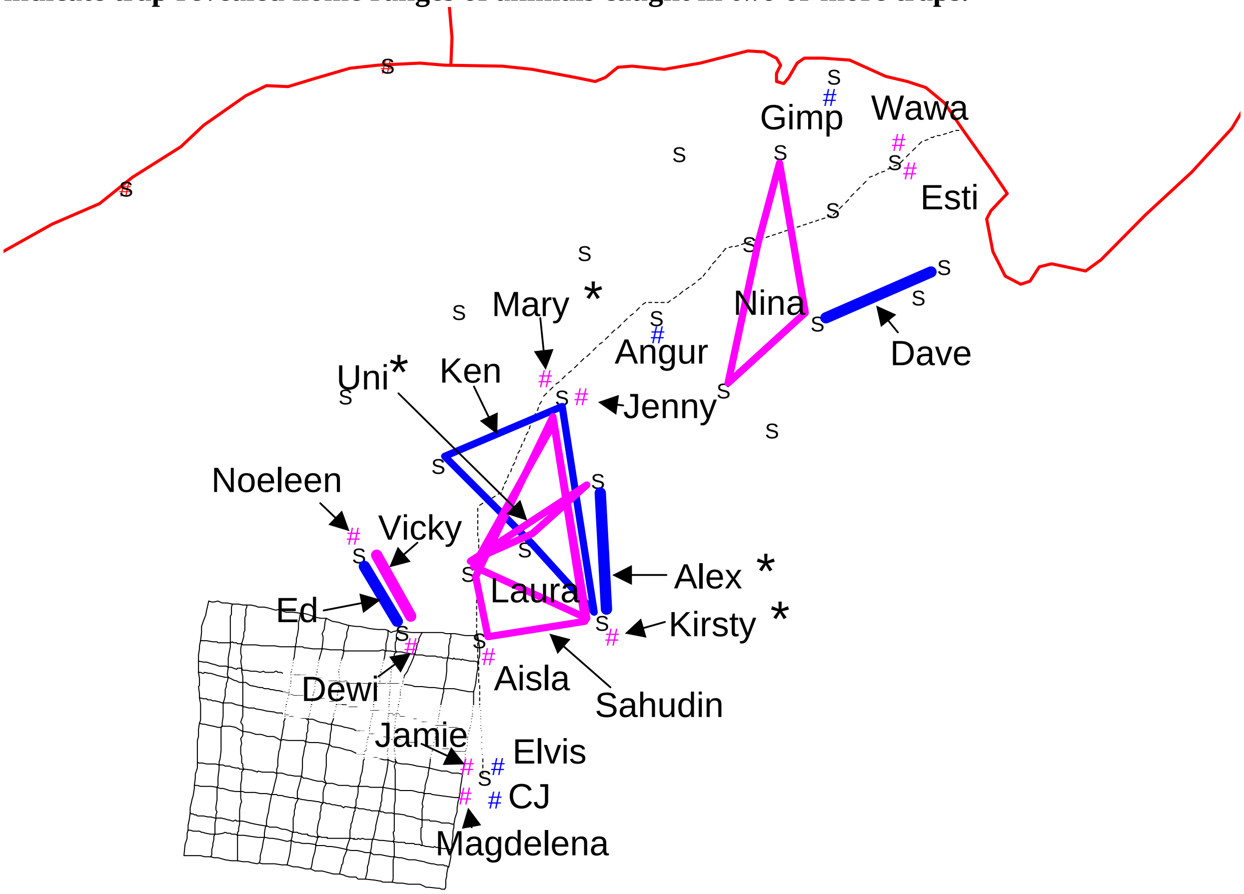
Trapping

Trapping was carried out between 6 July and 21 August 2006 resulting in 866 trap nights of capture effort. During this time there were 67 capture events involving twenty-six individuals. Animals were captured between one and seven times (mean capture frequency was 2.5 ± 1.8 (s.d.) captures). There was no significant difference between capture frequencies of males and females ($U = 69.5$, n = 25, $P = 0.76$). Forty-two percent of individuals captured in 2006 had also been captured in previous years, including two individuals that were last caught before 2005. The majority (62.5%) of those individuals caught for the first time in 2006 were either juveniles or subadults. The most commonly trapped age-class were adults (Table 3).

Table 3. Age structure of trapped civets in 2006

	Old Adult	Adult	Young Adult	Subadult	Juvenile	Total
Male	0	6	1	1	3	11
Female	1	6	3	2	3	15

Figure 9. Capture positions and trap revealed home ranges of civets captured in 2006. Open circles indicate trap positions, large blue and pink circles indicate capture positions (animals captured at one location only), and blue and pink lines and polygons indicate trap revealed home ranges of animals caught in two or more traps.



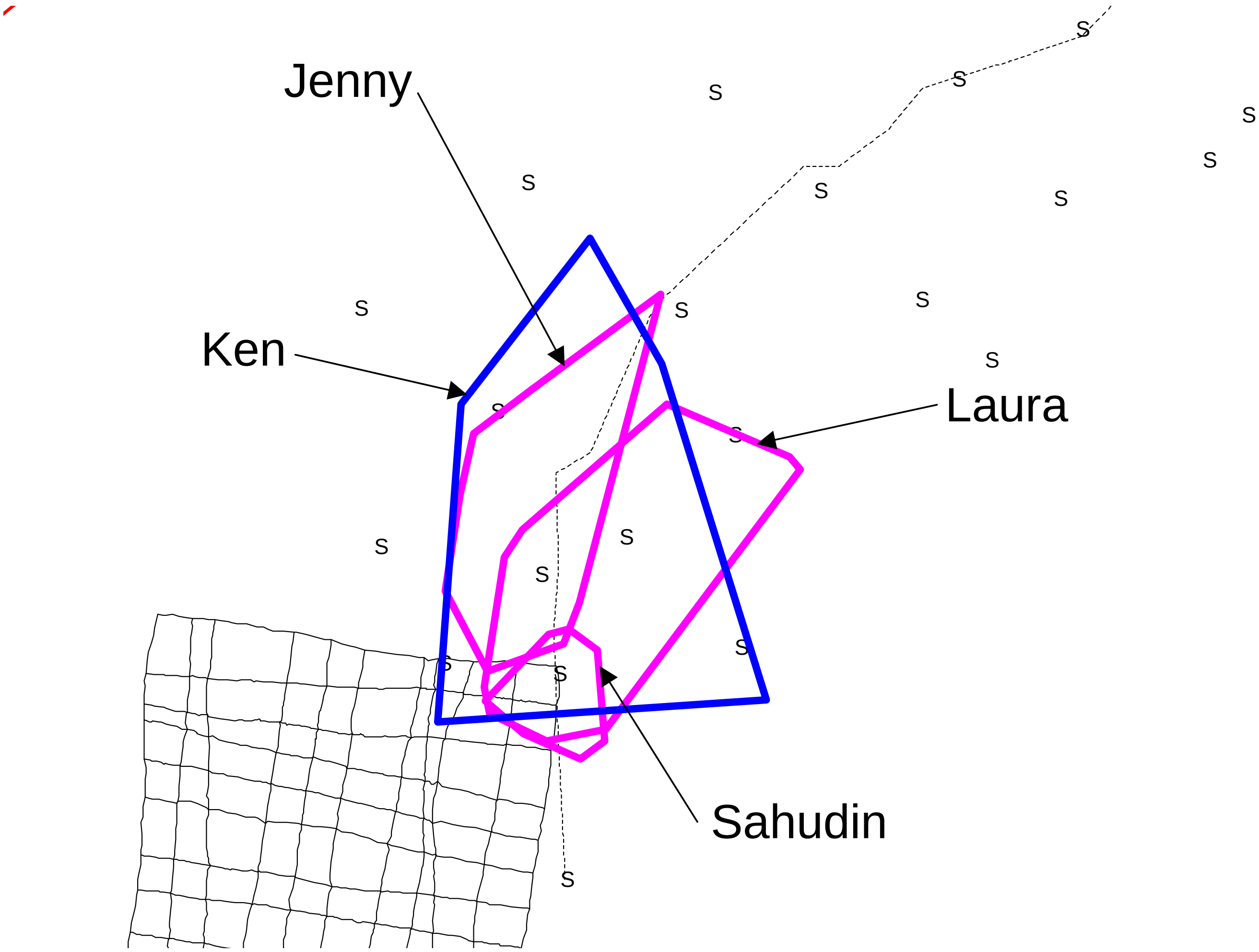
In contrast to the results of 2005, capture locations tended to be clumped, and adults of the same sex were frequenctly caught in the same trap suggesting intrasexual home range overlap. In 2006 civets were caught in 72% of traps, in contrast with 2005 (65% of traps), 2004 (90% of traps caught civets) and 2003 (89% of traps caught civets). Particularly conspicuous was the absence of civets in trap A-1, A0, A1, and A2 on the northwest side of the trapping grid.

Radio-tracking

Estimated home range sizes were 68.1 ha for Ken, 6.5 ha for Sahudin, 38.7 ha for Laura and 27.3 ha for Jenny (Figure 10). There was considerable intra-sexual home-range overlap, with 100% of Sahudin's range overlapped with Laura's range, 23.5% of Laura's range overlapped with Jenny's, and 33.3% Jenny's range overlapped with Laura's.

Papers will be submitted to peer-reviewed journals. On completion, these papers can be obtained on request from Adrian Seymour (aseymour_uk@yahoo.co.uk).

Figure 10. Estimated home-ranges of one adult male civet (Ken) and three adult females civets (Sahudin, Jenny and Laura) based on radio-tracking data (95% MCP).



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Estimating anoa abundance

Asri Dwiyahreni

Methods

Anoa were surveyed by counting independent sets of tracks on 3km transects. Details of the method and location are given in Operation Wallacea LIPI report 2004. Four transects at each of six sites were surveyed and numbers of anoa tracks at each transects were counted. Total efforts were calculated based on the total number of km walked during the surveys. Same techniques were applied for counting cow tracks and human trails. The mean abundances of tracks and human trails were calculated every 250 metres. Faecal samples were collected on these transects and from recce lines walked between transects.

Results

The 2006 survey results (Table 4) show that camp Wabalamba supports the highest anoa track abundances and camp Lapago was the lowest. Area with the highest human trails abundances was Wabalamba and the lowest was Lapago. Cows were recorded only in camp Wahalaka and camp Anoa. In contrast with previous year's data, the abundances of anoa tracks in 2006 were greater in areas with more human trails. However, anoa seems to avoid areas with high abundance of cow tracks although cow track abundance is also positivel correlated with the frequency of human trails.

Table 4. Anoa and feral cow track density and human trail density (mean number per 250 m) per node camp.

Camps	Km walked	Anoa tracks	Cow tracks	Human trails
Wabalamba	11.1	7.7	0	1.00
Anoa	12	3.9	0.8	0.06
Wahalaka	11.7	3.4	1.3	0.57
Lawele	11.3	3.3	0	0.20
Lasolo	11.3	2.9	0	0.16
Lapago	9.0	1.2	0	0.14

Faecal samples were collected from all camps. Corresponding with the track abundances in the 6 node camps, the highest number of samples were collected in Wabalamba and the lowest in Lapago (Table 5).

Over the two months (July and August) of the 2006 Operation Wallacea season, 5 anoas (two with infants) have been seen in the Lambusango forest. There were no encounters with hunters this year.

Table 5. Number of anoa faecal samples collected per node camp

Camps	Number of faecal samples
Wabalamba	25
Anoa	16
Wahalaka	10
Lawele	4
Lasolo	4
Lapago	2

Behaviour and human conflict of Buton Macaques

Nancy Priston

Introduction

The Sulawesi[1] Macaques are a unique radiation within the macaques, 7[2] of the 19 species exist on this island's relatively small area and are endemic (Fooden, 1980; Groves, 1980; Rosenbaum *et al.* 1998). The Buton Macaque *Macaca brunnescens* inhabits the islands of Buton and Muna. Its taxonomy has been debated and it has been classified as a sub-species of *M. ochreata* (Groves, 1980) which inhabits the south-easterly corner of Sulawesi, off which these islands lie. *M. brunnescens* is distinguished by a brown dorsal colour, shorter, mat fur and a shorter face than *M. ochreata* (as described by Fooden, 1969, 1980; Groves, 1980; Hamada *et al.* 1988). The separation of these species can be no more than 10,000 years, owing to the emergence of these islands in the Holocene (Groves, 1980). In light of this fact and in view of personal observations, which seemed to indicate no distinguishing brown coloration Groves' classification of *Macaca ochreata brunnescens* will be used in this study.

Figure 11. Dominant Adult male in fields, showing lack of brown dorsal colouration and classic grey "boots" of *Macaca ochreata.*

Sulawesi macaques are found in lowland and hill forest (Mackinnon, 1986), and have been sighted as high as 2000m, but are probably not common above 1500m (Whitten *et al.* 1987). Pythons, *Python reticulatus* and *P. molurus,* are their only predators other than humans, who hunt them as crop-pests over most of the island and occasionally for food (Whitten *et al* 1987). The main threat to Sulawesi macaques is habitat loss through deforestation due to agriculture, logging, transmigration camps (MacKinnon, 1986; Whitten *et al.* 1987; Rosenbaum *et al.* 1998). More than 67% of productive wet lowland forest on Sulawesi has been lost over two decades (Whitten *et al.* 1987; O'Brien & Kinnaird, 1996). Diversity of fruit tree species is likely to decline after logging, and food resources become lower in quality and quantity (Rosenbaum *et al* 1998). Sulawesi crested black macaques, *M. nigra,* have been shown to occur at significantly lower densities in logged than primary forest (Rosenbaum *et al* 1998). Behavioural observations of this species living in secondary forest suggest that they travel further, socialise less, and eat less fruit than conspecifics in better quality primary forest

[1] Formerly Celebes

[2] 4 – 7 species/sub-species are recognised by differing authors [see Chivers, 1986, Fooden, 1969, 1980, Groves, 1980, Whitten 1988]

with minimal disturbance and canopy-sized trees (O'Brien & Kinnaird, 1997; Rosenbaum *et al.* 1998).

In comparison to other Sulawesi macaques very little is known about the distribution or conservation status of the booted, *M. ochreata ochreata*, and Buton macaques *M. o. brunnescens.* Moreover there are few captive Buton macaques, and no captive breeding programme. The Buton macaque is endemic to the islands of Buton and Muna. Both islands have undergone extensive de-forestation in recent years, due to logging and farming, and these macaques are consequently under threat. Muna has lost the majority of its primary forest, and the largest population of macaques survives on Buton. The Lambusango and Kakenauwe forest areas in central Buton island represent a substantial remaining stand of forest and may support the largest remaining population of this endemic species.

Threatened species and sub-species such as the Buton macaque should be monitored within reserves and managed to maintain adequate populations (MacKinnon, 1986). Information on the ecology and behaviour of the Buton macaque, in addition to that on population, is essential for successful management plans to be designed to conserve this endemic primate (O'Brien *et al.* 1997). Further, specific data on habitat requirements, minimum areas for conservation, diet, and details of appropriate social and breeding systems, and conflict with people are necessary for the implementation of such plans (Sutherland, 1998).

Consequently this project aims to collect data on habitat use, behavioural ecology, and diet of three groups of macaques, one of which is a known crop-raiding group to enable a comparison of crop-raiding macaques with non-crop-raiding macaques living within the Lambusango and Kakenauwe protected areas. The data will also enable a comparison of the ecology of macaques living in different types of forest, as the Kaweli group inhabit a matrix of heavily logged secondary forest and agricultural land, the group at Kakenauwe a later-stage secondary forest, and the third group at Lapago inhabit higher canopy, secondary forest.

The human perception of primates is often one of contradiction, typified by extremes. Whilst for many cultures primates are a symbol of religion and are sacred e.g. Hindus of India, in others such as Japan, they are mythical creatures viewed as cunning and devious. However for most of the world's subsistence and plantation farmers living in close proximity to these animals, they are a significant crop pest. In many cultures these views overlap resulting in both a love and loathing of them such that they may be worshipped at a temple but shot on the field next door. Cultural tolerance alone is protecting many species of primate, but as this begins to wane in the face of increasing human populations, demographic movements and habitat destruction, it is vital that the conflict that exists be understood. Conservation depends on local perceptions, economy and social factors and it is within these limitations that it must work and against this background that this project has been set.

Human-wildlife conflict is of increasing concern in all parts of the world and has been the focus of recent conservation efforts (see for example Bell 1984; Else & Lee 1986; Hill 1998, Hoare 2000, Infield 1988, Naughton Treves 1998; Newmark *et al.* 1994). With increasing human populations, especially in the developing world, more human and wildlife populations are coming into direct competition (Eudey 1986; Strum 1987a, b, 1994; Tchamba 1996).

In subsistence agricultural societies the nuisance value of wildlife, from crop damage and livestock depredation, is often pronounced in people's minds (Ranjitsinh 1984). People feel threatened by wildlife, both in terms of crop loss and personal safety (Eley & Else 1984; Hill 1999; Malic & Johnson 1994; Priston 2001, 2005). Such losses can be enormous, both in direct economic terms and through indirect costs on time and energy devoted to protection and re-planting after damage (Hill 1998, 1999), as well as the cost of potential conflicts between activities and less time to complete other work. (Lee & Priston 2005). Estimates of damage reach 90% in some areas (Mishra 1984), representing an annual value of $500 per farmer which, though of little national importance, causes the individual farmer much suffering (Barnes 1996).

