CHAPTER 1 – INTRODUCTION: THE CONTEXT OF CONFLICT AND OUTCOMES

This is the first major study of the Buton macaque (*Macaca ochreata brunnescens)* and although it focuses on the issue of crop-raiding, is also the first to draw together the results of five years of student projects on the behaviour and ecology of this species. The majority of the Sulawesi macaques, unlike most macaque species, have been little studied, and the Buton macaque in particular has had only one short (17 day) study previously published (Kilner 2001). These macaques are endemic to two islands off South-east Sulawesi and their status, population and ecology are effectively unknown (see chapter 3). The Buton macaque is not considered a primary crop pest by either the Buton Department of Agriculture (pers. comm.) or in the literature (Whitten *et al.* 1988). However, following preliminary studies in 1999, when extensive crop-raiding was witnessed in villages near a protected forest area, this study was conceived in order to establish the extent of any damage and the perceptions of local people towards this.

It is fast becoming dogma that conservation will only work when the views of local people are considered and that these views are incorporated into plans to manage and conserve wildlife and wild places (see however Oates 1999). This is part of a wider recognition globally, that conservation and development policy conflict arises because differences in knowledge, understanding, ideas and beliefs between stakeholders determine their perceptions of the problem and the possible solutions (Adams *et al.* 2003). Thus it is not possible to, for example, simply analyse the economic interests of people in relation to claimants’ rights to a resource; different people will perceive the landscape and resources in different ways. Management effectiveness will always be hampered by incomplete knowledge and understanding of complex social and natural systems (Adams *et al.* 2003). Thus new strategies have been developed, often referred to as ‘community conservation’, to achieve this goal (Adams and McShane 1992; Hackel 1999; Infield and Namara 2001). Management of protected areas often brings hardship to poor, rural communities bordering protected areas due to lost economic opportunities, exclusion from potential resources and damage and depredation to crops and livestock by wild animals (Infield and Namara 2001). Conflicts between the needs of conservation programs and local needs for development are common problems, and have been approached through ICDPs (integrated conservation and development programs) (IIED 1994; McShane and Wells 2004; Woodman 2004). With rapidly increasing populations living in areas of high biodiversity and conservation interest, living in poverty and relying on subsistence farming, conflict between conservation priorities and or the species of conservation concern, is likely to increase. Contradictions between the demands for increased development, production and economic security, and needs of wildlife conservation have led to rejection of conservation efforts by communities living around protected areas in Africa and Asia (see for example Abrahamson 1983; FWI/GFW 2002; Hackel 1999; Infield and Namara 2001). Conflict may exist on a community level in terms of priorities for investment and aid between local development and conservation (Balmford *et al.* 2001; Hackel 1999). Conflict may also occur on an individual level and can take the form of depredation of livestock and crops by wild animals or human death and injury. Conflicts over habitat use may develop, for example access to water holes. Tourist lodges, temples and roadsides are other potential areas where conflict can occur. Disease transmission, competition, for example between fisheries and wild sea mammals, trapping for the biomedical trade and hunting for bush meat are also potential conflict areas (see for example Barnes 2002; Bertram and Ginsberg

1994; Lee *et al.* 1986; Robinson and Bennet 2000; Sillero-Zubiri and Switter 2001; Sitati *et al.* 2003; Southwick and Siddiqi 1998).

The existence of interactions between humans and wildlife, such as close encounters, crop damage or depredation of livestock by wild animals, does not automatically mean that conflict is present. The term conflict, which is so often used to describe these interactions, might in fact contribute to the escalation of such relationships into a conflict situation (Lee 2004). By using that label in studies there is the implication, *a priori*, human-wildlife interactions are negative and animosity exists. First and foremost it is necessary to establish whether such an interaction actually leads to a conflict situation, before assigning such provocative labels. It is very easy to witness a situation where a wild animal is taking crops from farmers' fields and immediately assume a conflict exists. Perhaps 'conflict' does not exist. If it does not, then it is important to understand the perceptions driving this view.

The relatively small (approximately 4520 km^2) island of Buton is the last stronghold of the Buton macaque. The original land cover was predominantly lowland forest (<1000m altitude) of semi-evergreen rain forest, with high tree species diversity, on limestone karst substrate (O'Donovan, pers. comm., Milsom, pers. comm.). With increasing clearance of land for farming, this species of monkey is of conservation concern. Ambonese transmigration camps have appeared in recent years, further eating into the forest (pers. obs.). A recent proposal to upgrade two of the forest reserves in central Buton to National Park status means that although their habitat may be potentially saved, there is a possibility of increased animosity towards wild animals by those farming the forest edge (see chapter 8). It is therefore vital to assess the impact of the Buton macaque on farmers' fields, to investigate perceptions towards the macaque and to distinguish whether macaques are really a problem or are just perceived as such. If macaques are deemed to be a significant threat to livelihoods or if conflict does indeed exist, it is vital to begin to develop suitable management strategies and to understand the causes and dynamics. If we hope to conserve species it is essential to understand any conflict in order to manage it, or to develop strategies for conflict mitigation. It was with this in mind that this study was conceived.

Cercopithecoids are frequent crop pests (see chapter 3), and in some places are classed as vermin, for example baboons (Mascarenas 1971). Generalisation of diet has probably enabled this; they are all opportunistic frugivores with increased intelligence and manipulative capabilities (Chivers 1986; Gautier and Biquand 1994). Terrestrial species are also more likely to raid crops than arboreal species (Sillero-Zubiri and Switter 2001). Crop-raiding does not necessitate the development of any particular suite of novel behaviours and thus many primates might be capable of using species-specific behaviours most often used outside the raiding context to take advantage of this abundant food resource (Warren 2003). Macaques, in particular, are commensal with humans across their whole range. Many species of macaques possess all the traits which enable them to successfully exploit agricultural resources, namely being primarily terrestrial with an ability to utilise arboreal habitats, generalised opportunistic frugivores, living in complex social groups, and possessing cheek pouches to store food and therefore maximise food acquisition (Sillero-Zubiri and Switter 2001). Macaques have been classified by Richard *et al.* (1989) as weed or non-weed species, according to their ability to exploit human resources. However, the Sulawesi macaques are not considered to be weeds and studies of *M. nigra* have suggested it is intolerant of human disturbance (Rosenbaum *et al.* 1998). Chapter 3 discusses what little is known about the socio-ecology of the Buton macaque in the context of other macaque species and primate pests. In chapter 8, the designation of the Buton macaque as a non-weed is challenged.

Farmers' perceptions regarding wildlife damage provide valuable information for determining ways to mitigate conflict. This topic is explored in detail in chapter 5. However, validation of crop depredation is required in order to support or refute farmers' perceptions. Wildlife damage management policies and strategies can then be enacted, if necessary, to reduce or eliminate conflicts between agriculture and wildlife. In chapter 4, exclosure plots are used to determine maximum potential offtake by macaques, while vegetation transects are used to measure damage in farmers’ fields. Measured damage is then compared directly with perceived damage. Predictive models for crop loss are then developed based on geographic and crop variety factors, which can ultimately be applied to the human perceptions (see chapter 8).

Chapter 5 focuses on the attitudes and perceptions of the farmers towards monkeys and crop loss. Demographic variables and socio-economic factors are investigated in relation to these perceptions. General attitudes towards monkeys are discussed and predictors for perceived damage levels are determined. Social factors, power, perceived exclusion, gender, wealth and knowledge, i.e. education, may be extremely influential as underlying determinants of attitudes (Infield 1988). These social factors are explored in detail.

Among most primates, food abundance and quality are key factors influencing general socio-ecology (Altmann, S.A. 1974; Terborgh and Janson 1986). Thus any primate that is able to exploit a predictable, geographically concentrated and rich food resource, such as crops, will probably show differences in activity patterns, range use and sociality (Asquith 1989; Musau and Strum 1984; Oyaro and Strum 1984; Strum 1994). The activities and behaviour of Buton macaques specifically in the context of proximity to farms are examined (chapter 6). Since little is known about these macaques outside the context of the farms, these data represent a first attempt to explore behaviour at the level of the age-sex class for this macaque. Farm behaviour is also used to develop a raiding profile for the monkeys (sensu Crockett and Wilson 1980; Maples *et al.* 1976). Characterising raiding behaviour can contribute to the development of conflict reduction strategies, and to understanding the potential consequences to and responses of the monkeys if raiding is prevented.

Human activity on farms will affect the likelihood of monkeys raiding that farm. The impact of humans on raiding has not been assessed before using direct observation, and typically relies on reports from farmers as to their activities on the farms. In this study focal farm surveys were used to both record the monkeys' behaviour on the farms, as well as human and dog activity. Human activities were then related to frequency and duration of raiding (chapter 7).

The ultimate goal of most studies on crop damage by wildlife is to suggest methods to reduce any crop loss, and although this was not the primary goal of this thesis, potential methods are discussed based on the findings of this study. Studies on the effectiveness of various deterrence techniques have been carried out for other species, for example the efficacy of hunting, feeding and fencing as a deterrent to European wild boar (*Sus scrofa*) (Geisser and Reyer 2004). However systematic studies of methods of deterrence are lacking for primates. The focal farm surveys and the recording of human activities enabled all instances of deterrence on those farms to be recorded. Although the effectiveness of these deterrents was not systematically evaluated, they have been related to the raiding activities of the monkeys on those farms in an attempt to explore avenues for further investigation (chapter 7). A small pilot study assessing the effectiveness of a particular deterrent, active patrolling, is also described in chapter 7.

In the final chapter, the ‘reality’ – what the monkeys do, when they do it, and how often – is placed into context with what the humans do, and what the humans think. In this first synthesis I have tried to link real-time perceptions with real-time damage, and explore when and why mismatches between perception and reality occur. This is the first attempt to directly explore the connection between perceptions and over- or under-estimates of damage, and is vital to enable management plans to address the attitudes driving any conflict. Potential routes for further study and possible management solutions are also discussed.

1.1 STUDY AIMS

Ultimately this study aims to investigate crop-raiding by the Buton macaque both in terms of what the monkeys are actually doing, and the attitudes and perceptions of the farmers towards them. It is an attempt to directly and quantitatively compare perceptions and reality with a view to understanding how to manage the situation in the long term, in order to conserve this primate.

1.2 SPECIFIC AIMS

Chapter 3

§ Collate the short-term studies on the Buton macaque to produce a basic profile of the socio-ecology and population abundance of this species.

Chapter 4

§ Quantify potential maximum offtake by macaques and pigs using exclosure plots.

- Assess levels of crop damage by macaques in farms and develop predictive models for this loss.
- Directly compare measured damage to estimates provided by farmers at the time of study. Many studies rely on recall of farmers to report damage events over the preceding month. This is the first attempt to do a direct, real-time comparison, hopefully negating the danger of recall bias.

Chapter 5

- Determine perceptions towards monkeys both as crop pests, and in general and relate this to socio-economic, demographic and crop damage factors to develop predictive models.

Chapter 6

- Investigate the raiding behaviour of the Buton macaque and characterise raiding.

Chapter 7

- Assess the impact of human presence as a factor in preventing or reducing raiding by macaques.
- Assess the influence of specific active deterrents on patterns of raiding.

Chapter 8

- Synthesise perceptions and reality to assess the impact of the Buton macaque as a crop pest and determine if a human-wildlife conflict exists in this area.
- Suggest future avenues of research to develop management strategies for the Buton macaque.

CHAPTER 2 - STUDY METHODS

2.1 INTRODUCTION

Following a pilot study in summer 2000 (Priston 2001) the main data collection for this research was carried out during two seasons; May 2002 – September 2002 and May 2003 – September 2003. Behavioural observations and data collection were carried out between May – September 2000 – 2004 (see appendix 10 for breakdown of data collection periods). Field seasons were split and relatively short owing to global and regional conflict occurring at the time. This study period coincided with a time of particular political instability in Indonesia and terrorist threats worldwide, coupled with the SARS outbreak in 2003. Thus fieldwork was carried out when possible on, or sometimes against, the advice of the FCO. Data collection used a variety of methods: questionnaire surveys, Rapid Rural Appraisal (RRA) techniques with local farmers, collection of farm data using direct observation of crop-raiding and vegetation transects, exclosure plots to estimate crop yields, population censuses of the primates and observations of raiding and non-raiding troops. Following a discussion of the study site and its selection in 2.2, the questionnaire survey methods and RRA techniques are described in section 2.3, farm work is discussed in section 2.4 and methods used to study the monkeys themselves in section 2.5. Details of specific methods and statistical analyses are discussed in more detail in the relevant chapters of the thesis.

2.2 STUDY SITE

The island of Buton is situated off the South-east coast of Sulawesi (longitude 123° 12’ E – 122° 33’ E and latitude 5° 44’ S - 4° 21’ S) (Figure 2.1). It is approximately 4,520 km^2 in size and covered with moist, deciduous, lowland forest on limestone karst, with an annual rainfall of 2012mm. Its population of approximately 439,000 consists of native

Butonese Muslims (over 86%) (Whitten *et al.* 1988), transmigrants from various islands including Bali (Hindus), Java and Ambon and a small number of Christians (pers. obs.). They inhabit 165 villages. The main export products are asphalt and teak, although they also grow coconuts, cocoa, and cashew nut and many people deal in pearls. They trade in copra, dried fish, sugar, tobacco, sago flour and coffee (pers. obs., Whitten *et al.* 1988). The main agricultural products are maize (*Zea mays*), cassava (*Manihot esculenta*), rice (*Oriza sativum*) and fruit (especially citrus fruit); however the majority of the population are engaged in subsistence farming (Whitten *et al.* 1988).

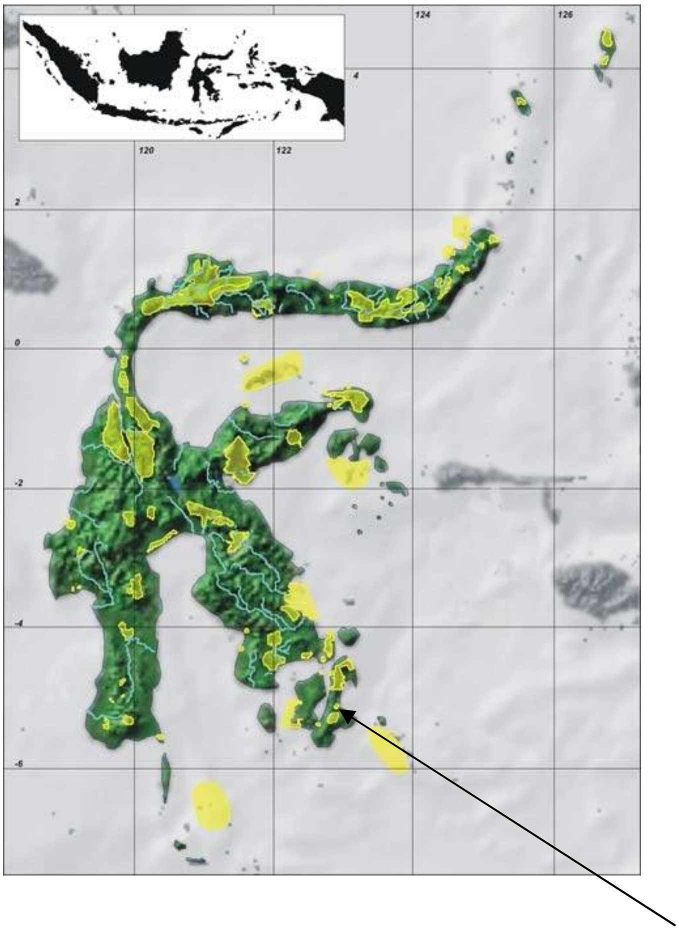


Figure 2.1 Map of Sulawesi. Protected areas are indicated in pale green. Island of Buton indicated with arrow. Adapted from Protected areas of Sulawesi map © 2004 ASEAN Regional Centre for Biodiversity Conservation (ARCBC)

It was decided that villages from the region of Kapontori would be the focus of this study. This region borders two forest reserves, the Kakenauwe (810 ha) and Lambusango reserve

(28,500 ha) (Figure 2.2) which are designated as *Cagar Alam* (nature reserve) and *Suaka Margasatwa* (wildlife and hunting reserve) respectively. However, there is currently a GEF (Global Environment Facility) project underway to introduce a new management scheme to these forests bringing both areas, and surrounding limited production forest under one management scheme. This would follow the model of a National Park designation for core areas, with limited controlled access to resources, such as timber, in the peripheral, buffer zones for local villages (on a contract basis). Unlike most National Parks in Indonesia, the area in Buton would be regionally controlled, not controlled by central government (Operation Wallacea 2004). Farms from the study villages were located within 5km of the reserves which enabled the effect of distance from forest on the amount of raiding and perceptions towards primates to be explored. It was decided to investigate four villages owing to logistic and time constraints. The villages used were; Kawelli, Wakangka, LaBundo Bundo and Wakalambe (Figure 2.2). Kawelli was used as it was known to suffer considerable crop-raiding (Priston 2001), LaBundo Bundo was home to the local Forest Ranger, Wakangka and Wakalambe both have large numbers of Hindu residents and these villages were chosen to enable any effect of religion to be assessed. Logistical constraints also governed village choice, namely very poor roads, weather conditions and the location of the base-camp. Most important was the agreement of the villagers to take part. Permission was sought from the regional chairman and the headman of each village prior to conducting interviews and each villager was also asked for permission. Although a random selection of villages may have been preferable (Woodman 2004) it was decided that the positioning and situation of these villages made them suitable study sites. It was important to ensure at least one village experienced high levels of crop-raiding so that this issue could be examined. Villages are typically small and arranged in a linear fashion along the main road which runs around the island (Figure 2.3 and Figure 2.4).

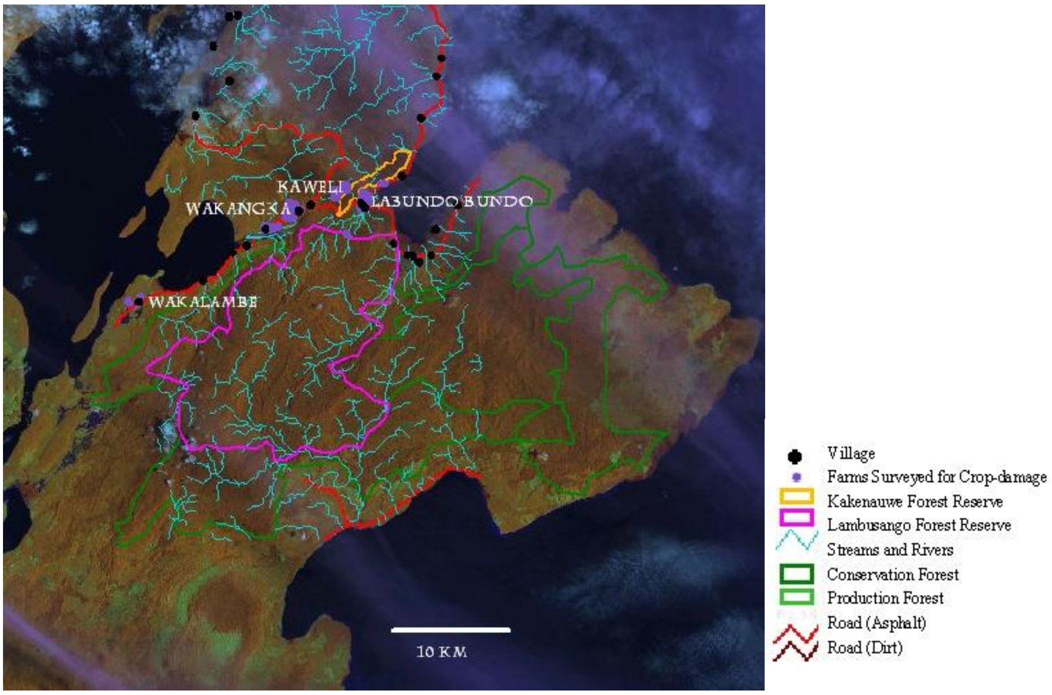


Figure 2.2 Satellite image of South-central Buton indicating study villages, farms surveyed for crop damage and forest reserves. Created using Arcview 3.3 and ButonGIS2004 data set and satellite image (Carlisle 2005)

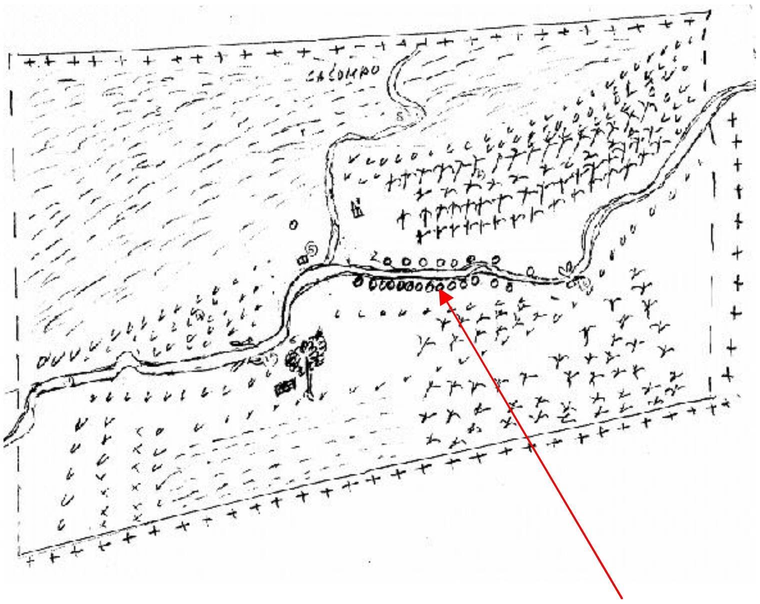


Figure 2.3 Map of Kawelli village, drawn by the Headman. Arrow indicates linear layout of houses along the road

Figure 2.4 Kawelli (a) and LaBundo Bundo (b) village, showing linear arrangement of houses along main road

2.3 FIELD METHODS - PEOPLE

2.3.1 Pilot Study

An extensive literature search and contacts with several primatologists in the field revealed no published literature on the Buton macaque or the crop-raiding behaviour of the seven Sulawesi species[1]. The macaque is not considered a primary crop pest by either the Buton Department of Agriculture (pers. comm.) or in the literature (Whitten *et al.* 1988). Following preliminary visits in 1999 which revealed that crop-raiding may be a potential problem in this area, a six week pilot study was conducted in 2000 (Priston 2001) to investigate and establish the extent of the problem. In this pilot study a total of 310 farmers from six villages were interviewed on their perceptions of this primate as a pest, its crop-raiding habits and preferred methods of deterrence. The main goal of this pilot study was to gain an understanding of the farmers' perceptions rather than the monkeys' behaviour. In this study factors relating to perceived damage were investigated and potential routes for further, more detailed investigation explored. Distance of the farm from the village, the frequency of primate raiding, time spent raiding and the religion of the farmer were found to be important predictors of perceived crop-damage by monkeys.

---

[1] Dr Rob Lee is currently investigating the other six species – as yet unpublished (pers. comm.)

General opinion and attitude towards monkeys was related to the perceived damage. Visits were made to farms and some time was spent watching crop-raiding in the farms, although no systematic data were collected at that time. Some troop follows were conducted by the author but not systematically. The behavioural implications of crop-raiding and its relevance to wider conservation issues were discussed and results from this limited survey were found to be in accordance with studies on other species (Lee and Priston in press; Priston 2001).

2.3.2 Interviews

Rationale and Aims

One widely used technique in sociological studies is that of the survey, being widely used as a feasible and economical way of collecting data on a study population (Bulmer and Warwick 1983). Surveys are not restricted to one particular data collection technique; questionnaires are widely used, but techniques such as structured and in-depth interviews can also be employed (De Vaus 2002; Marsh 1982). Surveys are characterised by the form of data and method of analysis; a variable-by-case data matrix and analysis based on case by case comparison (De Vaus 2002). They are also characterised by their subject matter in that it is ‘social’ (Marsh 1982). One function of survey analysis is to describe the characteristics of a set of cases. Surveys seek to collect standardized information from a relatively large number of individuals in order to generalise from the sample to the population from which is it drawn (Bulmer and Warwick 1983). Inherent in survey research is the location of causes of phenomena through comparison of cases to see if certain groups of cases differ systematically and therefore predictably from other groups (De Vaus 2002; Marsh 1982; Moser and Kalton 1989). Thus a survey aims to draw causal inferences. However researchers must be careful to exercise caution in making such inferences from associations. Associations cannot be given the status of causation because their place in a complex network of causality is often largely unknown (Oppenheim 1992). This, however, does not mean that a connection cannot be suggested; while it does not prove causality it does mean that the hypothesis cannot be ruled out (Marsh 1982).

Survey data are widely regarded as inherently quantitative and positivistic as opposed to qualitative methods involving participant observation, unstructured interviewing, case studies and so on (Marsh 1982). This distinction is frequently unhelpful and it is better to think in terms of the different stages of research: data collection and data analysis. At the data collection stage survey techniques, as mentioned before, can be both quantitative and qualitative as the data grid required for survey research can be filled from a variety of sources. A survey simply collects systematic data allowing systematic comparison between cases on the same characteristics. At the data analysis stage although quantitative statistical methods are usually employed, causal inferences are often made using logic as much as statistical processes (De Vaus 2002). De Vaus(2002) suggests it is most useful to consider survey research by emphasising its structured approach to data collection and analysis rather than using the qualitative/quantitative distinctions which it is felt emphasise statistical analysis at the expense of highlighting fundamental characteristics of the methods involved.

Surveys are considered to be most useful for collection of factual data although they are commonly used for collection of attitudinal and behavioural data (Moser and Kalton 1989; Nichols 1991). Survey data collected on matters that respondents perceive to be private or sensitive may be of limited reliability (Pratt and Loizos 1992). However, the use of a formal structured survey together with qualitative research methods allows cross-checking and collation of information from different sources and enables research to be conducted on complex and sensitive issues (Bulmer and Warwick 1983; Nichols 1991). Thus in this study, a semi-structured survey was utilised together with qualitative methods in the form of group discussions based on a Rapid Rural Appraisal approach (see section 2.3.3) to explore some of the issues raised.

Questionnaire Design

A semi-structured survey was drawn up following testing of several versions of the questionnaire during the pilot study and the first week of the 2002 study period. The final version was a modified and lengthened version of the one used for the pilot study. It was further adjusted in the field through discussions with local people and bilingual staff to ensure the right questions were being asked to get the information desired (Nichols 1991; Wuelker 1983). It included some questions and areas of interest modified from similar studies of human-wildlife interaction elsewhere (see Archbald and Naughton-Treves 2001; Gillingham and Lee 1999; Gillingham 1998; Hill 1997; Naughton Treves 1996; Newmark *et al.* 1993).

The questionnaire consisted of fifty eight questions (see appendix 1) and can be considered in three broad sections:

- 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.

There were also some additional questions on the protected status of the macaque, its religious significance and information on the pet trade and trapping. Easier, more straightforward, demographic questions were asked first (Moser and Kalton 1989). Questions regarding attitudes to the primates were be placed both before questions about damage and after as it is known that individuals' attitudes are usually dormant and only expressed in speech once the object of the attitude is perceived (Oppenheim 1992). Once provoked on the subject of crop loss otherwise hidden attitudes may be expressed. Questions requiring relatively more thought and analysis from the respondent followed after the factual demographic questions to avoid loss of concentration or boredom affecting the responses. Questions were a mix of closed, fixed-response and more open-ended ones, avoiding leading questions. All questions were delivered as open questions to encourage the respondent to answer in as much detail as they saw fit. Responses to the closed questions were field-coded and checked into pre-set response categories which were not revealed to the respondent (Sudman and Bradman 1982) to avoid forcing peoples' choice or suggesting answers to them (De Vaus 2002). Some questions required ranking responses. In addition all answers were recorded in long-hand to enable further cross-checking at a later date and to guard against the possibility of misinterpretation (Casley and Lury 1986; Moser and Kalton 1989). To ensure accuracy of the translation the questionnaire was discussed in detail with the translator so they understood exactly what information was required. The interview was initially written in English and this was then translated by three different bilingual staff as well as the translator himself. This ensured that any differences in understanding the questionnaire could be minimized. Although there was not time for the use of participatory rural appraisal[2] the ethos behind it and many of its techniques were employed in this study[3].

Sampling

Purposive sampling was used to obtain village statistics from the headman of each of the four villages. The sampling unit was the household as this is the basic shared unit of economic production and in line with other studies of this kind (see for example Casley and Lury 1986; Gillingham and Lee 1999; Gillingham 1998; Hill 1998, 1999; Naughton Treves 1996; Tchamba 1996). There are difficulties in defining the household as a unit of analysis due to the complexity and variability people may make for providing themselves with food and accommodation (Pratt and Loizos 1992). Sampling based on a definition of the household which is not appropriate to the social structure and living arrangements can lead to inaccurate and misrepresentative data (Casley and Lury 1986; Pratt and Loizos 1992).

For the villages in this study, the household unit is defined in terms of land rights. Each household is either allocated farm and house plots by the government, or buys them from other landowners or the government. Households may contain members of extended families. Thus a household may consist of two parents, a grandparent, children and cousins. The household may own or farm several plots of land. In such cases the crops produced are generally pooled for the subsistence needs of the household. Any income

---

[2] Participatory Rural Appraisal (PRA) is a label given to a number of participatory approaches and methods that emphasise local knowledge and enable local people to make their own appraisal, analysis, and plans. PRA uses group exercises to facilitate information sharing, analysis, and action among stakeholders. It evolved from rapid rural appraisal – a set of informal techniques used by development practitioners in rural areas to collect and analyse data, in response to the perceived problems of outsiders missing or miscommunicating with local people in the context of development work (Chambers, 1997)

[3] Tools used for PRA include semi-structured interviews, mapping, modelling and preference ranking

generated from the sale of crops is kept by the wife, although decisions on spending money are jointly made by the husband and wife. The final decision in any household lies with the household head who is usually the husband/father of the house, although there are also female heads of household. New households are usually formed when adult children get married and establish their own house. In such cases houses are often built on the parents' land and part of their farmland is also given to the newly married couple until they can afford their own. Thus the definition of a household used in this survey was that of Casley and Lury (1986)

> *"…a person, or group of persons, generally bound by ties of kinship, who live together under a single roof or within a single compound, and who share a community of life in that they are answerable to the same head and share a common source of food."*

In the pilot study it became clear that obtaining census lists of households was impossible as they are not always kept and even when they were, it was not possible to gain permission to use them. Villagers were wary of me compiling such lists and it was felt inappropriate to pursue this line. Instead households were selected randomly (as in the pilot study) by walking through the village and interviewing each household as it was reached (Nichols 1991). Often individuals were working in the farms but as the pilot study revealed no regular pattern to working hours this random method has been deemed satisfactory. It was repeated until almost all households (98.1%) were surveyed (N = 155 for the four study villages). As villages are small (approximately 40 households) this was a realistic goal. If necessary interviews were conducted in the farms themselves if that was more convenient for the individual.

For each household in the sample, the head of the household (male) (N = 81) was interviewed if possible. If the household head was unavailable or unwilling to participate another adult member of the household was approached; this was normally the wife of the head of the household (N = 63). On the few occasions when neither were available or women declined to be interviewed another permanently resident adult member was interviewed (N = 11, all male). Women who declined to be interviewed usually did so on the grounds that their husband knew about the farm and the women wouldn't be able to answer questions about it. There were also occasions when women were alone in the house and it would be inappropriate to enter without another family member present. The rate of non-response was otherwise very low. Only three houses declined to be interviewed at all and these were almost all very elderly individuals. There were also four households who were not resident in the villages at the time and thus could not be interviewed. Non-response can be a significant problem in survey research. Non-responders are often similar in some way and different to the rest of the population (Moser and Kalton 1989). In order to combat this one must either reduce non-response rates or find out the characteristics of the non-responders in order to see if they differ systematically. In general non-response rates for survey research are expected to be 10 – 15% (Moser and Kalton 1989). In this study as non-response rates were very low (1.9 %) it is not expected that this will be a significant problem.

Many members of different households would congregate in one house; in this case each person with their own, separate farm and house was interviewed. Although attempts were made to conduct all interviews alone this was rarely possible as our presence drew attention, so all joint or prompted answers have been disregarded (however the full interview was conducted so as not to upset any individual farmers by not including them).

Interview Procedure

The purpose of an interview is to elicit certain information from the respondent and it requires certain things of the respondent. Cannell and Kahn (Moser and Kalton 1989) suggest three main concepts which are required:

1. Accessibility of the required information by the respondent. The respondent must have the information if he/she[4] is to be able to answer. He may not ever have had the information or he may have forgotten or he may not be able to answer in the specified terms of reference.

2. Cognition and understanding on the part of the respondent of what is required of him. The respondent needs to know what is expected of him, must decide what information is of relevance, and how to express his answers.