Primates dominate amongst pests that damage crops, particularly around African and Asian reserves, being responsible for over 70% of the damage events and 50% of the area damaged (Naughton Treves 1998). Because of their intelligence, opportunism, adaptability and manipulative abilities some species can easily turn to crop foraging and make formidable crop-raiders. The human and non-human primate niches overlap extensively making competition much higher between the two and posing many management problems (Strum 1987a).

One fundamental factor is the cultural attitude of people towards primates. Levels of tolerance, acceptance and even demand for interactions vary with cultural context (Biquand *et al.* 1992; Gautier & Biquand 1994). For Hindus the monkey is sacred and in parts of Northern India, Indonesia and other areas, they are worshipped, protected and provisioned by the villagers. Whilst showing remarkable tolerance, people are understandably still reluctant to share their crops (Eudey 1994; Malic & Johnson 1994; Southwick *et al.* 1961a, b; Strum & Southwick 1986).

Traditional methods to prevent primate crop-raiding have limited success. The dexterity, deceptive skills, and intelligence of some primates make containment and control costly, inefficient and ultimately ineffective (Maples *et al.* 1976; Strum 1986, 1987a, 1994).

Indonesia has the fifth largest human population in the world (Atmosoedarjo *et al.* 1984) and nowhere is there a greater variety and diversity of primates than in South and Southeast Asia (Roonwal & Mohnot 1977). Sulawesi itself is one of the most distinctive islands with 127 indigenous mammals, 79 of which are endemic (Whitten *et al.* 1988). Legal protection of species and forested land is poor. As with almost every other primate species, the Sulawesi macaques are facing loss of habitat due to subsistence farming and logging, as well as subsistence hunting and “pest” control measures in some areas (O'Brien & Kinnaird 1997; Rosenbaum *et al.* 1998). Macaques are adaptable and opportunistic and thus can cope with these problems better than some species (Richard *et al.* 1989), but even within Sulawesi population declines of 75% have been witnessed (*Macaca nigra*) (Rosenbaum *et al.* 1998). An understanding of their foraging behaviour is essential to the formation of a suitable management strategy.

The Buton macaque is only one of several pests who damage crops, yet they typically receive much of the blame (Priston, 2001, 2005). Richard *et al* (1989) proposed categorisation of certain macaques as “weed macaques” based on their “differing abilities to tolerate and even prosper in close association with human settlements.” These macaques may choose to raid crops and/or human dwellings because benefits gained by eating readily available, highly nutritious and digestible foods outweigh any risks associated with human contact. Benefits such as better health, higher reproductive rates, and increased time for socialising have been shown to result from this type of strategy when used by vervet monkeys (*Cercopithecus aethiops*) in Africa (Strum, 1994). Other researchers have taken this idea further by questioning whether primates are capable of diversionary strategies to outwit farmers guarding their crops. Maples *et al* (1976) studied crop-raiding baboons and found that, while their behaviour in the field may have appeared to be a deliberate strategy to maximise crop-raiding success, their behaviour was actually reflected by the shape of the margins between forest and farm. In addition, the type and frequency of raids were directly affected by factors including degree of farmer vigilance and crop availability. On Buton Island, some farms suffer heavy damage by macaques while others are never or rarely raided. Similar conclusions to those found by Maples *et al* (1976) may apply to Buton Island, wherein type and frequency of crop raiding may be predicted based on factors such as farmer vigilance, state of crop availability and the geography of the farms.

The Buton macaque, *Macaca ochreata brunnescens,* is found only on the islands of Buton and Muna. The majority of Muna has been deforested, and the last stronghold of the species is on Buton. Large-scale habitat destruction on Buton through logging and farming has reduced potential habitat for these medium sized mammals. There is a paucity of information available regarding the behaviour and ecology of the Buton macaque and indeed the wild Sulawesi macaques in general (Kohlhass 1993; Reed *et al* 1997 cited in O'Brien & Kinnaird, 1997). Information on the ecology and behaviour of Buton macaques, in addition to that on population, is essential for successful management plans to be designed to conserve this endemic primate (O'Brien *et al* 1997). Further, specific data on habitat requirements, minimum areas for conservation, diet, and details of appropriate social and breeding systems are necessary for the implementation of such plans (Sutherland 1998). Data on key food resources and habitat features are essential to allow recommendations of areas suitable for conserving macaques. In addition, macaques are seed dispersers, and as such are important agents of forest regeneration. Knowledge of food resources is essential in understanding habitat and food resource needs of these macaques for their continued survival.

Macaques often come into conflict with local farmers through the damage they cause to crops. This can result in the macaques being trapped or poisoned, and the farmers losing a potentially significant proportion of their crops. Information on both the actual severity of this problem and the perceptions of local farmers and people is required to look at ways to reduce this conflict. This project also aims to increase our knowledge of these areas and to investigate the degree to which the pet trade affects this species.

Objectives

.Gather information on the behavioural ecology of the Buton macaque

- Compare the use of habitat in crop and forest areas, and compare the behaviour of macaques in these habitats.
- To characterise the vocalisations of the Buton macaque
- Investigate the extent of crop-raiding by macaques and farmers perceptions towards these primates

Methods

Behavioural data

Three groups of macaques were habituated to the presence of human observers, one in the forest bordering the village of Kaweli, one at the Kakenauwe study site, and one at the Lapago study site. Behavioural data were collected from all three study groups. The macaques at Kaweli crop raid and their behaviour was recorded both in the forest and when crop raiding. The macaques were located and then followed opportunistically for as long as possible throughout the day. General behaviours were recorded using instantaneous scan sampling every 10 minutes, and specific behaviours were recorded using both ad libitum recording and continuous focal sampling.

The following age-sex categories were used: alpha adult male, adult male, adult female, sub-adult, juvenile, infant.

Behaviours were categorised and recorded as follows:
Foraging: Searching for food, i.e. moving slowly with attention directed towards a potential food source. It includes digging for tubers and insects – i.e. extractive foraging. Where possible the food being foraged for was noted.
Carrying food: Carrying food. Whether the macaque was bi- or tripedal was noted.
Feeding: Ingestion or manipulation of food, i.e. handling prior to eating. Where possible the food being eaten was noted.
Locomotion: walking or running from one place to another. Bipedal or tripedal locomotion was noted
Climbing: any arboreal movement, including swinging, jumping and climbing.
Resting: sitting or lying, and not engaged in any other activity e.g. grooming or vigilance
Self grooming: macaque grooming itself.
Social grooming: macaque grooming or being groomed by another individual.
Vigilant: actively paying attention to the surroundings, visually scanning the general environment or focussing on a specific area.
Playing: characterised by an open mouthed play face. E.g. chase play, rough and tumble etc.
Fighting: aggressive interactions between individuals or groups usually accompanied by loud vocalisations. Characterised by open mouth threats and submissive grimaces.

This provided data on the amount of time that the macaques spent engaged in the various non-social and social behaviours. These will be compared between groups, and between the various age-sex categories.

Farmers' Perceptions Survey
A social geography, mixed methods approach of both qualitative and quantitative data was collected on site. The main method for this study was in the form of a semi-structured survey based on previous work done in the area, and carried out in 6 communities, from regions bordering the forest reserves of Kakenauwe and Lambusango. These communities were: La**b**undo-bundo (Kapontori), Wakangka (Kapontori), Lawele (Lasalimu), Kabongka (Pasarwajo), Harapan Jaya (Lasalimu) and Wakalambe (Kapontori).

Part of the interview comprised of closed questions in order to get data which may be analysed using SPSS, but others allowed interviewees to elaborate on answers so that a greater understanding of perceptions and attitudes could be found. The survey directed at farmers consisted of 49 questions, though up to 59 questions were asked to those involved in ranging or policing activities and those with pets. The questions included three main categories of information:

- Demographic/socio-economic data – name, age, sex, religion, socio-economic indicators etc.
- Geographic/crop data – crop types grown, farm size and position, distance of farm from village and forest.
- Attitudes/crop pests – attitudes towards monkeys, estimates of crop damage, opinions as to which animals are responsible and deterrence methods used.

Questions regarding knowledge of the recently established PKHL (the GEF-funded *Program Konservasi Hutan Lambusango*) and it's newly implemented ginger scheme were asked where appropriate. After permission was obtained from the Kepala Desa to work in the villages a local guide was employed to accompany the surveyors to respondant's farms or homes to make people feel more at ease. Random sampling was carried out by walking from one end of the village to the other, interviewing in people's homes as available respondants were found. Purposive sampling was used to gain village statistics from the headman and also to include rangers/policemen and pet owners if available in the community.

In farm vegetation transects (following Priston 2005) were also carried out in the villages where respondents were found to have crops suitable for study. These included farms growing crops likely to be raided by macaques such as sweet potato, cassava, banana and other short or long term crops in a state available for pest consumption (i.e. bearing fruit).

Crops present in the farm were recorded and the farms were stratified into three zones based on proximity to forest. Three transects (10 x 2m) were placed randomly within each zone to give nine in total. The distance from the forest to each transect was noted. Within each transect, each plant type was recorded and given a category for its availability as a food to primates, defined as whether or not the plant was in a state that primates would consume (ripe fruit or edible leaf versus unripe or inedible). A score for the severity of damage was assigned. Although primate damage was the focus of the study, pig and rat damage was also noted, as was any other discernable animal crop damage e.g. squirrel, snail, insect.

Plants were scored as follows (Priston 2005):

U – Unavailable to primates as food
0 – No damage
1 – Minor damage to plant e.g. bite marks on one fruit but left on the plant, damage to less than 5% of leaves
2 – Several fruits damaged, but not removed from plant, 10 – 20% leaves damaged.
3 – 50% of fruit or leaves damaged or removed. Plant largely undamaged otherwise
4 – Major damage to the plant, plant is severely damaged, 90% fruits or leaves damaged or removed, or large proportion of stalk or root damaged. But plant is still alive, some crop still remaining.
5 – Total destruction of the plant or removal of fruit such that the farmer is unable to get crop from that plant.

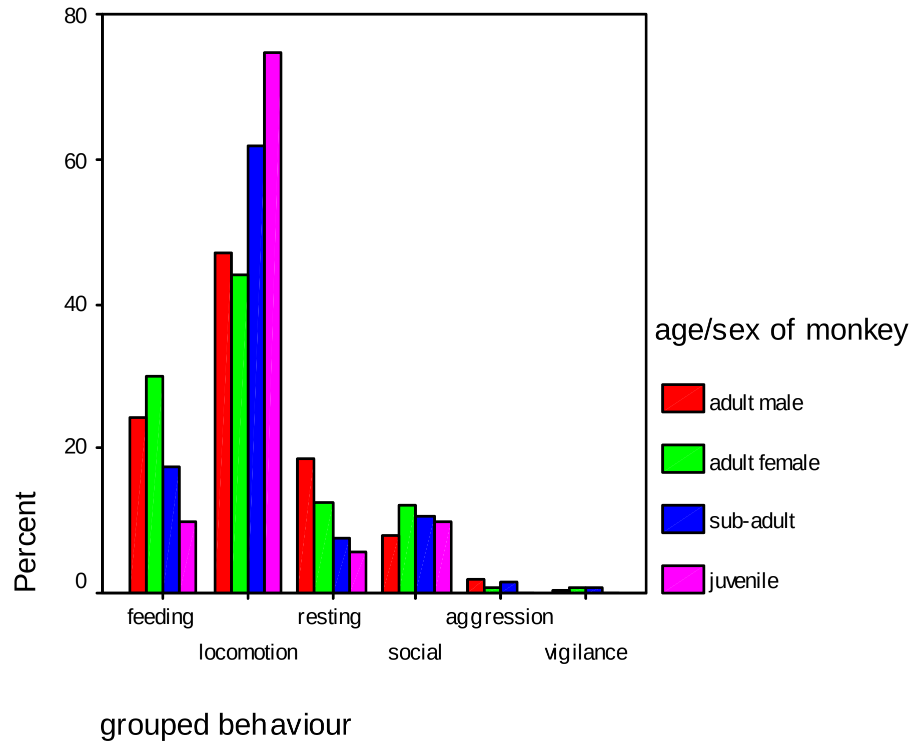
'One plant' was classified as a single-stemmed crop at ground level. In the case of sweet potato, which is a ground cover plant, after lengthy discussions with farmers on the spacing of planted seeds it was decided that 1m² be taken to represent one sweet potato plant. These values have been used to estimate the percentage of damage to plants, percentage of monkey foods (plants available for monkeys to consume), planting densities, and damage per m² and also extrapolated to provide estimates for the whole farm.

Results

Behaviour – comparison between Kakenauwe and Lapago

Overall the entire troop spent most of their time locomoting (Figure 12). Males spent 24.2% of their time feeding, compared with females spending 30.1% of their time feeding and juveniles spending only 9.8% of their time feeding. Males spent the most time out of the troop resting with 18.6% of their time resting, compared with juveniles only spending 5.5% of their time resting. Females spent most time out of the troop being social with 12.9% of their time, compared with males spending 7.9% of their time being social and juveniles spending 9.8%.

Figure 12. Frequency of macaque behaviour by sex and age-class.



Adult females appear to do the most feeding, closely followed by males. Juveniles seem to show most locomotion above the others in the troop, and males seem to rest the most, followed by females. They all showed quite a lot of social activity, with females showing the most, followed by sub-adults. There was only limited amounts of aggression and vigilance in both wild troops, but males did show the most aggression out of the others.

Figure 13. Frequency of behaviour by age class.

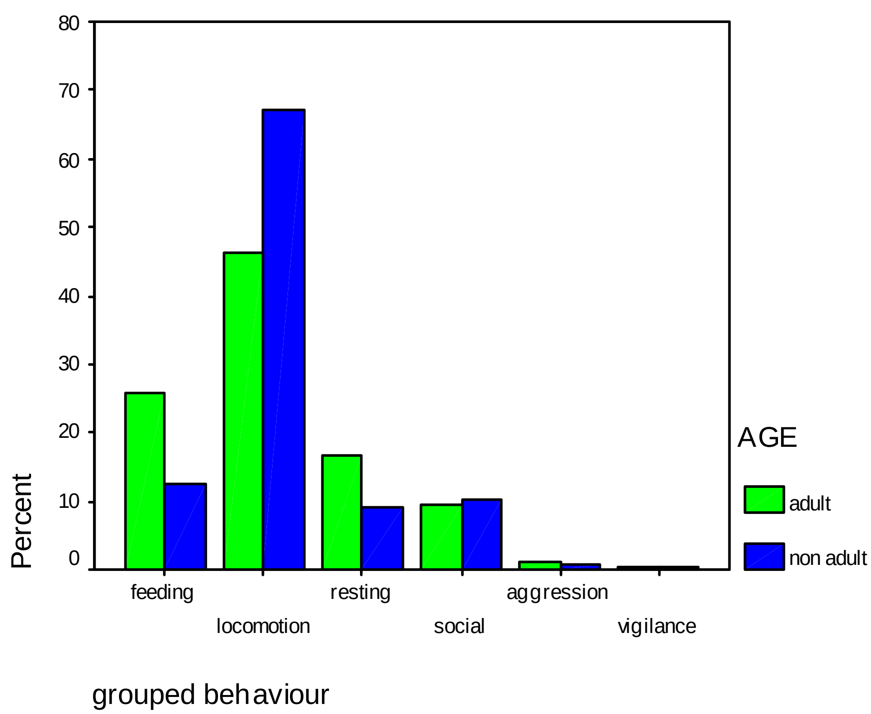
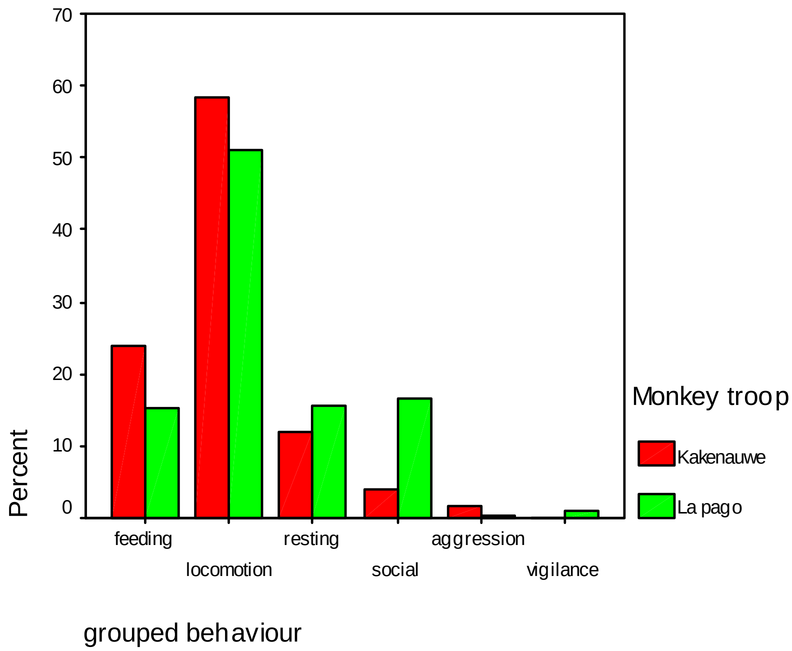


Figure 14. Frequency of behaviour by site.



Adults seem to be feeding almost double the amount of time that the non-adults did (Figure 13). The non-adults showed much more locomotion. Adults tended to rest more and they were both roughly similar with social activity.

The Kakenauwe troop appeared to be feeding more, spending about 25% of their time feeding, as opposed to Lapago spending only about 15% of their time feeding (Figure 14). Kakenauwe showed slightly more locomotion than Lapago and Lapago did slightly more resting. Lapago showed over double the amount of social activity.

Behaviour – comparison between Kakenauwe and Kaweli

Preliminary results suggest differences in both time activity budgets and feeding behaviours of the two troops of macaques. These differences can be seen by visual comparison in the following graphs. Both Kakenauwe and Kaweli troops spent the largest proportion of their time locomoting. However, the Kaweli troop of macaques spent a greater proportion of their time feeding and foraging, and resting than the Kakenauwe troop (Figure 15).

The diet of the Kakenauwe troop did not include crops, but appeared to be mostly consisting of forest fruits, as well as leaves and insects (Figure 16). The Kaweli troop of macaques had a diet which consisted largely of crop, but also of insects and forest fruits.

Figure 15. Frequency of behaviour types observed in the Kaweli and Kakenauwe troops.

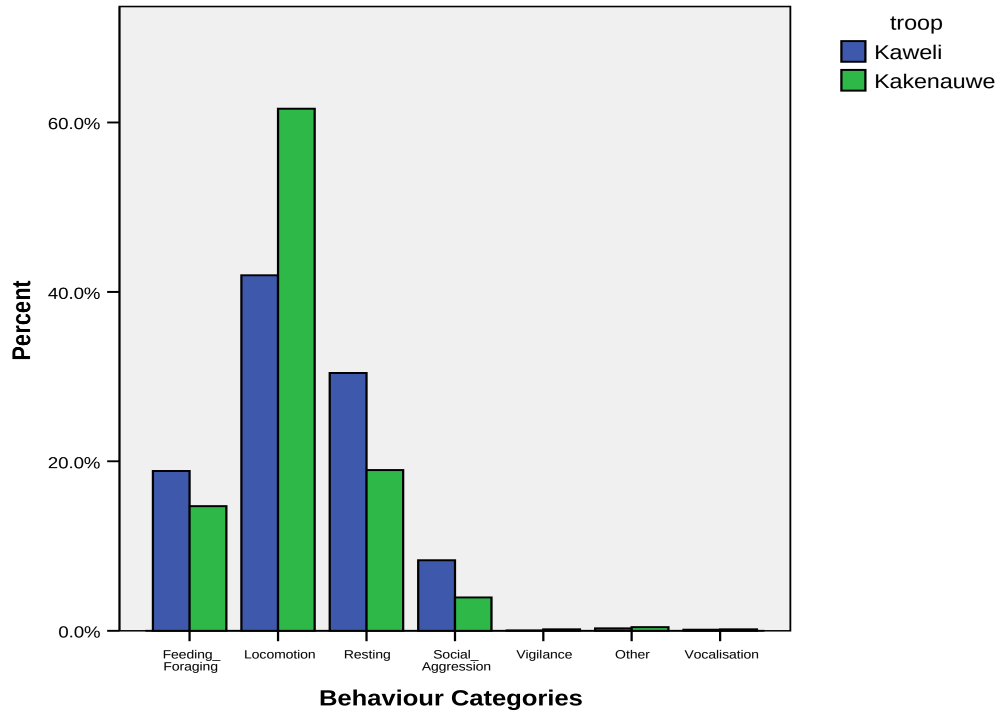
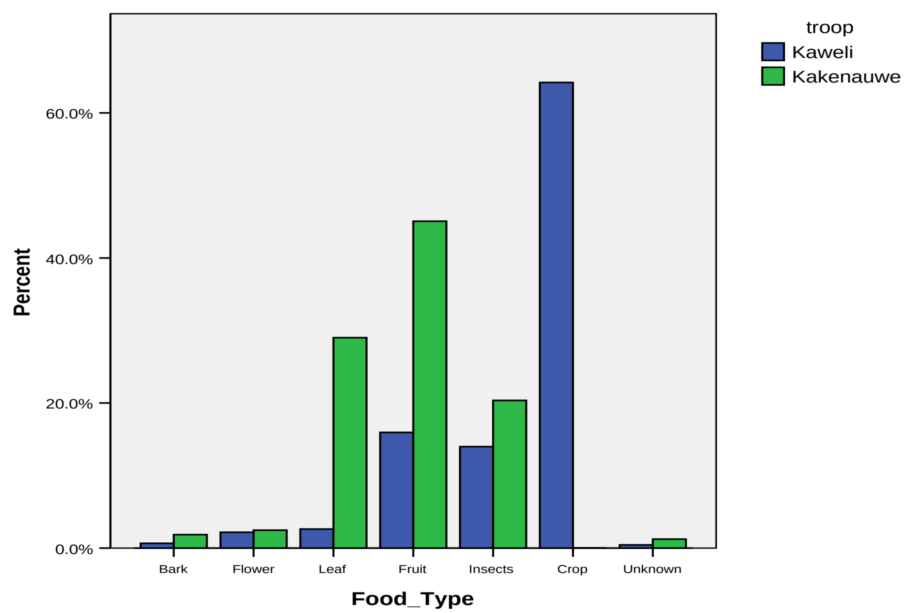
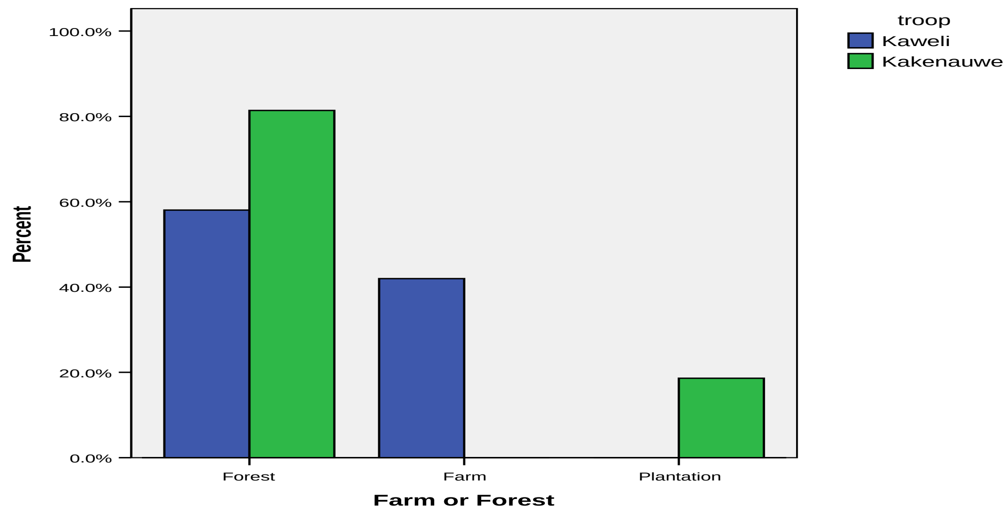


Figure 16. Diet of the Kakenauwe and Kaweli troops.



The Kakenauwe troop of macaques spent around 80% of their time in the forest, and around 20% in plantations (Figure 17). The Kaweli troop spent just under 60% of their time in the forest, but just over 40% in the farms.

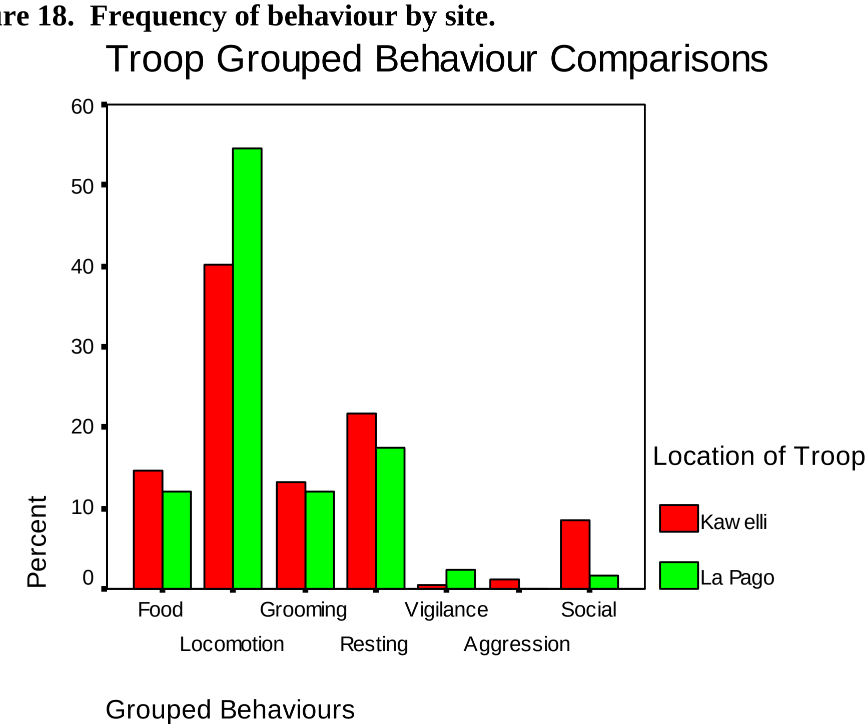
Figure 17. Habitat use by Kaweli and Kakenauwe troops.



Behaviour – comparison between Kakenauwe and Kaweli

Preliminary analysis indicates that the most common behaviour is locomotion, with a relatively high percentage of individuals locomoting at both sites (Figure 18). As expected the majority of occurrences of social behaviour, including grooming, were observed at Kaweli.

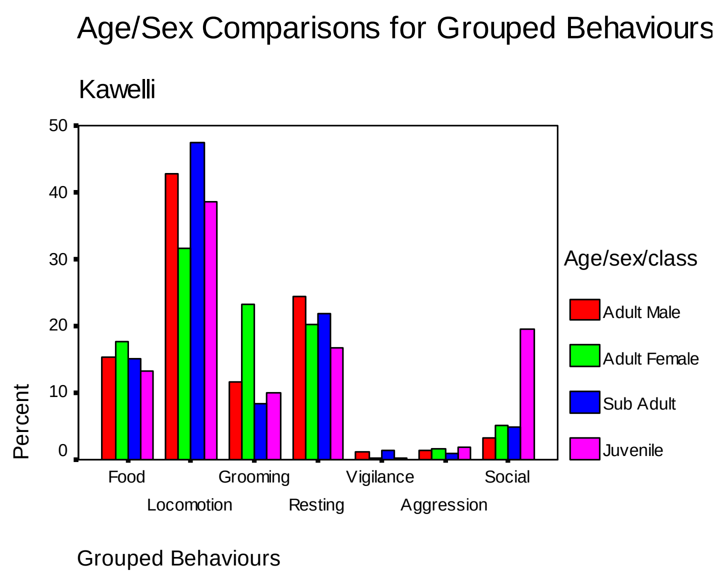
Figure 18. Frequency of behaviour by site.

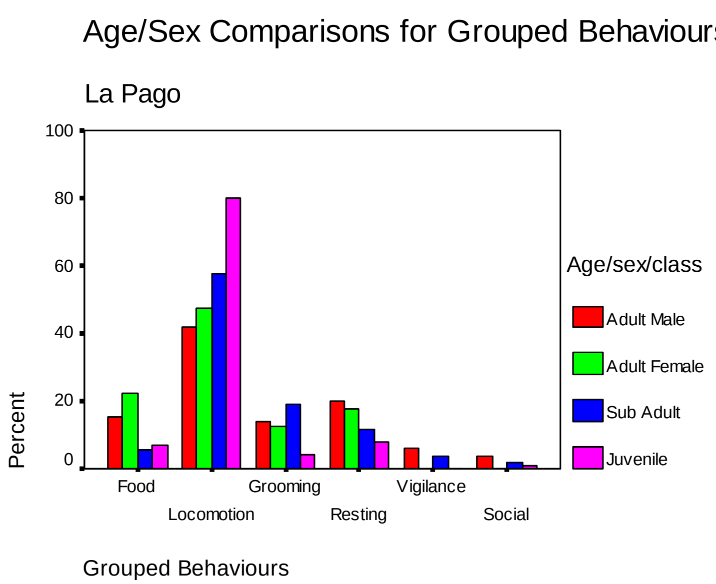


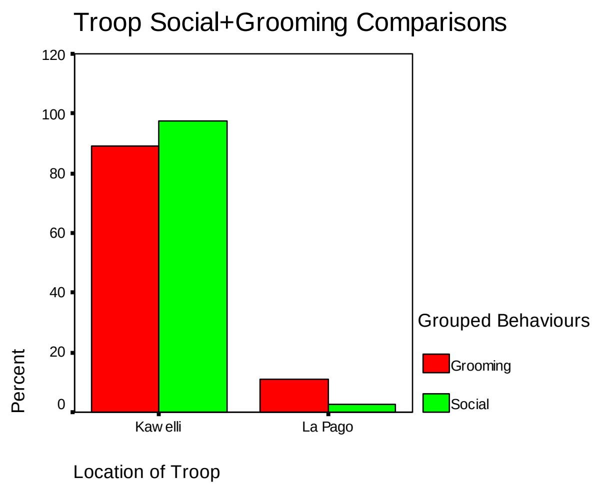
Adult females in both the Kaweli and Lapago troops spend the majority of time feeding, subadults were observed locomoting the most in Kaweli, and females groomed the most (Figure 18). Adult males rested the most, and juveniles appeared most social, spending a large amount of time playing. At both sites there was relatively low levels of aggression and vigilance observed.

The Kaweli troop spends a large amount of time interacting socially (Figure 19). This is likely to be for a number of reasons, but is most likely to be profoundly due to the level of food abundance and overall habituation to human activities. The Lapago troop were limited to their socializing due to greater importance with feeding and foraging, and greater need for higher substrate levels for troop and individual security.

Figure 19. Frequency of behaviours by site, age and sex-class.



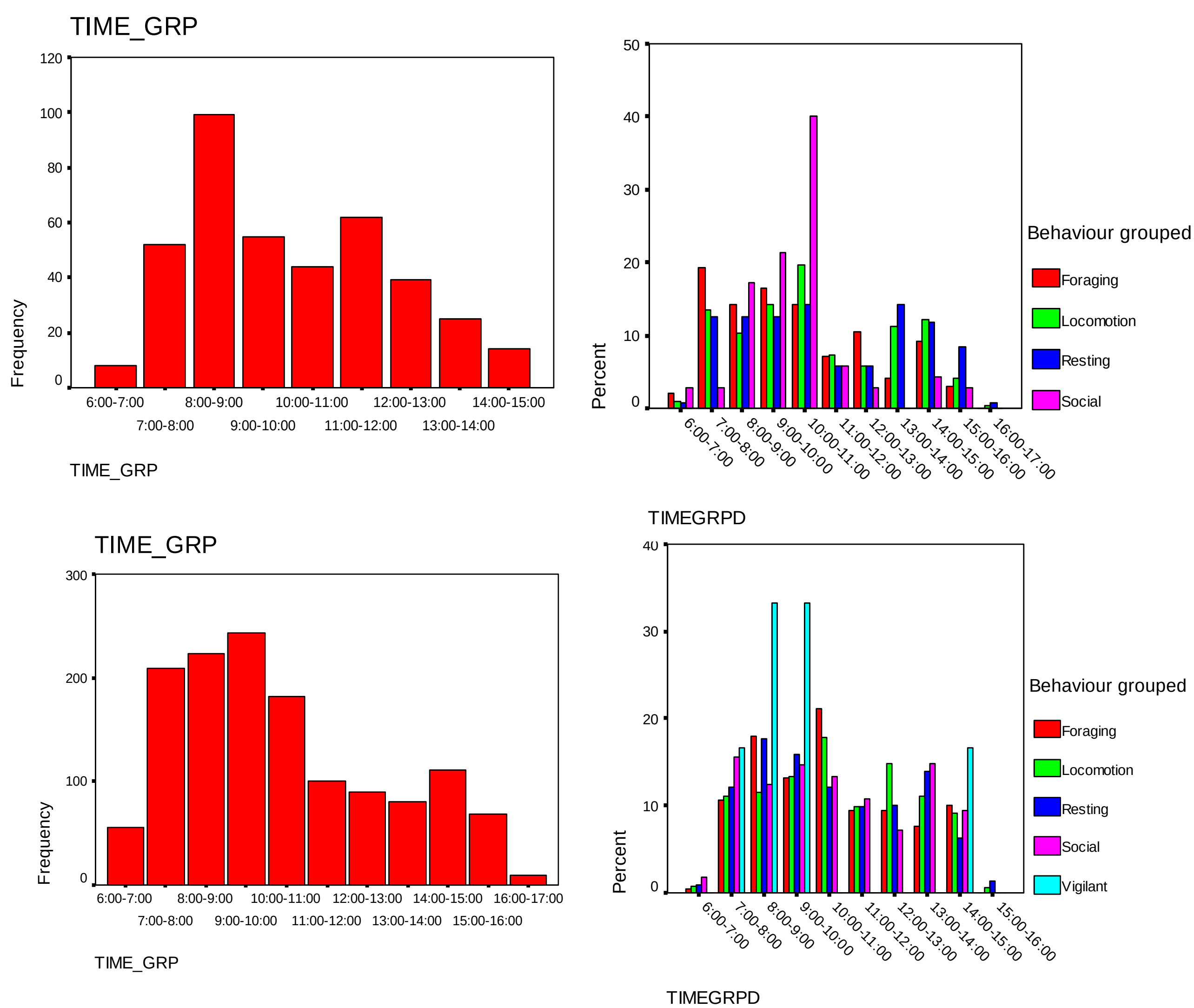




Vocal and Behavioural links in two Macaque troops

The frequency of vocalisation was correlated with activity patterns for both the Kakenauwe and Kaweli troops (Figure 20).

Figure 20. Daily vocalisation frequency (left panels) and activity frequency (right panels) for the Kaweli and Kakenauwe troops (upper and lower panels respectively).