3. Motivation of the respondent to answer accurately, if at all. Factors which might reduce motivation include desire to be doing something else, embarrassment, ignorance, dislike of interview or interviewer, or suspicions about intentions. Factors which tend to increase or maintain motivation include curiosity, sense of duty, politeness, and desire to help, liking the interviewer or interest in the subject.

An interview is a social process involving at least two individuals; thus the interaction between interviewer and respondent must be taken into account when viewing the outcome. Interviewers can and do affect responses, just as the reaction of a responder can affect the way the interviewer conducts the interview (Bulmer and Warwick 1983; Moser and Kalton 1989). These in turn affect the results obtained. Therefore interviews are best conducted by people with prior experience. In this study a translator with many years of

---

[4] It is assumed from this point on that the respondent can be of either gender

interviewing experience was used in addition to myself (see below). This person also helped with the initial translation of the questionnaire. Questions were asked in an impartial way, with a permissive attitude so the respondent felt free to express any views.

Surveys were carried out during May – September 2002 and the questionnaire was administered via a translator familiar with at least eight of the 45 local languages plus Bahasa Indonesia, the official Indonesian language. Questions were asked in Bahasa Indonesian and Butonese or another local language as appropriate to the situation. In preference Butonese was used where possible as it seemed to put people at ease. Knowing that the translator was local to the island and spoke the local languages made people much more amenable to being questioned. Answers were recorded on pre-prepared printed sheets. Interviews lasted twenty to forty minutes and were cross checked by myself as I have a conversational level of Indonesian and Butonese. Some interviews were also recorded using a minidisc recorder and microphone, if permission was gained by the respondent, and translations were double checked with other bilingual staff at the base camp. In order that respondents would feel at ease in familiar surroundings and that the interview would not impinge too greatly on their time, interviews were carried out in people’s homes or outside on the veranda, or even on occasions in their farms.

Interviews were begun in an informal manner by chatting with the respondent, offering cigarettes and sweets and generally putting them at ease. It is advisable to make the survey experience as pleasant as possible for the respondent (De Vaus 2002) and to minimize the burden on them to ensure they do not lose interest or good will during the process. With this in mind respondents were encouraged to relax. If they wanted to get up and get food or continue working or even walk to the farm every effort was made to accommodate this and interviews were portrayed as more of a chat. In the past these villagers have had some unpleasant experiences with the government carrying out interviews and then people being imprisoned because of their responses so they were often understandably wary[5]. Notes were written in as discrete a fashion as possible and people were not asked to give their names unless they wished to do so. Cultural customs were respected such as adopting an appropriate dress code, covering the shoulders and legs, offers of food and drink were always accepted graciously and finished. It is impolite to use the left hand to pass anything or touch someone with so this was avoided. Yawning or showing dissatisfaction or unhappiness is also considered impolite so it was important to maintain a smile at all times. This semi-structured style and less formal approach, fitting with the local culture, was found to be successful in the pilot study by allowing a dialogue to develop with the farmers and enabled additional information to be gleaned.

Problems of interviews

One difficulty in using interviews, especially open-ended questions, is in interpreting the meaning of people's responses. The same behaviour may mean different things or indicate different things for different people (De Vaus 2002). This problem is hard to eliminate but there are steps that can be taken to reduce its effect. The use of a variety of methods of data collection can be helpful in giving the researcher insights into the meaning of behaviour. In this study RRA group discussions, informal chats and the fact that I was living in the village with a family aided this enormously. Other responses can also be used to put responses into context and give a better overall picture (De Vaus 2002). Another technique is to ask people why they express that attitude and although this may be hard for some people to answer, responses can provide valuable insights (see Marsh 1982 for detailed discussion) and can prove useful in the piloting of a questionnaire to check if

---

[5] During the communist purge of the 1960s

respondents understand what the question was supposed to be asking (Marsh 1982). However, care must be taken when interpreting such responses. The wording of the questions also plays an important part and questions were phrased using simple language, were as short and unambiguous as possible, were not leading, and avoided negation, confusion or double-barrels. Questions also had to have the same meaning and be equally understandable for everyone regardless of education or status.

There is often a problem in asking for accurate estimates of crop yield/cost/weight in rural communities where crops are sold in variable units, harvested opportunistically and consumed as needed, and thus it may be hard to recall exact amounts when no records are kept (Casley and Lury 1986). Questions were therefore phrased such that people could answer in as vague or detailed a fashion as necessary. To counter any problems of innumeracy we worked in local units if necessary, for example sacks of maize, and later attempted to get numerical figures for this. Measurement questions were backed with observation and actual measurements such as land area. Amounts were worked through together using diagrams if necessary to arrive at figures the respondent felt were realistic. It must be noted that recall periods will vary from respondent to respondent, thus figures relating to the previous 12 months could be subject to significant variation. One way to overcome this is to spend time working through such answers with respondents and to be aware of the potential for error (Casley and Lury 1986).

During the interview, a variety of household objects were noted as present or absent (see appendix 1). These items or material possessions were subsequently coded into possession scores and compared with the self-reported economic indicators (see chapter 5).

Another factor to consider is whether the question has the same degree of importance to the people being questioned as to the interviewer. What preconceptions are at work which may be considered meaningless by the people concerned? Is there conceptual and linguistic equivalence (Mitchell 1983)? It requires systematic research (Pratt and Loizos 1992) and detailed knowledge of the local culture and language to gain ‘functional equivalence’ (Mitchell 1983). This can be achieved through back-translation. This was employed in this study. The interview was translated into Indonesian and then independently translated back into English to identify any discrepancies. As discussed previously, several translators were also used in the initial translation phase and questions and concepts were discussed at length with them all to ensure accuracy.

Errors may stem from the respondent – both intentionally and unintentionally. Rather than appear uncooperative respondents may prefer to volunteer misleading information. The only way to overcome this is to find out about any such taboos in the pilot stage by learning as much as possible about the community and designing questions accordingly. Social desirability bias is another problem, where respondents distort their answers to conform to prevailing norms and values in their own community or society (Bulmer 1983). A much more serious problem is that of unreliability from non-intentional ‘errors’ on the part of the respondent often concerning numerical questions of fact and differing concepts of ‘age’ or units or other terms taken for granted by interviewers (Bulmer and Warwick 1983). Questions eliciting opinions are subject to unreliability if the issue in question is not meaningful to those being asked. Knowledge of a topic should be ascertained before eliciting opinions on it (Bulmer and Warwick 1983).

There is disagreement about how far it is possible to give an ‘objective’ account of what is going on between groups of human beings (Pratt and Loizos 1992). There are questions of reliability and validity and various philosophical and perceptual problems to do with the extent to which two individuals can ever really share the same experience of the same 'real world' and to what extent one can succeed in communicating such experiences to another (Moser and Kalton 1989; Pratt and Loizos 1992). Respondents are not always aware of the motivations behind their actions. This issue of objectivity can never really be overcome except through precision, accuracy and control of biases and the awareness that results obtained may not be necessarily conclusive.

A number of characteristics of the interviewer and respondent will play an important role in the quality of data elicited. These include psychological and behavioural factors such as the respondents' sensitivity to the interviewer's attitude and questions, how the interviewer reacts to respondents' answers and the way a question is asked. Translation into another language introduces further opportunity for error in terms of conceptual and linguistic equivalence (Mitchell 1983). Probing respondents for answers, misrecording or 'improving' answers when written down, using language familiar to interviewer but not what respondents actually said and inferring meaning from respondents' answers incorrectly can all lead to further introduction of errors.

In developing countries there is the further complication in that the role of social research and interviewing are not widely recognised. Scope for misunderstanding what is required on the part of the respondent and the purposes of inquiry is wide (Nichols 1991). Interviewers are likely to be taken for tax collectors, police agents or political party workers (as experienced in Buton) (Bulmer 1983; Hershfield *et al.* 1983). In order to counter this village heads were met with first and the purpose of my visit clearly explained. It was often helpful to use suitable analogies to clarify my role (Hershfield *et al.* 1983). In these villages I found it most useful to describe my work as '*Kuliah Kerja*

Nyata (KKN)' rather than a PhD study. 'KKN' is a universally recognised part of the Indonesian education system whereby senior school children and university students conduct a period of independent study over their summer vacation. Once put in these terms people instantly had some understanding of my purpose there which allayed many of the initial fears that I was a government spy. Kahn and Cannell (1957) suggested a suitable model to illustrate such possibilities for introduction of bias (Figure 2.5). Awareness of such possible biases, accuracy and precision will help to reduce such errors.

One problem common to many studies in South-East Asia is the 'courtesy bias' (Jones 1983). Those being interviewed will express only views which they think the interviewer wishes to hear. It stems from a complex code of behaviour which emphasises respect for ones' elders and those of higher status, meaning it is impolite to disagree with such individuals. It stresses that the atmosphere between people must be kept pleasant and free from anger, that what is said should please and compliment and promotes shared hospitality and attention to the needs of others. To combat this, questions must be limited to those with no obviously 'pleasing' answer. When this is not possible, for example when eliciting an opinion on something more controversial, another way is to phrase the question in such a way as to make it clear that a negative response is as acceptable as a positive one e.g. "*I hear people often say that….*"(Jones 1983). Excellent rapport is also required to make the respondent feel at ease. Once an opinion has been expressed that has been difficult for the respondent to admit it is important to reassure them. For example on expressing a wish to kill monkeys, despite a law against it, it is important that neither I nor the translator showed any overt reaction to this; a gentle nod would often serve to reassure while not leading any further responses. An explanation at the start of the interview clarified my reasons for being there. It was important to ensure that farmers did not believe I was there simply to 'save' monkeys. In preference I would not mention monkeys or animals in my introduction but as rumours spread rapidly in small villages it was felt best to ensure that people understood fully. Thus I explained that I was interested in knowing more about farmers' crops, the forest and the forest animals and the problems farmers' faced. No compensation culture exists in this part of Indonesia and thus farmers would not be tempted to exaggerate crop losses in expectation of monetary compensation. No explicit promises were made about the results of this study for fear of raising expectations. In order to maintain good relations in the village and enable work in future years, on completion of the interviews, school books and stationary were bought for all children in the village, a selection of small toys were also distributed to the children. Households were given posters for their walls and new volley ball shirts were bought for the men and women in the village. These gifts, although low cost, served to keep the village happy with our presence there and allowed us the opportunity to work there again in future. In addition to this, after data collection and analysis for this project was completed an education project was run in the villages that had participated in the study (July – October 2004). Posters, leaflets and a short story book were distributed to school children aged 7 – 11 (elementary school) and to government authorities. These were designed to give basic information about the monkeys (see appendix 2). A fun quiz was run in the schools a month after they had received the leaflets to see what they had learnt and the children also participated in a drawing competition with monkey-themed prizes.

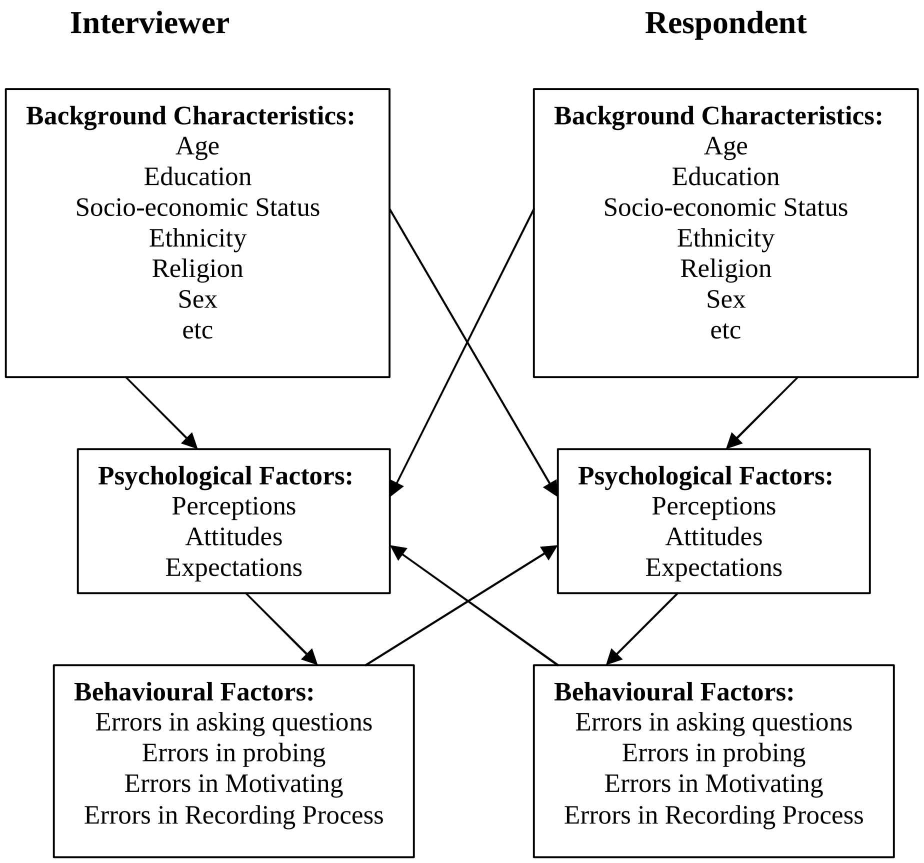


Figure 2.5 Model for the interaction between interviewer and respondent and sources of bias. (Kahn and Cannell 1957)

2.3.3 Rapid Rural Appraisal

Approach and Methodology

The 1970s saw the development of a new body of knowledge with methodological interventions stressing the importance of capturing the knowledge of poor, rural people through farming systems research, agro-ecology and Rapid Rural Appraisal (Ghai and Vivian 1995). RRA is a method of grassroots research used to identify the problems, goals and strategies of households, groups and communities. It has the benefits of being low cost and quick to do and was designed to prevent bias often associated with longer term research, for example only targeting easy to access communities, men or high status individuals. It is seen as flexible and allows for feedback to modify the original questions and may change the research agenda, thus in this study the final check list of points to cover was modified as the process continued and new issues or areas were raised. It does not necessarily entail use of a certain type of method but more an attitude towards the research (Pratt and Loizos 1992). RRA emphasizes the value of information from local people about local conditions expressed in their own terms, rather than those defined by some outside perspective. Thus the information gathered is at a level of accuracy relevant to the purpose for which it will be used and those using it (Chambers 1997). RRA seeks to enable outsiders to gain information and insight from rural people and about rural conditions and to do this in a more cost-effective and timely manner while avoiding the biases of ‘rural development tourism’ (Chambers 1992). It utilises non-formal data collection techniques such as observation, ranking exercises, group discussions and interviews and often the use of visual aids. Ranking exercises and the ethos behind RRA were included in the interview phase of research as well. Semi-structured interviews are really just another method of RRA. In this study group discussions and direct field observations were also employed but the use of visual aids was somewhat limited. During the pilot phase, map drawing exercises were tested but proved difficult to do and people were very uneasy about doing any drawing themselves – be it on paper or on the ground. Instead maps and diagrams were drawn by the author based on responses and shown to the respondents to comment on. They were much more comfortable with this approach. If possible they were asked to demonstrate or show me any relevant items or plants and if in the farm they were asked to demonstrate traps, point out crops and crop damage.

From 1980’s onwards RRA began to promote the participation side of gathering and analysis of data. This was eventually revised to become known as Participatory Rural

Appraisal (Chambers 1992). Although similar in many ways to RRA in that they both are accessible, versatile, and rapid and aim to break down barriers between communities and outsiders, there is a fundamental difference in the goals of the two approaches. RRA is primarily elicitive and used as a way for outsiders to gain information on a topic they choose or on externally initiated plans. PRA on the other hand is viewed as facilitating and empowering with a goal of sustainable local action and institutions (Chambers 1992, 1997). In fact many consider that RRA should be reserved for describing data collection activities while PRA is an ongoing empowerment. In this study the techniques utilised are of the former type, RRA, as discussions were directed towards the purpose of study and participation was instigated by me not by the villagers themselves.

Rapid Rural Appraisal techniques were employed in one village, Kawelli, in 2003 to obtain further baseline information regarding village composition, natural resource use, human-wildlife interactions, gender patterns, work habits and general feelings towards the macaques and also in what ways people wanted the situation dealt with. The use of RRA in this study was intended to see if results from earlier interviews still held true and that there were no significant changes over time, to check what was normal and that previous responses were not influenced by that particular time or the interview situation (Pratt and Loizos 1992). RRA group discussions were held with all residents of Kawelli in various group sizes. Both men and women were involved. Village leaders were also interviewed about the village history, planting patterns and so on. The information gathered was mainly to supplement the comprehensive interview data and to assess if there was any change in attitudes following a monkey poisoning event in 2002[6]. RRA is useful for cross-checking against other forms of data (Pratt and Loizos 1992).

Group discussions are a valuable way of quickly establishing basic background information or following a certain issue in more detail (Pratt and Loizos 1992). They aim to encourage a collective response and to identify differences of opinion as well as areas of consensus. It is likely to be less successful if the group is too heterogeneous as people may feel inhibited or uncomfortable if there are differences of status or class (Pratt and Loizos 1992). In this study ‘naturally’ occurring groups were used for discussions, such as groups of female friends helping in someone’s farm or men playing cards. It was hoped that in this way people would feel comfortable answering questions in that environment. Household gatherings were also used i.e. the groups of people congregating in certain houses. Although formal meeting groups do exist, for example women’s groups, farmers groups, these groups meet very infrequently and some people do not attend. On talking to members of the village it became clear that some viewed these groups as only relevant to the more important village members. It was thus decided not to utilise such groupings due to logistical constraints, poor attendance and a sense of exclusion.

Prior to each group discussion a checklist of key issues was prepared to give a rough guideline (see appendix 3). Informants were encouraged to participate as much or little as they liked in the discussion.

---

[6] see chapter 3 and 7 for more information on the poisoning event

Limitations of RRA

RRA is often hailed as the ‘best’ research method to use in rural, development situations (Chambers 1997) and there is evidence that RRA can yield a more valid, less costly, more timely and more useful result than other less participatory methods (Chambers 1992). However there are also examples of mistakes with RRA. A common problem is emphasis on the ‘rapid’ and Chambers (1992) suggests that the ‘R’ would better stand for ‘relaxed’. RRA should be a method which is complementary to other methods and is least reliable when employed alone (Pratt and Loizos 1992). It is usually carried out at a specific point in time and therefore may give a static view of the situation and may be victim to seasonal or other biases. Care must be taken to ensure that cultural norms are respected, for example, in Sulawesi it would not be appropriate for a male to attempt group discussions with a group of young females. This was facilitated by the fact that my translator is male and I am female, thus we were able to put most people at ease.

The value of the data depends on who is consulted and what they say. Mosse (1995) criticises the use of such participatory methods without established links to the community. The very informal and rapid nature of RRA may serve to create suspicion or lead to an inaccurate impression of a village. This is particularly pertinent to communities who have had previous negative experiences with development or conservation interventions (Ghai and Vivian 1995). It is also suggested that such techniques can lead to the information gleaned being strongly influenced by existing social relationships. Some members of the community may be unable to participate due to practical or social reasons. It is also felt that these techniques tend to emphasise general information by consensus and may therefore fail to identify differences of opinion within the community. Minimal participation of women in some participatory studies has been used to support this (Mosse

1995). In this study, although there was some tendency for women to be more tentative about discussions, once it was explained that it did not matter if they did not know about certain aspects but that they could just participate in the parts they knew about, they were happy to be involved. One problem was the time-consuming nature of such exercises and the potentially sensitive subjects under discussion such as crop pest control or the pet trade. In order to minimise these problems discussions were kept as short as possible and explanations for the research were given as clearly as possible. As the villagers were accustomed to my presence, having worked there since 1999, this problem occurred infrequently. Groups consisted of all men, all women and mixtures. Although it is a predominantly Muslim community and therefore one might expect it to be strongly gender-structured (Bulmer and Warwick 1983; Woodman 2004), women and men both contributed to discussions. The problem of variable participation in group exercises was overcome through careful cross-checking of information gathered with direct observations of village life, and formal and informal interviews with key informants. The information gained from the RRA was useful to elucidate certain issues that arose in the interview phase and the informal approach allowed cross-checking of some of the information gathered.

2.4 FIELD METHODS – FARMS

2.4.1 Farm Surveys

There are few studies comparing farmers’ estimates of crop damage to quantitative measurements. Those that have taken place find that claims of damage are sometimes inaccurate or exaggerated (Gillingham and Lee 2003; Naughton Treves 1996), especially when compensation is an issue (Bell 1984a, b; Conover 2002; Conover and Decker 1991; Martin 1984a, b; Wakely and Mitchell 1981). An assessment of the scale and impacts of wildlife crop damage, focusing on primate damage, were compared here with farmers' estimates of damage in 2002 (see chapter 4 and appendix 1 for details of questions asked). Due to the short field season it was not possible to set up long-term monitoring of crop damage. Magnitude and severity of damage were assessed at the time of interview so that direct comparisons could be made. Again, due to constraints of time and manpower, a sample of farms was selected for assessment.

Those farms surveyed had to fulfil certain criteria:

1) Dry-land crops must be planted. Paddy fields were not surveyed as there was no evidence of crop-raiding from any informants or observations. Paddy fields were almost always situated in large plains and therefore distant from the forest.

2) The farmers had to agree to have their farms assessed. As this could potentially conflict with statements that they had given me in their interviews it was surprising how willing people were to allow me to roam around their farm.

3) Farms had to be within walking distance of the study village

Farms were selected at random out of those interviewed each day and from those eligible on the above criteria. Both high and low risk areas were included in the survey. In practice, the choice was also governed by who was available and willing to take me to their farm at a mutually convenient time. No predictable activity pattern was observed for the farmers and the RRA confirmed that activity patterns were not set or pre-arranged (see chapter 5).

Approximately half of the farmers interviewed in each village were selected for farm surveys (N = 73). Location of these farms relative to the study villages can be seen in Figure 2.2. Farms were surveyed as close as possible to the time of interview so that direct comparisons could be made between farmers' perceived (as reported to me) estimates of crop damage and ground measures of damage. Detailed methods for damage assessment are presented in chapter 4.

2.4.2 Exclosure plots

Exclosure plots are defined as areas of land from which certain animals are excluded (Hone 1994). The use of exclosure plots to assess damage offtake and impact on crop yields by primates has not been explored. It has been used to investigate damage to cash crops from rabbits in Australia (Hone 1994), birds, deer, rabbits, bear and groundhog in North America (Drake and Grande 2002), geese damage to cereals (Borman *et al.* 2000, 2001), deer damage to forestry (Gary *et al.* 2000; Jenkins 2000) and in the context of wildlife management schemes in North American (Conover 2002; National Park Service 1997; WDACP 2003). Only one study has used exclosures to look at primate damage. It was used on a large scale in India to investigate wildlife damage to crops from a protected area, where monkeys were one of many species studied (Rao *et al.* 2002).

Due to costs and logistical constraints, the use of exclosures could only be piloted on a small scale during this study period. It is hoped that this can be replicated further in future. Exclosure plots were constructed on two farms in 2003 – one farm which was raided and one farm which was not, in order to examine whether the exclosures themselves had an effect on crops. Farms were matched in as many ways as possible e.g. distance to forest, crop type, size, crop density, level of human activity, stage of crop ripeness. One major difference was the presence of a river between the forest and the non-raided farm which is likely to have contributed to the fact that it was not raided. A total of twelve 3m^2 plots

(Drake and Grande 2002) were placed in each farm. Detailed methods for exclosure plot construction, sighting and analysis are presented in chapter 4.

2.4.3 Focal Farm Surveys

To obtain more in-depth information on the crop-raiding habits of the primates and to corroborate farmers' testimonies, several farms were selected for intense monitoring. This took the form of focal farm surveys. Although this method is time-consuming, therefore limiting the sample that can be studied, it provides more detailed information of raiding behaviour and frequency as well as information about crops targeted and human reactions to raiding animals. No literature has been found on the subject thus standard behavioural observation techniques were employed as for the troop-follows (see section 2.5.3).

Focal farm surveys were conducted in seven Kawelli farms in an eight week period in 2002 and nine farms in over a 10 week period 2003. Farms were chosen so as to exhibit a variety of characteristics such as distance to forest, crops grown and amount of human presence. Some farms were selected that were known to experience crop-raiding from previous years' work. In 2003 the same farms were used as for the previous year (where they still existed) and two more were added as it was possible to monitor four of the farms from two locations. Focal farms were monitored for a total of 201 days (2110 hrs and 30 minutes).

Focal farms were mapped using a GPS and the distance to the forest and village were measured. For the farms studied the amount of farm perimeter which was forested was measured. Perimeter was considered to be forested if scrub of 100m or less separated forest from farm for this part of the analysis (although actual measures to forest were also taken). It has been shown that scrub in the farm-forest margins is not a deterrence to raiding wildlife (Hill 1997, 2000), particularly if scrub is high and no people are present. Forested perimeter was then converted to a percentage of total perimeter for further analysis. Crops grown were noted and visual estimates of percentage of each crop in the farm recorded. The presence of any deterrent methods including the type of fence used was also noted. The state of availability of crops was recorded and this was reviewed weekly to note any changes.

Focal Farm surveys consisted of watching the farm from 6:30am until 16:30pm. For analytical purposes the study day was split into three time sections in order to determine whether or not the time of day had any influence over raiding patterns. These hours were chosen as they coincided with the period the primates were active (established in 1999 – 2003 through troop follows). Farms were watched from specific watch points (which in most cases were a farmer's watch hut, or the roadside) by myself and trained field-assistants, each with a local guide. Watch points were chosen so as to be as discrete as possible from macaques in order to reduce any possible deterrent effect from our presence. Eye contact with the macaques was avoided, as this is perceived as threatening behaviour. It was also necessary that the farmers were able to continue with their daily routine, and did not feel they had to allow the macaques to raid for the purposes of this study. Noise and movement were kept to an absolute minimum at all times. All movement within the farm was recorded including that of people and dogs and their specific activities undertaken during their time spent within the farm vicinity (N = 2110.5 hours).

Each focal farm was monitored in rotation. During each observation the following were recorded: weather conditions, arrival and departure time of humans, nature of human activity which was broadly grouped into general activities and deterrents (for categories and age-sex classes see appendix 4), presence of dogs and their activities, other sources of noise, and the activity of any macaques present. Continuous scan sampling was used to record human and dog activity on the farm.

Noise

Noises were classed as external or internal to the farm. Internal noises included shouting (although not as a deterrent to raiding macaques), crying, talking and hammering. External noises included road traffic, chainsaw, music from the village and shouting from outside the farm.

Primate Activity on the farm

The activity of the macaques on focal farms was systematically surveyed in relation to their location near or in the farm and their activities while present. Thus they were sampled while raiding and a raid was defined as any entry into the farm or onto the farm boundary (see chapter 6 for detailed description of raid classification). Behavioural scans were conducted every two minutes utilising standard behavioural observation methodology (see section 2.5.3) from first sighting of the monkeys outside the farm, until they left the farm area. A total of 9377 scans were made on the activity of individual monkeys on farms or at the farm edge. The following details were recorded:

- Time
- Age-sex class of the first individual seen (see section 2.5.3 for definitions of age-sex classes)
- Location (relative to farm boundary – Figure 2.6)
- Position – Tree (Tr), Ground (Gr), Fence (Fen)

- Time of first entrance to farm
- Location of entrance (Figure 2.6)
- Age-sex class of first entrant
- All entry points used by the monkeys (Figure 2.6)
- Time last individual leaves farm
- Age-sex Class last individual to leave farm
- Time of last sighting of monkeys outside the farm area

At each scan the following were recorded for all visible individuals:

- Age-sex Class
- Position of each individual: bordering trees, bordering ground, Fence, <5m from forest, <10m from nearest forest, <20m from forest, <30m from forest, <40m from forest, <50m from forest , >50m from forest (Figure 2.7)
- Activity of each individual (see section 2.5.3)
- The number and type of food items fed on or carried

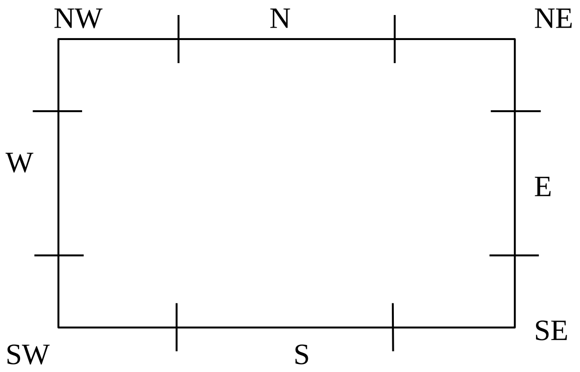


Figure 2.6 Location ot monkeys relative to farm boundary and entry points. 'North' was specified for each farm and noted on individual diagrams, although was usually the forested margin.

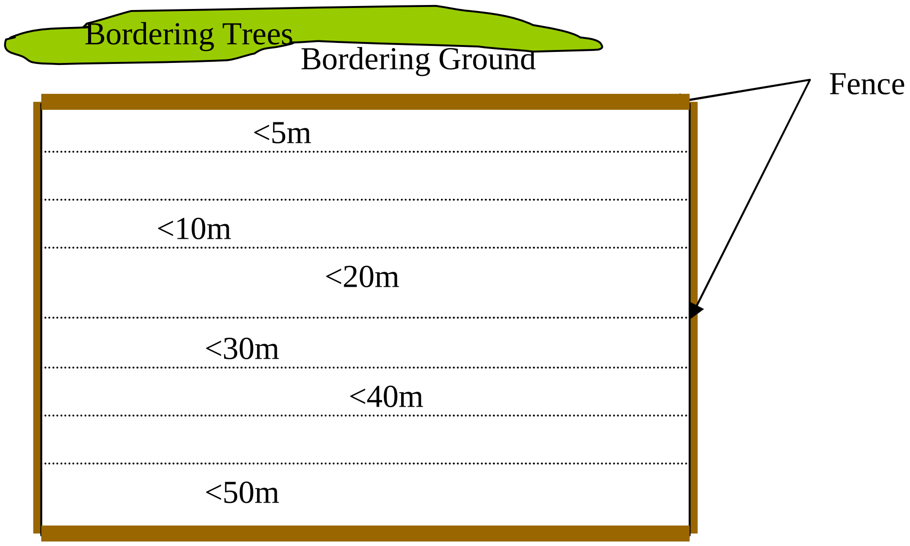


Figure 2.7 Potential positions of monkeys inside and outside the farm

Focal Farm Survey to Determine Success of Patrolling

There is little literature on the efficacy of deterrent techniques in the field, thus in addition to these focal farm surveys an investigation into the success of patrolling as a deterrent method was investigated. Three raided farms were chosen for study. They were matched as closely as possible in terms of distance to forest, size, crops grown, and human presence on the farm. These farms were observed (as above) in rotation. However, for half of the observation days the farm was patrolled by the observer (see chapter 7 and appendix 9 for a breakdown of total numbers of behavioural scans for focal farm and patrol surveys). Patrols took the form of a fifteen minute walk around the perimeter of the farm every hour on the hour throughout the day. The patroller was always the same individual, a white female. It should be noted that this may not represent a sufficient risk to the monkeys (compared to a local person patrolling) as there is evidence, from African sites, that monkeys respond to patrollers in different ways, and are aware of those who are more of a threat e.g. farmers who usually chase monkeys from the fields, compared to white researchers that do not (Hill C. M., pers. comm.). However, on these farms monkeys appeared to flee both when white people or local people approached them closely and therefore it is hoped that this did not reduce the efficacy of this method of deterrence too greatly. Patrol and non-patrol days were separated by at least two days to ensure there was no hang-over effect from patrolling. If monkeys were in the farm at the time a patrol was due it was continued regardless and scans were taken during the patrol. The monkeys were not chased or shouted at. It is recognised that this is a somewhat unrealistic situation in terms of assessing efficacy of a deterrent method, a farmer patrolling would be likely to chase monkeys out the farm, but it was felt the best way to enable a controlled, systematic assessment of patrolling as a possible deterrent in this limited study (see appendix 9 and chapter 7 for a breakdown of the total number of behavioural scans and hours of observation).

2.5 FIELD METHODS – MACAQUE ECOLOGY, POPULATION DENSITIES AND BEHAVIOUR

2.5.1 Measuring Primate Population Density

Accurate censusing of the number of primates and primate groups inhabiting protected and unprotected areas is essential for developing any successful management policies and conservation strategies (Anderson *et al.* 1979; Calouro *et al.* 2000; Defler and Pintor 1985; Fashing and Cords 2000; Sutherland 1996) and as such is of relevance to this project.

Population censuses were carried out at three sites – around the village of Kawelli in degraded forest/agricultural land, one hour's walk into the forest and another location four hour's walk into the forest. These sites were pre-established base-camps and so were chosen for reasons of logistical support and to limit further disturbance. The line-transect method was utilized since it facilitates rapid surveys of large areas (de Thoisy 2000; Mackinnon 1986). Estimation of the density of a sample population within a defined area then enables estimation of the total population based on extrapolation to a larger area (Struhsaker 1981). Line transect surveys have the advantage of providing information about animal abundance and distribution over a relatively short time period (Calouro *et al.* 2000; de Thoisy 2000; Johnson and Overdorff 1999; Struhsaker 1981), and are an effective method for estimating animal populations inhabiting very different geographic areas (Whitesides *et al.* 1988).

The three sites where surveys were conducted were the Anoa base camp (A), La Pago base camp (LP), and the area to the north of the road between the villages LaBundo Bundo and Kawelli (K). Anoa and La Pago are located in the Lambusango reserve (see Figure 2.2 for location of reserve) and represent relatively undisturbed rain forest habitat, although there is some evidence of rattan collection and selective logging, particularly at the La Pago site (O'Donovan 2002). Kakenauwe Reserve which is included in the third site has experienced high levels of forest disturbance due to road development and selective logging, leaving it reduced and fragmented. It also suffers from edge effects (O'Donovan 2002).

Standard transect methods were employed (Anderson *et al.* 1979; Barnett 1995; Bennett *et al.* 2001; Buckland *et al.* 1993; Burnham *et al.* 1980; de Thoisy 2000; Defler and Pintor 1985; Estrada *et al.* 2002; Fashing and Cords 2000; Jachmann 2001; Mackinnon 1986; NRC 1981; Peres 1999; Struhsaker 2002; Struhsaker 1981; Sutherland 1996; Whitesides *et al.* 1988). Four 3.5km transects were marked at each of the base camps and five between the Kakenauwe reserve and the village of Kawelli. In practice some transects had to be shortened due to topographic barriers e.g. cliffs and so in such cases other transects were extended to 4.5 km so that each site had approximately the same distance of trails. A total of 42.85km of transects were marked. Transects were marked leading away from base camp in different directions from a 1km^2 study grid. Existing trails and waterways were avoided because of their non-random location with respect to topography and vegetation and thus may result in atypical density estimates (Whitesides *et al.* 1988). Transects were cut along compass bearings irrespective of vegetation or topographic features thus reducing any bias (Jachmann 2001; Whitesides *et al.* 1988). To reduce disturbance minimal vegetation cutting took place, just enough to allow transects to be followed. The transects were left at least one day before being surveyed to allow for animals to redistribute themselves in the transect area free from observer disturbance (Peres 1999). All transects were separated by at least 1km. The transects were marked every 50m. Over the three month study period, each transect at the three study sites was walked in turn a minimum of five times to prevent the spatial location and timing of fruiting trees and other factors biasing the population counts (Struhsaker 2002). A total of 80 walks were made giving a cumulative census distance of 263.85km (Table 2.1). Survey walks began at 0700 hours, when macaques (and other diurnal animals) are typically most active, and hence detectable. Transects were not carried out in rainy conditions owing to the reduced detection ability in such conditions (NRC 1981; Peres 1999; Sutherland 1996; Whitesides *et al.* 1988). Transects were walked as quietly as possible so as not to disturb any animals. A speed of circa 1.25 km/hr was maintained, taking five minutes to walk each 100m section. Brief stops were made every 100m to minimize background noise and facilitate detection (Peres 1999). Upon detecting any sign of primates the observers did not leave the transect in search of them, nor did they follow them (see Whitesides *et al.* 1988). No more than 10 minutes were spent with any single sighting (NRC 1981; Peres 1999; Struhsaker 2002). Data were collected by the author and field assistants. There is evidence of highly significant differences between observers in their abilities to estimate distances accurately, especially in forested areas (Mitani *et al.* 2000). In an attempt to reduce any systematic observer bias all observers were jointly trained in the first few days of the survey (Peres 1999). In addition, all observers were familiar with the study animals' behaviour and had practice at distance estimation using known targets. Binoculars were used to improve detection ability (Buckland *et al.* 1993). All transects were walked with local guides. The same local guides were used for the entire survey period and were familiar with the primates' behaviour and characteristic patterns of movement and calls. This facilitated detection of the study animals.

For each census walk, the following information was recorded:

- Study site
- Transect ID number
- Date
- Start & finish times

For each sighting of monkeys, the following information was recorded:

- Time of sighting
- Position along transect
- Side of transect on which monkeys are seen
- Number of macaques sighted
- Diameter of group spread
- Perpendicular distance from transect to first monkey sighted

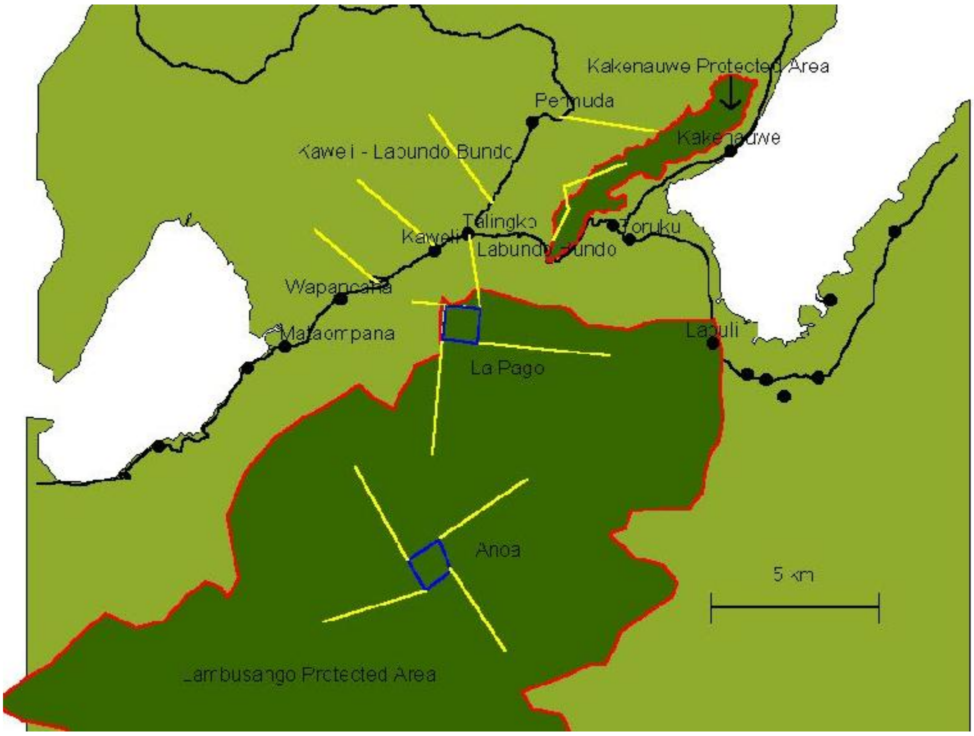


Figure 2.8 Map of transects for the three sites (yellow), blue lines indicate pre-established study grids used to access transects and not included in the census. Adapted from Williams (2004).

Table 2.1 Summary of census data from line-transect surveys and sampling effort

Transect	Site	Length (km)	times walked	Total length censused (km)	Total number groups seen
Arthur	La Pago	4	7	31	6
Big Red	La Pago	4	6	26.5	8
Gertie	La Pago	2.5	6	16.35	3
Maude	La Pago	2.5	6	17.5	4
Boulevard	Anoa	3.5	5	19	5
Easy St	Anoa	3.35	5	13.65	3
Picnic	Anoa	3.5	5	17.5	2
Walk in the park	Anoa	3.2	5	16	4
Charlie	Kawelli/Kakenauwe	3.5	7	24.5	8
Davey	Kawelli/Kakenauwe	3.5	7	24.5	12
Gerry	Kawelli/Kakenauwe	3.5	7	24.5	5
Vince	Kawelli/Kakenauwe	2.3	7	16.1	2
Kenny	Kawelli/Kakenauwe	3.5	7	28	1
TOTAL		**42.85**	**80**	**275.1**	**63**

The use of line-transects to give density estimates makes the following assumptions:

1) That groups are located randomly with respect to the survey path (in practice this is rarely the case as many primates maintain home-ranges or territories, however this is unimportant as long as the transect length is several times longer than the distance between groups (Whitesides *et al.* 1988)).

2) That the perpendicular distance of the group or animal from the transect is accurately estimated.

3) That each sighting is an independent event.

4) That animals are observed before they move away from the area and are not counted more than once.

5) That all animals in proximity to the transect are observed (de Thoisy 2000; Krebs 1999; NRC 1981; Whitesides *et al.* 1988).

If these assumptions are valid the density of the population can be estimated in a variety of ways. Density is expressed as the estimated number of animals per unit area (km^2) in the study or survey area (de Thoisy 2000; Estrada *et al.* 2002; Johnson and Overdorff 1999). A critical issue affecting the utility of the line-transect method is the estimation of area sampled (Defler and Pintor 1985; NRC 1981; Struhsaker 1997). Line transect data is most useful for estimating relative abundances i.e. number of animals per km walked, rather than estimating total densities (Jachmann 2001; Struhsaker 1997, 2002). Detailed studies of focal groups yields the most accurate estimates of absolute population density (Defler and Pintor 1985; Fashing and Cords 2000; Struhsaker 1997, 2002) thus the behavioural studies carried out in the same area will enhance the interpretation of the line-transect data.

Only visual detections were included in the final analysis, although auditory detections were recorded. Calls may be from solitary males or individuals temporarily separated form the group thereby giving a false impression of more than one group (Struhsaker 1997, 2002). Fixed width transects were not used as this method can result in significantly smaller sample sizes of animals being recorded and are most useful for species which occur in high densities and do not flee from the observer (Struhsaker 2002). Highly mobile animals, such as monkeys, present complicated problems when estimating effective transect width (*ibid*). The DISTANCE program (Thomas *et al.* 1998) can be used to estimate effective sample width of the transect, and in turn to estimate population densities. Despite some concerns over its value for sampling highly mobile animals (see Struhsaker 2002) this is a widely used program which utilises the perpendicular distance from the transect to sighted animal in order to generate transect widths.

Transect width may be estimated from a variety of measurements; a) perpendicular distance, the shortest distance from the detected animal to the transect line, b) animal-to-observer distance, the sighting distance from observer to the animal when detected, c) sighting angle, the angle between the transect line and the animal-to-observer line at detection (NRC 1981). On analysis of the data maximum reliable perpendicular distance can be used (NRC 1981) although this was found to be less accurate than the Whitesides method by Fashing and Cords (2000) and Defler and Pintor (1985). In this approach the frequency distribution of all estimates of perpendicular distance is plotted, the maximum reliable distance is where the curve begins to drop sharply (Kelker/truncated Method). If there is no such sharp decline a range should be calculated (NRC 1981). De Thoisy (2000) and Pruetz and Leasor (2000) found the line-transect and Kelker methods to provide satisfactory results for some neotropical primates as did Johnson and Overdorff (1999) for Malagasy primates. In some cases this method has been shown to overestimate numbers due to its underestimation of the area censused, as all sightings on the transect line itself are recorded as zero metres (Struhsaker 1997). In cases where the frequency of sightings on the transect itself is high, for example > 40%, this significantly affects the accuracy of the calculation of area surveyed (Struhsaker 1997, 2002).

Despite evidence that using the perpendicular distance can overestimate population numbers (Defler and Pintor 1985; Fashing and Cords 2000; NRC 1981) Burnham et al (1980) recommend the use of perpendicular distance data and believe that animal-to-observer distances should only be used in conjunction with sighting angles. There is some evidence that in situations in logged forest or thicketed vegetation perpendicular distances and observer-animal distances are not significantly different (Struhsaker 1997) and in fact perpendicular distances may be preferable (Janson and Terborough in Defler and Pintor 1985). In view of this and the increased difficulty and complexity of estimating sighting angles and animal-to observer distances with several different observers, it was felt that it would be simpler to use the perpendicular distance method and that this would be less prone to the systematic errors that estimating angles might cause (Peres 1999). Struhsaker (1997, 2002) discusses the limitations of the Whitesides method which adds a correction factor to the perpendicular distance value thus taking into account group spread. However this method assumes that the group is arranged in a semi-circle and that the first individual sighted is on the edge of this circle. The radius of the circle is added to the perpendicular value thus giving a distance to an assumed centre of the group. Struhsaker points out that there is little empirical evidence that monkey groups are arranged in a circular fashion and in fact often move in a linear or amoeboid fashion when foraging. It is felt that this method is unnecessarily complex and involves yet more assumptions which are largely unsupported. Fashing and Cords (2000) however found this to be the most successful method at estimating Kenyan forest primate densities and recommend it above maximum reliable distance estimates which do not take mean group spread into account and for species with large group spread is prone to creating overestimates. They point out that a circle may be the best two-dimensional approximation of group shape. It is argued that without an estimate of the distance to the centre of the cluster of animals rather than the distance to the nearest individual sighted density estimates may be biased (Anderson *et al.* 1979; Burnham *et al.* 1980; Whitesides *et al.* 1988).

It must be noted that the effects of seasonal changes in habitat use could not be investigated in this study, thus any density estimates may not be conclusive and may indeed be an inaccurate reflection of actual primate density in this forest (Fashing and Cords 2000). No studies have investigated whether these macaques show seasonal shifts in habitat usage. However, interviews with local farmers suggest they maintain similar ranges throughout the year (interview respondents, pers. comm.). As the primary objective of this thesis is to examine the effect of primate crop-raiding, even if these primates do show shifts in habitat in other seasons the information is still of value to show population levels around farmland at the time of the study (chapter 3).

2.5.2 Habitat Structure

Habitat surveys were conducted along each of the population census transects, using a total of 435 10 x 10m quadrats spaced at 100m intervals along the transects. Quadrats were located 5m from the trail to avoid disturbance caused by the trail itself. Within each quadrat the percentage vegetation cover at <1m, 1-5m, 5-20m, >20m was recorded using the Braun-Blanquet scale where:

- 1 = 0-5%

- 2 = 5-25%
- 3 = 25-50%
- 4 = 50-75%
- 5 = 75-100%

Percentage sky cover, rock, bare soil and leaf litter were also recorded using the same scale. The presence or absence of the following moisture indicators was also noted: bole climbers, epiphytic ferns, mosses, and epiphylls. The circumference of all trees with a circumference at breast height (CBH) > 30cm was recorded, as was the height of the tallest tree in the quadrat. These measures were chosen so as to be comparable to other data collected in previous years and by other researchers using the site. The results are presented in chapter 3.

2.5.3 Macaque Behaviour

A number of different monkey troops were observed during the field seasons (May – September 2000 to 2004). Troops were not followed in-between these study periods. In 2000 one troop was habituated to the presence of human observers in the farmland and degraded forest surrounding the village of Kawelli. During the 2002 season a further group was habituated in the forest surrounding the village of Kawelli and another one in the Kakenauwe study site.

Three groups of macaques were studied in 2003 and 2004, one in the forest-farmland bordering the village of Kawelli, one at the Kakenauwe study site, and one previously unstudied troop at the La Pago study site (see section 2.5.1 and Figure 2.8 for site description and map).

Behavioural data were collected from all study groups. The macaques at Kawelli crop-raided and their behaviour was recorded both in the forest and when raiding. In order to locate troops, the previous study day's last location was visited, followed by known sleeping trees and other known areas (for example the river and farmland). If they were lost during the day the home range was walked until the monkeys were found. The alpha male's distinctive 'clucking' call could be used to locate groups as could the presence of 'monkey birds'. 'Monkey birds' actually comprise two species (the fiery-billed Malkoha, *Phaenicophaeus calyorhynchus*, and the Hair-crested Drongo, *Dicurus leucopsand*; (Figure 2.9) which follow the monkeys feeding on insects flushed out by their passage, and discarded fruit/seeds. This phenomenon has been noted in other macaque species in Sulawesi (Matsumura 2001). The macaques were followed for as long as possible from dawn to dusk.

Figure 2.9 Hair-crested Drongo (a) and Fiery-billed Malkoha (b, c)

Instantaneous scan sampling was used to record behaviour (Altmann 1974; Martin and Bateson 2001) typically taken at ten-minute intervals (variation is detailed where appropriate). Scan sampling was used owing to its practical advantages and the quality and quantity of the results obtained (quantitative, instantaneous samples of state). Data were recorded from left to right to avoid re-recording the same animal within the duration of a single scan. Each scan took a maximum of two minutes to complete. If an individual entered the field of view during the course of a scan it was included in that sample, however if it entered after the scan was completed, even only a few seconds, it was not included. If, during a scan an individual's class could not be positively and certainly identified it was recorded as unknown (or as adult if only sex was undetermined). Further observation of the individual in between scans often resulted in a positive identification. A total of 16 mutually exclusive categories of behaviour and activity were defined (after Bertrand 1969; Cooper 2001) and distinction was made between major activity categories and social and non-social behaviour. A full ethogram is given in appendix 5.

In addition to recording the animals' behaviour, their position was also noted as either terrestrial (on the ground or fallen logs) or arboreal. Weather conditions (dry or wet) were recorded, as was the monkeys' presence in either farm or forest land. During the 2003 study period a GPS reading was also taken with each scan to allow calculation of home ranges.

Six age-sex categories were used and details are presented below (weights and ages are approximate and based on studies of other macaques[7] (Ménard and Vallet 1997; Smith and Jungers 1997) (NB photos are of both wild and pet animals in villages around the reserve).

---

[7] Smith and Jungers (1997) provide the only body mass estimates for this species at17kg for males. In my opinion this is too small for some individuals (see photos)

1) Alpha Adult Males – the largest and most easily distinguishable individuals. Behaviourally defined as the dominant male of the group. In some groups, there was more than one individual in this class based on physical features, although only one is dominant. Well muscled, square shouldered. Characterised by using loud clucking vocalisations. Ischial callosities have a bluish-grey tinge. (12 – 17kg, > 5years old).

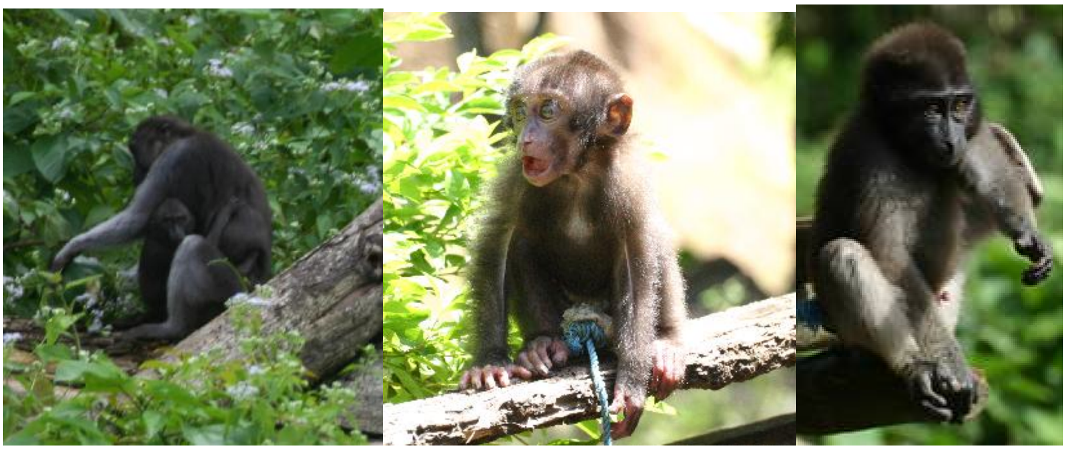
2) Adult Male – similar in appearance and behaviour to alpha male although lacking the bluish-grey patches at the top of the rear of the alpha male. Less muscled and less square shouldered. Did not make the clucking vocalisation. (12 – 17kg, > 5years old).

3) Adult Females – Most easily distinguishable by large, red, perineal sex skin swelling and swollen or distended nipples. Larger and bigger-built than sub-adults but slighter than adult males. It was hard to distinguish younger individuals who had yet to reproduce. Rarely engaged in play. (6 – 9kg, > 5 years).

4) Sub-adults – Smaller than both adult males and females. Not yet sexually mature, although it was sometimes possible to sex females by their lighter pink perineal skin and small, hardly visible nipples. Engaged in play. (3 – 4 years).

5) Juveniles – Smaller than sub-adults with rounded shoulders. Frequently involved in play. Loping gait rather than the purposeful stride of older individuals. Distinguished from infants in that they were entirely independent of their mothers. Often exhibited much browner pelage colour. (1 – 3 years).

6) Infant – Smaller than juveniles and not entirely independent of their mothers and would be seen attached to and suckling from their mothers and would return to be carried by them when the group moved. Infants were not separately scanned in this study as they remained almost exclusively attached to their mothers until the very end of the study. (< 1 year).



Scans provided data on the percentage of time that the macaques of each age-sex class spent engaged in the various non-social and social behaviours and the contexts of these activities. Behaviour is compared between groups, and between the various age-sex categories in chapter 3.

2.6 STATISTICAL ANALYSIS

All data were entered into SPSS version 9 for analysis. Data consisted of frequencies, and rates from behaviour scans, categories of events or responses (from questionnaires), locations and other continuous measures. Where necessary, responses or observations were re-coded into larger groupings – details are given in relevant chapters. Graphs were produced in SPSS or Windows Excel. Data were tested for normality using skewness/standard error of skew = < 3 to indicate normality (Rohlf and Sokal 1994). When not normal, data were logged and parametric statistics used. If still not normal after logging non-parametric statistics were used. Data were often categorised based on examination of frequency distributions and the modal peaks of the distribution. Independent sample t-tests (t) were used to test between two continuous variables. Levene's statistic was calculated to determine equality of variances and the appropriate t-value used. For comparisons of more than two variables, one-way ANOVA's (F) were used. Again Levene’s test for homogeneity of variance was used. When using post-hoc tests to identify differences among the sample means (multiple comparison tests) probability of a Type 1 error (a significant result occurring by chance) is greater, and increases with the number of tests performed. There is little consensus as to which tests provide the most reliable and accurate result, however when variances were equal (as tested by the Levene’s test) Scheffe’s test was used. This test protects against a Type 1 error and is designed to allow all possible linear combinations of group means to be tested, not just pairwise comparisons, resulting in a more conservative test and requiring a larger difference for significance. Scheffe’s test is also appropriate for use with groups of unequal sample size. When variances were significantly different between groups Tamhane’s T2 test was used, which is a conservative pairwise comparisons test based on a T test (Aspelmeier 2002; Field 2000). Bivariate correlations were used to test associations between continuous variables. Kruskal-Wallis H non parametric ANOVA , Mann-Whitney U, Wilcoxon signed ranks (Z), Spearman’s rank correlation and McNemar test for paired comparisons were all used when data were not normally distributed. Chi-square tests were also used to determine significant differences between categorical variables. Fisher’s exact test was used when comparing categorical variables in which both were binary (i.e. 2 x 2 contingency tables). Fisher's Exact Test is based on exact probabilities from a specific distribution (the hypergeometric distribution). The Chi-square test relies on a large sample approximation. Therefore, it is preferable to use Fisher’s Exact test in situations where a large sample approximation is inappropriate. Fisher's Exact Test is also very useful for highly imbalanced tables.

Multivariate tests were also used. For univariate general linear model (GLM) Type III sums of squares model (all variables entered simultaneously) was used to test hypotheses about differences in subpopulations (or marginal) means. The type III model is most appropriate for samples with unequal sample sizes. Logistic regression (Wald's statistic), multiple linear regressions and discriminant function analysis were also used and have been discussed in detail at the relevant points. Multiple linear regression is a more powerful tool than GLM (Bryman and Cramer 1997, Mascie-Taylor, pers. comm.) and has thus been used when developing predictive models of crop damage (see chapter 4 and 5). Multiple regression is used to account for (predict) the variance in a dependent variable, based on linear combinations of interval, dichotomous, or dummy independent variables. It can establish that a set of independent variables explains a proportion of the variance in a dependent variable at a significant level and can establish the relative predictive importance of the independent variables. It also allows the inclusion of nominal or ordinal categorical variables by transforming them into dichotomous dummy variables i.e. using binary coding. One variable must be left out to prevent multicollinearity and this becomes the reference variable (Schroeder *et al.* 1986), for instance, for the nominal variable 'Village' we may create a set of dummy variables called Kawelli, LaBundo Bundo, and Wakangka, leaving out Wakalambe as the reference group. The reference group must be well defined and not 'other' or 'miscellaneous' category and must also not have a small n, otherwise comparisons are unstable. The resulting b coefficient for each dummy variable can then be examined and a positive b coefficient means that variable had a bigger effect on the dependent variable than did the reference group, or if negative, then lower. A significant b coefficient for any included group means that group is significantly different from the reference group (Schroeder *et al.* 1986). Any variable can be the reference variable as the resulting values are all relative (Mascie-Taylor, pers. comm.). In order to avoid dummy variables being split up when entered into the model, and therefore creating a meaningless result, the 'Method=tests' model is used which allows the dummy variables from one category e.g. 'Village' to be grouped together. A stepwise regression cannot be performed as it could also split up the dummy variables which would create meaningless results. Therefore the block method must be employed and all variations of the model tested to discover which has the highest R^2 change.

Unless otherwise stated, all tests were two-tailed and a significance value of $p = 0.05$ was used. There were cases where tests were replicated on the same set of data, using different partitioning. In such cases the Bonferroni correction (p/n-1) was applied (see chapter 5). At other times it was felt that the data were sufficiently independent, and results were highly significant or sample sizes were small, therefore no Bonferroni correction was applied, as it can cause substantial loss in the precision of research findings and is not recommended in such cases (Perneger 1998). Although the correction controls for a type 1 error, it increases the likelihood of a type 2 error and is based on a general, not a specific null hypothesis. Therefore in some cases (chapter 7) multiple comparisons are performed and the tests used described without applying the correction, as recommended by Perneger (1998).

CHAPTER 3 - BEHAVIOUR, ECOLOGY AND POPULATION DENSITY OF THE BUTON MACAQUE

3.1 INTRODUCTION

Macaques are one of the more specious and widespread genera of non-human primates. They are also notorious as 'crop pests' (see for example Crockett and Wilson 1980; Roonwal and Mohnot 1977), making many species vulnerable to the consequences of conflict with human agriculturalists. In this chapter, I describe the Sulawesi macaque group and specifically the features of the Buton macaque as an island endemic. The issue of primates as global crop pests, and the problem of macaques in particular are then discussed. Population studies on the Buton macaque are presented as background information for this study, and the local area censuses carried out in 2003 set the context for the monkeys raiding the study farms. Finally, I present general information on socio-ecology covering trends in diet and ranging. The behaviour of the monkeys in relation to activity patterns in the forest is then compared with activities on the farms, and sex differences in behaviour and activity are outlined.

3.2 THE SULAWESI MACAQUES

Macaques are medium-sized primates of the family Cercopithecidae (Old World Monkeys), sub-family Cercopithecinae and the genus Macaca, with 19 species (Groves 2001). They are considered to be a monophyletic group, on the basis of morphology and genetics (Morales and Melnick 1998). Adult body weights range from 3 – 17kg and macaques possess heavily-built, robust limbs, of equal length. They are characterised by moderately long snouts, high-crowned molars with low cusps and long third molars. All species are sexually dimorphic to some degree, and several groups are tail less or have reduced tails. Macaques live in multi-male, female kin-bonded groups and ratios of males to females range from 1:1.2 (*M. radiata)* to 1:9 (*M. nemestrina*) (Feeroz 1996). Macaques typically are capable of breeding annually (Ross and Jones 1999). They are considered to be opportunistic frugivores (Chivers 1986) and are generally semi-terrestrial, although some species are more arboreal than others, for example *M. sinica, M. radiata, M. assamensis, M silenus*, while *M. thibetana* is predominantly terrestrial (Fooden 1986; Richard *et al.* 1989)

Macaques occupy the widest geographical range of any non-human primates, from 40°N to 40ºS latitude, and the widest variety of habitats, including grassland, mangroves, deciduous forest, tropical rainforest, temperate forest, rocky cliffs and beaches (Melnick and Pearl 1987). With the exception of the North African *Macaca sylvanus* all species inhabit Asia. There is also an originally introduced, but now feral, population of free-ranging *M. sylvanus* in Gibraltar; the only European wild non-human primate. The range of *M. fascicularis* extends farthest south-east of any non-human primate, while *M. fuscata* ranges the furthest north and east.

Macaque taxonomy is heavily debated, although they can be placed into four species-groups: *Silenus-sylvanus* (which includes the Sulawesi macaques), *sinica*, *fascicularis* and *arctoides* (Fooden 1976). Authors disagree over the placement of *M. sylvanus* and *M. arctoides.* Fooden (1976) places *M. sylvanus* within the *silenus-sylvanus* group and puts *M. arctoides* in its own group. Delson (1980), however, considers *M. sylvanus* sufficiently distinct to warrant a separate grouping and includes *M. arctoides* in the *sinica* group. Both authorities agree on the placement of the Sulawesi macaques within the *silenus* (or *silenus-sylvanus*) group.

Of the 19 extant species of macaque, seven can be found in Sulawesi (Fooden 1980). The Sulawesi macaques are thought to have evolved from *Macaca nemestrina* on Sumatra and Borneo approximately four and a half million years ago (Morales and Melnick 1998). Fooden (1969) and Whitten *et al.* (1988) propose an initial invasion of Sulawesi in the Pleistocene (1 – 0.7mya) by rafting or island hopping during the low sea levels of Pleistocene glaciation. The ancestral species then radiated out to colonise the whole island in a continuous distribution (Fooden 1969; Whitten *et al.* 1988). Fooden (1969) proposes *M. tonkeana* as the most ancient taxon, although Groves (1980) places *M. maura* in that position and suggests an earlier, Pliocene arrival on Sulawesi. Genetic evidence supports the notion of macaques entering Sulawesi in the Pliocene as part of the Siva-Malayan fauna, soon after the initial colonisation of Asia by the macaques (Morales and Melnick 1998). Based on mtDNA analysis Evans *et al.* (1999) suggest that Sulawesi was colonised twice, once to the base of the northern peninsular, now occupied by *M. hecki*, and then again to the south-western peninsula, now occupied by *M. maura*. The greatest genetic differences between the Sulawesi macaques are found between *M. nigra* and other species, particularly *M. ochreata* and *M. ochreata brunnescens*, which is consistent with the proposed differentiation of species and dispersal throughout the island after the initial invasion(s) (Morales and Melnick 1998).

The Sulawesi[1] macaques are a unique radiation within the macaques, in that seven[2] species exist on this island's relatively small area (179,426 km^2). Thirty seven percent of the macaques are found in just 1% of the total range of all macaques, representing more species than any other comparable land area (Reed *et al.* 1997; Sugardijto *et al.* 1989) and

---

[1] Formerly Celebes

[2] Between four and seven species/sub-species are recognised by differing authors (see Chivers 1986; Fooden 1969, 1980; Groves 1980; Groves 2001; Whitten *et al.* 1988)

are endemic (Fooden 1980; Groves 1980; Rosenbaum *et al.* 1998). Table 3.1 details the distribution of the Sulawesi macaques.

Table 3.1 Species, common name, distribution and conservation status of the Sulawesi macaques based on (Fooden 1969; Groves 1980).