Farmer perceptions survey - Attitudes towards the Buton Macaque as a crop pest and its Conservation

- Subsistence farming is very important in the area of study. Of the 240 people interviewed 230 were farmers, 189 of which (79%) relied on farming as their main or, quite often, only source of income.

- Overall the worst pest is considered to be the pig, though the rat scored higher in Wakangka and Wakalambe, villages which rely mainly on paddy farming.

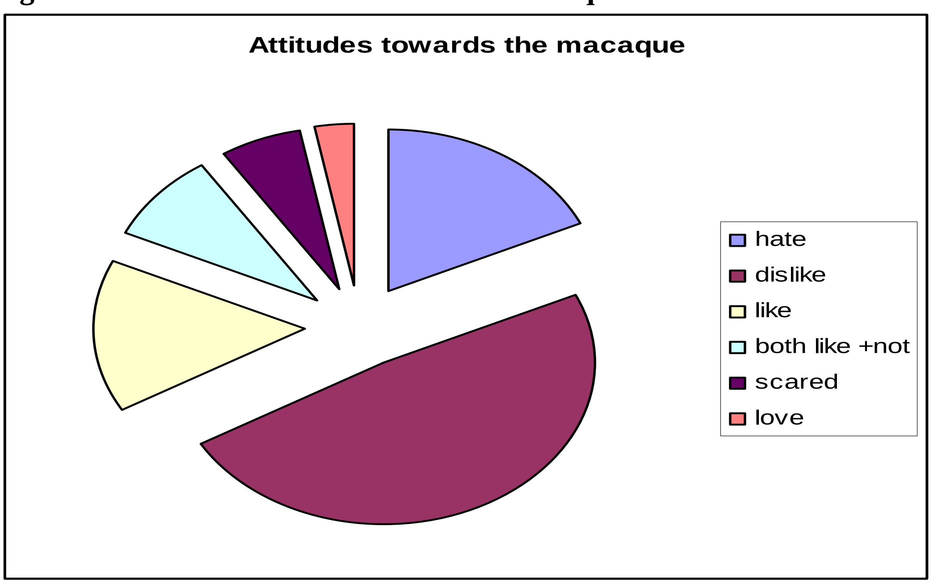
- Labundo-bundo and Lawele suffer most from crop-raiding by macaques. Macaques were considered to be one of the top three pests by 100% of the farmers interviewed in Labundo-bundo, 66% of whom claimed it was a 'serious' or 'very serious' problem. In Lawele (also a paddy growing village) 96% of the farmers who grew crops other than paddy, likely to be popular with macaques, claimed it was a 'serious' or 'very serious' problem.

- 72.5% respondents are aware the monkey is a protected species. 30 people (including some who answered 'yes' to, "is the monkey protected?") use traps/poison as a method against crop-raiding monkeys.

- 51.25% respondents think the macaque should not be protected if it is damaging farmers crops.

Overall the monkey was disliked in 5/6 villages. Respondents attitudes towards the macaque are shown in Figure 21 below.

Figure 21. Attitudes towards the Buton macaque



- There were 6 pet macaques among the 6 villages of study, and many more respondents said they had kept a pet at some time in the past.

- Only 40% of respondents had heard of PKHL and only 23.8% could give some idea as to what PKHL is about. The people who had never heard of PKHL surprisingly sometimes included those involved in the PKHL ginger scheme.

40% of those growing ginger had problems with it. These problems included: lack of knowledge and support for growing technique and having to re-plant after monkeys/pigs dig up the crop.

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Estimating abundance and key habitat requirements of tarsiers Tarsius spectrum *in the Lambusango forest*

Christine Lillie

Introduction

Tarsiers are small nocturnal primates found exclusively in southeast Asia. There are currently seven recognised species of tarsier though the taxonomy is still not clear, and the tarsiers on Buton may be a distinct Buton-endemic species, making them a potentially important but vulnerable population of conservation concern.

Tarsiers form small social groups that are territorial, with adults defending territories and sleeping sites (such as strangler fig trees or areas of thick vegetation) with duet calls in the evening and early morning.

Preliminary studies on the tarsier populations in the area found that tarsiers were more abundant in the Kakenauwe site than at the surrounding node camps (Lapago, Bala, Wahalaka, Wabalamba, Anoa), yielding a population estimate of 156 tarsiers / km^2 for this site. It is not known why tarsier abundance varies between sites. As well as being of ecological interest, a good understanding of the factors limiting tarsier abundance would be important for designing a tarsier management strategy. From previous observations, strangler fig trees appear to be an important sleeping site for tarsiers. In this study we estimate tarsier density, characterise tarsier sleeping sites, and test the hypothesis that sleeping site (especially strangler fig) availability is an important correlate of tarsier abundance.

Method

Tarsiers were surveyed on the Kakenauwe and Lapago study grids. A sample of twenty-five grid squares were randomly chosen from each study grid and surveyed for tarsiers and their sleeping sites. Surveys were carried out in the early morning during the tarsier's peak calling time (0530– 0615), when tarsiers issue duet calls when returning to sleeping site. Four field researchers carried out each survey, one began at each corner of the grid square and following any vocalisations until the last duet call. The location was noted. Each noted potential sleep site was subsequently checked during an evening survey (1730- 1815), and if tarsiers were observed emerging from the site it was confirmed as a sleeping site. The numbers of tarsiers emerging was recorded. The tarsier sleeping locations were then described. The height and dimensions of any holes were noted.

Habitat characteristics surrounding each sleeping site were measured within a 10 × 10 m quadrat centred on the sleeping site. In addition habitat characteristics were measured in 10 × 10m quadrats placed in 25 randomly selected sites Habitat variables measured in each quadrat included canopy density, vegetation density at 1.5m, rock cover, woody debris cover, topography, slope, aspect, density of different size classes of lianas (circumfernces 3-15cm, 15-30cm, >30cm), tree circumference and density (only trees >5 cm circumference), and presence of epiphytes, rattans and pandans.

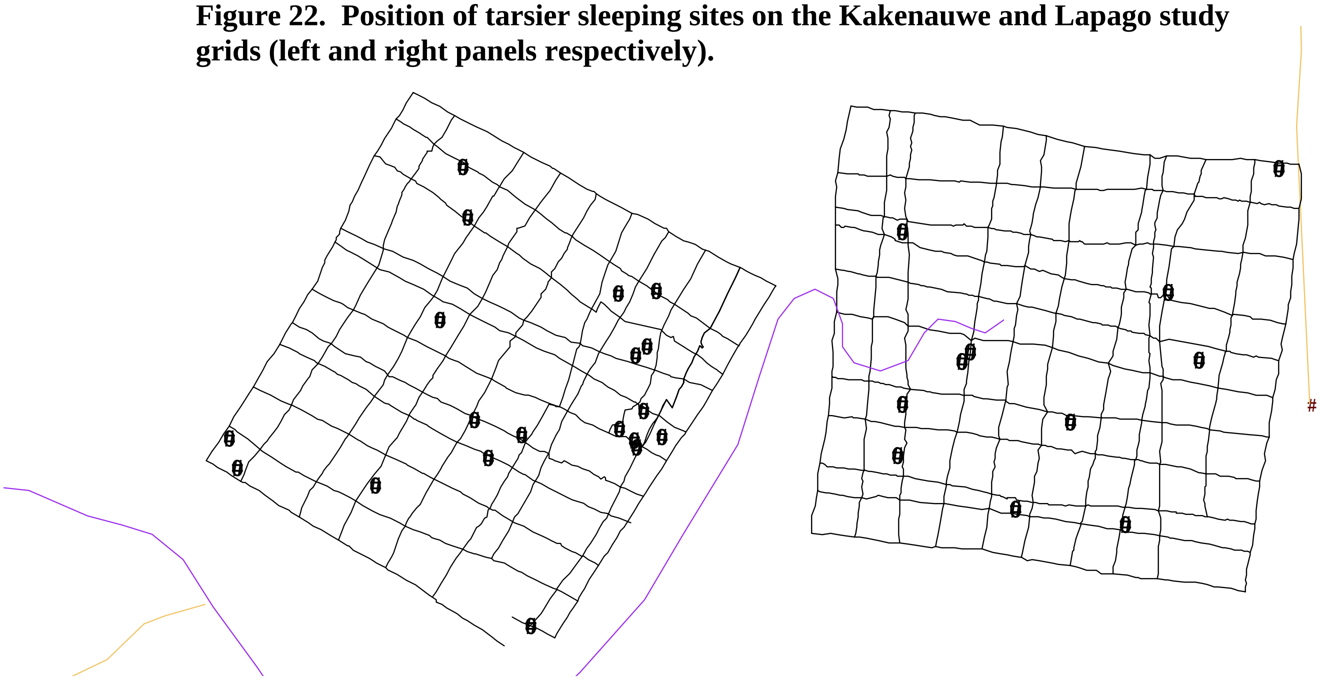
Canopy density was assessed using digital photos and vegeatation density at 1.5m recorded using a 1m visual obstruction pole with 100 black markings at 1cm intervals. Standing with the stick in the centre of the quadrat, recordings were taken by an observer standing 5m away in the middle of each of the 4 quadrat sides. A measure of topographic variation was taken by recording lowest and highest points along the midline where they deviated from ground level. Slope, aspect, number of lianas, presence / absence of rattan, pandans and epiphytes were also noted. The circumference of every tree (>5cm) was measured. In addition a randomly selected non tarsier sleep site $10m^2$ quadrat was measured for every sleep site quadrat for comparison.

In addition, all strangler fig trees of over 1m cbh within both grids were mapped, by crossing each hectare grid squre at 30m intervals and mapping to the nearest intersection. Their size was noted, large (>5mcbh), medium (2-5m) and small (1-2m)

Results

In the Kakenauwe grid tarsiers were detected in 14 (56%) of the 25 grid squares surveyed, and in Lapago tarsiers were detected in only 10 (40%) of the 25 squares surveyed. A total of 19 sleeping sites were found in Kakenauwe and 11 were found in Lapago (Figure 22).

Figure 22. Position of tarsier sleeping sites on the Kakenauwe and Lapago study grids (left and right panels respectively).



The density of strangler figs was higher in Kakenauwe (125 trees greater than 5 cm circumference breast height) than in Lapago (71 trees > 5 cm cbh; Figure 23).

Although there was a good correlation between tarsier abundance and strangler fig abundance, the functional relation is not clear, since it appears that strangler figs are not as important for sleeping sites as initially thought. Although 26% and 33% of all sleeping sites recorded in the Kakenauwe and Lapago grids respectively were strangler figs, the most commonly used type of sleep site in Kakenauwe were rock holes (37%), and in Lapago were tree tangles (44%; Figure 24). Lianas of all size classes were more common around tarsier sleeping sites than randomly selected sites, suggesting that lianas are an important criteria for sleeping site selection by tarsiers (Figure 25).

Figure 23. Strangler fig distribution in Kakenauwe study grid (left panel) and Lapago (right panel). Purple symbols denote large trees (> 5m cbh), green symbols denote medium size trees (2-5m cbh) and blue symbols small trees (<2m cbh).

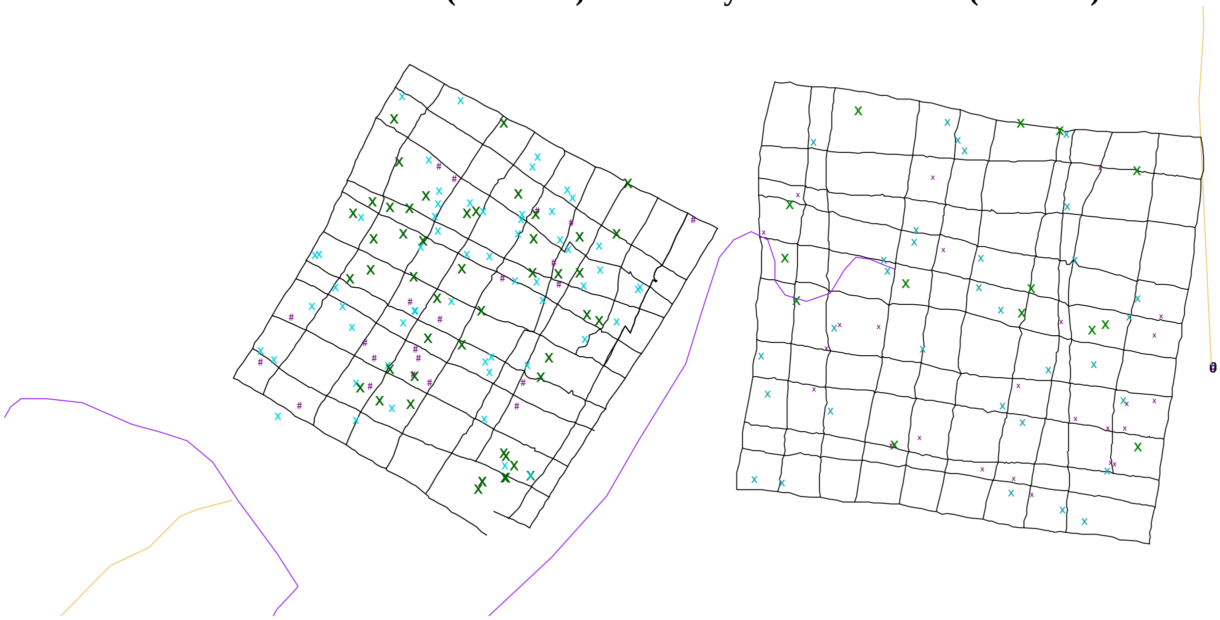


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Figure 24. Percentage of each type of tarsier sleeping sites found in Kakenauwe and Lapago.

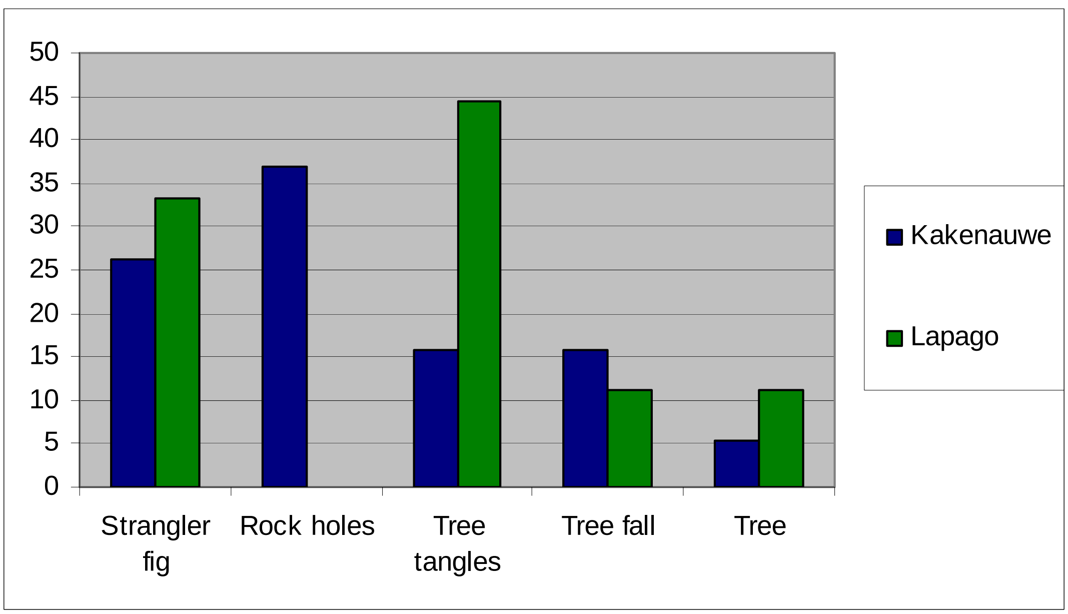
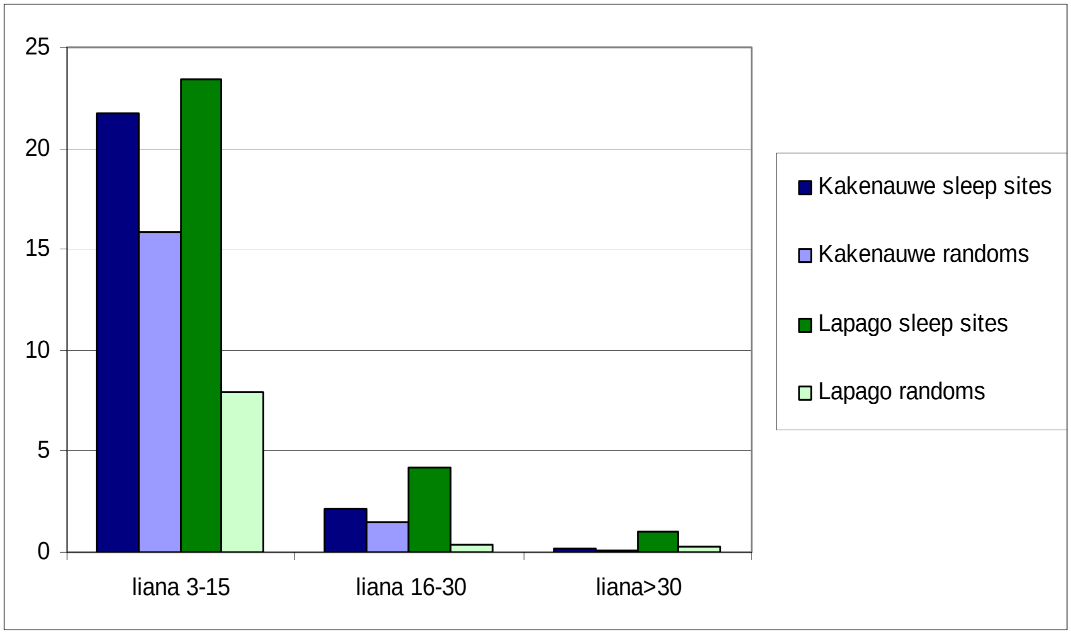


Figure 25. Liana density in quadrats around tarsier sleeping sites and random sites within the Kakenauwe and Lapago grids.