Species	Common name	Distribution (area of Sulawesi)	Status (IUCN 2004))[3]
nigra nigra	Black crested macaque	Northeast	**Endangered**
nigra nigrescens	Dumoga-bone macaque	North	**Lower risk**
tonkeana hecki	Heck's macaque	Northwest	**Lower Risk**
tonkeana tonkeana	Tonkean macaque	Central	**Lower risk**
maurus /maura	Moor macaque	Southwest	**Endangered**
ochreata ochreata	Booted macaque	Southeast	**Data deficient**
ochreata brunnescens	Buton macaque	Southeast (restricted to the islands of Buton and Muna)	**Vulnerable**

---

[3] www.redlist.org

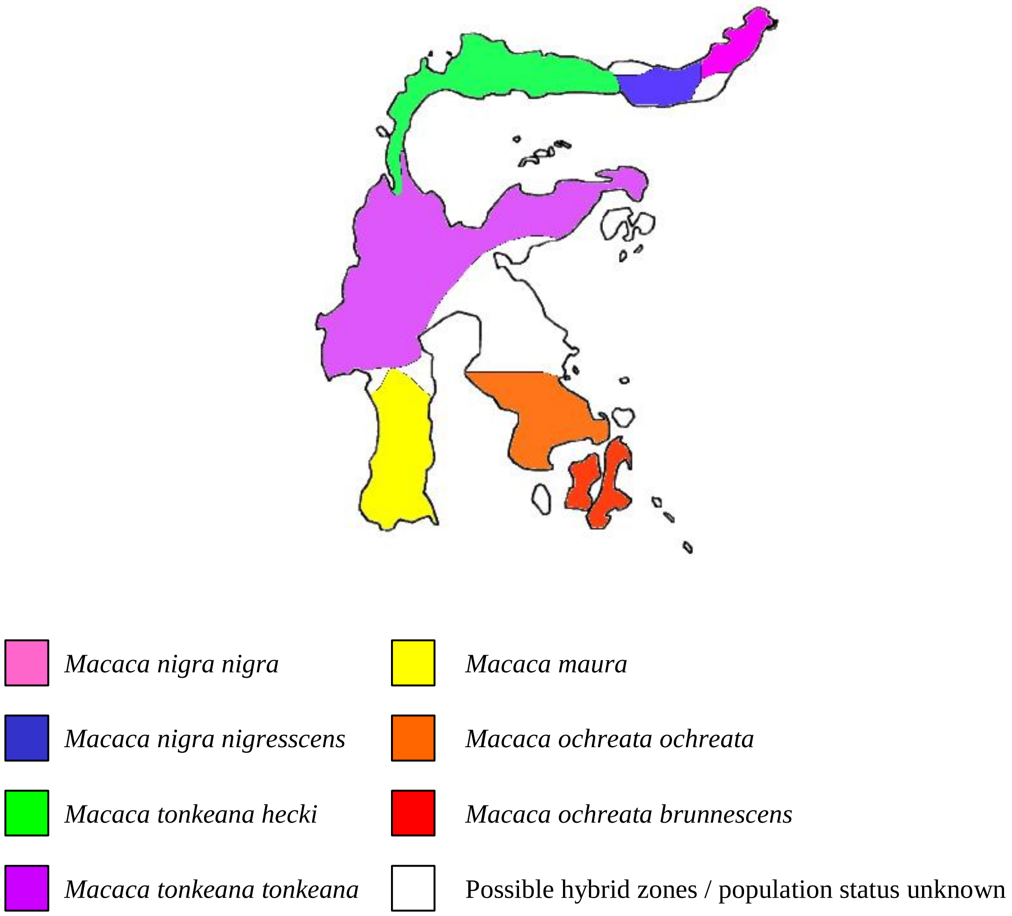


Figure 3.1 Map of Sulawesi indicating approximate distribution of the seven macaques. Modified from (Groves 1980)

Whether the Sulawesi macaques constitute as few as four (Groves 1980; Groves 2001) or up to seven species (Fooden 1969, 1980) is debated, and relationships between the Sulawesi macaques remain ambiguous (Hoelzer and Melnick 1996). The Buton macaque (*Macaca ochreata brunnescens*) inhabits only the islands of Buton and Muna. Its taxonomy has been debated and it is classified either as a separate species (*Macaca brunnescens* (Fooden 1980)) or as a sub-species of *M. ochreata* (Groves 1980; Groves 2001) which inhabits the south-easterly corner of Sulawesi, off which the islands of Buton and Muna lie. *M. o. brunnescens* is distinguished by a brown dorsal colour, shorter mat fur and a shorter face than *M. o. ochreata* (as described by Fooden 1969; Groves 1980; Groves 2001; Hamada *et al.* 1988) The separation of these populations can be no more than 10,000 years, owing to the separation of these islands in the Holocene (Groves 1980). In light of this fact and in view of personal observations, which indicate no distinguishing brown coloration in the adults, Groves' classification of *Macaca ochreata brunnescens* is used in this study.

Figure 3.2 Dominant Adult male in fields, showing lack of brown dorsal colouration

Indonesia has the 5th 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 and Mohnot 1977). Sulawesi lies in the region of Wallacea which includes Sulawesi, the Moluccas, and the Lesser Sundas (which encompasses Timor Leste, and the Indonesian region of Nusa Tenggara). Mittermeier *et al*. (1999) and Myers *et al.* (2000) listed the Wallacea region as a 'Biodiversity Hotspot' (Figure 3.3). Two factors are considered for hotspot designation; a great diversity of endemic species and, at the same time, significant impact and alteration by human activities. To qualify as a hotspot, a region must have lost more than 70 percent of its original habitat and must support over 1,500 endemic plant species (0.5 percent of the global total). 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 and 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 (*M. nigra*) (Rosenbaum *et al.* 1998). An understanding of their socio-ecology and behaviour is essential to the formation of a conservation strategy.

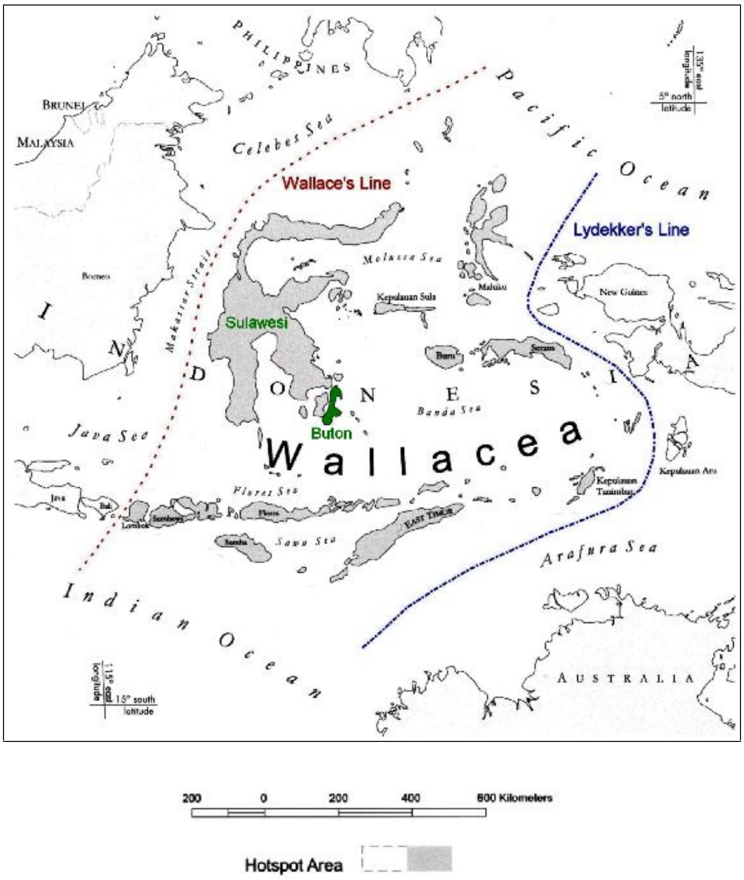


Figure 3.3 Wallacea Biodiversity Hotspot. Adapted by Grimwood (2005) from Conservation International Wallacea Hotspot map © 2002 Conservation International GIS & Mapping Laboratory.

3.3 PRIMATES AS CROP PESTS

Increasing competition between humans and non-human primates is a major problem facing primate populations in the developing world. Primates are 'pests' in a huge variety of contexts – on farms, tourist lodges, reserves, roadsides, temples or towns (Brennan *et al.* 1985; Eley and Else 1984; Eudey 1994; Forthman Quick 1986b; Mohnot 1971; Mukherjee 1972; Saj *et al.* 2001; Southwick *et al.* 1961a, b; Southwick and Siddiqi 1994;

Southwick and Siddiqi 1967; Strum 1986, 1987a, b, 1994). 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 1998b). Because of their intelligence, opportunism, adaptability and manipulative abilities many species easily turn to crop foraging and make formidable crop-raiders (Lee and Priston in press). The human and non-human primate niches overlap extensively making competition much higher between the two and posing many management problems (Strum 1987a).

Early studies on primates as crop-raiders and commensality[4] focused primarily on the Indian rhesus macaque (Mukherjee 1972; Neville 1968; Southwick *et al.* 1961a, b; Southwick and Siddiqi 1977; Southwick and Siddiqi 1967) probably due to its conspicuous presence in urban surroundings. After the early 1970's interest in this phenomenon waned and only recently have new studies emerged (see for example Boulton *et al.* 1996; Brennan *et al.* 1985; Else and Lee 1986; Forthman Quick 1986a, b; Hill 1998; Lee *et al.* 1986; Naughton Treves 1998a, b; Pirta *et al.* 1997; Saj *et al.* 2001; Siex and Struhsaker 1999a, b; Strum 1986; 1987a, Revue d'Ecologie :49 (3), 1994).

Primates from almost all families have been identified as crop-raiders (Table 3.2), although species differ in their ability to cope with encroaching human settlement. Perhaps the most infamous is the 'Pumphouse gang' of olive baboons studied by Strum (1986; 1987a; 1987b; 1994; 1998). The cercopithecoids, most notably macaques, vervets and baboons are frequent culprits. This is probably enabled by their rather generalised locomotion and diet; they are all semi-terrestrial, opportunistic frugivores with enhanced

---

[4] Primate commensality is defined as a primate population taking advantage of human food, waste or crops to supplement their diet or as a main food source (Gautier and Biquand 1994) thus encompassing crop-raiding populations.

intelligence and manipulative capabilities (Gautier and Biquand 1994) and many are forest-edge species (Chivers 1986). Richard *et al.* (1981; 1989) have classified macaques according to their ability to exploit human resources as weed species which depend on and compete with people through much of their range, or non-weed species which reach highest densities in forests with little or no human contact. They considered this a major determinant in the genus' initial dispersal, current distribution and evolution. Interestingly the only species considered 'weeds' are *Macaca mulatta, M. fascicularis, M. radiata* and *M. sinica* but not the Sulawesi macaque species. However, classification as a non-weed does not mean that raiding activity is not exhibited; all macaque species crop-raid, even infrequently, including the more reclusive species, for example *M. cyclopis* (Richard *et al.* 1989).

Table 3.2 Crop-raiding species of primate by location and food type given in the literature

Species	**Location**	**References**	**Other info**
Propithecus verreauxi coquereli	Madagascar	(Ganzhorn and Abraham 1991)	Raid cashew fruit, mango, tamarinds. Protected or sacred (*fady*) in some areas.
Eulemur fulvus	Madagascar	(Ganzhorn and Abraham 1991)	Raid cashew fruit, mango, tamarinds
Eulemur mongoz	Comoros	(Tattersall 1998)	Farmers report lemurs to be raiding breadfruit and jack fruit crop, and also (unreasonably) coconuts. This negative perception is relatively new. Farmers are now considering the use of poison to discourage perceived lemur depredations, and there is also widespread use of slingshots by children.
Leplilemur mustelinus edwardsi	Madagascar	(Ganzhorn and Abraham 1991)	Raid cashew fruit, mango, tamarinds
Avahi laniger occidentalis	Madagascar	(Ganzhorn and Abraham 1991)	Raid cashew fruit, mango, tamarinds
Daubentonia madagascariensis	Madagascar	(Fitter 1974; Mittermeier *et al.* 1994; Oryx 1964)	Coconut and lychee plantations. Local superstitions surrounding this species often mean it is killed if it passes through a village.

Perodicticus potto	Cameroon	(Pimley, pers.comm)	Raids gardens for fruit, No negative impact on perceptions as such. Losses are not great and are attributed by villagers to other animals as they raid at night.
Galago alleni	Cameroon	(Pimley, pers.comm)	Nocturnal garden raider. Few negative perceptions reported.
Callithrix jacchus	Brazil	(Moura, pers. comm.)	Raids fruit plantations
Cebus apella	Brazil, Northern and central South America	(Freese and Oppenheimer 1981; Freitas *et al.* 2002; Ludwig *et al.* 2002; Lynch and Rimoli 2000; , Moura, pers. comm, Rimoli and Ferrari 2002)	Raids maize and sugar cane. Prolific crop-raider. Increased manual dexterity makes this species particularly troublesome. The use of a dead monkey hung at the edge of the field has limited success, but depends on the alarm call of an approaching troop. Kept as pets and also hunted.
Cebus albifrons	Brazil, Northern and central South America	(Freese and Oppenheimer 1981)	Raids agricultural crops, particularly maize
Cebus capuchinus	Costa Rica	(Gonzalez-Kirchner and Sainz de la Maza 1998)	Raids agricultural crops, particularly maize and bananas. Considered by farmers to be the most destructive raider
Cebus olivaceus	Venezuela	(Kinzey *et al.* 1988)	Raids agricultural crops
Saimiri oerstedii	Costa Rica	(Gonzalez-Kirchner and Sainz de la Maza 1998)	Occasional raider of plantations
Alouatta palliata	Costa Rica	(Gonzalez-Kirchner and Sainz de la Maza 1998)	Occasional raider of plantations
Macaca mulatta	India, Nepal, Pakistan, China	(Chalise 2000; Goldstein and Richard 1989; Lindburg 1976; Makwana 1978; Malic and Johnson 1994; Mukherjee 1972; Neville 1968; Pirta *et al.* 1997; Richard and Goldstein 1981; Richard *et al.* 1989; Southwick *et al.* 1961a, b; Southwick and Lindburg 1986; Southwick and Siddiqi 1994; Southwick *et al.* 1983; Southwick and Siddiqi 1967; Teas *et al.* 1980; Wang and Quan 1986; Yongzu *et al.* 1989)	Weed species Raid wheat and rice fields and edible crops.
Macaca radiata	India	(Bertram and Ginsberg 1994; Caldecott 1986b; Crockett and Wilson 1980; Eudey 1986; Malic and Johnson 1994; Richard and Goldstein 1981; Richard *et al.* 1989; Southwick and Lindburg 1986)	Weed species

Macaca fascicularis	Borneo, Malaysia, Mauritius, Sumatra, Thailand,	(Bertram and Ginsberg 1994; Caldecott 1986b; Crockett and Wilson 1980; Eudey 1986; Richard and Goldstein 1981; Richard *et al.* 1989; Salafsky 1993)	Weed species, damages sugar cane, vegetables and fruit. Major pest where introduced.
Macaca sylvanus	Gibraltar, North Africa	(Eudey 1994; Richard and Goldstein 1981; Richard *et al.* 1989; Tappen 1960)	Tourist attraction; provisioned and poses health problems through contact. Population expansion due to provisioning on Gibraltar. Forestry pest in High Atlas.
Macaca assamensis	Nepal, Thailand	(Chalise 2000; Eudey 1986; 1994, pers.comm.; Richard and Goldstein 1981; Richard *et al.* 1989; Roonwal and Mohnot 1977; Wheatley and Harya Putra 1994)	Edible crops
Macaca fuscata	Japan	(Asquith 1989; Knight 1999; Richard and Goldstein 1981; Richard *et al.* 1989)	Crop-raider in past; provisioned at feeding sites. Tourist attraction.
Macaca nemestrina	Indonesia, Malaysia, Thailand	(Crockett and Wilson 1980; Richard and Goldstein 1981; Richard *et al.* 1989; Roonwal and Mohnot 1977; Salafsky 1993)	Plantation pest. Used for harvesting coconuts.
Macaca cyclopis	Taiwan	(Richard and Goldstein 1981; Richard *et al.* 1989)	Edible crop pest. Provisioned in some places. Tourist attraction.
Macaca sinica	Sri Lanka	(Richard and Goldstein 1981; Richard *et al.* 1989; Roonwal and Mohnot 1977)	Weed species
Macaca silenus	India	(Green and Minkowski 1977; Richard *et al.* 1989)	Little evidence that they are serious crop pests, but they are shot by farmers in the belief they damage the cardamom crop.
Macaca nigra	Sulawesi	(Hamada *et al.* 1988; O'Brien and Kinnaird 1997; Whitten *et al.* 1988)	Garden raider. Pest with some incorporation into traditional belief systems. Hunted.
Macaca maura	Sulawesi	(Richard *et al.* 1989)	Raids agricultural crops infrequently
Macaca arctoides	China, India, Thailand	(Richard and Goldstein 1981; Richard *et al.* 1989; Roonwal and Mohnot 1977)	Crop-raider and considered a pest.
Papio anubis & P. cynocephalus	Kenya, Uganda, Nigeria	(Harding 1973; Hill 2000; Maples 1969; Maples *et al.* 1976; Musau and Strum 1984; Naughton Treves 1998a, b; Oyaro and Strum 1984; Strum 1986, 1987a, b, 1994; Tappen 1960; Warren 2003)	Raid maize, banana, cassava and cashew crop as well as fruit. Raids garbage houses and lodges. Use of 'deceptive' tactics demonstrated. Viewed as malicious, cunning and dangerous.
Papio hamadryas	Saudi Arabia	(Biquand *et al.* 1992a, b; Dunbar 1977; Tappen 1960)	Raids garbage and crops. 'Sacred' baboon; dangerous pest species

Papio ursinus	Botswana	(Balakrishnan and Ndhlovu 1992; Parry and Campbell 1992)	Raids garbage, lodges and crops.
Mandrillus sphinx	Gabon, Cameroon	(Lahm 1996; Tappen 1960)	Raids manioc. Intensely hunted and valued for meat
Mandrillus leucophaeus	Nigeria, Cameroon	(Lee *et al.* 1988, Morgan, pers. comm.)	Intensely hunted and valued for meat
Theropithecus gelada	Ethiopia	(Dunbar 1977)	Rare raiders of wheat farms. Shot for manes in traditional dress.
Semnopithecus entellus	India	(Chalise 2000; Malic and Johnson 1994; Mohnot 1971; Pirta *et al.* 1997; Southwick and Lindburg 1986)	Raids mainly large fruit trees. Sacred primate to Hindus.
Presbytis rubicunda	Borneo	(Salafsky 1993; Yanuar *et al.* 1993)	Often raids gardens and is perceived to be destructive.
Colobus guereza	Uganda	(Hill 2000; Oates 1977)	Fruit plantations, cashews.
Colobus abyssinicus	Africa	(Tappen 1960)	Infrequent raider
Colobus satanus	Gabon	(Lahm 1996)	Reported to raid agricultural crops infrequently
Procolobus kirkii	Zanzibar	(Siex and Struhsaker 1999a, b)	Coconuts and other plantations. Although raiding may actually increase harvest despite farmers' opinions to the contrary.
Miopithecus talapoin	Gabon	(Lahm 1996)	Reported to raid agricultural crops.
Cercocebus torquatus	Congo, Nigeria, Cameroon, Guinea, Gabon	(Lahm 1996; Tappen 1960)	Garden raider, peanut crops.
Cercocebus albigena	Gabon	(Lahm 1996)	Reported to raid agricultural crops infrequently.
Cercocebus atys	Ghana, Guinea, Ivory Coast, Sierra Leone, Liberia	(Tappen 1960)	Cocoa plantation and garden raider.
Cercocebus galeritus agilis	Central African Republic, Cameroon, Gabon, Congo, DRC, Uganda, Tanzania, Kenya	(Kamisse and Turkalo 2002; Tappen 1960)	Rice farm raider. Also raids maize, cassava, papaya, peanuts and will steal cassava being soaked for consumption
Cercopithecus sclateri	Nigeria	(Oates *et al.* 1992)	Raids gardens. Heavily hunted.
Cercopithecus cephus	Gabon, Cameroon, DRC	(Lahm 1996; Tappen 1960)	Regular raider
Erythrocebus pattas	East Africa	(Tappen 1960)	Occasional farm raider; rapid at escape.
Cercopithecus aethiops	Barbados, Cameroon, Kenya, Malawi, St Kitts	(Balakrishnan and Ndhlovu 1992; Boulton *et al.* 1996; Brennan *et al.* 1985; De Boer and Baquette 1998; Eley and Else 1984; Gillingham and Lee 1999; Hill 2000; Horrocks and Baulu 1994; , Jack, pers. comm., Kavanagh 1978; King and Lee 1987; Lee *et al.* 1986; Naughton Treves 1998a, b; Parry and Campbell 1992; Struhsaker 1967; Tappen 1960)	Raids maize, banana and cassava or field crops mainly. Often resident on farms. Considered 'vermin' and a major weed species.

Cercopithecus ascanius	Uganda	(Hill 2000; Naughton Treves 1998a, b)	Raids maize, banana and cassava mainly.
Cercopithecus mitis	Kenya, Uganda, Zanzibar, South Africa	(Bell 1984a; De Boer and Baquette 1998; De Vos and Omar 1971; Hill 2000; Oates 1977; Siex and Struhsaker 1999a)	Crop and plantation raider; tourist lodge/ camp pest. Considered major pest species.
Cercopithecus nictitans	Gabon	(Lahm 1996)	Reported to raid agricultural crops infrequently.
Cercopithecus l'hoesti	Uganda	(Biryahwaho 2002; Naughton Treves 1998a, b)	Infrequent garden raiders.
Cercopithecus solatus	Gabon	(Lahm 1996)	Reported to raid agricultural crops infrequently.
Hylobates agilis	Borneo	(Salafsky 1993)	Reported by farmers to occasionally raid crops. Often present in forest-garden buffer zones.
Gorilla gorilla gorilla	Gabon	(Lahm 1996)	Reported to raid agricultural crops such as manioc.
Gorilla gorilla berengei	Uganda	(Biryahwaho 2002, Andama, E. pers. comm)	Raid field crops, increased due to loss of fear of humans through habituation. Considered quiet animals, generally afraid of humans. Valuable in context of eco-tourism.
Pan troglodytes	Cameroon, Gabon, Uganda	(Biryahwaho 2002; Hill 2000; Lahm 1996; Naughton Treves 1998a, b)	Raid maize, banana, cassava and field crops. Raid sugar plantations. Considered both dangerous and sacred in some areas.
Pongo pygmaeus	Borneo	(Salafsky 1993, Siregar, pers. comm.)	Reported to damage oil palm plantations.
Pongo abelii	Sumatra	(SOCP 2002)	Reported to damage fruit tree crops and palm oil plantations.

Human population density affects raiding patterns and it has been suggested that areas of greater human density suffer raiding from small rather than large vertebrates (Newmark *et al.* 1994) although this may be confounded by proximity to forested areas (Naughton Treves 1996). Certain primate species have been observed to seek out areas of human-wildlife interface (Southwick and Siddiqi 1994). Rhesus macaques adapted to such an extent that when translocated to a patch of forest rich in wild food, they returned to an area inhabited by humans.

Rainfall, season, crop variety and characteristics, wild-food availability, distance from forest, nearest farm or village, and farm protection methods all impact on raiding of farms (Biquand *et al.* 1992a; Gautier-Hion *et al.* 1985; Hill 2000; Horrocks and Baulu 1994; Lee *et al.* 1986; Maples *et al.* 1976; Mohnot 1971; Musau and Strum 1984; Naughton Treves 1998b). Troop size and individual characteristics of the primate (age, sex, experience, motivation) may also be important; for example, in olive baboons, young adolescent males were found to be more frequent raiders (Forthman Quick 1986a; Oyaro and Strum 1984; Strum 1986, 1994). In turn, raiding frequency and intensity feeds back into local farmers' attitudes towards the primates.

Crop-raiding is integral to the ecology of primates inhabiting areas of human-animal interface (Naughton Treves 1998b). Optimal foraging theory predicts that animals will maximise the quality of their nutritional intake whenever possible (Begon *et al.* 1986), which explains adoption of crop-raiding under certain conditions. A field of ripe crops may be viewed as analogous to a mass fruiting event (Naughton Treves 1998b). When discussing the feeding ecology or behaviour of primates, crop-raiding is rarely considered, despite some species undoubtedly including it as a major component of their foraging repertoire (Richard *et al.* 1989). Human-non-human primate co-existence (or antagonism) has certainly gone back centuries, and is likely to have been an issue as long as humans have planted crops and maintained some form of sedentary life (Vansina 1990); even before farming, competition would have existed for the same forest resources. Crop-raiding is not, however, inevitable (Strum 1986, 1987a, 1994) and different troops in the same area may well react completely differently to agricultural incursion. In the study of baboons at Gilgil, Kenya (1986; 1987a; 1987b; 1994) Strum demonstrated that troops responded either with migration and sporadic raiding at critical periods and a reduced home range, or by complete reliance and a shift in home range (Musau and Strum 1984).

Maples (1969) first demonstrated that crop-raiding baboons exhibited adaptive behaviours with regard to group organisation and raiding techniques. Thus it would seem that raiding itself influences, or is associated with a variety of ecological traits. For example, a reduction or shift in range size has been documented for baboons (Musau and Strum 1984; Strum 1986, 1987a, 1994). Activity budgets have been shown to shift such that crop-raiding results in greater inactivity and increased sociality, owing to food predictability and decreased foraging costs (Asquith 1989; Biquand *et al.* 1992b; Forthman Quick 1986a; Lee *et al.* 1986). Social structure also alters with group fragmentation occurring (Asquith 1989; Biquand *et al.* 1992b; Forthman Quick 1986a; Mohnot 1971; Strum 1986, 1987a). Overall group size can increase (Biquand *et al.* 1992b; Brennan *et al.* 1985; Siex and Struhsaker 1999b), while the frequency of aggressive interactions can go up as well (Asquith 1989; Lee *et al.* 1986; Mohnot 1971).

Crop-raiding can be casual or systematic (Maples 1969) reflecting the degree to which it is relied upon (see chapter 6). It is a high-risk activity and while many primates can, and do adapt, others suffer mortality and morbidity as a consequence of human deterrence (Strum 1986) and some are simply eliminated (Naughton Treves 1998b).

In some areas, farmers balance crop loss with bush meat (Balakrishnan and Ndhlovu 1992) but primates are rarely the primary target (Hill 2000) in communities who, for religious or legal reasons, do not eat monkeys, for example East Africa (Oates 1977) and Buton (Priston 2001). Traditional methods to prevent primate crop-raiding (Table 3.3) have limited success. More recent suggestions to manage crop pests focus on the use of a combination of methods, such as early warning systems, crop planting, and noise making, to increase the risk of raiding for monkeys (Hill *et al.* 2002). The dexterity, deceptive skills[5], and intelligence of some primates make containment and control costly, inefficient and ultimately ineffective (Maples *et al.* 1976; Strum 1986, 1987a, 1994).

Table 3.3 Methods of Deterrence

Method	Details of Use and effectiveness	References
Guarding/chasing	Effective. Often by women or children, time expensive and keeps people from other activities.	(Balakrishnan and Ndhlovu 1992; Bell 1984a; Biquand *et al.* 1992b; Biquand *et al.* 1994; Hill 2000; King and Lee 1987; Knight 1999; Maples *et al.* 1976; Pirta *et al.* 1997; Sekhar 1998; Southwick *et al.* 1961a; Southwick and Lindburg 1986; Southwick and Siddiqi 1977; Strum 1987a, b, 1994, 1998)
Noise/bells etc	Quite effective, but habituation is a problem.	(Biquand *et al.* 1992b; Biquand *et al.* 1994; Hill 2000; Naughton Treves 1998a, b; Sekhar 1998; Strum 1987a, b, 1994, 1998)
Stones/slingshots/spears	Particularly effective, but causes considerable damage and distress to monkeys (welfare issues).	(Biquand *et al.* 1992b; Biquand *et al.* 1994; Hill 2000; King and Lee 1987; Maples *et al.* 1976; Naughton Treves 1998a, b; Strum 1987a, b, 1994, 1998)
Shooting / hunting	Legal issues in many areas where the pest species is also a Red List species, or where legislation controls hunting or the issue of licences.	(Balakrishnan and Ndhlovu 1992; Bell 1984a; Bertram and Ginsberg 1994; Sekhar 1998; Yongzu *et al.* 1989)
Trapping/culling	Results in population skews. Effective in the short term, but can result in 'mining' populations as new groups move into the empty habitat.	(Balakrishnan and Ndhlovu 1992; Bertram and Ginsberg 1994; Biquand *et al.* 1992b; Biquand *et al.* 1994; Boulton *et al.* 1996; Brennan *et al.* 1985; Lee *et al.* 1986; Martin 1984a, b; Mitchell and Tilson 1986; Pirta *et al.* 1997; Southwick *et al.* 1961a, b; Southwick and Siddiqi 1977, 1994; Southwick and Siddiqi 1967; Struhsaker 1967)
Poison	Tends to be detectable and thus learned avoidance minimises effectiveness.	(Bertram and Ginsberg 1994; Priston 2001)
Chemical deterrents	Tend to be ineffective in the long term due to learning.	(Bell 1984a; Biquand *et al.* 1994; Strum 1987a, b, 1994, 1998)
Taste-aversion conditioning	Ineffective long term due to learning and the species tendencies to sample foods despite aversion. Generally not practical owing to expense and need to trap animals.	(Forthman Quick 1986a, b; Strum 1986, 1987a, 1998; Strum and Southwick 1986)
Fences / electric fences	Ineffective as primates can climb or get through almost all barriers.	(Bell 1984a; Maples 1969; Maples *et al.* 1976; Sekhar 1998)
Dogs	Often very effective, but requires a culture of keeping dogs.	(Biquand *et al.* 1994; Hill 2000; King and Lee 1987; Maples *et al.* 1976; Strum 1987a, b, 1994, 1998)
Playback of alarms	Ineffective – individuals habituate rapidly.	(Bell 1984a; Strum 1987a, b, 1994, 1998)

---

[5] Tactical deception is itself a point of debate amongst primatologists (see for example Cheney and Seyfarth 1990; Hauser and Nelson 1991) but in this context it is taken to mean the distraction of a farmer by one part of the troop while the other part raid another area of the farm silently (Maples 1969; Maples *et al.* 1976; Strum 1986, 1987a).

Painting Individuals	Involves the capture of one troop member, usually the dominant male, painting him white/red and re-releasing him, thereby scaring the troop away as he runs towards them.	(Priston 2001)
Translocation	Can be effective in rare cases (Imam *et al.* 2002) but requires that a suitable unoccupied habitat can be found and requires some provisioning and monitoring. Is often very expensive. Only one long term study has assessed the effectiveness (in baboons (Strum 2005)) and found after an initial adjustment period with increased mortality translocated groups performed similarly to indigenous groups. However, it required several interventions, some provisioning and many years intensive monitoring.	(Biquand *et al.* 1994; Caldecott and Kavanagh 1983; Imam *et al.* 2002; Lee *et al.* 1986; Pirta *et al.* 1997; Southwick *et al.* 1998; Southwick and Siddiqi 1994; Strum 1987a, b, 1994, 1998; Strum 2005; Strum and Southwick 1986)
Birth control	Could be effective but requires capture of animal and thus is not often practical or affordable.	(Bertram and Ginsberg 1994; Biquand *et al.* 1994; Boulton *et al.* 1996)
Cropping patterns	Alter crops grown and timing of planting and harvesting – causes disruption to traditional agricultural practices.	(Bell 1984a; Boulton *et al.* 1996; Else 1991; Horrocks and Baulu 1994; Naughton Treves 1998a, b; Strum 1994)
Buffer zones	Regions of partially cleared land surrounding farms or buffers of less desirable crops – particularly effective when barrier crops are grown for 'sacrifice'. Difficult when specific areas of land are allocated to people.	(Biquand *et al.* 1994; Boulton *et al.* 1996; Else 1991; Hill 2000; Horrocks and Baulu 1994; Naughton Treves 1998a, b; Pirta *et al.* 1997; Strum 1987a, b, 1994)
Conservation of forest refugia	Necessity for many species' survival. Suitable forest habitats may lessen the need for primates to encroach on farms.	(Boulton *et al.* 1996; Else 1991; Horrocks and Baulu 1994; Naughton Treves 1998a, b; Pirta *et al.* 1997; Strum 1986, 1987a, b, 1994)

3.4 THREATS AND CONSERVATION

Habitat loss or modification is the major problem facing wildlife conservation globally (Fimbel *et al.* 2001; Johns and Skorupa 1987), and is the single greatest threat to the survival of virtually all primate species (Cowlishaw and Dunbar 2000; Mace and Balmford 2000; Mittermeier and Cheney 1987) with 21 million ha of tropical forests worldwide being destroyed annually (Laurance 1999). On average, 1.7 million ha of Indonesia's forests were removed each year from 1985-1997, during which time 20% of the forests of southeast Sulawesi were destroyed (MacKinnon and Whitten 2001). Almost all of Indonesia's lowland forests have already been exploited by commercial loggers (Myers 1984) and what remains is continuing to be degraded annually (Johnson and Cabarle 1993). All seven species of Sulawesi macaque are facing threats due to habitat loss or hunting (often as agricultural pest control) with some populations experiencing a 75%

decline over 15 years (*M. nigra*: (O'Brien and Kinnaird 1997; Rosenbaum *et al.* 1998)). *M. nigra* is more abundant in undisturbed than disturbed forest, probably due to the higher carrying capacity owing to greater food quality and quantity in primary forest (Rosenbaum *et al.* 1998).

As noted above, the Buton macaque is endemic to the islands of Buton and Muna, inhabiting lowland and hill forest. Buton is thought to be its last refuge as Muna is virtually totally deforested and its population of Buton macaques is likely to be extinct (Mackinnon 1986). This last refuge of the species is under threat, as Buton is being deforested at an estimated rate of 10% per annum due to logging and clearance for subsistence farming, despite forests being designated as protected areas (Operation Wallacea 2003). Hunting is not a major threat to the Buton macaque as the majority (over 80%) of Butonese are Muslim, and monkeys are considered *'Haram'* and therefore not eaten. Some trapping is practiced for crop pest control (see chapter 7).

The Buton macaque faces a high risk of extinction in the medium-term future (IUCN 2004), and yet virtually nothing is known about the species. The GEF (Global Environment Facility) has provided funding to Operation Wallacea for a five year project (2004 – 2009) to protect and develop a management plan for the Lambusango and Kakenauwe protected forests. Assessing the population of macaques within the reserve is integral to this. However, assessing the status of populations in unprotected areas is equally important for endangered primates (Feistner and Lee 2001). Density data can be used to estimate population sizes of endangered species (Karanth and Nichols 1998), and indicate population viability (Franklin and Frankham 1998; Lynch and Lande 1998). Information on habitat use and preferences is also critical to species management in order for conservation measures to be effectively targeted.

3.5 POPULATION STUDIES ON BUTON

3.5.1 Transects

The data presented are derived from Williams' (2004) project, with some data collected by the author. A total of 80 transects were walked over the three sites, giving a cumulative census distance of 263.85km

Table 3.4 Transect length and sampling effort for each site, including details of protected status of area surveyed by author, students and field assistants (adapted from Williams 2004)

Trail	Length (km)	Number of walks	Total Distance (km)	Protected forest?	Disturbance
Anoa	**13.6**	**21**	**66.15**		**Low**
Boulevard	3.5	6	19	Yes	
Easy St	3.4	5	13.65	Yes	
Picnic	3.5	5	17.5	Yes	
WITP	3.2	5	16	Yes	
La Pago	**13**	**29**	**91.35**		**Moderate**
Arthur	4	8	31	Yes	
Big Red	4	7	26.5	Yes	
Gertie	2.5	7	16.35	No	
Maude	2.5	7	17.5	No	
Kakenauwe/Kawelli	**16.3**	**36**	**117.6**		**Moderate - High**
Charlie	3.5	7	24.5	No	
Davie	3.5	7	24.5	No	
Gerry	3.5	7	24.5	Yes	
Vince	2.3	8	16.1	No	
Kenny	3.5	7	28	No	
Total	**42.9**	**86**	**275.1**		

A summary of sighting data is given in Table 3.5. No significant differences were found in number of macaque sightings between study sites, nor between macaque sightings and protected status of the area. Macaque encounter rate, perpendicular sighting distance and group size also did not differ between the three sites. However group spread at La Pago was significantly greater than at Kakenauwe/Kawelli (Williams 2004).

Table 3.5 Sighting data for study sites. Encounter rate means and standard deviations were calculated based on data at the transect level; all others were at the observation level. (adapted from Williams 2004)

Site	Number of sightings	Macaque encounter rate (groups encountered per 10 km censused)	Perpendicular sighting distance (m)	Group size (individuals)	Group spread (m)
Anoa	14	2.09 ± 0.94	13.50 ± 5.85	4.57 ± 3.59	25.56 ± 14.16
La Pago	21	2.36 ±1.69	17.19 ± 13.93	3.52 ± 3.25	30.36 ± 14.47
Kakenauwe/Kawelli	28	2.35 ± 1.61	18.96 ± 15.21	2.61 ± 1.91	12.87 ± 7.10
Total mean	**21**	**2.27 ± 1.35**	**17.04 ± 12.10**	**3.35 ± 2.88**	**22.31 ± 14.18**

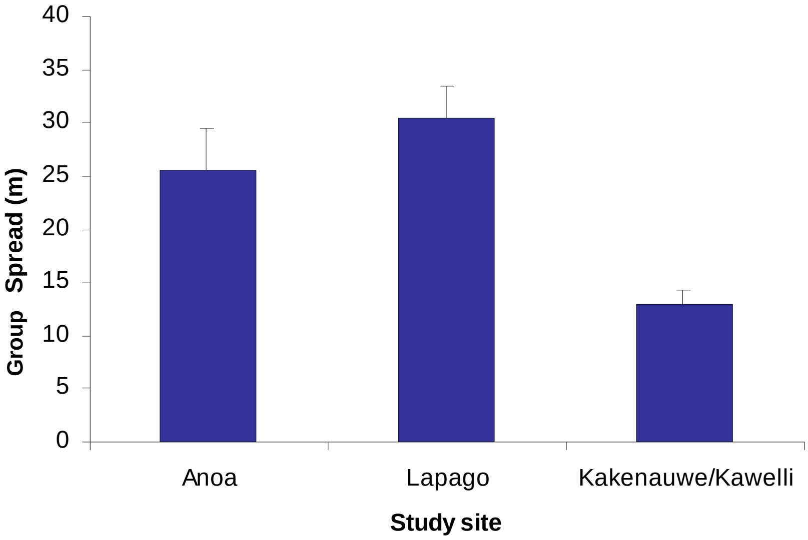


Figure 3.4 Group spread at the three study sites. Error bars represent standard errors (adapted from Williams 2004)

3.5.2 Estimates of Macaque Population Density and Size

A comprehensive discussion of transect methods and the use of DISTANCE was given in chapter 2 (section 2.5.1). Since there was no significant difference between perpendicular sighting distances across the sites and sample sizes were too small to calculate separate effective strip widths (ESW) for individual study sites, sighting data were pooled (see Buckland *et al.* 1993; Chiarello and de Melo 2001). It was therefore only possible to generate an overall population density estimate for the area surveyed. No truncation was applied. Due to limited data, and the potential for problems of mis-measurement, such as under- or over-estimation of distances, or rounding-off of measurements to convenient or favoured figures (heaping), perpendicular sighting distances were grouped for analysis. This grouping provides more accurate fits to the various estimator models used in DISTANCE analysis (Barraclough 2000; Buckland *et al.* 1993; Chiarello and de Melo 2001). The half-normal key function with hermite expansion provided the best fit to the data, although all models gave similar density estimates, indicating that the data were consistent. This generated an overall density of 4.45 macaque groups/km^2 (confidence limits, 3.04 - 6.49) with an ESW of 25.15m. The density was multiplied by the overall mean sighting group size (as there was no significant difference in group size between different sites) of 3.35 individuals to give a population density of 14.91 macaque individuals/km^2 (confidence limits, 10.18 - 21.74).

The total area sampled (total length sampled (275.1 km) x width sampled (2 x ESW = 2 x 0.025 = 0.050 km)) was 13.8 km^2. There was no evidence for significantly different population densities or ESWs across the three study sites, so the overall population density (14.91 individuals/km^2) can be multiplied by the total area surveyed (13.8 km^2) to give a population size of 206 macaques within the area sampled. There was no evidence for significantly different population densities in the two reserves, thus an overall population density for the combined area of the Lambusango and Kakenauwe reserves (251.63 km^2) can be calculated. This produces a population size of 3,752 macaques (confidence limits, 2,562 - 5,402) within the protected forests of central Buton. There were no significant associations between the numbers of macaque sightings and protected or unprotected areas suggesting that a substantial population of macaques lives outside the protected areas. If the range of the Buton macaque extends far north then there is also a good chance that the sizeable forest reserve in northern Buton could harbour a potentially large population of macaques. The total size of the entire population on the island is therefore likely to be greater still, and could theoretically be many times greater than these extrapolations (Williams 2004).

3.5.3 Home Range and Group Size

Habitat disturbance places ecological constraints on primates, such as restricting group size and home range (Menon and Poirier 1996). Group size is, in part, a trade off between the costs of foraging efficiency and the benefits of reduced risk from predators (Chapman *et al.* 1995; Terborgh and Janson 1986) and depends in part upon the abundance and distribution of food resources (Chapman *et al.* 1994; Matsumoto-Oda 2002). Groups of primates living in farm-forest mosaics, like the Buton macaque in this study, face increased human disturbance and degradation of forest, with a likely reduction in wild-food abundance. They are, however, also able to exploit a new resource; farms. Farms are an abundant and predictable food source, but come at a cost. Crop-raiding is a high risk activity (as discussed above, see section 3.3). In this section home range and group size of three troops of Buton macaque are compared to investigate the impact of both habitat disturbance and exploitation of cultigens.

Studies of other species have demonstrated larger group sizes in areas where monkeys can crop-raid, for example *M. radiata* groups in agricultural-edge habitats have been reported to be significantly larger than groups in forested habitats (Singh and Vinathe 1990). Of the Sulawesi macaques, only *M. nigra* has been sufficiently studied. Home ranges for *M. nigra* have been reported to be 2 km², and patterns of use were dependant on the spatial and temporal distribution of food and habitat quality, with primary forest being used significantly more than expected (O'Brien and Kinnaird 1997).

Home range and group size data for the Buton macaque are presented in Table 3.6, based on Carroll's study (2003). These data are presented here as this is the only study to look simultaneously at the three troops in my study area. It is recognized that data may underestimate the true home range of these troops as data were only collected in the summer, over 3 months. The densities below also assume no group overlap, and again there may be some overlap at different times of the year. These limitations should be borne in mind when comparing with other species, but the data still enables an internal comparison between the three sites and at the very least offers a minimum home range size. It should be noted that in other years, group sizes for the Kawelli and Kakenauwe troops were even larger (23 individuals for Kawelli in 2002 and 41 individuals for Kakenauwe in 2004) (Priston, unpublished data).

Table 3.6 Home range and group size data based on observations by the author and modified from Carrol (2003) and Williams (2004). Studies were carried out July-September 2003

Study group	Home range (km²)	Group size	Macaque density (individuals/km²)
Kaweli	0.29	20	68.97
La Pago	0.85	40	47.06
Kakenauwe	0.72	36	50.00
Overall mean	**0.62**	**32**	**55.34**

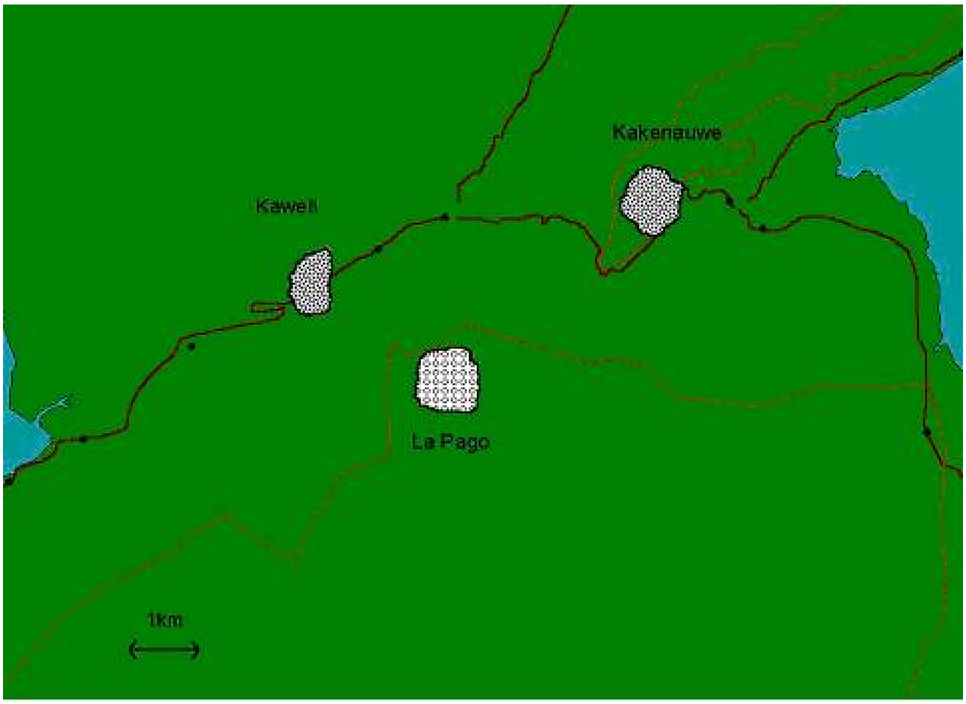


Figure 3.5 Home range maps for the three study troops (based on data from Carlisle 2005; Carroll 2003, Smith, unpublished data). See chapter 2 for maps of study area for focal farm studies and interviews.

Average group size for the Buton macaque and *M. nigra* is estimated to be 30+, while *M. nigrescens* and *M. ochreata* occur in groups of 16 and 18 respectively (Whitten *et al.* 1988), although *M. nigrescens* has been seen in groups of up to 62 individuals (Kohlhaas and Southwick 1996). *M. maura* has been recorded in troops of 20-30 individuals (Matsumura 1998). The overall mean for this study of 32 individuals is consistent with the higher end of these estimates. Although the Kawelli troop could be predicted to be the largest, owing to the predictable and abundant food sources from crop-raiding combined with the increased risk of predation from humans, it was not. La Pago had the largest group size in 2003, with the Kawelli troop being only half its size. Studies of black and white colobus in degraded or patchy habitats have shown a similar pattern (Oates 1977; Struhsaker 1997), however this is not a good species comparison owing to very different diets. The small Kawelli troop may be somewhat of an anomaly. Although the habituated troop has been consistently small in size (ranging between 16 individuals up to 26 from 1999 – 2004 (pers. obs)) other troops in the area are certainly much larger. Troops of over

40 individuals have been witnessed raiding farms (pers. obs.). The Kawelli troop also suffered from an incident of poisoning in 2002 which led to the death of 11 troop members, including the dominant and other adult males. This highlights the need for longer term studies to determine population fluctuations.

Mean home range size across the three troops was 0.62km^2 (Table 3.6) which is less than a third that found for *M. nigra* (O'Brien and Kinnaird 1997). The Kawelli troop had the smallest home range, again less than half the size of the other troops. Small home ranges have been found in other crop-raiding species such as baboons in Kenya (Musau and Strum 1984; Strum 1994), provisioned troops such as *M. sylvanus* (Fa 1986), or groups living in disturbed forest, for example *Cercopithecus nictitans* and *Cercopithecus cephus* (Tutin *et al.* 1997). A smaller average home range may be a response to predictable and spatially concentrated food, cultigens, resulting in reduced traveling distance to obtain sufficient food for the group (Altmann and Muruthi 1988; Brennan *et al.* 1985; Fa 1986). Smaller group size would further reduce the need to travel to obtain sufficient food. Studies of activity budgets found that the small Kawelli troop spent less time traveling and foraging, and more time resting or being social (see section 3.6.3). Groups may also respond to resource scarcity and increased intra-group competition by forming smaller sub-groups for foraging**.** Chapman *et al.* (1994) suggest that sub-grouping increases the area over which a group forages, enabling smaller concentrations of a resource to be utilized and increasing foraging efficiency. The La Pago troop regularly split into small sub-groups of between two and five individuals to forage, rejoining the groups later in the day (pers. obs., Carroll 2003). Foraging in sub-groups has also been reported for *M. fascicularis* (Aldrich-Blake 1980).

3.5.4 Habitat Preferences

Habitat variables from the three study areas are summarised in Table 3.7. These were measured in conjunction with the population survey (see chapter 2 for details of methods employed) and thus included the Anoa site (not used in behavioural studies) and Kakenauwe/Kawelli, which in this context covers both within the Kakenauwe reserve and outside the reserve around the village of Kawelli.

Table 3.7 Habitat measures for the three study sites. Vegetation quadrats were conducted along the transects used for population surveys (see chapter 2 for details of methods) and were conducted by the author, students and field assistants (adapted from Williams 2004).

Mean (± SD)	Anoa	La Pago	Kakenauwe/Kawelli	Total
Tree basal area (cm^2)	626.44 (± 1624.96)	598.46 (± 1475.70)	591.41 (± 1696.63)	**607.08 (± 1592.77)**
Tree density (trees per 100 m^2)	8.09 (± 3.95)	9.39 (± 11.64)	5.26 (± 2.92)	**7.46 (± 7.24)**
Height of tallest tree (m)	20.10 (± 5.56)	20.81(± 6.44)	16.13 (± 7.84)	**18.79 (± 7.07)**
Vegetation density (%)				
Ground level	2.69 (± 1.03)	3.38 (± 0.91)	3.62 (± 1.11)	**3.24 (± 1.08)**
Low-level	2.76 (± 0.89)	2.62 (± 1.00)	2.89 (± 1.03)	**2.75 (± 0.98)**
Mid-level	2.92 (± 0.81)	2.50 (± 0.82)	2.29 (± 0.96)	**2.57 (± 0.90)**
Canopy level	1.59 (± 0.95)	1.46 (± 0.72)	1.19 (± 0.43)	**1.41 (± 0.70)**
Ground cover (%)				
Earth	2.29 (± 0.92)	2.32 (± 1.03)	2.93 (± 1.02)	**2.51 (± 1.03)**
Rock	1.61 (± 0.89)	1.22 (± 0.60)	1.36 (± 0.72)	**1.39 (± 1.39)**
Litter	3.17 (± 0.94)	3.59 (± 1.03)	3.16 (± 1.09)	**3.32 (± 1.04)**
Sky visible >20 m (%)	3.65 (± 1.47)	4.41 (± 0.89)	4.84 (± 0.50)	**4.30 (± 1.14)**
Moisture indicators (% positive quadrats)				
Bole climbers	0.74 (± 0.44)	0.68 (± 0.50)	0.52 (± 0.47)	**0.65 (± 0.48)**
Ferns	0.55 (± 0.50)	0.20 (± 0.50)	0.47 (± 0.40)	**0.39 (± 0.49)**
Mosses	0.92 (± 0.26)	0.47 (± 0.47)	0.68 (± 0.26)	**0.68 (± 0.47)**
Epiphylls	0.85 (± 0.35)	0.63 (± 0.42)	0.77 (± 0.48)	**0.74 (± 0.43)**
Moisture index[6]	**3.08 (± 0.76)**	**2.00 (± 1.24)**	**2.45 (± 1.00)**	**2.48 (± 1.13)**

---

[6] The sum of the number of indicator species present in each quadrat (0 – 4)

Some significant differences existed between sites and are consistent with their disturbance classification (see Table 3.5). Tree basal area, density and height were significantly greater at Anoa and La Pago than Kakenauwe/Kawelli. Vegetation density at mid- and canopy level showed the same pattern. At ground level, however, this trend was reversed, most likely due to the more open canopy at Kakenauwe/Kawelli. Anoa and La Pago were more similar to each other than to Kakenauwe/Kawelli. Ground cover was characterised by a large percentage of rock at Anoa, leaf litter at La Pago and bare earth at Kakenauwe/Kawelli. Anoa and La Pago had significantly more moisture indicators than Kakenauwe/Kawelli. Although there are significant differences in the lithology, altitude and moisture levels (as indicated by the moisture indicator data collected) between sites, the main cause of these disparities in vegetation is likely to be different levels of anthropogenic disturbance due to accessibility. Transects at Anoa were considerably further from roads and villages than were those at La Pago, which in turn were further than Kakenauwe/Kawelli (see chapter 2, section 2.5.1 Figure 2.7 for map). This pattern was confirmed by personal observations; chainsaws were frequently heard at Kakenauwe/Kawelli, but never at the other sites. There was frequent evidence of recently felled trees such as trunks and discarded planks at Kakenauwe/Kawelli, but only occasional sightings at La Pago. Even near Anoa, although no timber extraction was observed, rattan and honey were both harvested, especially towards the fringe of the reserve.

Despite these differences between the sites the only relationship between macaque encounters and habitat was found for percentage of leaf litter cover, with a significant negative relationship (Williams 2004) (Figure 3.6). This may be an artefact of the problems associated with observing macaques in dense foliage, as fewer leaves on the ground may be indicative of fewer leaves in the trees, thereby making them easier to detect. That few habitat preferences could be identified supports the theory that these macaques are adaptable, generalist primates. However it should be noted that fruiting tree abundance and distribution were not recorded and these may have a greater influence on monkey distribution and abundance than more general characters of habitats.

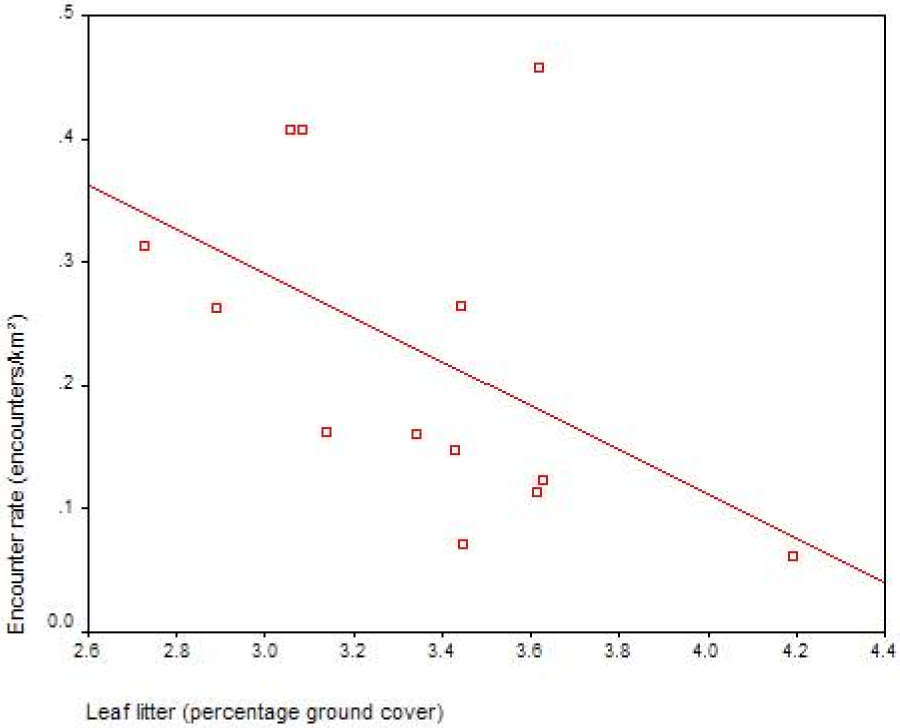


Figure 3.6 Graph of leaf litter ground cover against macaque encounter rate. Points represent individual transects. Percentage ground cover is given using the Braun-Blanquet scale (from Williams 2004)

3.6 BEHAVIOUR AND ECOLOGY OF THE BUTON MACAQUE

3.6.1 Diet

Macaques have been described as opportunistic frugivores (Chivers 1986). O'Brien *et al.* (1997) reported that the diet of *M. nigra* consisted mainly of fruit (66% of observed feeding bouts), with over 145 species being consumed. The diet of *M. nigra* has also been reported to include invertebrates, some vertebrate prey and vegetative material (Fooden 1969). In the first, short study (17 days) of the diet of the Buton macaque Kilner (2001) reported that the Buton macaque consumed mainly fruits (67% of observations) (particularly kapok, *Ceiba petandra*) and some insects and fungi. However a large amount of the foods consumed were cultivated crops (9.4% of observations). Crop-raiding occurred on 71% of study days, indicating the potential importance of farms as a food source. This was further confirmed by Cooper (2001), who reported that up to 60% of feeding time was spent on cultivated crops, with wild fruits (including kapok) forming 21% of feeding time and invertebrates 13% of time. He reported 31.5% of total observation time spent in farms versus the forest (N = 9173 observations over 31 days).

Andrews (2002), conducted a more detailed study of the diet and feeding behaviour of the Buton macaque, using all occurrence sampling of feeding behaviour. Fifty different food items were observed, consisting of 66% fruits (including crops), 20% stems and flowers, 12% leaves and 2% invertebrates. Cultivated crops made up 24% of the food items ingested (see appendix 6 for list of crops). The majority of food items were only identified by local names making direct comparison with other studies difficult. However the five species which made up the majority of the macaque diet were ‘white berry fig’ (20.6% of the feeding time), sweet potato (18.0%), cocoa (10.0%), bananas (9.8%) and kapok (9.7%). During the whole study period (22 days), over a third (37.75%) of feeding time was devoted to cultivated crops and crop-raiding occurred on 62.5% of observation days. Andrews concluded that the monkeys’ diet was diverse, having a Shannon-Weiner H’ index[7] of 1.17 across the study period (N = 2164 behavioural observations over 22 days). However, this is substantially lower than that found for *M. nigra* and *M. fascicularis.* An index of 1.91 was found in *M. fascicularis* (Yeager 1996). While dietary diversity for *M.*

---

[7] The Shannon-Weiner diversity function (Krebs 1972) is used to calculate species diversity in a number of contexts. The function used is: $H = ?\ (p_i)\ (\log_2 p_i)$ where: H = diversity index and p_i = proportion of total sample belonging to the i^{th} species. Shannon-Wiener makes no assumption about the shape of species abundance curves, is relatively independent of sample size, but is most sensitive to the abundance of rare species, and sensitive to species richness. Shannon’s index is also the most widely used. It does not, however, account for the dominant species in the sample, for which Simpsons Index is a better indicator (Magurran 1988).

nigra was found to be 1.914 – 2.293. Diets for both these species are considerably more diverse that that found for the Buton macaque although the low levels are likely to be due to the limited study period. Macaques are known to be opportunistic foragers and therefore a high dietary diversity is expected. A longer study period would probably reveal a higher dietary diversity.

The greatest proportion of feeding time was spent eating forest fruits (47.9%) with only slightly less time on cultivated fruits (42.5%) (if crop leaves and stems are included, cultivated crops make up 43.9% of feeding time). Thus 90.4% of the monkeys' feeding time was devoted to fruit. Representing well over 50% of total diet, Buton macaques can be considered highly frugivorous (see Caldecott 1986b; Lindburg 1976; O'Brien and Kinnaird 1997; Su and Lee 2001; Yeager 1996). The contribution of other plant matter to the diet for these monkeys is quite small in comparison to studies of other macaque species. Greater proportions of leaves, stem, shoots and flowers occur in macaque diets; for example, 36.4% for *M. cyclopis* (Su and Lee 2001); 26.1% for *M. fascicularis* (Yeager 1996), 12.2% for *M. nemestrina* (Caldecott 1986a). This high level of frugivory may be due to seasonality since studies took place at a time when forest fruits appeared abundant, or it may also be due to the dependence on cultivated crops. The amount of time feeding on invertebrates was similar to other macaques, e.g. 4.1% for *M. fascicularis* (Caldecott 1986a; Kilner 2001; Yeager 1996), and to other studies of the Buton macaque (Cooper 2001; Kilner 2001). Greater concentration on invertebrates in the diet has been found for *M. cyclopis* at 9.8% (Su and Lee 2001) with up to 31.5% for other Sulawesi macaques (Fooden 1969). Disparities may be due to differing habitats, seasons, study lengths and the availability of cultivated foods. It is difficult even to compare across the studies of the Buton macaque owing to their different lengths and study years. However, all studies on Buton macaques show a predominance of fruit in the diet and specifically a reliance on cultivated foods which affects the degree of frugivory. Although troops of forest interior Buton macaques undoubtedly exist (pers. obs.), none have been habituated as yet and thus no detailed feeding studies have taken place on troops who do not crop-raid.

3.6.2 Behaviour

Although only one preliminary study has been published (Kilner 2001) several behavioural studies have been conducted on the Buton macaques. However all were relatively short term (2 months or less). Of the Sulawesi macaques most studies have focused on the crested black Sulawesi macaque (*M. nigra).* This species is considered to be diurnal and semi-terrestrial (Reed *et al.* 1997), devoting the majority of daily activity budget to moving between and exploiting food resources that fluctuate temporally, and which are patchy and widely dispersed (O'Brien and Kinnaird 1997).

Table 3.8 Substrate use by the buton macaque. All studies were conducted with Operation Wallacea and were either supervised by or assisted by the author. Data have been reanalysed. Terrestrial included all observations on the ground and fallen logs.

Study	Troop	Group Size	Level of Crop-raiding	Percentage of time Terrestrial	Habitat Type
(Cooper 2001)	Kawelli	19	High	63	**Degraded forest/farmland**
(Kilner 2001)	Kawelli	17	High	40	
(Andrews 2002)	Kawelli	19	High	48	
(Carroll 2003)	Kawelli	20	High	67	
(Priston and Burnett, unpublished data 2002)	Kawelli	19	High	42	
(Priston and Kime, unpublished data 2004)	Kawelli	23	High	61	
(Priston and Taylor, unpublished data 2004)	Kawelli	23	High	56	
(Priston and Todd, unpublished data 2004)	Kawelli	23	High	57	

(Priston and Burnett, unpublished data 2004)	Kakenauwe	Unknown (23 +)	Moderate	51	**Secondary forest/some farmland and plantation**
(Carroll 2003)	Kakenauwe	36	Moderate	50	
(Priston and Kime, unpublished data 2004)	Kakenauwe	41	Moderate	48	
(Carroll 2003)	La Pago	40	None	1	**Disturbed forest one hour's walk into forest**
(Priston and Todd, unpublished data 2004)	La Pago	Unknown (13 +)	None	0	
Troop mean	Kawelli	20.4	High	54.3	**Degraded forest/farmland**
Troop mean	Kakenauwe	33.3+	Moderate	49.7	**Secondary forest in Reserve/some farmland and plantation**
Troop mean	La Pago	26.5+	None	0.5	**Disturbed forest one hour's walk into forest**
Overall Mean		**24.3+**		**44.9**	

Overall, Buton macaques spent similar amounts of time terrestrially and arboreally, with only slightly more time spent in the trees (55% time). This might suggest they could be classed, like *M. nigra* (Reed *et al.* 1997), as semi-terrestrial. However, substrate use varied markedly between sites and studies (Table 3.8). The La Pago troop, the forest interior troop living in continuous forest, was the most arboreal and rarely descended to the ground. This is consistent with O'Brien and Kinnaird's study (1997) of *M. nigra* which found them to be more arboreal in primary forest areas. The Kakenauwe troop divided its time approximately equally between the trees and the ground which might be expected in a secondary forest area subjected to logging. The Kakenauwe reserve site had smaller trees than La Pago (see Table 3.7). The Kawelli monkeys have been the most extensively studied and live in a forest-farm mosaic. They were the most terrestrial of the three study sites as expected of troops inhabiting such an environment (Onderdonk and Chapman 2000). Similar variation has been seen in *M. silenus* (Menon and Poirier 1996), who remain in the trees when in continuous forest, while in disturbed habitats they travel mostly on the ground. As in *M. silenus,* and despite being more terrestrial, the Kawelli macaques seemed to show a preference for staying off the ground and would jump across gaps in the canopy between trees wherever possible rather than descending to the ground. They would however, descend to the ground to raid crops in the farms and also to cross roads to reach both farms and kapok and assam trees when in fruit. They moved swiftly and alertly when on the ground and if disturbed returned to the forest or a vantage point such as a fence (pers. obs., Carroll 2003). These differences in substrate use among sites demonstrate the effect of habitat quality on the Buton macaque and also the ability to tolerate and adapt to degraded habitats. It also serves as a note of caution in assigning labels to species based on short-term studies; the Buton macaque could be classed as semi-arboreal, semi-terrestrial or fully arboreal, depending on the troop and site studied.

3.6.3 Activity Budgets

Habitat disturbance can cause animals to alter their activity patterns (Umapathy and Kumar 2000, chapter 6). Changes in ranging and home range size and possible reduction of food availability affect time devoted to travelling, foraging, feeding and consequently social activities (Johns and Skorupa 1987; Umapathy and Kumar 2000). Thus activity patterns can be used to indicate the tolerance of a species to habitat disturbance and forest fragmentation (Menon and Poirier 1996). The relations of activities to crop-raiding are presented in detail in chapter 6. Here I compare general non-crop raiding activity budgets of the macaques.

M. nigra has been shown to devote the majority of its daily activity budget to moving among and exploiting food resources that fluctuate temporally, are patchy and widely dispersed (O'Brien and Kinnaird 1997). *M. nigra* spends 23.6% of the day foraging and 22.5% travelling with a daily path length of approximately 2 km (O'Brien and Kinnaird 1997). As mentioned above, studies of the Buton macaque have been short-term, student-based undergraduate or Master’s projects over a number of years. Comparisons between them are difficult owing to variation in sampling methods. In order to generalise about activity budgets, the studies have been compared in Table 3.9. Although conducted over a period of five years, these reported studies used similar ethograms and age-sex classes and thus should be indicative of the time spent in major activities. All studies used instantaneous scan sampling with scans taken at intervals of: 20 minutes (Slater, unpublished data; Andrews 2002), 15 minutes (Priston and Burnett, unpublished data), 10 minutes (Carroll, 2003; Priston and Kime, unpublished data; Priston and Taylor, unpublished data; Priston and Todd, unpublished data), five minutes (Kilner 2001) and four minutes (Cooper 2001).

to each behaviour for each study. Data are modified from reports listed below. Values have been obtained from final reports or not collected by the author, all studies were assisted or directly supervised by the author.