Management Recomendations

- Architecturally diverse vegetation structure is needed for tarsier sleeping sites, and sufficient forest with suitable sleeping sites such as mature strangler figs and areas of high liana density are required to maintain tarsier populations.
- Tarsiers feed largely on insects and small vertebrates. It is not known how forest disturbance influences the tarsier's prey base. Reduction of tree diversity and size due to selective logging may have adverse effects on prey populations. Other anthropogenic factors, such as the use of pesticides in neighbouring agricultural land may have a detrimental effect on insect prey base.

Fauna – Community studies

Characterisation of diversity and assemblage composition of the bats on Buton

Stephen Rossiter

Introduction

Bats are the only mammals capable of true flight and are one of only a few taxonomic groups to have evolved echolocation. These key evolutionary innovations influence the ecological flexibility of bats, and thus their community structure (reviewed by Arita & Fenton 1997). In addition, they have important implications for the methods needed to capture and survey bat populations.

In Old World rainforests, bats are a highly diverse yet vulnerable component of vertebrate diversity. Indonesia is at the centre of paleotropical bat diversity (Findley 1993) with over 200 insectivorous species (Corbet & Hill 1992; Simmons 2004). Sulawesi has over 60 listed bat species (Simmons 2004), of which approximately one third are endemic to the Wallacea region. Despite this diversity, very few surveys of bats have been undertaken on Sulawesi, and, to the best of our knowledge, no previous study has employed capture methods to sample bats that inhabit the forest interior.

Insectivorous species that inhabit the forest-interior exhibit specializations in echolocation signal design and wing morphology that enables them to forage in the dense clutter of the forest understory. Echolocation signals must allow bats to distinguish echoes returning from prey items from those of the surrounding vegetation. 'Flutter detection' (Hipposideridae, Rhinolophidae) and low intensity calls (Kerivoulinae, Murininae) are effective evolutionary solutions to this problem in high clutter (Schnitzler & Flieger 1983; Vogler & Neuweiler 1983; Bell & Fenton 1984; Link *et al*. 1986, Kingston *et al*. 1999). Such species are also capable of foraging in cluttered environment are highly manoeuvrable,conferred by low wing loading, rounded wingtips and low aspect ratio (Norberg & Rayner 1987). This combination of clutter-resistant echolocation and manoeuvrability means that many forest interior species are able to detect and avoid mist-nets. The development of the four-bank harp-trap (Francis 1989) has allowed many forest-interior species to be captured more systematically, and in greater numbers (e.g. Kingston 2000).

In contrast, many insectivorous species that live on the forest edge or in open spaces have evolved higher intensity and lower frequency echolocation calls, which attenuate less rapidly, and thus offer a greater operational range for detecting aerial insects (see Arita & Fenton 1997). In addition, members of these assemblages show morphological adaptations in wing shape for rapid, quick and energetically efficient flight (Norberg & Rayner 1987). Such species often fly too high for capture in harp-traps, but are less able to detect and avoid mist-nets.

Methods

Different assemblages of bats are characterised by marked variation in ecological niches and associated foraging behaviours. For these reasons, a comprehensive survey necessitates the use of a range of trapping techniques. Here, two main assemblages were targeted using contrasting trapping methods. Bats that forage in or commute across open spaces, such as aerial insectivores and fruit bats, were mainly targeted using static mist-nets. On the other hand, forest-interior species were captured in harp traps positioned along forest trails in the Kakenauwe Nature Reserve and Lambasango Wildlife Reserve.

In addition, two caves were surveyed and the bats present were captured by mist-nets and/or harp-traps placed inside the cave.

All bats were held individually in cloth bags and identified following Medway (1982), Payne and Francis (1985) and Lekagul and McNeely (1977). Bats were weighed, measured and banded with unique wing bands (Kunz 1996). For some species, wing membrane biopsies (3-mm diameter) were taken following the non-lethal method described elsewhere (e.g. Rossiter et al. 1999).

Additionally, the echolocation calls of individuals of *Rhinolophus philippinensis* were recorded using a Pettersson D1000X Professional UltraSound Rescorder with a sampling rate of 400 kHz. Animals were held in the hand approximately 30 cm from the microphone for recording, and time-expanded (10x) outputs were downloaded to a PC for analysis of spectrograms with the software BatSound Pro Version 5. Power spectra were generated to derive the frequency of maximum energy (kHz) for each call of each individual. All bats were released at their point of capture within 12 hours.

Results

In total, 305 captures were recorded, of which 39 were recaptures. Details of numbers and species are given in Table 6. The relative abundance of the common species is consistent with previous years, with Hipposideros cervinus, Rhinolophus euryotis and Kerivoula papillosa comprising the most numerous taxa. *Kerivoula hardwickii*, *Murina florium*, *Hipposideros diadema* and *H. cineraceus* were also relatively common, albeit at lower numbers. *Megaderma spasma*, *Phoniscus jargorii* and *Rhinolophus philippinensis* are all rarely captured and appear to be relatively uncommon based on seven years of capture records. One species, *Myotis horsfieldii* is seldom captured in the forest but was captured this year over a large dry river-bed within the Lambasango Reserve.

Two caves (UTM 0496945, 9425282) were surveyed for the first time during August, both located in the village of Nambo in Central Buton. The first cave contained a small colony (~8 bats) of *Megaderma spasma* and a larger number of *Rhinolophus celebensis* (~20 bats). The second cave, located within 30 metres from the first, contained a large colony (approximately 4000 individuals) of *Rhinolophus euryotis* – the largest recorded on Buton to date for this species. Although all three species are common on Buton, these colonies are likely to be important to the local populations of these taxa. Moreover, the surrounding habitat was highly disturbed secondary forest and at the time of surveying, was subject to selective logging.

Discussion

Assemblage composition recorded during the 2006 field season was broadly consistent with previous years, with *Hipposideros cervinus* and *Rhinolophus euryotis* representing the most common species. However, contrary to the pattern of species composition based on field seasons 2000-2005, *Kerivoula hardwickii* was much more abundant that the larger *K. papillosa, and R. celebensis* was captured in much lower numbers than usual. More years of data are needed to determine the likely causes of such fluctuations. Notable records of rare species include *Phoniscus jargorii*, *Cheiromeles parvidens* and the large morph of *Rhinolophus philippinenesis*. More detailed analyses, particularly of temporal trends, are pending.

Table 6. Habitat type is categorised as river (R), forest (F), village (V) or cave (C). Trapping method is classified as either mist net (MN) or harp trap (HT).

Species name	Number	Habitat type	Trapping method
Cheiromeles parvidens	1	R	MN
Cynopterus brachyotis	2	R	MN
Dobsonia viridis	2	R	MN
Hipposideros cervinus	123	F	HT
Hipposideros cineraceus	10	F	HT
Hipposideros diadema	3	F	HT
Hipposideros dinops	1	F	HT
Kerivoula hardwickii	28	F	HT
Kerivoula papillosa	15	F	HT
Macroglossus minimus	2	R	HT
Megaderma spasma	1	F C	HT
Murina florium	19	F	HT
Myotis horsfieldii	5	F	HT
Phoniscus jargorii	1	F	HT
Rhinolophus celebensis	9	F C	HT
Rhinolophus euryotis	68	F C	HT
Rhinolophus philippinensis S	3	F	HT
Rhinolophus philippinensis L	1	F	HT
Rousettus amplexicaudatus	6	R	MN
Rousettus celebensis	2	R V	MN
Tadarida sarasinorum	3	R	MN

Management recommendations

Most of the bat species that are captured regularly in the Kakenauwe and Lambasango Forest Reserves are forest specialists and are likely to be extremely adversely affected by forest disturbance activities such as selective logging and rattan extraction. Moreover some of these species (*Kerivoula* spp.) use trees as roosts. To safeguard the populations of these bat species, some of which are Red Data listed (e.g. *Murina florium*), it is recommended that logging and rattan collection in the two reserves is carefully regulated.

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Habitat relationships of herpetofauna assemblages across a habitat disturbance gradient

Graeme Gillespie & Mary Campling

Introduction

Even intact rainforests are subject to anthropogenic habitat alteration due to selective logging, and the harvesting of non-timber forest products. Very little is known about how such alterations influence the community composition of rainforest herpetofauna, and what implications such effects have for the conservation of key herpetofauna. Previous herpetofauna sampling in the Lambusango forest found relatively little difference in herp communities sampled in 'minimally' and 'moderately' disturbed forest, suggesting that forest herp communities in the Lambusango forest were relative insensitive to disturbance such as selective logging, rattan harvesting, and the introduction of trail networks. However, there are a priori reasons to expect changes in community structure with disturbance. For example, in the Lambusango forest, heliothermic lizards such as *Eutropis grandis and Eutropis rudis* may benefit from selective tree harvesting, allowing them access to larger areas within the forest with basking sites nearby. Similar patterns have been recorded for lizard species in the Amazon (Vitt *et al*, 1998). However, logging and understory removal may be negatively impacting on shade-dwelling and fossorial species such as the *Calamaria* snakes and *Sphenomorphus* skinks as a result of habitat removal.

This study aimed to characterise the herpetofauna communities in an area of forest consisting of a range of disturbance regimes.

Methods

Seven sites were surveyed for herpetofauna with pit-lines (each consisiting of four pit-buckets connected by a drift fence) and nocturnal surveys in July and August 2006. These sites were arranged along a transect that stretched from a single-track road towards the forest interior.

Habitat surveys were carried out to quantitatively assess differences in forest structure along each pit-line. A 5mx5m quadrat was established at both ends of each pit-line. Variables measured within the quadrats included leaf litter depth, vine count and circumferences, log count, tree count, aspect and gradient. The number of large trees, mean number of buttresses and a log count were also recorded for the area surrounding the pit site (within a 20m radius) and 10 canopy photos taken. These variables were shown to correlate highly with variations in pitfall data during previous analysis by Gillespie *et al* (2005).

Results

The pit-lines yielded 896 captures of herpetofauna from 22 distinct taxa. The most commonly captured species were the skink *Sphenomorphus variagatus* (279 captures), the Sulawesi-endemic toad *Bufo celebense* (118 captures) and the Buton-endemic snake *Calamaria butonnensis* (111 captures). Average number of captures per pit-bucket varied across sites from 20.0 to 43.25. Patterns of community structure with habitat disturbance have not yet been examined.

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The distribution and abundance of murid rodents along a 3 km transect in the Lambusango forest

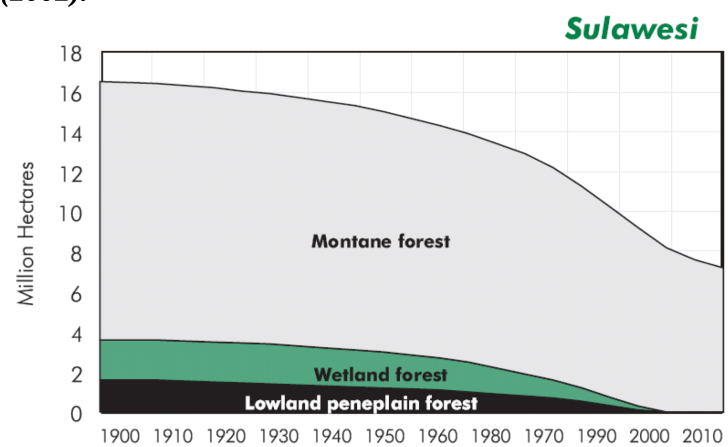
Nicola Grimwood and Katie Wilkinson

Introduction

Forest decline

On Sulawesi, 20% of the forest area was lost between 1985 and 1997 alone, and this figure does not account for the quality of the forest remaining, which may be heavily disturbed. Forest habitat in Sulawesi is subject to many anthropogenic pressures, including timber extraction (on both commercial and small scales), harvesting of other natural resources (e.g. rattan), road building and an increase in the number of introduced species, all of which have been exacerbated by transmigration of refugees into previously unsettled areas (Whitten *et al.* 2002). Forest cover in the study region on Buton Island is still relatively high, but this is partly due to the proportion of land on slopes unsuitable for agriculture.

Figure 26. Estimated loss of lowland and other dominant forest types in Sulawesi between 1900 and 1997 and projected forest loss expected by 2010, assuming continuation of current deforestation trends. This indicates that lowland forest area in Sulawesi has already been reduced to statistical insignificance. ***Adapted from Barber et al. (2002).***



Source: *Holmes, 2000*

Sulawesi's richest forests, the lowland rain forests, have now been almost entirely destroyed (Barber *et al.* 2002), and lowland dry forest, the most valuable type of Indonesian forest for both logging and biodiversity conservation, is essentially defunct as a viable resource in Sulawesi (Holmes 2000 - see Figure 1). This is a major conservation concern as Sulawesi is a unique region, and its lowland forests support a highly distinctive fauna and flora.

Sulawesi rodents: Endemism & vital ecological roles

Sulawesi supports a surprising number of mammal species for an island of its size. One reason for this is that Sulawesi has been the centre of an extraordinary radiation of Murid rodents (Musser 1987). There may be up to 40 species of rats and mice on Sulawesi, making up around one third of the total mammalian fauna, and over half of the endemic species (Musser 1987). If only the non-volant species are considered, a startling half of all Sulawesi mammal species are Muridae. These endemic murids display a combination of primitive and unique characters, and some genera are morphologically highly specialised. This suggests that much of the murid fauna has evolved in isolation on Sulawesi for a significant amount of time, and is likely to have descended from an ancient group of Asian mainland rodents that is now largely extinct (Musser 1987).

It is thus clear that on Sulawesi at least, all rats and mice should not be dismissed as the pest species they are so commonly assumed to be in other regions. None of the Sulawesi endemic murids are commensal, or are known to be large-scale agricultural pests (Priston, pers. comm.). On the contrary, the endemic rats appear to be predominantly restricted to forests, both lowland and montane, whereas the introduced murid species occur in areas of human habitation (Musser 1987). Given the rate of loss of their forest habitat, and the introduction of non-native species, the fate of the Sulawesi endemic murids is now uncertain, and is of conservation concern.

In addition to having intrinsic conservation value due to their endemicity, the small mammals of Sulawesi play a vital role in forest ecosystem processes. There are relatively few studies on the function of small mammals in rainforest systems; however those which have taken place indicate that small mammals not only provide a prey base for various carnivore species but may also function as pollinators, seed dispersers and seed predators. For example, on Sulawesi, Musser (1990) has observed that many of the endemic rats consume fig fruits; however most digest the only the pulp, with the seeds passing through intact in the faeces. In contrast, the pygmy tree mouse *Haeromys minahassae*, Sulawesi's smallest endemic rodent, discards the fig pulp and eats only the seeds. The larger rodents thus act as seed-dispersers to such fig species, whereas *H. minahassae* is a seed predator.

Whether in their role as seed dispersers or predators, rodents may have an impact on critical issues such as tree diversity (Asquith *et al.* 1997). Some species have extremely hard fruit which need to be opened by rodents (e.g. Perez *et al.* 1997) and other tree species need seeds to be buried by scatterhoarding rodents (e.g. Leigh *et al.* 1993). Even trees which are generally known as self-dispersing or wind-dispersing may be affected by rodent species. For example, many dipterocarps are wind-dispersed, but the nutritious seeds are commonly harvested by rodents which store them in spatially scattered caches (Ashton 1988). Such cached seeds may be in better environments for germinating and developing than unharvested seeds (Jansen & Forget 2001. Thus, although rodents do not carry seeds very far, and will consume part of their food reserves later, they may have a positive net effect on the survival of seeds and could be important agents for secondary seed dispersal in Sulawesi tree species.

The small mammal fauna of Buton's forests is thus of importance to forest management and conservation, but to implement effective conservation strategies we must understand key ecological issues and ecosystem processes. The ecological factors determining distribution of tropical species and organisation of tropical communities are complex, and studies of community structure and dynamics in rainforest mammal fauna are in their infancy. This is particularly the case for small mammal species with little obvious charismatic or commercial value, and progress may be further hindered by the difficulties inherent in conducting such studies; small forest mammals tend to be cryptic, traps and baits selective and their environment highly complex.

Gaining an understanding of the ecology of Sulawesi endemic small mammals is not only important for the conservation of those species. Many studies have shown that the richness, distribution and abundance of coexisting small mammal species are affected by the availability of microhabitats which can be characterised by specific quantifiable variables. Small mammal species with distinct microhabitat preferences may act as effective indicator species, as they can be highly sensitive and quick to respond to disturbance.