Group Size	Percentage of time for each activity									
	Locomotion	**Resting**	**Foraging**	**Feeding**	**Self-grooming**	**Social-grooming**	**play**	**Vigilance**	**Agonism**	**Other (sexual)**
19	45	18	10	10	2.5	4	4	3	0.5	0.5
17	26.7	10	40.9		9.6	5.7	5.1	n/a	2.1	0.0
19	27.4	17.1	2.8	30.9	13.8		4.1	1.3	2.3	0.4
19	25.6	27.2	8.3	13.8	22.9		1.2	0	0.8	0.0
19	23.2	28.9	5.6	16.9	14.4		6.6	3.2	0.8	0.4
23	25.1	26.5	7.0	15.4	14.9		7.5	3.1	0.5	0.1
20	30.2	32.7	5.6	11.9	3.1	9.2	2.2	4.0	0.4	0.6
23	35.6	16.4	6.7	11.5	6.7	7.5	7.6	5.9	2.5	0.6
23	39.3	19.5	9.7	10.1	9.1	7.3	1.1	n/a	2.5	1.4
23	41.5	18.7	3.1	11.0	3.1	6.0	9.3	2.6	3.1	1.9
nknown (23+)	62.5	8.3	14.2	11.3	2.9		0.0	0.4	0.4	0.0
36	78.0	7.0	6.2	2.7	0.5	1.6	0.8	0.8	1.1	1.3
41	50.1	7.5	24.2	2.8	3.4	2.2	3.7	5.3	0.0	0.3
40	70.3	12.9	5.6	5.6	2.6	0	0	1.3	0.9	0.8
nknown (13+)	64.7	10.6	6.5	10.0	2.4	1.2	0.0	1.2	1.8	1.8
20.5	31.9	21.5	23.1		13.9		4.9	2.5	1.6	0.6
33.3+	63.5	7.6	20.4		3.5		1.5	2.2	0.5	0.5
26.5+	67.5	11.8	13.9		3.1		0	1.3	1.4	1.3
23.9+	**43.0**	**17.4**	**21.3**		**10.5**		**3.5**	**2.2**	**1.3**	**0.7**

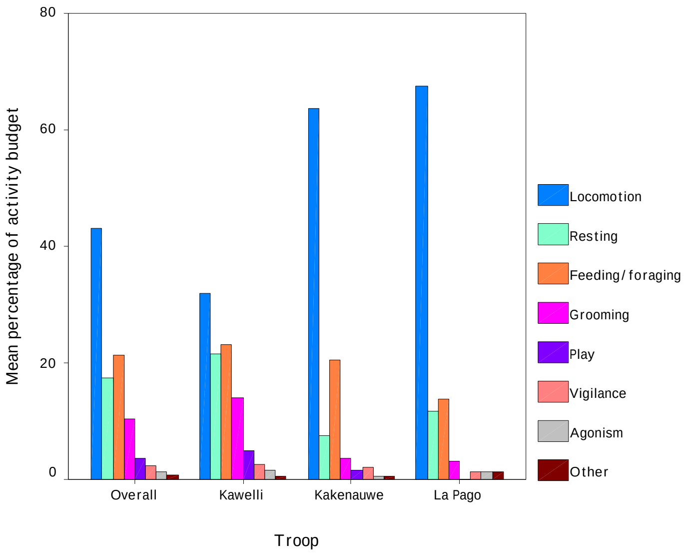


Figure 3.7 Mean percentage of activity budget devoted to each behaviour for the three study troops and for all studies combined

Overall, the Buton macaque devoted the majority of its activity budget to travelling between feeding sites and procuring food, followed by resting and grooming (Figure 3.7). These activity patterns are consistent with those of *M. nigra* (O'Brien and Kinnaird 1997) and attributed to the patchy distribution of food, particularly fruit, and a need to travel around a home range. Significantly more time was spent travelling and feeding and less time in social activities than might have been expected at random ($?^2$ = 38.95, df = 4, p << 0.001). A predominance of travelling, feeding and resting is also seen in other species of macaques, a selection of which are presented in Table 3.10.

Table 3.10 Percentage of time devoted to locomotion, feeding/foraging and resting by other species of macaques

Study	Species	Locomotion	Feeding/Foraging	Resting
(Wheatley 1980)	*M. fascicularis* (males only)	45	13	42
(Vello 1995)	*M. fasicularis*	33	33	Not specified
(Hanya 2004)	*M. fuscata*	16	38	32
(Teas ***et al.*** **1980)**	*M. mulatta*	25	27	8
(Vello 1995)	*M. mulatta*	10	45	Not specified

(Feeroz 1999)	*M. nemestrina leonina*	16.8	61.3	9.6
(O'Brien and Kinnaird 1997)	*M. nigra*	22	37	20
(Ménard and Vallet 1997)	*M. sylvanus*	21	30	5
(Vello 1995)	*M. radiata*	12	31	Not specified

The activity pattern is generally consistent across all three study areas and differences could potentially be explained by variability in crops (for the Kawelli site) and forest fruits (for the La Pago site). The Kawelli troop(s) spend far less time travelling ($?^2 = 13.96$, df = 2, $p << 0.001$), while resting ($?^2 = 7.47$, df = 2, $p = 0.02$) and social time (grooming ($?^2 = 11.05$, df = 2, $p = 0.003$) and play ($?^2 = 5.91$, df = 2, $p = 0.05$)) is greater than in other troops. These could be a result of their dependence on cultigens. The Kawelli troop(s) are the only ones to show significant levels of play, while none was witnessed in the La Pago troop. This may be as a result of differences in observation ability since the La Pago troop spent most time in the canopy and were thus harder to see; however both studies of this troop were consistent in showing no play. Thus a more plausible explanation may be that due to more widely dispersed food sources and a larger group size (see section 3.5.3 and Table 3.9) the group has to devote more time to travelling between feeding sites, reducing the time available for social activities. Alternatively the group may fission into smaller foraging sub-groups (see section 3.5.3). As noted in section 3.3 studies of other species have found that crop-raiding groups spend less time travelling and more time resting or being social than do groups subsisting on forest resources, for example *Papio anubis, Papio cynocephalus, Macaca mulatta, Macaca sylvanus* (Altmann and Muruthi 1988; Dunbar 1992; Strum 1994). Crops have high caloric content, are generally easily digestible (Forthman Quick and Demment 1988), abundant and concentrated, and, as mentioned, analogous to a mass fruiting event (Naughton Treves 1998b). Thus foraging efficiency is enhanced (Saj *et al.* 1999b) and nutritional requirements are met more quickly, leaving more time for social activities and resting**.**

Habitat quality has long been related to the balance among social and resting time (Altmann and Muruthi 1988; Bronikowski and Altmann 1996; Dunbar 1992; Lee 1983, 1984; Saj *et al.* 1999b). For example, in *M. sylvanus* Ménard and Vallet (1997) found that the group in better quality habitat (more resource rich) minimised feeding time and increased social time, whereas the group in the poorer habitat devoted more time to foraging and feeding. In the Sulawesi crested macaque, *M. nigra* (O'Brien and Kinnaird 1997) differences in amount of time spent socialising were attributed to food abundance and proportions of primary forest utilised (habitat quality). The group with the least primary forest travelled the farthest, ate less fruit and socialized less than did the groups who spent more time in better quality, primary forest. The Kawelli troop displayed a similar pattern to *M. nigra*, in terms of greater time spent socialising compared to the other troops. While for *M. nigra* troops this was taken to support the notion that *M. nigra* was intolerant of human disturbance (Rosenbaum *et al.* 1998), for the Buton macaque the opposite is clearly the case. In situations of human disturbance with encroachment of farmland the Buton macaque is able to exploit this abundant resource. The La Pago troops devoted a large proportion of their activity budget to travel, with very little time for social activities or resting. This is a response to poor habitat quality or food scarcity, where more time must be devoted to finding sufficient food to meet nutritional requirements (Dunbar 1992; Schoener 1971). As the habitat at La Pago was the least disturbed this suggests that food quality and abundance are low at La Pago**.** Although lacking the data to confirm food scarcity at La Pago ad hoc observations suggest fruiting trees were more widely dispersed, certainly more so than for the Kawelli troop, who incorporate crops heavily into their diet.

Thus food abundance and distribution appears the most important factor rather than level of disturbance per se.

In contrast to the crested macaque, the Buton macaque appears to cope quite well with human disturbance (in terms of farmland) where it can utilise cultigens. No effect was seen on population sizes outside compared to within the protected areas (although group sizes were smaller for Kawelli, see above). However no behavioural studies were conducted in primary rainforest. The least disturbed site was at La Pago, an hours walk into the forest. This is, however, subject to human activity and some illegal logging and it is thus a lightly disturbed habitat. Unlike the heavily disturbed habitat at Kawelli or Kakenauwe however, it has no farmland for the monkeys to utilise, which might explain the activity pattern seen. Group size and composition differences may also explain the variations between study troops for the Buton macaque. *M. nigra* spent more time travelling and foraging as group size increased (O'Brien and Kinnaird 1997) and the largest groups of the Buton macaque also spent the most time travelling.

3.6.4 Age-sex Differences

Sex differences in feeding and social activities can be expected if there are differences in factors affecting reproductive success. Males are expected to spend less time foraging, feeding and being social to conserve energy for activities which increase fitness or access to females, for example vigilance and mate guarding (Nakagawa 2000; Schoener 1971). This pattern may be especially relevant to the dominant male. Whereas for females (in female kin-bonded groups) access to resources is linked to reproductive success and maintenance of social bonds is key to securing those resources (Wrangham 1980). Thus more time is expected to be devoted to both feeding, to meet metabolic demands related to reproductive fitness (Altmann 1980; O'Brien and Kinnaird 1997), and to social activities such as grooming. This is characteristic of female-bonded groups, where males occupy a more peripheral social role than females (Cheney and Seyfarth 1990). Another explanation for the differences in feeding time may be due to priority access for males at feeding sites, therefore having higher quality, shorter feeding time compared to females (O'Brien and Kinnaird 1997; Post *et al.* 1980).

Differences in behaviour have been found among age-sex classes in activity patterns for both captive and wild groups of *M. nigra*. Adult males travelled more and foraged less than did adult females, who spent the most time socialising (Melfi and Feistner 2002; O'Brien and Kinnaird 1997). Chatani (2003) also reported that *M. fuscata* males spent less time feeding than females. Studies of the Buton macaque vary in their results. Cooper (2001) reports increased terrestriality with age, which could be a consequence of being larger and thus more likely to come to the ground than are the younger, smaller monkeys who can use the secondary shrub-like trees. Adult males spent less time feeding and foraging than did females and more time being vigilant and agonistic. Adult males also devoted less time to grooming than did females and were more often the recipient of grooming rather than the groomer. Andrews (2002) found however that adult males spent more time feeding and travelling than did females. Her results found support for males grooming less than females (10% less for males) and vigilance was much higher (12% compared to 2% for other age sexes). She also observed few instances of male aggression; in fact most instances were by females. Juveniles spent more time travelling than any other age-sex class, with just under 90% of their activity budget devoted to active behaviours rather than resting. However, overall daily activity patterns among age-sex classes did not differ significantly. A subsequent study (Carroll 2003) also found no significant difference between male and female activity budgets. However, females did spend slightly more time grooming than males, and males spent less time feeding than females. Preliminary data from recent studies supports the finding that juveniles devote the most time to locomotion; while adult males spend less time grooming and feeding than do adult females. A trend towards increased terrestriality with age was again found (Priston and Burnett, unpublished data, Priston and Kime, unpublished data, Priston and Taylor, unpublished data, Priston and Todd, unpublished data). Very high levels of aggression by the alpha male compared to other age-sex classes were found in one study, with over 40% of the male's activity budget devoted to aggressive interactions and very little time devoted to feeding, foraging and grooming (Priston and Burnett, unpublished data). In all studies of Buton macaques, juveniles engaged in play more than other age-sex classes did (Andrews 2002; Carroll 2003; Cooper 2001).

Variation in substrate use by different age-sex classes has been documented for a number of other species, for example *M. sylvanus* with individuals showing a trend towards increased terrestriality with age (Ménard and Vallet 1997). This is attributed to the increased energetic costs of climbing through the trees which would be even greater in the less agile, larger adults, especially males. Lack of predators may also influence this (Thierry *et al.* 1994) as the risks of staying on the ground are lower than the costs of expending energy to climb. The main predator on Buton is the reticulated python (*Python reticulatus*) (Figure 3.8) and pythons are known to take small monkeys (Grindley 2003). Since the reticulated python is an adept climber there would be no increased risk to being more terrestrial. Salt water crocodiles (*Cocodilus porosus*) are recorded on Buton (Howard, pers. comm.) and would undoubtedly take a macaque if given the chance, although the species are unlikely to come into contact frequently as crocodiles are restricted to estuaries and mangroves. Larger monitor lizards (*Varanus salivatori*) (Figure 3.9) are likely to opportunistically take small juveniles (Howard, pers. comm.). Sulawesi palm civets (*Macrogalidia musschenbroeki*) are reported as macaque predators on mainland Sulawesi (Whitten *et al.* 1988), however there are no formal reports of palm civets on Buton (despite unsubstantiated sightings).

Figure 3.8 Young (1.5m long) (a) and adult (over 4m long) (b) reticulated pythons found in the reserve

Figure 3.9 Monitor lizard. Very large individuals were sighted in the vicinity of farms in Kawelli and along river banks.

The larger eagles take monkeys and there are three large species on Buton that are potential predators: Sulawesi serpent eagle (*Spilornis rufipectus*), Sulawesi hawk eagle (*Spizaetus lanceolatus*) and white-bellied sea-eagle (*Haliaeetus leucogaster*) (Figure 3.10). The serpent eagle with a wingspan of approximately 100cm and a body weight of 500 – 1000g (White and Bruce 1986), is unlikely to attack anything larger than an infant macaque. The hawk eagle is slightly larger with a wingspan of 120cm+ and a probable weight of 1000g (White and Bruce 1986). Although there are no data for the Sulawesi hawk eagle, crowned hawk-eagles (*Stephanoaetus coronatus*) are thought to be the most powerful eagles on earth and able to tackle small mammals up to twice their body weight (Grambo 1999) and there are many reports of both crowned and mountain-hawk eagles (*Spizaetus nipalensis*) predating primates (see for example Cheney and Seyfarth 1990; Cooke *et al.* 2004; Daneel 1979; Iida 1999; Sanders and Mitani 2000). However these are substantially larger than the Sulawesi hawk eagle (crowned hawk eagle weight ± 3.8kg, wingspan 160 – 180, mountain hawk eagle, 1.8 – 3.5kg, wingspan 130 – 165cm (Grambo 1999). Predation on Buton macaques by eagles is likely to be rare or opportunistic on small, vulnerable infants. The largest likely avian predator is the sea-eagle (weight 2.1 – 3.4kg and wingspan 180 - 218 cm (White and Bruce 1986)) whose food includes mammals and has been recorded taking live rabbits and fruit bats (pers. obs., Kelly, pers. comm.). It is also known to be a klepto-parasite so, if any of the smaller eagles took a young macaque, it could easily steal it from them (Kelly, pers. comm.). However, like the crocodiles, these eagles tend to be restricted to coastal and estuarine habitats. Overall the most significant predator to the Buton macaque is likely to be the reticulated python, and while predation risk is relatively high, losses to predators can be assumed to be relatively low.

Figure 3.10 White-bellied sea eagle on a coconut palm near the coast (20 minute drive from the Kakenauwe reserve).

The male biased terrestrial substrate use and age-sex specific activity patterns reported here are consistent with those seen in *M. arctoides* (Bertrand 1969), *M. fuscata* (Chatani 2003), *M. mulatta* (Lindburg 1977; Post and Baulu 1978; Roonwal and Mohnot 1977; Southwick *et al.* 1965; Teas *et al.* 1980), *M. nigra*, (Melfi and Feistner 2002; O'Brien and Kinnaird 1997; Reed *et al.* 1997), *M. tonkeana* (Thierry *et al.* 1994) and *Papio cynocephalus* (Post *et al.* 1980).

High levels of vigilance in adult males are also seen in other macaque species, for example *M. arctoides* (Bertrand 1969), *M. mulatta* (Lindburg 1977; Post and Baulu 1978) and could be motivated by escape from dominant members of the group, protection of status within the group or directed outside the group to predators, other groups or human presence (Bertrand 1969; Teas *et al.* 1980). The large amount of time devoted to agonistic behaviours by the alpha male is considered a consequence of the 'control role' of high ranking males in macaque groups and consists mostly of non-contact chase or displays (see for example Bertrand 1969; Lindburg 1977; Roonwal and Mohnot 1977; Thierry *et al.* 1994). A relatively high frequency of agonistic behaviour, but lacking in intensity or severity is consistent with a linear dominance hierarchy (Reed *et al.* 1997), and a 'relaxed' dominance style with greater emphasis on group cohesion (social grooming), hence their designation as a fourth grade 'tolerant' species (Slater 2002; Thierry 2000).

For some species all ages take part in play regularly, for example *M. nemestrina* (Roonwal and Mohnot 1977), but other studies find that, as in the Buton macaque, juveniles account for the majority of play [for example *M. mulatta* (Post and Baulu 1978; Roonwal and Mohnot 1977; Southwick *et al.* 1965; Teas *et al.* 1980), *M. nigra* (Bernstein and Baker 1988; O'Brien and Kinnaird 1997), *M. arctoides* (Bertrand 1969), *M. radiata* (Roonwal and Mohnot 1977)]. In *M. nigra,* a reduction in other behaviours was seen with increased play suggesting that it was an important behaviour for juveniles, important enough to result in a reduction in feeding, foraging and resting time (O'Brien and Kinnaird 1997).

3.7 SUMMARY OF SOCIO-ECOLOGY

Although little published literature exists on the Buton macaque the series of short-term projects that have been conducted over the past five years enable some general conclusions to be drawn.

- The abundance of the Buton macaque does not differ significantly between protected and unprotected areas. Overall density is 14.9 macaque individuals/km^2. The total population within the Lambusango and Kakenauwe reserves is estimated at 3,752 monkeys and there could be up to ten thousand on Buton as a whole.

- Mean home range was only 0.62km^2 and mean group size was 32. The Kawelli (crop-raiding) troop had the smallest home range and group size which was somewhat unexpected, although this may be an anomaly owing to a poisoning event the previous year.

- The study sites differed in habitat but no preferences were found for undisturbed forest or croplands, suggesting the Buton macaque is relatively adaptable and able to cope with high levels of forest disturbance or alteration.

- All studies consistently found that fruit dominated the diet of the macaques, in addition to farm crops. Thus the Buton macaque could be considered frugivorous, although exploiting cultivated crops where available.

- The degree of terrestriality was habitat dependent and the macaques were most terrestrial in degraded habitats, while almost entirely arboreal in continuous forest. There was also a trend towards increased terrestriality with age in those troops which did descend to the ground.

- Differences were seen among the troops in activity budgets. The forest troop spent the most time travelling, while the crop-raiding troop devoted more time to grooming and resting.

- Some age-sex differences were noted. Adult males feed, rest and groom less than adult females, but engage in more agonistic and vigilance behaviours. Juveniles engage in play most frequently and account for almost all the groups' play budget.

CHAPTER 4 - FARM GEOGRAPHY, ECOLOGY AND CROP LOSS

This chapter explores the factors affecting crop-raiding by examining how measures of crop damage relate to the physical and ecological characteristics of farms. First I introduce the factors that have been shown to influence crop-raiding in other studies. I present the results of the exclosure plot study to provide estimates of offtake by monkeys in a controlled setting. I then go on to discuss the results of the vegetation transects in farms from the four study villages, linking measured damage to perceptions of damage, and finally I use multivariate tests to predict crop damage based on geographic and crop factors of a farm.

4.1 PHYSICAL FACTORS INFLUENCING RAIDING OF FARMS

4.1.1 Farm Factors

As mentioned in chapter 3, rainfall, season, crop variety and characteristics, wild-food availability, distance from forest, nearest farm or village, and farm protection methods all impact on raiding of farms (Biquand *et al.* 1992b; Gautier-Hion *et al.* 1985; Hill 2000; Horrocks and Baulu 1994; Lee *et al.* 1986; Maples *et al.* 1976; Mohnot 1971; Musau and Strum 1984; Naughton Treves 1998a). Distance to forest, farm size and levels of human activity (guarding) have been shown to be significant predictors of large vertebrate damage, both in frequency and amount of crop loss (Hill 1997; Maples *et al.* 1976; Naughton Treves 1996, 1998a; Saj *et al.* 2001). The frequency with which farmers experience crop damage is dependent on their proximity to the forest, due to a reluctance on the part of forest animals to venture far from the cover of trees, or to visit distant fields once they have satisfied their hunger foraging in fields closer to the forest (Cowlishaw and Dunbar 2000). Naughton Treves (1996) found that 90% of crop damage occurred within 200m of the forest boundary. With this in mind, it is likely that forest presence or the amount of forested perimeter will be related to the amount of raiding which a farm receives and this will be investigated in this chapter.

Natural borders hinder large vertebrates and specifically macaques from entering a farm. Rivers or streams can create a major obstacle and increase the costs of crop-raiding to the animal. While macaques are known to be adept swimmers (Smuts *et al.* 1987), a troop might not enter a farm where a stream cuts through the forest-edge boundary because of the added risk and effort. Females carrying infants expose the infant to drowning while attempting to cross a stream deeper than chest height. Roads increase risk for raiding primates; thus they may help protect a farm from raiding as an added obstacle between the farm and the forest. There is no evidence as yet that traffic noise is an effective deterrent to raiding primates, in fact in India groups of rhesus macaques have taken to living on roadsides (Southwick *et al.* 1961a). However, roads do indicate habitat disturbance, therefore although the presence of roads may not decrease crop-raiding in itself, roads do isolate forest patches which primates are less likely to inhabit (Cowlishaw and Dunbar 2000). However, in the short term raiding can increase due to such habitat loss.

Damage to fields by livestock is often comparable or even greater than that caused by wildlife (Naughton Treves 1996; Warren 2003) but is rarely complained about, potentially because of the perceived benefits of livestock as opposed to wildlife, and because compensation may be given by the owners of the livestock or the community. In this study livestock as a source of crop damage was only mentioned in three cases.

4.1.2 Crop Factors

The crop variety in a field will affect raiding patterns. Crockett and Wilson (1980) described pig-tailed macaques exhibiting a preference for sweet potato and maize in Sumatra. In studies of African agricultural areas (Hill 1997, 2000; Naughton Treves 1997, 1998a) and Buton (Priston 2001) farmers report heavy losses of maize and sweet potato due to non-human primate raiding. These are staple, subsistence food crops and, in some of these studies, are also the most abundant crop in the farms (Hill 1997; Saj *et al.* 2001). Thus it is possible that their loss assumes greater significance for farmers than does that of other crops (Hill 1997), although there are data to suggest such a preference by monkeys is real (Naughton Treves 1996). These are portable crops with high caloric returns for low harvest effort; cultivated maize has elevated protein content (12%) (Sukumar 1989) (see section 6.5.2 for a detailed discussion and appendix 6.2). Maize presence is a predictor of crop damage (Naughton Treves 1996, 1997, 1998a; Saj *et al.* 2001) and primates will raid maize regardless of abundance of forest foods (Naughton Treves 1997, 1998b). Ripening fields of maize attract primates and other wildlife (Conover 1994; Crockett and Wilson 1980; Else 1991; Maples *et al.* 1976; Naughton Treves 1998b).Bananas are also cited as a preferred crop by some raiding primates (Naughton Treves 1998b) while in other studies they are not touched (Hill 1997). This depends on the other available crops and individual preferences of the monkeys, making concrete predictions hard to give. Bananas and other crops are often used as 'fall-back' foods during times of wild-food scarcity .

Horrocks and Baulu (1994) found only a weak tendency for greater damage to crops with higher carbohydrate content. When accessibility to vervets is considered other patterns emerged. Damage to sub-soil crops was greatest in those for which fat and protein content was high, while for ground level crops it was those high in protein, carbohydrate and fat which suffered greatest damage. Tree crops suffered the most damage overall but damage bore no relationship to nutritional composition. They suggest monkeys are only selective in terms of nutritional content when maximising food returns per unit foraging time is critical e.g. due to predation risk or risk of being spotted by farmers.

Yellow, orange or red, softer-skinned fruits are preferred by primates (Gautier-Hion *et al.* 1985; Horrocks and Baulu 1994) suggesting that for certain crops physical characteristics may also govern choice as opposed to merely nutritional content. The proportion of simple sugars to other carbohydrate is likely to be important as simple sugars increase with ripeness, accompanying the skin and colour changes (Horrocks and Baulu 1994).

As raiding increases with proximity to forest boundaries crops closest to forest or to farm edge are most vulnerable. So clearly those crops most preferred by monkeys should be placed further away from these vulnerable areas, while crops that are less palatable e.g. chilli could utilise the forest edge zone. By doing this, farmers would increase macaques' perception of risk and tip the cost-benefit scale in favour of not raiding (Horrocks and Baulu 1994; Naughton Treves 1998b). Of course this is not always possible where plots are small and limited crop varieties are grown.

4.2 EXCLOSURE PLOTS

I present here the detailed methods and results of a pilot study on crop offtake. The results are then integrated into issues of crops grown, raiding frequency and perceptions. General methods associated with exclosure plots were presented in chapter 2, section 2.4.2.

A total of twelve $3m^2$ plots (Drake and Grande 2002) were placed in each of the two study farms; the control and raided farm (see chapter 2 section 2.4.2). This pilot exclosure study was designed to determine the yield of sweet potato, and to obtain a quantitative measure of the amount of sweet potato raided by monkeys and pigs. However it was important to also assess any effect on yields due to the plots themselves (control for plot effect).

Exclosures were designed to assess all large vertebrate damage, i.e. primates and pigs, thus they were designed so that rats and smaller pests had equal access to all plots. Plots were of three types:

1) Mesh plots – these were fenced and topped with mesh.

2) No-mesh plots – these were merely fenced and left open on top.

3) Open plots – these were staked out and represent controls for location.

The mesh used was two inch square and this was deemed sufficiently large to enable rats to enter by a rodent expert working in the region (Grimwood, pers. comm.). The mesh plots excluded both pigs and monkeys, while the no-mesh ones allowed monkeys entrance but not pigs. The open plot allowed both to enter. Mesh and no-mesh exclosures were constructed using planks of wood, stakes and nails. On advice of the IUCN's Pig, Peccary, and Hippo Specialist Group fences were built 1.5m high, to ensure pigs could not jump over them (Oliver and Vercammen, pers comm.). They were dug into the ground as far as possible to prevent pigs digging under (Figure 4.1), although in places the ground was too rocky for this.

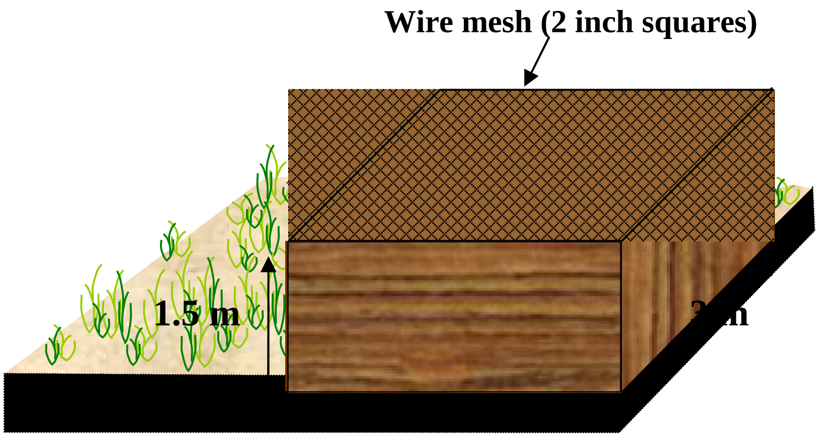


Figure 4.1 Diagram of mesh exclosure plot

The study was limited to one crop, sweet potato, in order to enable comparisons to be made between plots and because other crops were planted too thinly and randomly to fill an entire plot. Sweet potato was ideally suited as it is a ground cover plant, farmed over large areas of land.

Three of each of the mesh and no-mesh plots were set up randomly within the area of farm covered with sweet potato. Next to each of these a control or open plot was staked out, leaving a one metre gap between the plots. The direction that the control plot extended was selected at random. The purpose of placing plots together was to control for any differences in crop type across the field itself. When exclosures were constructed care was taken not to trample any crop within the exclosure and areas of similar density of plant were used (Figure 4.2)

Figure 4.2 Exclosure plots in control farm

This process was repeated on both farms. Exclosures were then left in the field for three months until the usual sweet potato harvest time. They were monitored weekly to ensure that they were still sound. At harvest, the plots were dug over by experienced local women under my supervision and all sweet potatoes were removed and counted. Plots were checked repeatedly to ensure all potatoes were removed. The total from each plot was also weighed using a 20kg spring balance and a plastic sack (Figure 4.3 and Figure 4.4).

Figure 4.3 Harvesting and counting the sweet potato harvest

Figure 4.4 Weighing the sweet potato harvest

4.2.1 Results

Open plots were sub-divided into those placed next to no-mesh and those next to mesh plots. For the raided farm the mean number of sweet potato per plot, weight of sweet potato per plot, number per m^2 and weight per m^2 differed significantly between plot types (Table 4.1). Open plots matched with no-mesh had significantly lower yields than no-mesh and mesh plots (Scheffe, $p < 0.03$) for all measures. Open plots matched with mesh plots had significantly lower weights of sweet potato and weight per m^2 (Scheffe, $p < 0.037$) compared to no-mesh and mesh plots. There was no significant difference between no-mesh and mesh plot yields, although mesh yields were typically higher.

Table 4.1 Mean yields of sweet potato for each plot type on the raided farm presented by total number, weight of yield and weight and number per square metre of exclosure. (Anova comparison, F, df = 3, 8, p)

Raided Farm	Open matched with no mesh	No-mesh	Open matched with mesh	Mesh	F	Sig. value
Number ± SD	36.33 ± 10.02	103.67 ± 26.63	55.00 ± 25.51	110.33 ± 13.05	9.71	**0.005**
Weight (kg) ± SD	1.17 ± 0.38	4.25 ± 1.56	1.33 ± 0.80	4.5 ± 0.66	10.50	**0.004**
Number per m^2 ± SD	4.04 ± 1.11	11.52 ± 2.96	6.11 ± 2.84	12.26 ± 1.45	9.71	**0.005**
Weight per m^2 (Kg/ m^2) ± SD	0.13 ± 0.04	0.47 ± 0.17	0.15 ± 0.09	0.50 ± 0.07	10.50	**0.004**

The amount of the sweet potato taken by large vertebrates can be estimated. Only monkeys had access to the no-mesh plots therefore all reduced yields can be attributed to them (it was assumed all other pests had an equal effect on all plots). Both pigs and monkeys had access to the open plots. Therefore subtracting open plot yields from no-mesh plots estimates pig damage and subtracting no-mesh yield from mesh yield provides an estimate of monkey damage. The mesh plots provide an estimate of potential yield with no large vertebrate damage (Table 4.2)

Table 4.2 Amount of damage attributable to large vertebrates from results of exclosure plots in the raided farm

MEAN	No Large Vertebrates	Amount damaged by Monkeys	Amount damaged by Monkeys and Pigs	Amount damaged by Pigs	Percentage damage by monkeys	Percentage damage by Pig
Number	110.33	6.66	19	12.4	34.7	65.3
Weight (kg)	4.5	0.25	2	1.75	12.5	87.5
Number per m^2	12.26	0.74	2.11	1.37	35.1	64.9
Weight per m^2 (Kg/ m^2)	0.50	0.03	0.22	0.19	12.6	86.4

Pigs appeared to cause more damage to sweet potato than did monkeys, being responsible for approximately 65% of number of sweet potato damaged compared to 35% by monkeys. Pigs were responsible for 87% of sweet potato damaged by weight compared to 13% for monkeys. Pigs may have been damaging the bigger tubers preferentially although this cannot yet be proved. It is likely that the damage attributed to monkeys is an under-estimate owing to reduced usage of the exclosure plots. Although monkeys were observed to forage within the fenced (no-mesh) plots it was almost a month before they seemed comfortable doing this. Thus more of the damage in the open plots is likely to be due to monkeys than pigs. Rao *et al.* (2002) demonstrated that wild boar and monkeys caused 50-60% of the total crop damage overall but that study was based on much larger plots covering a variety of crops and with many more large vertebrate pests. Since this was a pilot study applying this method specifically for monkeys, some design flaws were exposed. Exclosures need to be larger to reduce any inhibition on the part of the monkeys from entering them. An increase in replicates would also be advantageous, although this needs to be traded against larger size and financial cost.

It is also possible that the exclosures themselves were having an effect on the yields obtained. On the control farm, no significant differences were found between the plots for any of the measures, as was expected (Table 4.3). As expected a significant difference was found between the raided and control farms considering all plots (Table 4.4).

Table 4.3 Mean yields of sweet potato for each plot type on the control farm presented by total number, weight of yield and weight and number per square metre of exclosure (Anova comparisons, F, df = 3, 8, p).

Control Farm	Open matched with no mesh	Open matched with mesh	no-mesh	mesh	F	Sig. value
Number ± SD	131.0 ± 53.33	288.0 ± 144.11	127.67 ± 38.48	173.33 ± 96.03	1.964	0.198
Weight (kg) ± SD	7.25 ± 2.646	14.33 ± 8.383	6.08 ± 1.876	8.42 ± 5.393	1.469	0.294
Number per m^2 ± SD	14.56 ± 5.926	32.00 ± 16.012	14.19 ± 4.275	19.26 ± 10.670	1.964	0.198
Weight per m^2 (kg/ m^2) ± SD	0.81 ± 0.294	1.59 ± 0.931	0.68 ± 0.209	0.94 ± 5.993	1.469	0.294

Table 4.4 Differences between farms for overall sweet potato yields for all exclosures (t – test, df = 22, p)

MEAN	Control Farm	Raided Farm	t	Sig. value
Number ± SD	180.00 ± 104.09	76.33 ± 37.10	3.250	**0.006**
Weight (kg) ± SD	9.02 ± 5.566	2.81 ± 1.823	3.671	**0.003**
Number per m^2 ± SD	20.00 ± 11.565	8.48 ± 4.122	3.250	**0.006**
Weight per m^2 (kg/ m^2) ± SD	1.00 ± 0.619	0.31 ± 0.203	3.671	**0.003**

Generally yields from the control farm mesh plots were higher than those of the raided farm (Table 4.1 and Table 4.3). This may be due to differences in soil type. The raided farm was much rockier than the control farm. While it would have been preferable to choose farms with exactly the same terrain and soil type, the selected farms were matched for other attributes. Sweet potato yields in the absence of large vertebrate raiding can be expected to be 12.26 (mesh plot raided farm value) – 23.28 (open plot control farm value) sweet potato per metre square.

Since the control farm received little or no raiding (supported with regular observations of the farm and crop checks) one would expect the yields from the three plot types to be similar. However, the open plots had consistently higher yields than the fenced plots, and fenced plots more than mesh plots (Figure 4.5). This suggests that the exclosures themselves were having some effect on the yield of sweet potato. This may be due to shading or perhaps damage of the plants when the plots were constructed. As the mesh plots showed a greater effect than the no-mesh plots a shading effect seems most likely. It is possible that these plots happened to be on areas of crop with fewer tubers by chance, but as the pattern is consistent across the 12 plots, this seems unlikely.

The possible shading effect suggests that yields in the mesh and no-mesh plots in the raided farm should be slightly greater than observed, and thus damage attributed to large vertebrates is potentially greater than estimated.

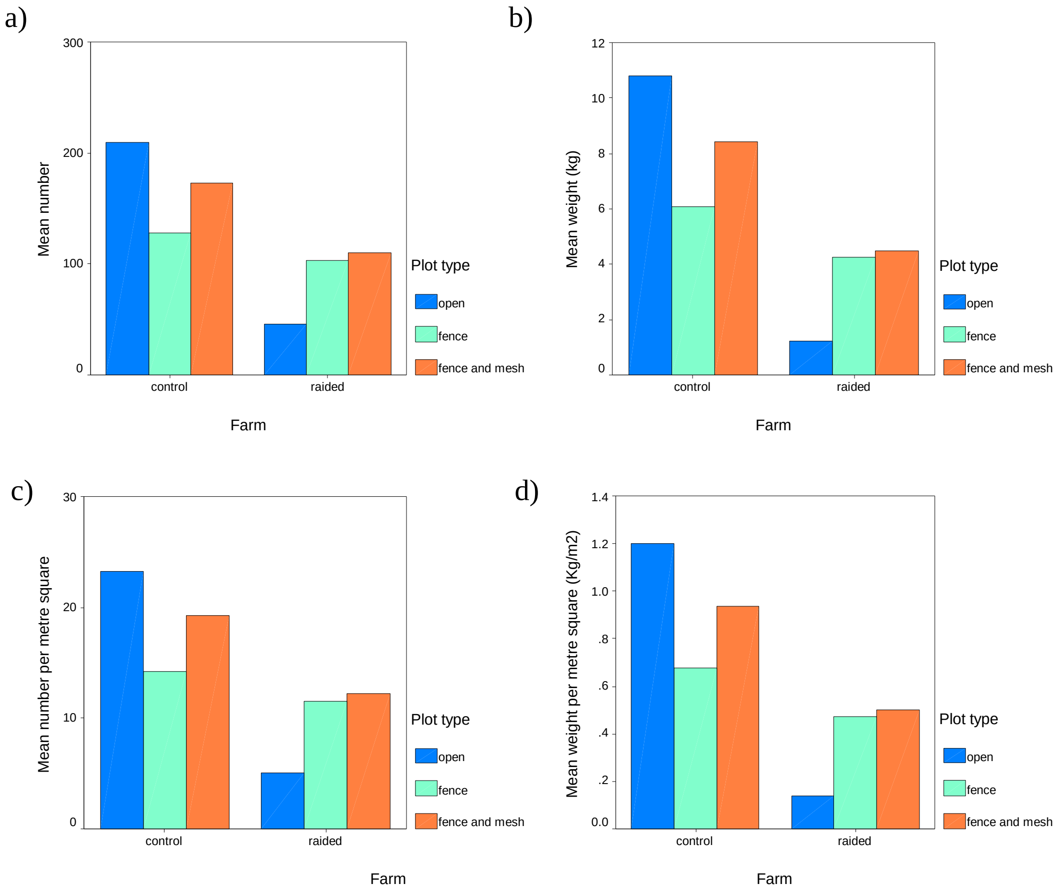


Figure 4.5 Sweet potato harvest for each plot type on the study farms (a) mean number, (b) weight (kg), (c) number per m^2 and (d) weight (kg) per m^2.

4.3 FARM TRANSECTS

4.3.1 Farm Surveys

Seventy three farms were surveyed for crop damage (see chapter 2). Each farm's GPS location was recorded using a handheld Garmin 12xl GPS. The distance to the forest and from the village was measured if close, or estimated to the nearest 50m. Crops present in the farm were recorded and the farmer was asked to direct us to any particularly serious patches of crop damage. Notes were taken of the severity, magnitude and location of these, although no systematic measurements were taken at that stage.

Initially, percentage damage was to be measured using a quadrat and grid system (Naughton Treves 1996). It became clear that this technique was too time consuming and did not give enough scope to score the severity of the damage for such a variety of crops without reducing the sample size so as to make analysis impossible. It was not possible to sample specific stands of crops (Hill 2000) owing to the heterogeneous planting arrangement in the fields. Thus new methods were developed. Farms were stratified into three zones based on proximity to forest. Three transects (10 x 2m (Hill 2000)) 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 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 (Hone 1994) 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:

U – Unavailable to primates as a 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 $1m^2$ 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 m^2 and also extrapolated to provide estimates for the whole farm.

Familiarity with crop damage by these primates since 1999 enabled me to identify primate damage as opposed to that from other animals. Pig damage was easily discernable owing to the size and scale of the damage and footprints left in the soil. Primate damage tended to be less destructive; finger marks could often be seen in the soil where they had been digging and discarded sweet potato skin, maize cobs, fruit and leaves often showed distinctive bite marks. Rat damage was much smaller, although there may have been some confusion of squirrel and rat damage to cocoa pods.

4.3.2 Perceived vs. Measured Damage

Farmers were asked for their estimates of damage by monkeys, both at the time of interview and also an estimate for total loss over the previous 12 months. These estimates were usually worked out with the farmers, using visual aids if necessary, until they came to an agreed estimate that they felt represented their opinions. For those who were not numerate it was important to talk through all these questions to achieve the greatest accuracy of answers, although care was taken not to suggest answers to respondents, if they were unable to produce an estimate. Maps and plans would be drawn of the farm to aid estimation.

Farmers' estimates of present percentage damage (related to the current growing season) and damage over the entire last year (annual damage) were log transformed, as was the percentage damage of available monkey foods from the transects, to normalise the data.

Table 4.5 Mean (± SD), max and min values for perceived present percentage damage, perceived annual damage, measured percentage of damage to available foods and measured percentage damage of all plants

	Total Mean	Max	Min
Perceived Present % Damage	15.36 ± 23.56	90	0
Perceived Annual % Damage	21.80 ± 25.17	95	0
Measured % damage of available foods	10.35 ± 14.61	70	0
Measured % damage of all plants	7.34 ± 12.30	60.57	0

Table 4.6 Pearson's correlation coefficients of perceived present damage, perceived annual damage, measured damage of available monkey foods and measured damage of total plants. (significant at the 0.01 level)**

(all N = 69)	Damage perceived - now	Damage perceived - annual	Measured damage – all plants
Measured damage – available monkey foods	0.533 **	0.589 **	0.864 **
Measured Damage – all plants	0.569 **	0.615 **	
Damage perceived - annual	0.644 **		

Perceived present damage, annual damage, measured damage of available monkey foods and total plants were all found to correlate positively (Table 4.6). From this relationship unstandardised residual values were created, such that a high relative perceived damage was greater than predicted for actual damage, and vice versa. Although significant, the relationships between measured damage and perceived present damage or annual damage are only weakly linear (Figure 4.6) as individuals reported much damage but had none. Therefore, to investigate this further, measured damage was grouped into three categories of low (0 – 20%), medium (20 – 40%) and high (> 40%) based on the frequency distribution. When relative perceived damage is plotted against this categorised variable of measured damage (Figure 4.7) it can be seen that this relationship is not straightforward. Those farmers experiencing low levels of damage were less accurate at estimating damage, whereas those experiencing medium or high levels were more accurate and even gave under-estimates.

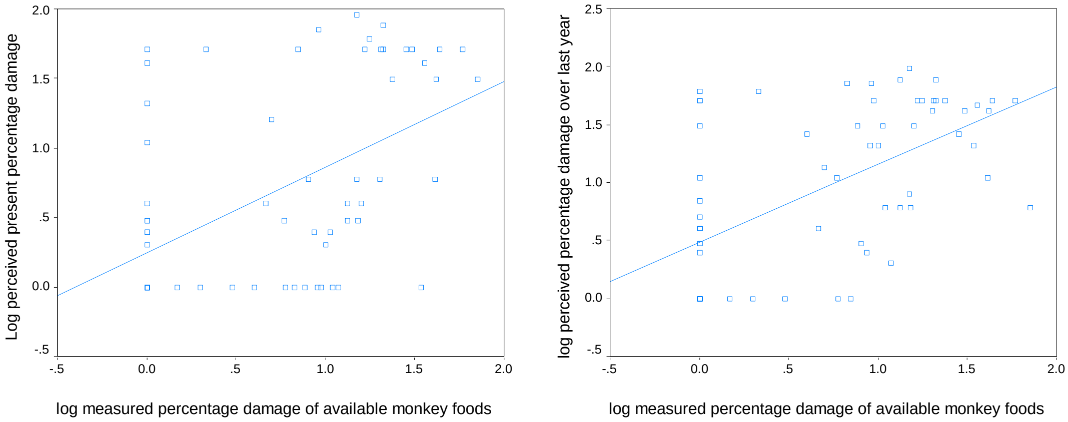


Figure 4.6 Measured percentage damage of available foods plotted against perceived present damage and damage over the last year (least squares regression line added to indicate positive trend).

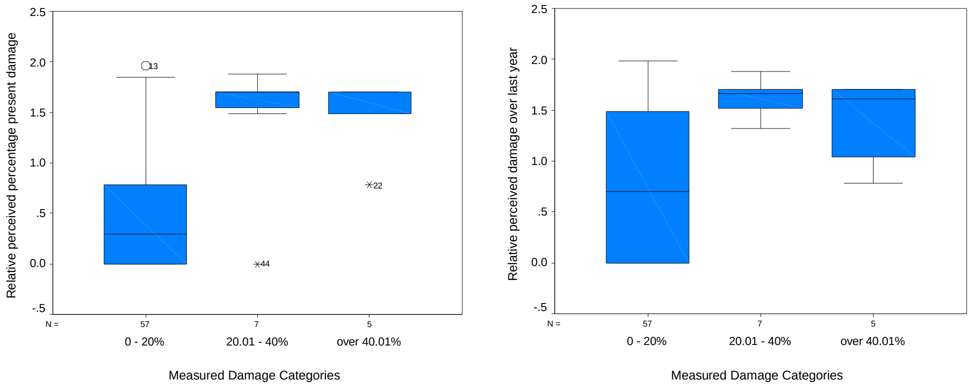


Figure 4.7 Relative perceived present and annual damage (median, Inter-quartile range and 95% confidence limits, using residuals) for measured damage categories of low, medium and high

Many factors influence perceptions of damage and these are discussed in chapter 5.

4.3.3 Distance From Farm to Forest

Distance to forest (log-transformed for normalisation) correlated negatively with distance to village (r = - 0.251, N = 69, p < 0.037), perceived present damage (r = - 0.265, N = 69, p < 0.028), percentage annual damage (r = - 0.389, N = 69, p< 0.001), measured damage of available monkey foods (r = -0.376, N = 69, p < 0.001) and measured damage of all plants (r = - 0.518, N = 69, p < 0.001). Distance to village was unrelated to any damage measures or perceptions. Although these correlations are significant, there is considerable scatter both above and below the trend lines (Figure 4.8) indicating that there are likely to be many other factors also influencing damage and perceptions (see section 4.4).

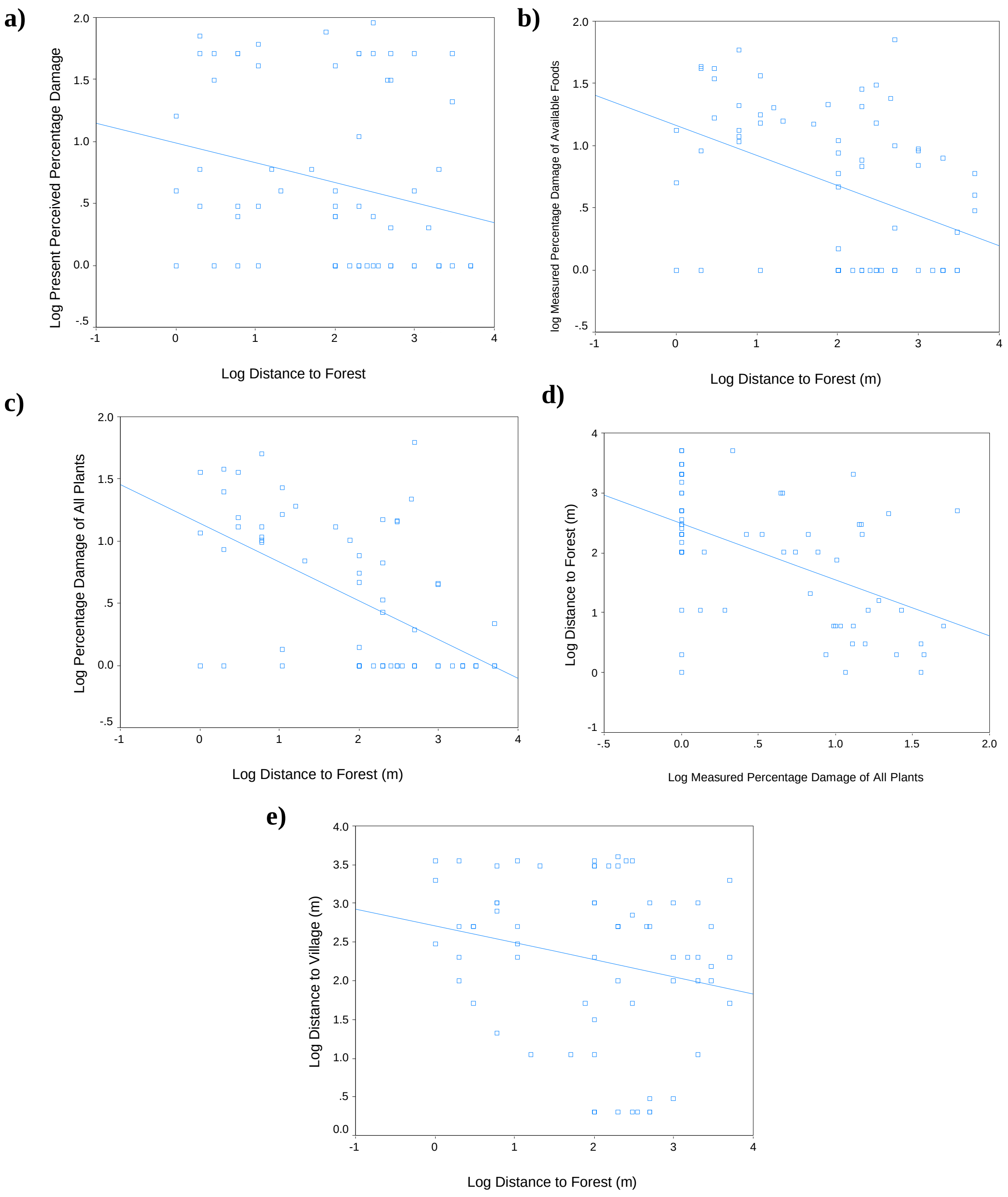


Figure 4.8 Distance to forest plotted against present perceived damage (a), perceived damage over last year (b), measured damage of available monkey foods (c), measured damage of all plants (d) and distance to village (e). (least squares regression line added to indicate trend).

Distance from forest was categorised into near, average and far based on the three modal peaks of the distribution. Near to forest included all farms 100m or less from forest, average distance to forest was 101 – 500m, and over 500m was considered far. This categorisation also took into account the behaviour of the macaques. Although 100m is a substantial distance to cross, if there was scrub or some sort of cover, or even another farm this was a feasible distance for macaques to travel out of the forest especially as they were happy to travel on the ground (pers. obs.). Distance to village was similarly categorised into near (100m or less), average (101m – 1000m), far (over 1000 m), again based on the sample distribution.

Table 4.7 Perceived and measured percentage damage for each distance to forest and village category (Anova comparisons F, df = 2, 68, p significant at the 0.01 level, * significant at the 0.05 level)**

	Distance to Forest					Distance to Village				
Mean ± SD	**Near < 100m**	**Average 101 – 500m**	**Far > 501m**	**F**	**Sig. value**	**Near < 100m**	**Average 101 – 1000m**	**Far > 1001m**	**F**	**Sig. value**
Perceived Present % Damage	15.99 ± 24.09	19.26 ± 26.28	8.60 ± 17.58	1.07	0.349	11.70 ± 23.90	24.41 ± 25.28	5.25 ± 12.66	4.09	**0.021***
Perceived Annual % Damage	24.18 ± 24.89	24.98 ± 28.90	12.13 ± 18.39	2.22	0.116	17.04 ± 27.23	34.82 ± 23.55	6.47 ± 9.03	9.34	**<< 0.001****
Measured % damage of available foods	14.19 ± 15.03	9.80 ± 16.97	2.69 ± 3.27	4.39	**0.016***	10.02 ± 17.16	13.03 ± 14.90	6.19 ± 8.02	1.79	0.176
Measured % damage of all plants	11.08 ± 12.78	6.33 ± 13.90	0.54 ± 1.24	8.83	**<<0.001****	7.78 ± 14.16	8.83 ± 12.18	4.05 ± 9.03	1.55	0.221

Interestingly, distance to forest was related to measured damage, both to available foods and all plants, while distance to village was only related to perceived damage, both present and annual (Table 4.7). These effects are most pronounced between near and far categories of distance to forest (Tamhane, p < 0.029), while for perceptions of annual damage, average differed from both near and far categories (Scheffe, near – average p < 0.003, average – far p < 0.002). For perceived present damage, differences were seen between average and far categories only (Tamhane, p < 0.002). Thus it appears that perceptions of damage are more likely to be associated with human activities, such as access to and from villages, while damage itself is a function of monkey behaviour with respect to distance from forest refuges.

4.3.4 Farm Transect Results in Relation to Distance from Forest

Above (section 4.3.3), damage was considered at farm level. Here damage is examined at transect level to explore within farm effects, such as edge effects. Transect distance from the edge of the farm (the closest edge to forest) was log-transformed to normalise it and categorised as near (less than 10m from farm edge), average (10.01 – 30m) and far (over 30.01m) based on three modal peaks of the distribution (Table 4.8). Using the categories for overall farm distance from forest (near, average and far) the percentage damage for each group of transects was compared.

Table 4.8 Mean (± SD) for measured damage of available monkey foods, all plants, damage per metre, pig and monkey damage score for each category of transect distance from farm edge

	Distance of Transect to Farm Edge		
Mean	**Near < 10m**	**Average 10.01 – 30m**	**Far > 30m**
Measured % damage of available foods	17.89 ± 37.58	6.26 ± 16.88	5.40 ± 16.28
Measured % damage of all plants	21.53 ± 40.28	7.97 ± 18.70	6.61 ± 17.74
Number plants damaged per metre	0.10 ± 0.20	0.04 ± 0.10	0.03 ± 0.10
Total monkey damage Score	7.04 ± 16.48	1.78 ± 5.81	1.00 ± 3.66
Total Pig Damage Score	0.88 ± 3.04	0.63 ± 2.18	0.39 ± 1.27

In order to assess the effect of both distance from forest of farm and distance of transect from farm edge, a multiple regression was used. However, since the variables are categorical, dummy variables were first created for both distance from forest (DCATF) and distance of transect from farm edge (DTRAN). These were then entered into a multiple regression analysis using the ‘Method=Tests’ model, this allows all dummy variables for one variable i.e. three categories of distance from forest, DCATF1, 2 and 3, to be grouped together and entered at once. A stepwise regression cannot be performed as it could split up the dummy variables which would create meaningless results. Therefore the block method must be employed and all variations of the model tested to discover which has the highest R^2 change.

Distance from forest was entered in block 1 and transect distance from farm edge in block two in model 1. This was reversed for model 2 and the R^2 change values compared. This procedure was carried out for percentage damage of available monkey foods, percentage damage of total plants, number plants damaged per metre, total monkey damage score and total pig damage score[1].

---

[1] Each plant within a transect was scored for severity of damage from 0 – 5 (see section 4.3.1) for pig or monkey damage. Thus for each transect a total score can be calculated for pig damage and monkey damage whereby a greater score indicates increased severity of damage by that animal for that particular transect.

Table 4.9 Mean (± SD) percentage damage of available monkey foods, total plants, number plants damaged per metre, monkey damage score and pig damage score damage for each category of transect distance from farm edge within each band of distance from forest (Near, Average and Far) (sample sizes are in brackets after the SD).

Distance of Farm from Forest	**Near < 100m**			**Average 101 – 500m**			**Far > 501m**		
Distance of transect from farm edge	**Near < 10m**	**Average 10.01 – 30m**	**Far > 30m**	**Near < 10m**	**Average 10.01 – 30m**	**Far > 30m**	**Near < 10m**	**Average 10.01 – 30m**	**Far > 30m**
Measured % damage of available foods	28.40 ± 46.80 (103)	7.88 ± 17.03 (108)	5.07 ± 14.01 (79)	8.01 ± 19.72 (64)	6.39 ± 20.08 (72)	10.85 ± 24.45 (45)	1.78 ± 6.55 (28)	1.41 ± 5.08 (38)	0.40 ± 1.88 (44)
Measured % damage of all plants	32.14 ± 48.58 (91)	9.78 ±18.49 (87)	5.71 ± 14.67 (71)	10.26 ± 21.82 (50)	8.52 ± 22.83 (54)	16.84 ± 28.90 (29)	2.38 ± 7.52 (21)	1.78 ± 5.68 (30)	0.46 ± 2.02 (38)
Number plants damaged per metre	0.16 ± 0.24 (103)	0.05 ± 0.13 (108)	0.02 ± 0.18 (79)	0.05 ± 0.13 (64)	0.02 ± 0.06 (72)	0.07 ± 0.17 (45)	0.01 ± 0.02 (28)	0.01 ± 0.03 (39)	0.03 ± 0.02 (44)
Total monkey damage Score	11.87 ± 20.73 (103)	2.60 ± 7.41 (108)	0.62 ± 1.94 (79)	3.05 ± 8.07 (64)	1.35 ± 4.16 (71)	2.48 ± 6.34 (45)	0.25 ± 1.14 (28)	0.30 ± 1.36 (39)	0.16 ± 0.80 (44)
Total Pig Damage Score	5.95 ± 16.44 (103)	3.70 ± 11.64 (108)	1.82 ± 5.09 (79)	1.98 ± 5.61 (64)	2.18 ± 6.09 (72)	2.46 ± 5.74 (45)	1.11 ± 4.03 (28)	0.74 ± 3.02 (39)	0.72 ± 3.16 (44)

There is a decrease in mean percentage damage of available monkey foods, total plants and number damaged per metre as distance from forest increases, and a similar pattern is observed for transect distance from farm edge. Transects near the farm edge in farms near the forest suffer the greatest damage (Table 4.9). Model 1 was the best predictor of these variables (Table 4.10); distance to forest entered first, followed by transect distance to farm edge. For general measures of damage, distance of farm from forest was a more important predictor than was crop location within the farm. For farms 101 – 500m from the forest, the transects furthest from the farm edge showed greater levels of damage than did the transects nearer to the farm edge (Table 4.9). This may be due to a smaller sample size for that category, or to other confounding factors such as crop variety in those farms and the distribution of certain crops within and among farms, or to the influence of neighbouring farms or plantations. It is possible that, despite a farm being 101 – 500m from the forest, there could be farms and plantations which act as a refuge for the monkeys between farms experiencing damage and the forest. Overall, only small percentages of the variance (< 13.5%) in damage measures are accounted for by forest and transect distance. There are undoubtedly other factors influencing damage levels.

Table 4.10 Comparison of two linear regression models testing distance from forest (df = 2) and transect distance from farm edge (df = 2) as predictors of percentage damage of monkey foods, total plants, plants damaged per metre, monkey and pig damage scores (excluding and including zero scores) (N = 581 unless otherwise indicated) (significant at the 0.01 level,* significant at the 0.05 level)**

	Model 1 – distance from forest entered first				Model 2 – Distance from transect to edge of farm entered first				Chosen Model
	Adjusted R^2	R^2 Change	F change	Sig. value	Adjusted R^2	R^2 Change	F change	Sig. value	
Damage to available foods (%)	12.4%	0.059	19.39	0.73 x 10^{-8}**	12.4%	0.056	18.45	0.17 x 10^{-7} **	**Model 1**
Damage to all plants (%)	13.4%	0.068	18.51	0.18 x 10^{-7}**	13.4%	0.060	16.19	0.16 x 10^{-6} **	**Model 1**
No. plants per metre damaged	8.7%	0.049	15.65	0.24 x 10^{-6} **	8.7%	0.037	11.72	0.10 x 10^{-4} **	**Model 1**
Monkey damage score (excluding 0 scores) N = 141	9.8%	0.085	6.61	0.002 **	9.8%	0.026	1.98	0.14	**Model 1**
Monkey damage score (including 0 scores)	13.4%	0.077	25.73	<<0.1 x 10^{-8} **	13.4%	0.054	17.93	0.28 x 10^{-7} **	**Model 1**
Pig damage score (excluding 0 scores) N = 98	11.9%	0.010	0.54	0.58	11.9%	0.130	7.14	0.001**	**Model 2**
Pig damage score (including 0 scores)	1.1%	0.004	1.04	0.353	1.1%	0.012	3.64	0.026*	**Model 2**

The total monkey and pig damage scores did not follow a normal distribution even after being log-transformed, due to a high number of zero scores. In effect there were two distributions, one where no damage was detected and one where damage was detected and it varied in severity. When all zero scores were excluded, the logged data for both variables followed a normal distribution. As it is the relationship between severity of damage and distance from farm/forest edge which was of interest this data set was used for the analysis.

For total monkey damage score (excluding zero scores) once again model 1 produced the greatest R^2 change. However within this model, distance from forest was only close to significance ($F = 2.80$, df = 2, 138, $p = 0.064$). This is due to the exclusion of zero scores representing farms further from the forest; examination of the raw data confirms this. The same analysis was run including zero scores[2], once again producing the greatest R^2 for model 1 with distance from forest being highly significant ($F = 19.65$, df = 2, 578, $p << 0.0001$) followed by distance from transect to farm edge ($F = 19.65$, df = 2, 578, $p << 0.0001$). There is a decrease in monkey damage score as distance from forest and transect distance from farm edge both increase.

For total pig damage, again excluding zero scores, model 2 produced the greatest R^2 change. As distance from the forest increases, severity of pig damage decreases (Table 4.10). The same pattern is seen when the zero scores are included. These results suggests that once a pig makes it onto a farm the damage will be of a similar severity across the whole area, not just close to the farm edge, whereas for monkeys, the most severe damage

---

[2] This was done for comparison despite the fact that the distribution was not normal. The results must therefore be viewed with extreme caution.

is found close to the farm edge. This may be due to the fact that pigs forage at night when the farm is unguarded and they cannot be seen.

Pig and monkey damage were correlated when zero scores are included (r = 0.303, N = 581, p << 0.001), although when they are excluded this is no longer significant (r = 0.201, N = 191, p = 0.171). Farms with no monkey damage tended to have no pig damage (p << 0.001, Fisher's exact).

Regression explores severity of damage – here I look at overall occurrence. Total monkey and pig damage scores were recoded as present or absent to see if there were significant differences between farms with distance from forest, and for transects with distance from farm edge using Chi Square tests.

Presence or absence of monkey damage is significantly related to the distance of the farm from the forest (?^{2} = 37.19, df = 2, p << 0.001). Damage is present in more farms near to the forest than for those average distances or far from the forest (Table 4.11 and Figure 4.9a). Thus monkey damage is more likely to occur in farms closer to the forest.

Table 4.11 Crosstabulation for presence of monkey damage against distance of farm to forest

		Distance to Forest			**Total**
		Near <100m	Average 101 – 500m	Far > 501m	
Monkey damage absent	Observed	191	145	104	**440**
	Expected	219.6	136.3	84.1	
Monkey Damage present	Observed	99	35	7	**141**
	Expected	70.4	43.7	26.9	
Total	Observed	**290**	**180**	**111**	**581**

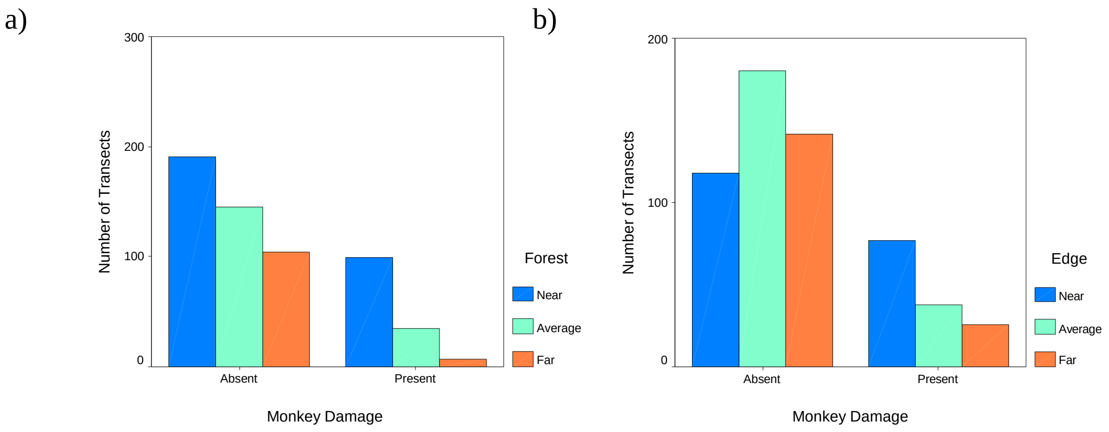


Figure 4.9 (a) Number of transects with or without monkey damage at varying distances of the farm from the forest and (b) Number of transects with or without monkey damage at varying distances from the farm edge.

Presence or absence of monkey damage is also significantly related to distance of transect to farm edge (?^{2} = 37.19, df = 2, p << 0.001). A higher than expected number of transects in the near category show monkey damage (Table 4.12 and Figure 4.9b) while distant transects are less likely to show damage. There is a within-farm edge effect, with those crops closer to the farm-edge experiencing more damage.

Table 4.12 Crosstabulation for presence of monkey damage against distance of transect to farm edge.

		Distance of transect to farm edge			**Total**
		Near <10m	Average 10.01 – 30m	Far > 30m	
Monkey damage absent	Observed	118	180	142	**440**
	Expected	147.7	165.1	127.2	
Monkey Damage present	Observed	77	38	26	**141**
	Expected	47.3	52.9	40.8	
Total	Observed	**195**	**218**	**168**	**581**

Presence or absence of pig damage is also related to the distance of the farm from the forest (?^{2} = 6.31, df = 2, p = 0.043), however it is only just significant. There are slightly more transects than expected with damage in the near and average distance of farm to forest categories, and slightly less than expected in the far category (Table 4.13 and Figure

4.10a), but these values are quite close. Only in the far category are differences between observed and expected numbers seen. Farms within 500m of the forest experience more damage from pigs but the effect is more uniform across farms regardless of distance to forest. It is interesting to note that the number of transects exhibiting pig damage (N = 98) is fewer than those with monkey damage (N = 141).

Table 4.13 Crosstabulation for presence of pig damage against distance of farm to forest.