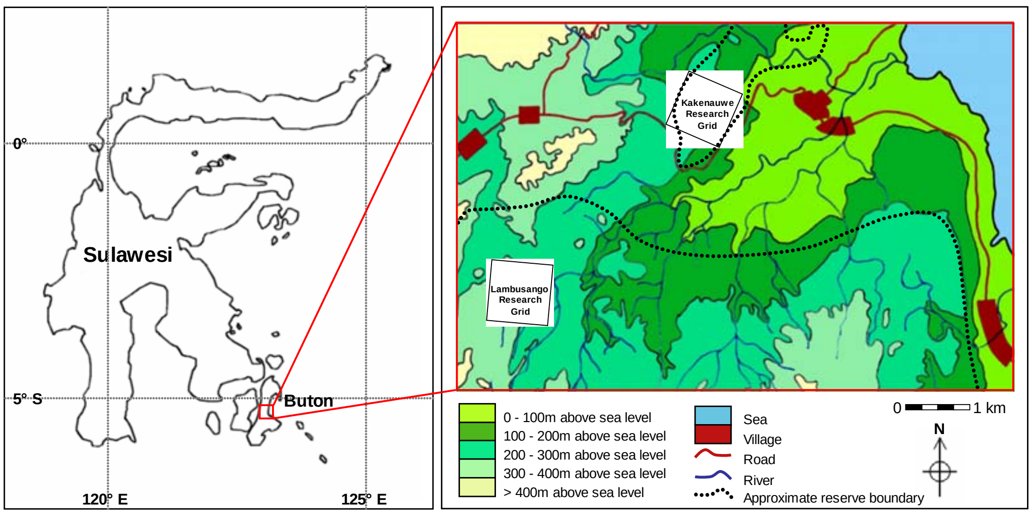
The main aims of this season's work were characterise the distribution patterns and abundance of rodent species, and to evaluate whether small mammal abundance and community composition vary with distance away from the road into the forest. In addition, the study contributed to the existing data-set on the microhabitat preferences of Sulawesi endemic small mammals.

Methods

Study site

This study was carried out on Buton Island, Sulawesi (5°15'S, 122°50'E), in the vicinity of the Lambusango Wildlife Refuge (28,500 ha) (Figure 27).

Figure 27. Location of the study area within Sulawesi and the locations of the study sites in central Buton. ***Topographical map redrawn with permission from field map prepared by A. Dykes, 2001.***



Trapping methods

Three 1km transects were set up along the existing Jalan Kodok trail radiating from the Bau Bau to La Bundo Bundo road. These transects were named Jalan Kodok A (JKA), Jalan Kodok B (JKB) and Jalan Kodok C (JKC). The Jalan Kodok transect runs towards the Lambusango Wildlife Refuge to the south-west of the road. The Lambusango transects are topographically complex including steep slopes and plateaus.

Each of the three 1km transects consisted of six 140m long trap-lines running at right angles to the trail. On each line were 8 trap stations, with an inter-station distance of 20m. This spacing was based on the habitat type and the likely home range size of the target species. Each trap station was marked with flagging tape and a large 'Type B' Elliott aluminium box trap (46x15x15cm. Elliott Scientific Equipment, Melbourne, Australia) and a small 'Type A' Elliott trap (33x10x9cm) were placed in suitable locations on the ground within 3m of the station marker. At three stations on each line a locally modified Tomahawk cage trap (49x16x16cm. Tomahawk Live Trap Company, Wisconsin, USA) was also set. The number of traps used on each transect therefore totalled 114; 96 Elliott traps and 18 Tomahawks.

Traps were baited with a mix of porridge oats, peanut butter and banana and strawberry food flavouring. Trapping took place predominantly in the dry season, commencing on the 15th July in Jalan Kodok A and finishing on 21st August on Jalan Kodok B. All three transects were trapped for a total of 10 nights. However due to logistical reasons JKB was trapped continuously for the full 10 nights whereas JKA and JKC trap stations were closed on the 5^{th} night for two nights and then reopened and baited. This resulted in 1,140 trap nights trapping effort on each of the transects thus totalling 3,420 trap nights in overall.

Previous work had shown that the target rodents were primarily nocturnal, and that shrews were unlikely to be caught given the bait being used; therefore the traps were checked once daily at 07:30, whilst the day was still relatively cool. Any traps lacking sufficient bait were re-baited, and those which had been disturbed were re-set in their original location.

Any small mammals caught were removed from the trap into a mesh bag for weighing and were then run into a wire mesh handling tube. In the tube the animals could be safely handled whilst they were identified and sexed. Morphometric measurements were recorded, including hind-foot, ear and tail length. Other features which allow differentiation between very similar species were also noted. Small sections of fur were clipped to enable each individual to be recognized if re-captured (Gurnell & Flowerdew 1994). After processing, each animal was released at the trap station at which it was caught. Mammal taxonomic nomenclature follows that of Corbet and Hill (1992) and Nowak (1999).

Microhabitat characterisation

In order to obtain data on the potential microhabitat preferences of the rodents, a microhabitat quadrat was carried out at each of the 144 trap stations. A 10x10m quadrat was marked out with a tape measure centred between the two/three traps present at each station. The quadrat was then divided by two additional 10m tape measure lines to provide three 'quadrat transects' which were then used to measure rock and woody debris. The full list of microhabitat variables recorded within each quadrat are shown in Table 7. These were predominantly based on variables and methods used in previous microhabitat studies (for example Dueser & Shugart 1978; 1979; Lambert & Adler 2000).

Data analysis

The trapping produced data on captures that could be categorised by transect, trap-line, trap-station, trap type, species, sex and weight.

As animals had been uniquely marked, it is possible to estimate population size using models which utilise full capture histories. Summary tables of individual capture histories will be created for each species of rodent trapped. The summary data will be initially processed in 'Simply Tagging' (Version 1.31, PISCES Conservation Ltd., Lymington, UK) which offers a range of analytical techniques to estimate population size from mark-recapture methods. Other more robust and complex population estimation models will be fitted to the data on return to the UK using MARK (MARK 2001, http://www.cnr.colostate.edu/~gwhite/mark/mark.htm). Where overall captures or recaptures were very low, precluding the use of mark-recapture population estimates, a very simple catch-per-unit effort measure will be used to allow comparison of species numbers.

The microhabitat assessments produced a set of variables for each trap station. For microhabitat variables where multiple measures were taken within each 10x10m quadrat, (e.g. tree circumference, % cover, vegetation density), a mean value will be obtained for each trap station. These values, along with single value data (e.g. tree number) will be analysed in SPSS for Windows (Version 11, SPSS Inc., Chicago, Illinois). Both univariate and multivariate techniques will be used to identify significant differences in microhabitat between transects and between individual trap-lines. As there are likely to be significant intercorrelations between the microhabitat variables, a principal components analysis (PCA) will be carried out to attempt to reduce the dimensionality of the data for subsequent analysis. Discriminant function analysis (DFA) will be used to investigate relationships between species and microhabitat. Finally CANOCO (Version 4.0, Plant Research International, Wageningen, The Netherlands) software will be used to carry out a redundancy analysis (RDA) on the species and microhabitat data.

Table 7. Microhabitat variables recorded at each trap station.

	Variable	Methods
1	Position	Topographic position of trap station R= ridge S = Slope G = Gully F = Flat
2	Slope	Slope angle measured by standing at the lowest point of terrain with a clinometer 1m above ground lined up with a 1m pole opposite at the highest point
3	Aspect	Aspect of terrain recorded by taking a compass bearing whilst facing the direction that water would flow.
4	Canopy cover photo	Canopy cover recorded by digital photograph taken from each corner of the 10mx10m quadrat.
5	Tree number	Number of all trees ≥ 15cm circumference at chest height (CBH) in 10x10m quadrat.
6	Tree circumference	Mean circumference of all trees ≥15cm CBH in 10x10m quadrat.
7	Tree base type	Base type of all trees >15cm CBH in 10x10m quadrat: 1 = round, 2 = buttress, 3 = multiple/stilt, 4 = strangler fig.
8	Number of buttresses	If base type of tree ws buttress then the number of buttresses was recorded.
9	State of decay	If there was a dead standing tree then the state of decay was recorded using a 1-4 scale. 1 = freshly felled or fallen 2 = moderately decayed 3 = decayed to a large extent 4 = almost wholly decayed and collapsed.
10	Liana number and size	Number of lianas at eye-level in the quadrat in 3 size classes: 3-15cm circumference (small), 15-30 cm diameter (medium) and >30cm diameter (large).
11	Connectivity of trees in quadrat	Connectivity: 0 = all trees largely isolated from neighbouring trees, 1 = majority of trees have only weak contact by small tips of branches or foliage, 2 = up to 5 connections with neighbouring trees by substantial branches or lianas., 3 = over 5 connections to neighbouring trees by substantial branches and lianas.
12	Percentage vegetation cover at 0.5m above ground	Mean vegetation density at 0.5m above ground, using visual obstruction pole at all four corners of 10x10m quadrat.
13	Length of exposed rock in cm along three quadrat lines	If rock passed under the transect line then it was measured in cm.
14	Max rock height	Where rock was present anywhere within the quadrat the height above ground was measured in cm.
15	Length of woody debris cover in cm along three quadrat lines	If woody debris passed under the transect line then it was measured in cm.
16	Presence / absence of epiphytes	Epiphylls, moss >1m, moss <1m presence absence for each.
17	Log number	Number of all logs >15cm diameter in 10x10m quadrat
18	Log diameter at midpoint	Log diameter when above >15cm in 10x10m quadrat
19	Total length of log	Total length of all logs >15cm diameter measured in cm.
20	State of decay	State of decay recorded on a scale 1-4. 1 = freshly felled or fallen 2 = moderately decayed 3 = decayed to a large extent 4 = almost wholly decayed and collapsed.

Preliminary Results and Discussion

Trapping results

Over the 3,420 trap-nights, there were a total of 154 captures, consisting of 67 individuals of 4 species (Table 8). All species trapped are endemic to Sulawesi on at least the level of genus. Species trapped consisted of Andrew's shrew-rat (*Bunomys andrewsi*), (Figure 28), Sulawesi giant rat (*Paruromys dominator*), Hoffman's rat (*Rattus hoffmanni*) and the Yellow tailed rat (*Rattus xanthurus*). The latter species has not been previously found on the Buton island however confirmation of the identification of this species will take place upon return to the U.K.

A total of only four species trapped over 3,420 trap-nights and 67 individuals is low compared to other small mammal studies in Asia. For example, studies in Sabah have trapped 16 small mammal species in terrestrial traps (Wells *et al.* 2004). However the mammal fauna in Sulawesi is very different to that of Borneo, lacking the numerous species of sciurids and tupaids which occur at the terrestrial level of the forests in that region. However, although low for other tropical forests in Asia, the number of species trapped here is comparable to that found by (Maryanto & Yani 2003) in Lore Lindu, Central Sulawesi.

Table 8. Summary of small mammal captures; taxonomy, level of endemism in Sulawesi and numbers of individuals captured for all species trapped.

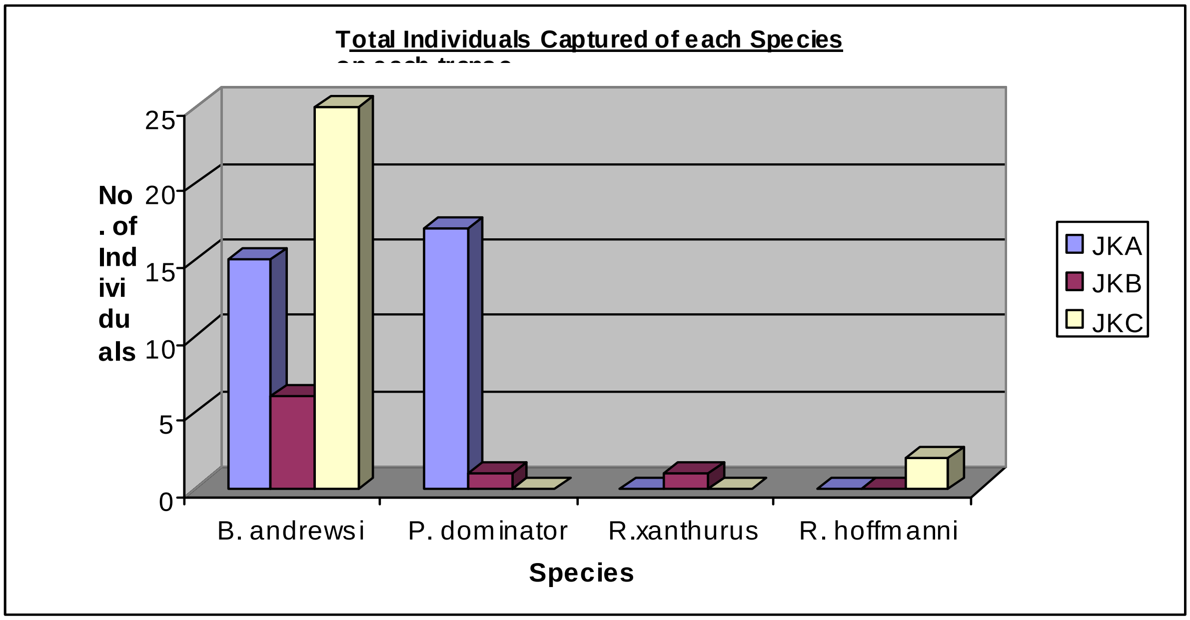
Family	Species name		Level of	Captures
	English	Scientific	Endemism	Individuals
Muridae	Andrew's shrew-rat	*Bunomys andrewsi*	Genus	46
Muridae	Sulawesi giant rat	*Paruromys dominator*	Genus	18
Muridae	Hoffman's rat	*Rattus hoffmanni*	Species	2
Muridae	Yellow tailed rat	*Rattus xanthurus*	Species	1
			Total	67

For lowland forest sites they caught between 2 and 5 species of small mammals. However this was only over four-night trapping periods, so figures would potentially be slightly higher if they had trapped for the longer periods used in this study. The complete domination of captures by murid rodents in this study continues a pattern unchanged in 5 years of small mammal trapping on Buton; no sciurids have ever been live-trapped on Buton (despite arboreal trapping in 2004). This is also quite comparable to Maryanto and Yani's captures in Lore Lindu; out of 309 individuals only two were sciurids.

Figure 28. Andrew's shrew rat (*Bunomys andrewsi*). © N. Grimwood 2004.

Distribution of captures by transect
As shown below (Figure 29) the community composition between the three Jalan Kodok transects were similar, with most captures dominated by *B. andrewsi* except for in transect JKA where *P.dominator* had comparable trapping rates to *B.andrewsi.* However, each transect also had one additional species which was not found in the other transects.

Figure 29. Distribution of small mammal captures by transect.



Species lists and capture frequencies alone are not sufficient to describe community diversity on the different transects. Alpha diversity measures incorporate both the number of species and their relative abundance, and to compare small mammal species diversity between the transects, two basic non-parametric α-diversity indices will be calculated upon returning to the UK. Although these indices are commonly applied in ecological studies, their limitations are recognised and are widely discussed in the literature (e.g. Colwell & Coddington 1994). Neither Shannon-Wiener H' or Simpson's D make any assumptions about the shape of species abundance curves, but the Shannon-Wiener index is most sensitive to the abundance of rare species whereas Simpson's D is more sensitive to dominant species. It is predicted that Jalan Kodok B should produce the highest diversity scores with a total of three species captured (if identification of *Rattus xanthurus* is confirmed).

Distribution of captures by trap-line
As shown below (Figure 30), there was an increase in small mammal capture success up to 1000m in distance from the road. However along Jalan Kodok B (1200m to 2400m) there was a sharp decrease in captures then a sharp increase. At 2400m (Jalan Kodok C) captures decrease again only to increase at 2800m and then a final decline at 3200m. It seems that there is no clear pattern of an overall increase in captures the further away from the road the trap lines are, therefore a more discrete variable could be influencing the distribution of the small mammals. Thus further analysis will be carried out to investigate this disparity in

individual captures by relating both variation in microhabitat variables and distance from the road with captures.

Microhabitat characterisation

Microhabitat data was collected for all trap stations. It was not possible to analyse this data in the field, so results are not presented here.

Figure 30. Distribution of small mammal individuals by trap-line (a) Jalan Kodok A (b) Jalan Kodok B (c) Jalan Kodok C

Figure 6a

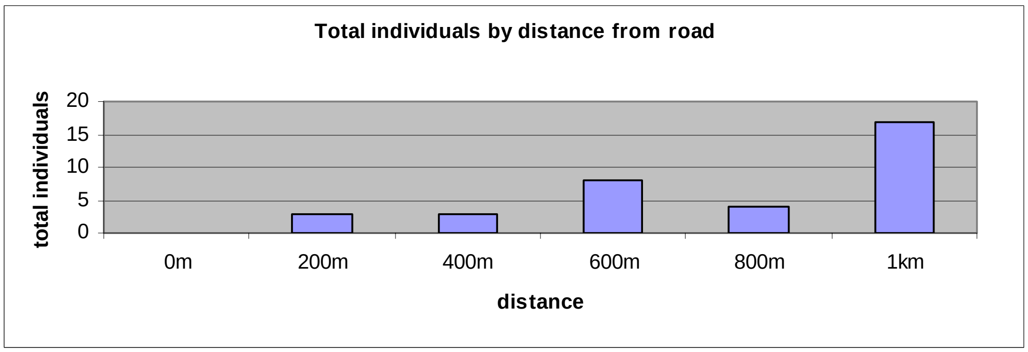


Figure 6b

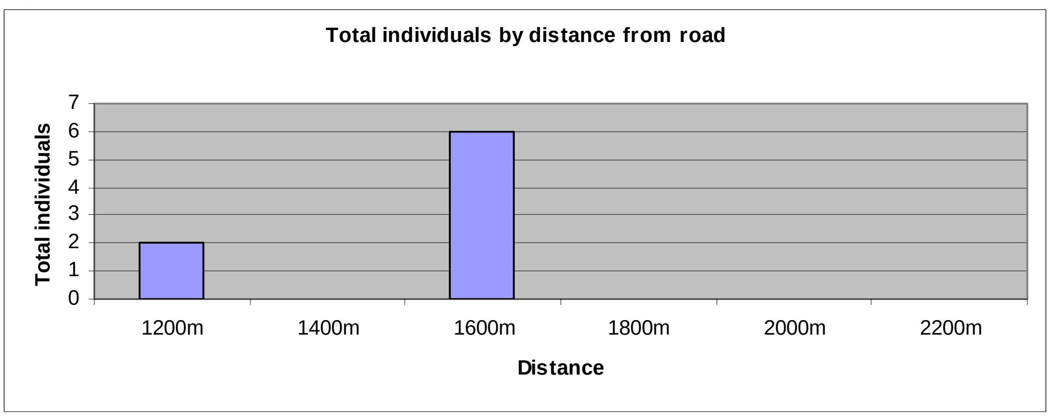
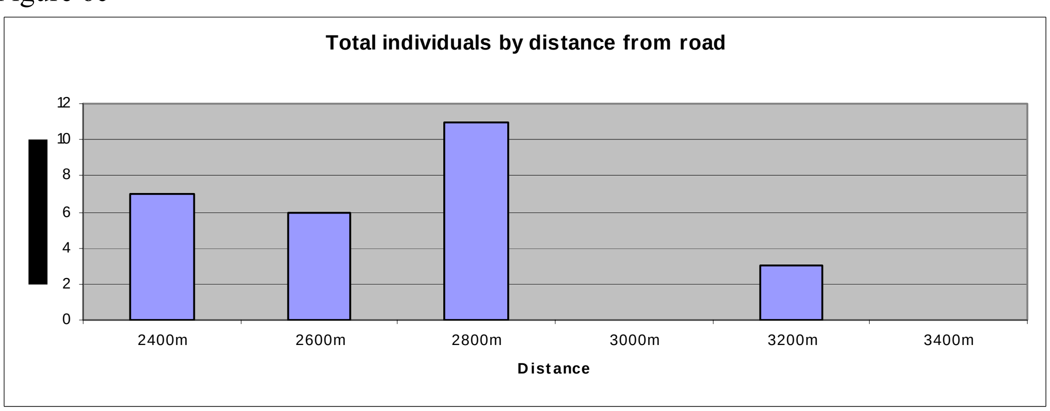


Figure 6c



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Patterns of Bird Communities in Lambusango Forest

Nurul L. Winarni

Introduction

For the last five years, the Lambusango Forest Area of Buton Island has been the focus for Operation Wallacea biological research. The long time studies have shown that the area represent high biodiversity of Sulawesi, including anoa and Buton macaques. Buton island is known to support at least 231 bird species including 52 Sulawesi endemics and 9 Indonesian endemics (Catterall 1996), making it an extremely important site for bird conservation.

With the high biodiversity, the Lambusango Forest has been suffered from various disturbance including hunting, forest conversion to agriculture, asphalt mining, illegal logging, and uncontrolled rattan extraction. Thus, in early 2005, a joint programme between Operation Wallacea and Global Environmental Fund (GEF) of the World Bank, established the Lambusango Forest Conservation Program. The programme aims to develop an integrating forest management system for the protection of forest and its surroundings and the development of the people living around the forest areas. One of the measures of success of the programme is a biodiversity monitoring project and this report focuses on one aspect of this, namely the monitoring of the bird communities.

The continuous change of forests will obviously affect biological communities, and there is a necessity to conduct ecological monitoring to assess the impact on those communities (Spellerberg 2005). Spellerberg (2005) also suggests that such ecological monitoring is particularly important when the ecosystems in question have not been researched comprehensively. In addition, long-term monitoring is needed to support management schemes to combat human-induced disturbances which themselves have an impact in the longer term (Spellerberg 2005). The study is to determine the response of avian communities in Lambusango Forest to habitat disturbance. This report presents preliminary findings of bird diversity in Lambusango Forest.

Methods

Study Area

Studies were conducted between July-August 2005 in 6 node camps in Lambusango Forest Area, Lasolo, Wabalamba, Walahaka, Anoa, Lawele, and Lapago. Lasolo and Lawele are Production Forest whereas the others are Protected Areas. Four of three kilometers transects are set up at each site and each transect is marked every 50 m. Approximately one week was spent at each node camp.

Bird Counts

Bird species was surveyed using the Variable Circular Plot methods (point counts with distance estimates to each contact) following Bibby et al. (2000). Points were located at 150-m interval along each of the transects at each node camp and were visited approximately between 0600 and 0830 hours. Preliminary surveys in the area suggested that bird activity started to increase at 0600 and dropped off markedly after 0800. Therefore, we decided to use 150-m interval to reduce the travelling distance between each point and increase the number of points each day. Due to increased possibility of double counting the birds, we monitored the position of calling birds so that the same birds were not recorded at more than one point. Two groups consisting of 2-3 recorders led by an experienced observer stayed at each point and recorded any birds detected around the central point for 10 minutes without the use of a settling down period. Recent research has shown that settling down periods reduce the numbers of contacts recorded (M. Jones pers.comm.). Each group visited different points each day and did point counts only once at each point. When one group conducted a count at one point, then the other group would replicate the point on the following day. All birds heard and seen were recorded (those flying were noted but not used for the subsequent analysis) and an estimate of distance was made to each contact. All observers spent approximately one week prior to data collection, learning to recognize bird species and bird calls, as well as practicing methods.

Habitat Measurement

At each of point, habitat structure variables are measured. We recorded the undulation of the site, slope, and number of fallen trees. We measured ten nearest trees with DBH ≥ 50 cm and noted the position of first branch (less or more than halfway of the height) as well as any indication of flowering or fruiting of the tree. Measurements of understory density using 50 marked stick and canopy closure were also recorded. And as an indication of disturbance, presence of rattan, palms (Palmae), lianas, pandanus were also recorded. In addition, we also recorded number of above-two-meter saplings, number of ferns, tree ferns, and bird-nest ferns.

Preliminary Results

The survey was conducted during July-August 2006. All of the habitat data and bird's point count data are still being analyzed. However, we managed to survey 28 points at each node camps with approximately twice replication at each point resulting 366 counts. The observers spent approximately one week for bird identification prior to survey. To ensure that the assumptions are met needs experienced observers. We tried to lessen this bias by having at least one experienced observer at each team.

A total of 49 bird species from 23 families was observed during point counts in overall 6 node camps with Wahalaka with the highest number of species seen (42 species). Among the accounted species, 25 species are endemic to Sulawesi. Highest number of species was recorded in Wahalaka (42 species). Bird species based on foraging guilds are presented in Appendix 1.

The five most common species in all node camps were similar to last year (2005) including the Green Imperial Pigeon (*Ducula aenea*), Hair-crested drongo (*Dicrurus hottentottus*), Sulawesi Babbler (*Trichastoma celebense*), Bay coucal (*Centropus celebensis*), and Black-naped oriole (*Oriolus chinensis*).

Diversity and similarity indecies were calculated using program EstimateS 7.5 (Colwell 2005). Shannon's index of diversity (Magurran 1988) revealed that the diversity index ranged from 3.07-3.17 with the lowest index at Anoa and the highest index at Wahalaka (Table 9). Simpson's index of diversity (Magurran 1988) which place more emphasis on the partitioning of birds between the different species showed the same patterns (Table 9). This diversity patterns are relatively similar with previous year in which Anoa having the least diversity and Wahalaka with the most diverse birds (Winarni and Jones 2006). The Morisita-Horn similarity index which is influenced by the most abundant species depicted the closest similarity of community between Wabalamba and Wahalaka. Numbers of shared species in those areas are the highest (Table 10). The least similar numbers of species shared are between Anoa and Lasolo.

Table 9. Matrix of pairwise Morisita-Horn similarity index comparing each node camp, along with Shannon-Wiener index and Simpson's index

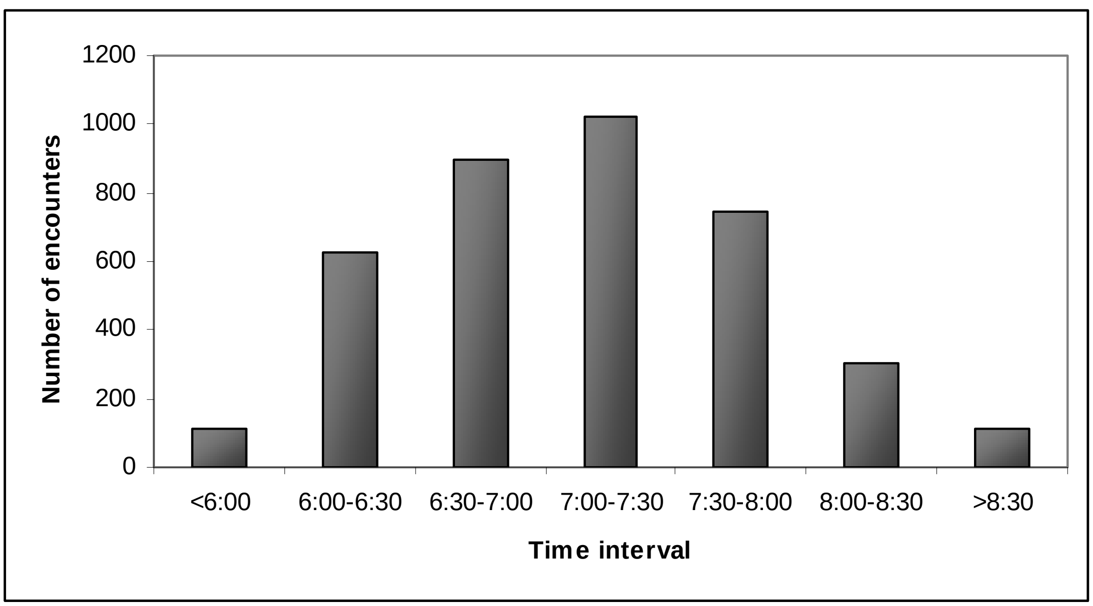
Node Camps	Anoa	Lapago	Lasolo	Lawele	Wabalamba	Shannon's	Simpson's
Anoa						3.07	16.37
Lapago	0.924					3.13	16.92
Lasolo	0.873	0.927				3.15	17.32
Lawele	0.882	0.929	0.874			3.16	17.44
Wabalamba	0.906	0.948	0.942	0.891		3.16	17.41
Wahalaka	0.923	0.948	0.910	0.890	**0.950**	**3.17**	**17.48**

Table 10. Total number species recorded at each node camp and matrix of pairwise shared species among node camps

Node Camps	Total Species	Anoa	Lapago	Lasolo	Lawele	Wabalamba
Anoa	35					
Lapago	37	31				
Lasolo	35	29	32			
Lawele	36	33	32	31		
Wabalamba	39	31	32	31	34	
Wahalaka	42	33	34	33	35	37

Bird activity recorded during point counts reached peak at approximately 0700-0730 hrs and was markedly dropped off afterwards (Figure 31). Some birds that usually active before 0600 hrs are Sulawesi babbler, Bay coucal, Red junglefowl, sunbirds, Green imperial pigeon, and White-bellied imperial pigeon. Others such as Sulawesi cicada bird, Pied cuckoo-shrike, and Silver-tipped imperial pigeon are mostly recorded after 0600 hrs.

Figure 31. Bird activity recorded during point counts



Further analysis will be conducted to determine the abundance of bird species and to relate both the presence-absence and abundance of birds to vegetation structure.

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Appendix 1. List of bird species recorded during point count along with foraging guild and their endemic status

Guild	English	Endemic
Arboreal frugivores/predator	Red Knobbed Hornbill	E
	Sulawesi hornbill	E
Arboreal frugivores	Blue-backed Parrot	
	Brown Cuckoo-dove	
	Green Imperial Pigeon	
	Grey-cheeked Green Pigeon	
	Silver-tipped Imperial Pigeon	E
	Sulawesi Black Pigeon	E
	White-bellied Imperial Pigeon	E
Predator/insectivores	Purple-winged Roller	E
Arboreal predator	Spot-tailed goshawk	E
	Sulawesi Serpent Eagle	E
Sallying substrate-gleaning insectivores	Hair-crested Drongo	
Sallying insectivores	Citrine Flycatcher	
	Ivory-backed Wood-swallow	E
	Rufous-throated Flycatcher	
	Grey-rumped tree-swift	
Bark-gleaning insectivores	Ashy Woodpecker	E
Terestrial insectivores	Blue-breasted Pitta	
Omnivores	Red Junglefowl	
	Spotted Dove	
Arboreal foliage-gleaning insectivores/understory specialists	Sulawesi Babbler	E
Arboreal foliage-gleaning insectivores	Drongo cuckoo	
	Bay Coucal	E
	Black-naped Fruit-dove	
	Pied Cuckoo-shrike	
	Sulawesi Cicada Bird	E
	Yellow-billed malkoha	E
Arboreal foliage-gleaning insectivores/frugivores	Black-naped Monarch	
	Crested Myna	E
	Golden-mantled raquet-tail	E
	Gross-beaked starling	E
	Ornate lorikeet	E
	Piping crow	E
	White-necked Myna	E
	Yellow-crested Cockatoo	
Miscelaneous insectivores/piscivores	Blue-eared kingfisher	
	Kingfisher	
	White-collared kingfisher	
	Grey-sided flowerpecker	E
	Black sunbird	
	Black-naped oriole	
Nectarivores/insectivores/frugivores	Flowerpecker	
	Large Sulawesi hanging-parrot	E
	Small Sulawesi hanging-parrot	E
	Sulawesi white-eye	E
	Sunbird	
	White-eye	
	Yellow-sided flowerpecker	E

Patterns of Butterfly Communities in Lambusango Forest

Nurul L. Winarni

Introduction

For the last five years, the Lambusango Forest Area of Buton Island has been the focus for Operation Wallacea biological research. The long time studies have shown that the area represent high biodiversity of Sulawesi, including anoa and Buton macaques. For butterfly communities, 557 species are recorded for Sulawesi in which 43% are endemic to the region (Vane-Right and de Jong 2003). At least 175 species have been recorded in Buton (Opwall 2000) with at least 55 species (excluding Hesperiidae and Lycaenidae) recorded around the forest of Lambusango (Wallace 2004). Majority of Sulawesi butterflies are forest inhabitants and thus have been threatened by continuous forest loss (Schulze et al. 2004).

With the high biodiversity, the Lambusango Forest has been suffered from various disturbance including hunting, forest conversion to agriculture, asphalt mining, illegal logging, and uncontrolled rattan extraction. Thus, in early 2005, a joint programme between Operation Wallacea and Global Environmental Fund (GEF) of the World Bank, established the Lambusango Forest Conservation Program. The programme aims to develop an integrating forest management system for the protection of forest and its surroundings and the development of the people living around the forest areas. One of the measures of success of the programme is a biodiversity monitoring project and this report focuses on one aspect of this, namely the monitoring of the butterfly communities.

The continuous change of forests will obviously affect biological communities, and there is a necessity to conduct ecological monitoring to assess the impact on those communities (Spellerberg 2005). Spellerberg (2005) also suggests that such ecological monitoring is particularly important when the ecosystems in question have not been researched comprehensively. In addition, long-term monitoring is needed to support management schemes to combat human-induced disturbances which themselves have an impact in the longer term (Spellerberg 2005). The study is to determine the response of butterfly communities in Lambusango Forest to habitat disturbance. This report presents preliminary findings of butterfly diversity in Lambusango Forest.

Methods

Study Area

Studies were conducted between July-August 2005 in 6 node camps in Lambusango Forest Area, Lasolo, Wabalamba, Walahaka, Anoa, Lawele, and Lapago. Lasolo and Lawele are Production Forest whereas the others are Protected Areas. Four of three kilometers transects are set up at each site and each transect is marked every 50 m. Approximately one week was spent at each node camp.

Butterfly Counts

In 2005, we have tried out different methods of surveying butterflies such as 'Pollard' walks and fruit-bait traps as well as trying to identify butterfly species in the field. We decided to use Pollard walks for the surveys as the methods provides a greater chance to get more species than fruit-bait traps and is less time-consuming. We have also prepared a complete field guide based on "Butterflies of Southeast Sulawesi" by K. Wilmott (Willmot, 2001). All the butterfly pictures are printed and laminated into a small handy folder that will be easy to carry in the field.

Prior to data collection, observers walked along Kakenauwe road for couple of days to get familiar with butterfly species. Butterflies were captured, photographed for identification, and then released. Butterfly species was surveyed using Pollard walk methods which is a combination of transect walk and point counts. We focused our survey on Papilionidae, Nymphalidae, and Pieridae, excluding Hesperiidae and Lycaenidae which are too small to identify directly in the field. Points are located at 150-m interval at each transect. Observers walk along the 900-m transect and estimate the distance of the butterfly to observers and the angle of observer to the object as well as the angle of the path. At each point, observer stood and recorded any butterfly detected in circular area of 5-m range (vertical and horizontal) for approximately 10 minutes. All butterflies seen were noted and distance of each detection was estimated.

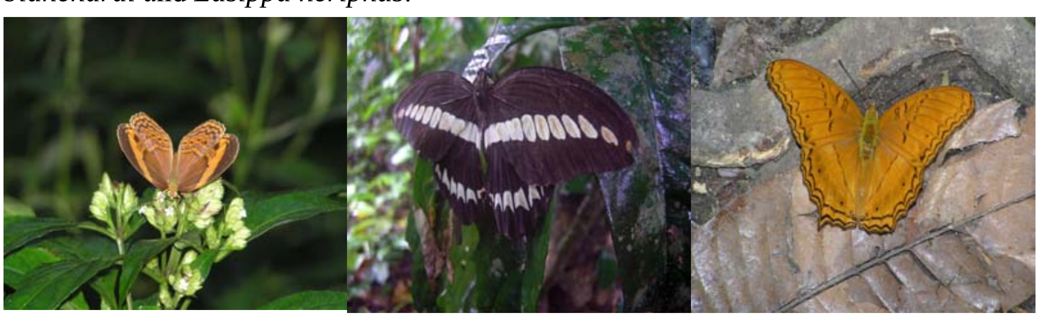
Habitat Measurement
At each of point, habitat structure variables are measured. Habitat structure variables are in conjunction with the bird survey (see bird section).

Results and Discussion

The butterfly survey was conducted during July-August 2006. All of the habitat data and butterfly's point count data are still being analyzed. However, we managed to survey 28 points at each node camps with approximately twice replication at each point resulting 366 counts.

During July-August 2006, a total of 69 species were recorded which consists of 11 species of Papilionidae, 47 species of Nymphalidae, 11 species of Pieridae, and 1 species of Riodinidae. Amongst these, 26 species are endemic to Sulawesi region and to Buton Island. Some species are still in process of identification. The line transect method recorded more species (66 species) than point count (49 species; Appendix 3).

However, we found that five most common species which found in all node camps includes *Faunis menado, Lohora opthalmica, Cupha maeonides,* and *Elymnias hewitsoni*. Both *Faunis menado* and *Lohora opthalmica* were mostly found in forest understory. The *Faunis menado* has been know to reside the understory of natural and old secondary forests (Schulze et al. 2004). The middle story is mostly used by Papilionidae, *Cethosia myrina*, *Idea blanchardi* and *Lasippa neriphus*.



Several butterflies seen in Lambusango Forest (*Cupha maeonides, Papilio gigon, Vindula erota*)

Diversity and similarity indecies were calculated using program EstimateS 7.5 (Colwell 2005). Only data from line transects method were used for the diversity analysis. Shannon's index of diversity (Magurran 1988) revealed that the diversity index ranged from 2.68—2.91 with the lowest index at Anoa and the highest index at Wahalaka (Table 11). Simpson's index of diversity (Magurran 1988) which place more emphasis on the partitioning of birds between the different species showed the same patterns (Table 11). The Morisita-Horn similarity index which is influenced by the most abundant species depicted the closest similarity of community between Wabalamba and Wahalaka. Numbers of shared species are the highest in Lapago and Wabalamba (Table 12). The least similar numbers of species shared are between Lasolo and both Wabalamba and Wahalaka.

Table 11. Matrix of pairwise Morisita-Horn similarity index comparing butterfly communities at each node camp, along with Shannon-Wiener index and Simpson's index

Site	Anoa	Lapago	Lasolo	Lawele	Wabalamba	Shannon's	Simpson's
Anoa						2.68	10.86
Lapago	0.872					2.81	10.95
Lasolo	0.788	0.824				2.84	10.92
Lawele	0.748	0.892	0.702			2.88	11.15
Wabalamba	0.921	0.925	0.897	0.803		2.89	11.08
Wahalaka	0.925	0.885	0.864	0.789	0.965	2.91	11.20

Table 12. Total number species of butterflies recorded at each node camp and matrix of pairwise shared species among node camps

Site	Total species	Anoa	Lapago	Lasolo	Lawele	Wabalamba
Anoa	21					
Lapago	45	17				
Lasolo	18	11	17			
Lawele	35	17	30	15		
Wabalamba	36	17	27	14	24	
Wahalaka	36	17	26	14	24	25

Further analysis will be conducted to determine the abundance of butterfly species and to relate both the presence-absence and abundance of butterflies to vegetation structure.

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Appendix 3. List of butterfly species encountered in Lambusango forest using bothe line transect and point count methods with their endemic status

Family	Species	Transect	Point Count	Endemic
Nymphalidae	*Acrophtalmia leuce*	1	1	E
Nymphalidae	*Amathusia sp.*		1	
Nymphalidae	*Amathusia virgata*	1	1	E
Nymphalidae	*Ariadne ariadne*	1	1	
Nymphalidae	*Athyma libnites*	1	1	E
Nymphalidae	*Cethosia biblis*	1	1	
Nymphalidae	*Cethosia myrina*	1	1	E
Nymphalidae	*Chersonesia rahria*		1	
Nymphalidae	*Cirrochroa semiramis*	1	1	E
Nymphalidae	*Cupha maeonides*	1	1	E
Nymphalidae	*Cyrestis strigata*	1	1	E
Nymphalidae	*Dichorragia nesimachus*	1	1	
Nymphalidae	*Elymnias hewitsoni*	1	1	E
Nymphalidae	*Euploa algea*	1	1	
Nymphalidae	*Euploea sp.*	1		
Nymphalidae	*Faunis menado*	1	1	E
Nymphalidae	*Helycra celebensis*	1		E
Nymphalidae	*Hypolimnas anomala*	1	1	
Nymphalidae	*Idea blanchardi*	1	1	E
Nymphalidae	*Ideopsis juventa*	1	1	
Nymphalidae	*Ideopsis vitrea*	1	1	
Nymphalidae	*Junonia atlites*	1	1	
Nymphalidae	*Junonia hedonia*	1	1	
Nymphalidae	*Lasippa neriphus*	1	1	E
Nymphalidae	*Lethe europa*	1	1	
Nymphalidae	*Lohora ophtalmica*	1	1	
Nymphalidae	*Melanitis phedima*	1	1	
Nymphalidae	*Melanitis velutina*	1		
Nymphalidae	*Mycalesis itys*	1		E
Nymphalidae	*Mycalesis janardana*	1		
Nymphalidae	*Neptis ida*	1		E
Nymphalidae	*NW-BL 008*	1	1	
Nymphalidae	*Nymphalidae sp.2*	1		
Nymphalidae	*Nymphalidae sp1.*	1		
Nymphalidae	*Nymphalidae sp3.*	1		
Nymphalidae	*Orsotriaena jopas*	1		E
Nymphalidae	*Parantica cleona*	1		
Nymphalidae	*Parantica menadensis*	1		E
Nymphalidae	*Pseudergolis avesta*	1	1	E
Nymphalidae	*Symbrenthia hippoclus*	1		
Nymphalidae	*Tarattia lysania*	1	1	E
Nymphalidae	*Terinos taxiles*	1		
Nymphalidae	*Vagrans sinha*	1		
Nymphalidae	*Vindula dejone*	1	1	
Nymphalidae	*Vindula erota*	1	1	
Nymphalidae	*Yoma sabina*	1	1	
Nymphalidae	*Ypthima nynias*	1		E
Papilionidae	*Graphium agamemnon*	1	1	
Papilionidae	*Graphium androcles*	1	1	E
Papilionidae	*Graphium codrus*	1	1	
Papilionidae	*Graphium dorcus*	1		E
Papilionidae	*Graphium milon*	1	1	
Papilionidae	*Pachliopta polyphontes*	1		
Papilionidae	*Papilio ascalaphus*	1	1	E
Papilionidae	*Papilio gigon*	1	1	E
Papilionidae	*Papilio polytes*	1	1	
Papilionidae	*Papilio sataspes*	1	1	E
Papilionidae	*Troides hypolitus*	1		
Pieridae	*Appias hombroni*	1	1	
Pieridae	*Appias spp.*	1	1	
Pieridae	*Appias zarinda*	1	1	
Pieridae	*Catopsilia pomona*	1	1	
Pieridae	*Eurema alitha*	1	1	
Pieridae	*Eurema celebensis*	1	1	E

Family	Species	Transect	Point Count	Endemic
Pieridae	*Eurema hecabe*		1	
Pieridae	*Eurema spp.*	1	1	
Pieridae	*Hebomoia glaucippe*	1		
Pieridae	*Pareronia tritaea*	1	1	E
Riodinidae	*Abisara echerius*	1	1	

Sociological Studies

Use of forest products by local communities

Sarita Mavgee

Introduction

In an age when environmentalism is gaining monumental recognition and development is high on political agendas, there is likely to be a conflict of interests within states, local communities and different forest stakeholders. Forest use has been a highly contentious issue for centuries, from the heyday of sixteenth century exploration to modern day concerns such as the over exploitation of resources.

Since the term “sustainable development” was coined in 1987 by the Brundtland Commission in their report entitled *Our Common Future* (WCED, 1987), the concept of sustainability, and all it encompasses, has been integral to development practices. Many have argued for the democratization of forest resource control to enable “a correction of the commercial bias promoted by successive governments, and for the proper participation in management and decision making by local user groups” (Guha, 2001 p.18).

In recent years there has been greater interest over non-timber forest products (NTFP) especially “in conservation and development circles” (Arnold and Pérez: 1998 p.17). NTFP have been known to “contribute in important ways to livelihood and welfare of populations living in and adjacent to forests” (ibid, 1998 p.17). All potential uses adds immense value to the forest as a whole and consequently intensifies the need for sufficient and effective management. Maintaining an environment compatible to conservation aims is a delicate process, and can rarely function without local support and co-operation.

By exploring land use and forest utilization changes, one can grasp a broader understanding of past, present and future changes to the area; and this can ultimately provide a sound basis for sustainable management plans.

With respect to gendering of forest resources Agarwal (2000) refutes any romanticized notion of an innate female link to nature, but does go on to examine the distinctive social networks women belong to and its resultant impact where women have been shown to bare the greatest burden of forest resource inefficiencies and mismanagement.

On a more global context, forests can hold great socio-cultural and religious significance (Corbridge, 1991). In Hindu theology, tree worship is very important, the existence of temple forests and sacred groves ensures the protection of sustainable areas of forest land (Guha, 1989), is this true in the Indonesian context?

The principal aims of this study was to a) determine how the use of forest products have changed over time, b) determine how the use of forest products differs between genders and c) evaluate the level of cultural importance the forest holds for local communities.

Method

The research was carried out over a four week period in July and August 2006. This research ran alongside the Global Environment Forum (GEF) three year survey. The stud villages included: (sub-village, district) *Lawele* (Lasalimu), *Watambo* (Lasalimu), *Kabongka* (Kapontori), *Harapan Jaya* (South Lasalimu) and *Nambo* (Lasalimu). All these villages apart from Nambo, the control village, are involved in ginger planting, part of the Lambusango Forest Conservation Program's Village Business Development contract, aimed at reducing people's dependence on the forest.

Before research was conducted the *Kepala Desa* (headman) of each village was consulted to ensure that we had his approval. Semi- structured interviews consisted of questions covering a range of issues including basic demographic information, individual forest use, and awareness of management practices employed and perception of threats to the forest. I also examined perceptions on the concept of conservation, if people were part of any social networks, opinions on gendered forest roles and any cultural attachments respondents may have with respect to the forest. The interviews lasted around one hour. A range of respondents were questioned, the *Kepala Desa*, *Ketua Adat* (traditional chief), Head of the PKK (Political Female Group) and an assortment of respondents of varying ages. I also questioned the Head of Agricultural Services for the District of Kapontori, the Forest Department based in Pasarwajo, Head forest ranger at the Natural Resource Conservation Agency (*Konservasi Sumber Daya Alam*- KSDA) based in LaBundo Bundo as well as a brief interview with Mr. Ali La Opa (elected candidate for Deputy of Buton Regent/*Bupati Buton*).

I also conducted a series of focus groups in each of the five villages. Four focus groups were set up in each village with five or six people in each group. There were two female focus groups, under and over 25 years of age and the same for the male groups. Each focus group lasted around 2 hours. The questions were same as those used for the semi structured interviews but other than the demographic information, group answers were collaborated and noted, due to the time constraint.

I also incorporated a participatory technique into the focus groups. The respondents were asked to draw a plan view map of their village and put on any sites of importance. If the Lambusango forest was not put on the map by the end of the exercise, they were asked to add it to the map.

Direct observation was also an important aspect of my study. It was very useful to experience first-hand the surroundings of the study sites and the activities respondents commented on.

Results

Many respondents extract and use timber for construction and fuelwood. There may have been a possible shift to increased fuelwood use due to a recent government fuel subsidy cut which has meant since October 2005 there has been a 186% price increase for kerosene. Many extract NTFP (non-timber forest products) such as rattan, which is used for both domestic and commercial purposes. Domestic purposes for rattan include rattan baskets and string. Many people noted illegal logging and rattan extraction as a major threat to the forest and the reserve. They were also aware of the wider importance of forest protection in terms of climate control, probably because their livelihood and farmland would be at great risk if there were water shortages, floods or high rates of erosion. In terms of the management, may were for the protection of the forest but felt their individual needs were compromised because it meant that they couldn't expand their farmland. They were generally not satisfied with the management because the rules and regulations weren't always enforced and when they were, they were not enforced fairly. There appears to be a fairly regressive approach to the implementation of the rules and regulations. The poorest of the poor seem to bear the greatest burden as opposed to those commercially logging who are not using the forest in a sustainable manner. Most respondents feel that there should be more community involvement in the rules and regulations, their needs should be met and income alternatives should be provided if the authorities want to reduce people's dependence on the forest.

With respect to gendering of forest resources, there doesn't appear to be a clear cut gender division, there are crossovers in the roles between men and women, although it does appear that it is mainly the women that collect the fuelwood and small items such as vegetables, rattan for string and bamboo for domestic use. The men, not surprisingly, are involved in more heavy duty activities, such as timber carrying and extraction, rattan and honey extraction as well as land clearance for new farmland. There appears to a communication breakdown between those that enforce the rules and the people that are supposed to abide by them. The information is usually passed onto the headman and village representatives, usually all men. It is probably for this reason that the men were more well-informed than the women. This situation is perhaps not helped by the social networks people are engaged in. The social groups that respondents partake in are almost always same sex groups.

Many respondents are aware of religious and socio-cultural significance of the forest, even if they do not always know all the specifics. Many mentioned the annual offerings of food made to the forest at sacred sites to ward off any evil spirits and prayers made for good crop yields. These offerings are usually made before planting, after harvest or on opening of new farmland. Some people mentioned that they would go to the forest for leisure activities and to take in the scenery and wildlife of the forest. Almost everyone said that the forest was important to the beliefs, although some could not state the specifics. There was great recognition that the forest and the creatures within it. Many reiterated comments such as the following made by one respondent, "God created the forest and the animals within it for humans and so it must be protected". Many people also knew of the historical significance of the forest, they knew of ancient forts such as the Benteng Kopea near Lawele and graves of important historical figures such as Sangia Karampau, an ancient Butonese Sultan, mentioned by one respondent and Waode Bunga, a female warrior who lead a battle against colonialists mentioned by another. I found that it was usually older members of the community that were more informed on the socio-cultural aspects, and one Ketua Adat also mentioned that fewer and fewer people are interested in the role because it involves a lot a training and huge amount of experience.

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Conservation Issues and Reccomendations

The Lambusango Forest Conservation Program (LFCP) has been running for a year and has experienced some successes and many challenges. This section is not meant to be a report documenting the actions and experiences of the LFCP, but rather a series of observations by Operation Wallacea staff along with some broad management recommendations based on our research and some personal opinions.

The most striking (though not necessarily the most important) problem Opwall staff encountered was the extensive illegal logging around the Lapago grid. Approximately 40-50 timber and other neighbouring trees were felled in the northern area of the Lapago grid and the areas west of Jalan Kodok. Compared to the amount of illegal logging observed in the Wabalamba area in 2004 this destruction was not particularly serious in terms of area affected or the number of trees taken. What is worrying, however, is that this occurred close to Labundo-bundo which has a ranger station and the presence of Operation Wallacea. This suggests that even when a village is receiving economic benefit in return for forest conservation, and with the presence of KSDA rangers (presumably resulting in increased policing), forest conservation is far from guaranteed. Discussion with many people from Labundo-bundo indicate that the illegal loggers came from one or two neighbouring villages, Talingko and Toruku. Indeed, I have observed men carrying timber heading towards Talingko, suggesting that this is probably true. What is also of concern is that none of these illegal activities were observed by the KSDA rangers in Labundo. Some of the logged timber was cut probably less than 3 km from the road, probably close enough to be heard by anyone passing along the road between Talingko and Labundo-bundo.

Another startling finding by Opwall staff and students was that a surprising high percentage (60%) of people from villages involved in the Lambusango forest Consertvation Program's business development schemes were not aware of the the LFCP, including some individuals engaged in the LFCPs ginger growing program. Forty percent of the ginger farmers interviewed were having trouble with growing ginger because of lack of technical assistance and problems with pests, especially wild pigs, which were initially not thought to be a threat to ginger crops. These issues need to be rectified by the LFCP and/or the Lambusango Forest Forum.

It is clear from our ecological research that the greatest level of forest disturbance (forest clearance for agriculture, asphalt mining or other) results in the complete loss of forest specialists from many taxanomic groups including birds, herpetofauna, bats, murid rodents, anoa, tarsiers and monkeys. What is less clear is how intermediate and low levels of forest disturbance (selective logging, rattan collecting) that change forest structure and/or tree species composition influence these species. Some species are likely to be more sensitive than others in their response to intermediate disturbance. The topic of much of Opwall's wildlife research focusses on this topic, and more precise management recommendations will be presented when results become available.

There is still evidence of wildlife persecution in the forest. Most notable is conflict with crop-raiding Buton macaques, which are perceived by many farmers as major pests. One possible way of resolving this problem is to grow crops favoured by monkeys in areas far (>100 m) from the forest edge and closer to farm houses and to use trained dogs to guard crops. Birds are apparently still sometimes trapped for the pet trade, and some species such as the sulphurcrested cockatoo are no longer seen by the bird survey teams. Anoa too are apparently still hunted, but unlike previous years, no groups of anoa hunters were encountered this year.