		Distance to forest			**Total**
		Near <100m	Average 101 – 500m	Far > 501m	
Pig damage absent	Observed	238	145	101	**484**
	Expected	241.2	150.5	92.3	
Pig damage present	Observed	52	36	10	**98**
	Expected	48.8	30.5	18.7	
Total	Observed	**290**	**181**	**111**	**582**

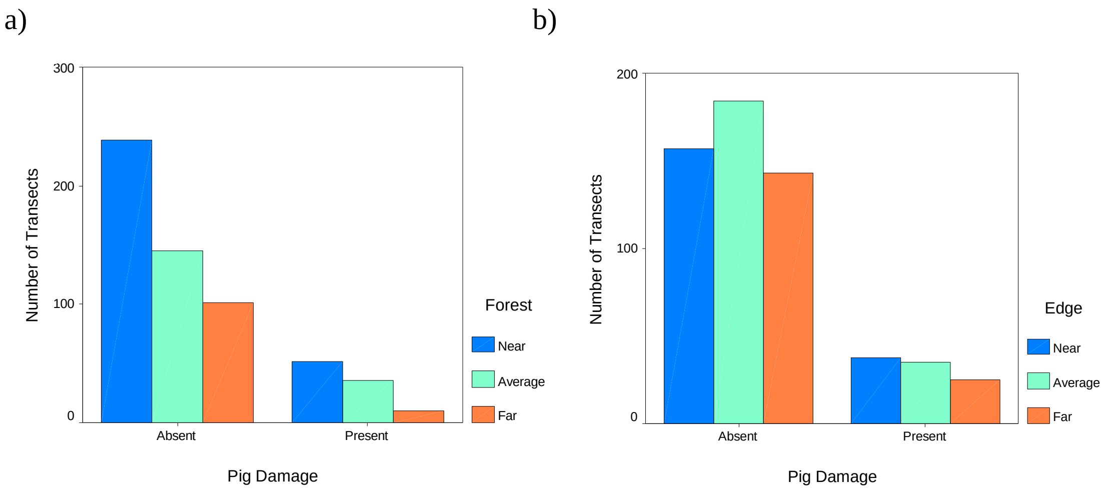


Figure 4.10 (a) Number of transects with or without pig damage at varying distances of the farm from the forest and (b) Number of transects with or without pig damage at varying distances from the farm edge.

Presence or absence of pig damage is not significantly related to distance of transect to farm edge ($?^2$ = 1.55, df = 2, p = 0.46) (Table 4.14). This suggests that within farms pig damage is more uniformly spread across the farm. Of course this does not take into account the severity of such damage (discussed above).

Table 4.14 Crosstabulation for presence of pig damage against distance of transect to farm edge

		Distance of transect to farm edge			Total
		Near <10m	Average 10.01 – 30m	Far > 30m	
Pig damage absent	Observed	157	184	143	**484**
	Expected	162.2	182.1	139.7	
Pig damage present	Observed	38	35	25	**98**
	Expected	32.8	36.9	28.3	
Total	Observed	**195**	**219**	**168**	**582**

4.3.5 Crop Type and the Amount of Damage

For each transect the crop with the highest number of plants **available to monkeys** (e.g. ripe fruit) was considered to be the main crop for that transect. There were 21 main crops in the transects from the 73 farms sampled, these were then grouped such that any crop type with a sample size less than 10 was categorised into 'other', *sawi* and *bayam* were grouped together with other green-leaved vegetables as 'vegetables' (Table 4.15).

Table 4.15 Numbers of transects for each main crop type before and after re-coding

Main Crop in Transect	Number of transects	Category after re-coding (12 categories)	Number of transects for that Category
Cassava	40	**Cassava**	40
Taro	14	**Taro**	14
Sweet Potato	127	**Sweet Potato**	127
Papaya	7	**Other**	40
Peanut	4	**Other**	40
Maize	46	**Maize**	46
Sugar Cane	9	**Other**	40
Chilli	21	**Chilli**	21
Pumpkin	3	**Other**	40
Cocoa	97	**Cocoa**	97
Banana	33	**Banana**	33
Dry Rice	1	**Other**	40
Wet Rice	4	**Other**	40
Green Bean	4	**Other**	40
Long Bean	4	**Other**	40
Unspecified Vegetables	8	**Vegetables**	13
Tomato	4	**Other**	40
Aubergine	11	**Aubergine**	11
Coconut	26	**Coconut**	26
Sawi	3	**Vegetables**	13
Bayam	2	**Vegetables**	13
No available foods	114	**No available foods**	114
Total Number transects	**586**		**586**

Sweet potato is the most numerous of those plants which are available to monkeys, and cocoa is also present in large numbers. Cassava, maize, banana and coconut are present in reasonable numbers while the other crops are less numerous. One hundred and fourteen transects had no available foods (fallow plots are also included in this category).

The mean percentage damage of available foods differed significantly between main crop types (Table 4.16). Cassava suffered significantly less damage than did sweet potato (Scheffe, $p = 0.026$), maize (Scheffe, $p << 0.001$) and banana (Scheffe, $p = 0.044$). Sweet potato, maize, banana and ‘other’ transects suffered significantly more damage than transects with no available plants (Scheffe, $p << 0.001$). Maize also suffered significantly more damage than chilli, cocoa (Scheffe, $p << 0.001$) and green-leafed vegetables (Scheffe, $p = 0.049$).

Monkey and pig damage scores were compared with crop availability (again excluding zero scores for normalisation as per section 4.3.4). Crop type was recoded to combine categories with a sample size less than five into ‘other’. For monkey damage these were vegetables, aubergine and cassava, and for pig damage; chilli, vegetables, cassava, taro and coconut. Mean total monkey damage score (for the transect) and mean total pig damage scores do not show significant heterogeneity between mean score for each crop type (Table 4.16). Where monkey damage occurs, it is of a similar severity for those crops. Although overall there was no significant heterogeneity between means for mean total monkey damage score, there was a significant difference between some crops. Coconut showed a significantly greater severity of monkey damage than did either maize or sweet potato (Tamhane, $p << 0.001$). This may be due to the scoring system in that damage to coconuts was often scored as severe because once the coconut is opened it is useless for human consumption, whereas if a small area of a cob or one tuber is damaged the rest can still be, and is, used (pers. obs.).

Of the common crops, sweet potato was the crop most frequently damaged by both monkeys and pigs. However pigs appeared to damage it more severely than did monkeys (Table 4.16) despite a similar frequency of damage (by transect). This is due to the larger body mass of pigs and their foraging mode, which is to root up entire plants to find tubers, thereby destroying large areas of crops. Monkeys, however, tended to dig up individual tubers, often missing others, such that the damage overall was less severe (pers. obs). Monkeys damaged cocoa more severely than did pigs, owing to their ability to climb the trees and remove whole pods. Pigs usually had to wait for pods to drop, although they did destroy saplings. Pigs damaged cassava and taro more severely than did monkeys, again due to the foraging mode and the need to root up tubers. The damage to chilli by pigs was also severe but occurred in only one transect and was likely to be the result of pigs moving through that area to access other crops.

food, monkey and pig damage score for each main crop. Monkey and pig damage scores reflect the means when zero , F, df = 11, 580, p significant at the 0.01 level)**

eet tato	Maize	Chilli	Cocoa	Banana	Veg.	Coconut	Aubergine	other	F Test	Sig. value
.71 ± .66 = 27	19.81 ± 22.65 N = 46	0.00 N = 21	9.92 ± 24.31 N = 97	20.11 ± 27.38 N = 33	0.31 ± 1.11 N = 13	10.89 ± 21.05 N = 26	6.06 ± 15.41 N = 11	19.41 ± 64.12 N = 40	11.97	<< **0.001****
.78 ± .03 = 50	15.14 ± 10.29 N = 28	Excluded from analysis (zero score)	12.00 ± 11.64 N = 17	6.93 ± 5.30 N = 14	3.00 N = 1 Included under ‘other’ for analysis	2.83 ± 0.75 N = 6	1.50 ± 0.70 N = 2 Included under ‘other’ for analysis	31.46 ± 39.86 N = 13	1.69	0.128
.02 ± 070 = 48	15.71 ± 8.98 N = 7	30.00 N = 1 Included under ‘other’ for analysis	9.33± 8.16 N = 15	10.00 ± 4.65 N = 6	5.00 N = 1 Included under ‘other’ for analysis	2.00 N = 1 Included under ‘other’ for analysis	Excluded from analysis (zero score)	12.40 ± 2.50 N = 4	1.53	0.187

d absence of monkey damage against main crop type for each transect

	Main crop type										Total
o	Sweet potato	Maize	Chilli	Cocoa	Banana	Veg	Coconut	Aubergine	other	No available foods	
	77	18	21	80	19	12	20	9	27	112	**440**
6	96.2	34.8	15.9	73.5	25.0	9.8	19.7	8.3	30.3	85.6	
	50	28	0	17	14	1	6	2	13	1	**141**
	30.8	11.2	5.1	23.5	8.0	3.2	6.3	2.7	9.7	27.4	
	127	**46**	**21**	**97**	**33**	**13**	**26**	**11**	**40**	**113**	**581**

pig damage against main crop type in each transect

	Main crop type										Total
o	Sweet potato	Maize	Chilli	Cocoa	Banana	Veg	Coconut	Aubergine	other	No available foods	
	79	39	20	82	27	12	25	11	36	109	**484**
6	105.6	38.3	17.5	80.7	27.4	11	21.6	9.1	33.3	94.8	
	48	7	1	15	6	1	1	0	4	5	**98**
	21.4	7.7	3.5	16.3	5.6	2.2	4.4	1.9	6.7	19.2	
	127	**46**	**21**	**97**	**33**	**13**	**26**	**11**	**40**	**114**	**582**

Presence or absence of monkey damage was also significantly related to the major crop type within the transect (?^{2} = 111.74, df = 11, p << 0.001), although the sample sizes for some categories were quite low. There were more transects than expected with damage when the main crop was sweet potato, maize, cocoa, banana and other (includes papaya, pumpkin and peanut etc.). Slightly more transects than expected had damage when taro was the main crop, while for coconut, observed and expected were almost equal (Table 4.17 and Figure 4.11a) The small amount of damage seen in transects with no available crop is due to damage from passing through the field as opposed to actual crop-raiding on that transect.

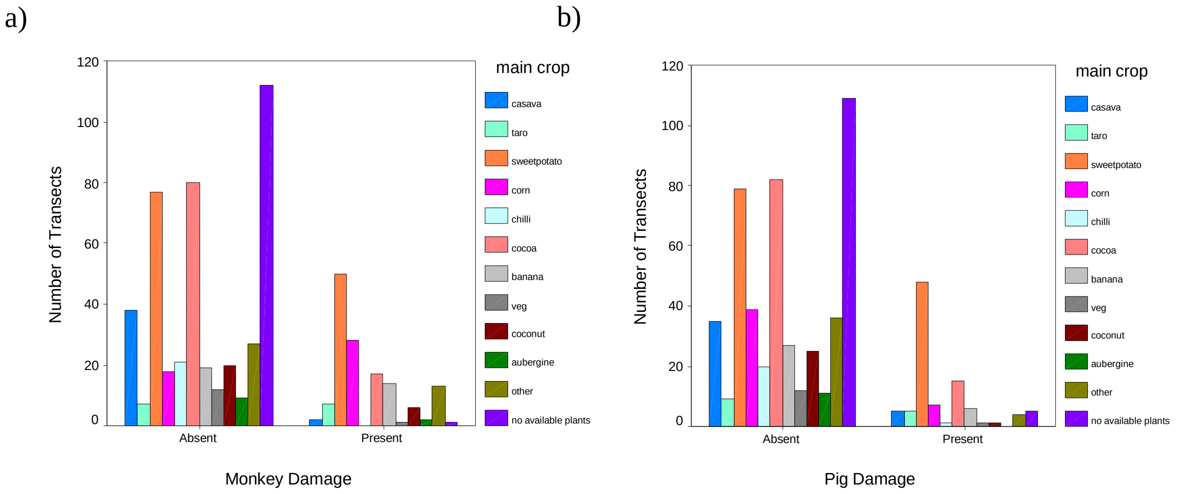


Figure 4.11 (a) Presence or absence of monkey damage for each main crop type (b) Presence or absence of pig damage for each main crop type

Presence or absence of pig damage was also significantly related to the major crop type within the transect (?^{2} = 66.47, df = 11, p << 0.001), and once again the sample sizes for some categories were quite low. As with monkeys, there were more transects than expected with damage when the main crop was sweet potato (Table 4.18 and Figure 4.11b). It was interesting to note damage due to passage rather than crop-raiding occurred in more transects for pigs (five) than for monkeys (one), due to their greater bulk and mode of locomotion.

4.3.6 Farm Size and Village as Factors Influencing Damage

The average farm size for all the farms is 0.683 ha with the most common size being 0.5ha. Of the farms surveyed, LaBundo Bundo had the largest and Wakangka the smallest (Scheffe, p< 0.002) (Table 4.19). The sizes of farms associated with each village were all significantly different (F = 8.21, df = 3, 65, p << 0.001). A smaller number of farms were surveyed in Wakangka and Wakalambe because the majority of farmers had paddy fields not dry-land crops.

Table 4.19 Mean farm size and percentage damage of available foods and total plants, number of foods and total plants per transect by village

Village	Mean Farm Size (ha)	Mean percentage damage of available foods per transect	Mean percentage damage of total plants per transect	Mean number of available foods per transect	Mean number of total plants per transect	Number of Farms Surveyed	Number of Transects Surveyed
Kawelli	0.66	22.18	23.77	13.41	19.27	22	198
Wakangka	0.29	3.85	4.02	5.50	6.00	14	94
Wakalambe	0.31	3.53	3.75	6.50	7.56	4	34
LaBundo Bundo	0.94	3.48	5.41	5.33	11.52	29	255

Owing to the confounding effect of village affinity, a simple correlation between farm size and percentage damage cannot be performed. A multiple regression was used to assess the effect of village and farm size on mean percentage damage of available foods and total plants. Dummy variables were created for village (DVILL) and the ‘Method=Tests’ model was used to allow these to be entered simultaneously. Village was entered in the first block and farm size in the second block. Village was a significant predictor but once this effect was removed farm size was not a predictor of damage to available foods (R^2 change = 0.002, F change = 0.156, p = 0.695, N = 69) or damage to total plants (R^2 change = 0.308, F = 0.146, p = 0.703, N = 69). This is in contrast to other studies which have found an effect of farm size on crop loss (Naughton Treves 1996, 1998a) and may be due to the relatively small variation in farm sizes overall.

Significant differences between villages were found in mean percentage damage of available foods (F = 46.64, df = 3, 577, p << 0.001) and mean percentage damage of total plants (F = 32.98, df = 3, 467, p << 0.001). Kawelli had significantly higher mean percentage damage of available and total plants than the other three villages (Tamhane, p << 0.001) (Table 4.19). It is interesting to note that for LaBundo Bundo, the percentage damage of available foods was much less than that of total plants. This suggests that farms in LaBundo Bundo had a greater proportion of unavailable plants, confirmed by personal observations. Many of the farms in LaBundo Bundo were newly planted at the time of the surveys and thus not yet bearing fruit. Only 46% of the total plants per transect were available to monkeys by contrast to other villages where over 70% of the total number of plants per transect were available foods for monkeys (Table 4.19). This may well have an impact on how seriously villagers view the problem of monkeys at that time. If all the crops ripen simultaneously then raiding may be more serious for that farmer, however if the crops ripen at different times perhaps the losses may not assume such a great importance (see chapter 5).

4.4 MULTIVARIATE PREDICTORS OF PERCENTAGE CROP DAMAGE

4.4.1 The Influence of Distance to Forest, Crop Type and Village on Amount of Crop Loss

Several factors influenced percentage damage of available and total crops. A multiple regression was performed using distance from forest, distance of transect to farm edge, main crop and village against measures of damage. Once again dummy variables (for categorical variables) and the ‘Method=Tests’ were used. To determine the significance of each variable all but one were entered in block 1 and the variable of interest entered in block 2. Each variable was tested in block 2 in turn and the resulting R^2 change and significance values compared.

Distance to forest and village were the most significant predictors of damage to available foods (Table 4.20) and total plants (Table 4.21), followed by transect distance from farm edge and main crop type. All four were significant and therefore entered into the model.

Table 4.20 Multiple linear regression model summary for each predictor of percentage damage of available foods entered in block 2 and the final model. Variables ordered by difference in p value (highest to lowest)

Variable entered in block 2	**Model summary**			
N = 468	**Adjusted R^2**	**R^2 Change**	**F change**	**Sig. value**
Distance to Forest (df = 2)		0.082	30.299	<< **0.0001**
Village (df = 3)		0.165	40.363	<< **0.0001**
Distance of Transect to Farm edge (df = 2)		0.065	24.081	<< **0.0001**
Main Crop (df = 9)		0.066	5.415	<< **0.0001**
Final model - all 4 entered in block 1 (df = 16,451)	**36.5%**	**0.387**	**17.782**	<< **0.0001**

Table 4.21 Multiple linear regression model summary for each predictor of percentage damage of total plants entered in block 2 and the final model. Variables ordered by difference in p value (highest to lowest)

Variable entered in block 2	**Model summary**			
N = 468	**Adjusted R^2**	**R^2 Change**	**F change**	**Sig. value**
Distance to Forest (df = 2)		0.084	30.961	<< **0.0001**
Village (df = 3)		0.167	40.984	<< **0.0001**
Distance of Transect to Farm edge		0.064	23.729	<< **0.0001**

(df = 2)				
Main Crop (df = 9)		0.066	5.388	<< **0.0001**
Final Model - all 4 entered in block 1 (df = 16,451)	**36.8%**	**0.389**	**17.961**	<< **0.0001**

For monkey and pig damage score, zero scores were once again excluded for normalisation. Village and distance to forest were once again the most significant predictors, followed by crop type and transect distance from farm edge (Table 4.22) and all four were entered into the model. Pig damage was predicted by village, distance from forest and crop type but not transect distance from farm edge and so all but the latter were entered into the model (Table 4.23). This confirms the previous results: pig damage was of equal severity within a farm whereas for monkeys there was a clear edge effect within farms.

Table 4.22 Multiple linear regression model summary for each predictor of total monkey damage score (severity of monkey damage) with zero scores excluded entered in block 2 and the final model. Variables ordered by difference in p value (highest to lowest)

Variable entered in block 2	**Model summary**			
N = 140	**Adjusted R^2**	**R^2 Change**	**F change**	**Sig. value**
Village (df = 3)		0.156	11.268	<< **0.0001**
Distance to Forest (df = 2)		0.109	11.745	<< **0.0001**
Main Crop (df = 9)		0.160	6.146	<< **0.0001**
Distance of Transect to Farm edge (df = 2)		0.073	7.900	**0.001**
Final Model - all 4 entered in block 1 (df = 15,124)	**35.7%**	**0.426**	**6.146**	<< **0.0001**

Table 4.23 Multiple linear regression model summary for each predictor of total pig damage score (severity of pig damage) with zero scores excluded entered in block 2 and the final model. Variables ordered by difference in p value (highest to lowest)

Variable entered in block 2	**Model summary**			
N = 93	**Adjusted R^2**	**R^2 Change**	**F change**	**Sig. value**
Village (df = 3)		0.236	12.718	<< **0.0001**

Distance to Forest (df = 2)		0.136	10.984	<< **0.0001**
Main Crop (df = 9)		0.144	2.907	**0.007**
Distance of Transect to Farm edge (df = 2)		0.013	1.018	0.366
Final Model - village, distance to forest and main crop entered in block 1 (df = 13,79)	**43.0%**	**0.511**	**6.338**	**<< 0.0001**

These models leave over 60% of the variance in percentage damage unexplained and there are a number of other factors influencing crop damage. These may include climate, ranging patterns of the monkeys, other physical barriers such as roads or rivers or number of surrounding farms.

Damage to available foods and total plants, severity of monkey and pig damage were all significantly lower where road(s) bordered the farms (Table 4.24). Although the same appears to be the case for farms with rivers bordering them, the difference was not significant, which may be a consequence of sample size.

Table 4.24 T-test of percentage of damage to available foods, total plants (t, df = 579, p), monkey and pig damage scores (excluding zero scores) (t, df = 96, p) against presence or absence of roads and rivers.

Means ± SD (N)	**Road**				**River**			
	Present	Absent	t	**Sig. value**	Present	Absent	t	**Sig. value**
% damage of available foods	8.00 ± 35.07 (173)	10.73 ± 21.39 (408)	4.09	<< **0.001**	7.43 ± 16.93 (49)	10.15 ± 26.91 (532)	0.43	0.670
% damage of total plants	9.62 ± 38.261 (144)	13.40 ± 23.14 (327)	4.49	<< **0.001**	9.11 ± 18.37 (40)	12.53 ± 29.40 (431)	0.29	0.628
Total monkey damage score (0 scores excluded)	6.32 ± 5.96 (22)	15.48 ± 19.16 (119)	3.29	**0.002**	12.64 ± 11.87 (11)	14.18 ± 18.51 (130)	0.19	0.844
Total pig	9.62 ±	18.72 ±	2.80	**0.006**	9.00 ±	17.47 ±	1.30	0.196

damage score (0 scores excluded)	7.93 (21)	19.03 (77)			5.98 (8)	18.17 (90)		

The number of surrounding farms[3] affected the percentage damage to available foods, total plants and monkey and pig damage scores (Table 4.25). Farms with two surrounding farms suffered the greatest damage to available foods and total plants and differences were significant between all categories (Tamhane, $p < 0.04$). Monkey and pig damage was most severe in farms with two farms surrounding them (Scheffe, $p < 0.05$). Farms surrounded on all four sides by agricultural land suffered the least damage for all measures. Interestingly farms with no or one side bordering farmland also suffered lower levels of damage, which may be due to confounding factors of farm geography and crop variety.

Table 4.25 Percentage damage of available foods, total plants (ANOVA comparison, F, df = 4, 576, p), monkey and pig damage score (excluding zero scores) (F, df = 4, 136, p) against number of surrounding farms.

Mean ± SD (N)	**Number of surrounding farms**					**F**	**Sig. value**
	0	**1**	**2**	**3**	**4**		
% damage available foods	7.83 ± 14.82 (37)	14.38 ± 57.50 (55)	22.69 ± 29.25 (138)	5.64 ± 13.89 (242)	1.63 ± 10.93 (109)	26.28	**<< 0.001**
% damage total plants	8.05 ± 14.97 (36)	15.21 ± 59.06 (52)	27.04 ± 30.00 (116)	7.03 ± 15.21 (194)	2.51 ± 13.30 (73)	26.49	**<< 0.001**
Total monkey damage score (0 scores excluded)	11.00 ± 11.45 (11)	10.00 ± 6.87 (8)	19.79 ± 22.32 (72)	7.41 ± 8.83 (44)	5.00 ± 6.45 (6)	6.59	**<< 0.001**
Total pig damage score (0 scores excluded)	N/A N = 0	12.56 ± 6.71 (9)	20.89 ± 13.83 (37)	15.76 ± 22.31 (43)	8.88 ± 8.63 (9)	4.20	**0.008**

There was a strong trend for distance from forest to farm and number of surrounding farms to be associated (?^{2} = 15.18, df = 8, p = 0.056) although the sample sizes were very low.

---

[3] Number of surrounding farms refers to the number of farms bordering the farm in question, i.e. the number of sides of the farm bordered by agricultural land. It does not indicate the number of farms between the forest and the farm in question.

More farms with two or three surrounding farms were close to the forest and farms with four sides bordered by farmland were average distances from the forest. This may contribute to the increased damage in farms with two or three farms bordering them.

Distance from village to farm and number of surrounding farms were significantly associated ($?^2 = 26.28$, df = 8, $p = 0.001$) but once again sample sizes are low. Lone farms or those with one surrounding farm were closer to the village, farms surrounded by two or three others were average distance from the village and those with more than three or four sides bordering farmland were far from the village.

Farms closer to the village or closer to the forest are likely to be constrained by space and therefore have fewer farms surrounding them. However, as seen before (section 4.3.3) distance to forest and distance to village are significantly related themselves, therefore there may be a confounding effect.

4.4.2 The Effect of Roads, Rivers and the Number of Surrounding Farms on Crop Damage

In order to investigate the effects further the presence of a road or river next to the farm were added to the model. While the effect of road presence was almost significant for both available foods and total plants, the presence of a river was not (Table 4.26). As road presence was almost significant it was added into the model for both damage to available foods and total plants (Table 4.28), predicting approximately 37% of the variance in both.

Table 4.26 Model summary for multiple linear regression adding road and river as predictors of damage to available and total plants (block 1 contains main crop, distance to forest, transect distance and village)(df = 1).

Variable entered in block 2	Model summary			
N = 468	Adjusted R^2	R^2 Change	F change	Sig. value

Available Plants				
Road	39.2%	0.005	3.619	**0.058**
River	38.7%	0.000	0.311	0.578
Total Plants				
Road	39.4%	0.005	3.780	**0.052**
River	39.0%	0.000	0.322	0.571

River presence did not predict severity of monkey or pig damage but road presence was an almost significant predictor for monkey damage (Table 4.27) and was therefore added to the model (Table 4.28).

Table 4.27 Model summary for multiple linear regression adding road and river as predictors of monkey damage score (excluding zero scores) (block 1 contains main crop, distance to forest, transect distance and village).

Variable entered in block 2	Model summary			
N = 140	**Adjusted R^2**	**R^2 Change**	**F change**	**Sig. value**
Road (df = 1)	36.8%	0.015	3.213	**0.076**
River (df = 1)	35.3%	0.001	0.239	0.626

Table 4.28 Model summary for multiple linear regression entering main crop, distance to forest, transect distance, village and road presence as predictors of damage to available foods and total plants and severity of monkey damage.

	Model summary			
	Adjusted R^2	**R^2 Change**	**F change**	**Sig. value**
Percentage damage of available foods (df = 17, 450)	36.9%	0.392	17.046	<< **0.0001**
Percentage damage of total plants (df = 17, 450)	37.1%	0.394	17.231	<< **0.0001**
Total monkey damage score (df = 16, 123)	36.8%	0.441	6.065	<< **0.0001**

Number of surrounding farms was a significant predictor of damage to foods and total plants (Table 4.29) and was therefore entered into the overall model (Table 4.30) which then accounted for approximately 39% of the variance seen. For monkey damage it was significant at the 90% level and therefore also entered into the final model (Table 4.29).

Table 4.29 Model summary for multiple linear regression adding number of surrounding farms as a predictor of percentage damage and monkey and pig damage score (excluding zero scores) (block 1 contains main crop, distance to forest, transect distance, village and road for all but pig damage score for which the model includes main crop, distance to forest and village).

	Model summary			
Number of surrounding farms entered into block 2	**Adjusted R^2**	**R^2 Change**	**F change**	**Sig. value**
Percentage damage of available foods (df = 3, 447)	38.8%	0.023	5.824	**0.001**
Percentage damage of total plants (df = 3, 447)	39.2%	0.024	6.082	<< **0.001**
Total Monkey Damage Score (df = 3, 120)	38.5%	0.028	2.141	0.099
Total Pig Damage Score (df = 3, 76)	44.6%	0.032	1.781	0.158

Table 4.30 Model summary for multiple linear regression entering main crop, distance to forest, transect distance, village, road presence and number of surrounding farms as predictors of damage to available foods and total plants and severity of monkey damage.

	Model summary			
	Adjusted R^2	**R^2 Change**	**F change**	**Sig. value**
Percentage damage of available foods (df = 20, 447)	38.8%	0.415	15.829	<< **0.0001**
Percentage damage of total plants (df = 20, 447)	39.2%	0.418	16.055	<< **0.0001**
Total Monkey Damage Score (df = 19, 120)	38.5%	0.469	0.588	<<**0.0001**

Thus percentage damage to available food and total plants is predicted by the position of a farm relative to the forest, which village the farm is part of, the main crop type grown, whether a road is present, how many farms are surrounding the farm and also the part of the farm itself (Table 4.31). This is also the case for the severity of monkey damage. Thus the area closest to the farm edge, in a farm closest to the forest in the village of Kawelli, growing maize, sweet potato or cocoa, with no road bordering the farm and two surrounding farms will have the greatest amount of damage and the most severe monkey damage. For pigs, the damage is of a similar severity for all areas within a farm but farms which are closer to the forest, growing sweet potato or maize in Kawelli suffer the most severe damage.

Table 4.31 Components of the multiple linear regression models for predicting percentage damage to available plants, percentage damage to total plants, monkey and pig damage scores (excluding zero scores).

	Components of model					
Dependent variable	**Distance to forest**	**Village affinity**	**Main crop**	**Distance of transect to farm edge**	**Presence of road**	**Number of surrounding farms**
Percentage damage of available foods	ü	ü	ü	ü	ü	ü
Percentage damage of total plants	ü	ü	ü	ü	ü	ü
Total Monkey Damage Score	ü	ü	ü	ü	ü	ü
Total Pig Damage Score	ü	ü	ü	û	û	û

However, these models still leave over 55% of the variance unexplained. Climatic variables, crop positions within farms, differing crop combinations in farms, forest food availability and ranging patterns of the monkeys are some of the factors that may contribute towards this but which cannot be assessed in this study. Human activity as a factor in deterrence, and thereby reducing crop damage on the farms, is considered in chapter 7 using focal farm data.

4.5 SUMMARY

In this chapter a portrait of crop damage by monkeys has been presented, in terms of potential offtake by monkeys, the influence of the geographic situation of the farms and the crop varieties within farms. Measures of damage have then been linked to farmers' perceptions of them in order to assess the degree of concordance. Finally predictors of monkey crop damage have been explored.

§ **Offtake**

Exclosure plots revealed a potential yield of sweet potato of between 12 and 23 potatoes per m^2. Pigs appeared to cause more damage to sweet potato than did monkeys, being responsible for approximately 65 % of sweet potato tuber damage compared to 35% by monkeys. Monkeys damaged 0.74 potatoes per m^2, while pigs damaged 1.37 potatoes m^2. However, damage by both pigs and monkeys was likely to be slightly under-estimated owing to a shading effect of the exclosure plots themselves.

§ **Perceptions of damage vs. measured damage**

Perceptions of damage and measured damage were positively correlated, although the relationship was not straight forward. Those farmers experiencing low levels of damage were less accurate at estimating damage as indicated by transects, whereas those experiencing medium or high levels of damage were more accurate and even under-estimated transect damage.

§ **Distance to forest vs. distance to village**

Measured damage was associated with distance from the farm to the forest edge. Farms closest to the forest (<100m) experienced the most crop damage by monkeys and a pronounced edge effect was seen within farms, with crops under 10m from the forest edge being most severely damaged. For pigs no such edge effect was found within farms suggesting that once in a farm, pigs cause damage randomly over the whole area. However, perceptions of damage were unrelated to the distance of respondents' farms from the forest; instead they were related to the distance of the farm from the village. Thus while perceptions of damage are more likely to be associated with human activities, such as access to and from villages, damage itself is a function of monkey behaviour with respect to distance from forest refuges.

§ **Crop and farm factors**

No effect of farm size was seen in this study. However, crop variety did seem to influence raiding. Sweet potato, maize and banana were the most frequently and severely damaged crops. Difference between farms in the availability of these crops influenced the amount of damage farms experienced.

§ **Predicting crop damage**

Amount and severity of crop damage by monkeys was predicted by the distance of the farm to the forest (< 100m), position of crops within a farm itself (< 10m from the forest edge), which village the farm was in (Kawelli), the main crop in the farm (sweet potato, maize or banana), the absence of a road, and the number of surrounding farms (two or less surrounding the farm). For pigs, position within the farm did not predict damage, however in common with monkeys, farms which were closer to the forest (< 100m), growing sweet potato or maize in Kawelli suffered the most severe damage

CHAPTER 5 – FARMERS' PERCEPTIONS TOWARDS CROP-RAIDING

5.1 INTRODUCTION

The human context for crop-raiding by the Buton macaques is detailed in this chapter. Firstly I explore why the study of attitudes and perceptions of the nature and extent of a 'problem' are valuable in attempts to manage human-primate interaction from the perspective of effective conservation. Secondly, I present the results of the rapid rural appraisals (RRA) and the detailed household interviews conducted over two field seasons. The people's voice is used to situate the nature of the interaction, from conflict to co-existence. A description of the communities, the attributes of the households and individuals, and the geographical distribution of the respondents are presented in the final section and linked to the perception of the macaques.

5.2 WHY STUDY ATTITUDES?

Information about the attitudes and perceptions of villagers towards the pest-monkeys, or indeed any commensal species, is a prerequisite to designing optimal and effective management schemes and introducing suitable preventative measures (Else and Lee 1986; Gillingham and Lee 1999; Parry and Campbell 1992; Pirta *et al.* 1997). In the past, attempts to deal with problems have run into severe difficulties due to lack of local consultation (Strum 1987a). The appropriate management strategy depends on the prevailing physical, social and economic context and conservation objectives (Naughton Treves 1998b; Newmark *et al.* 1994).

For the farmers, the extent of economic loss due to primates may be less important than the belief that monkeys are responsible. As a result primate populations may be persecuted and will suffer mortality and other costs. If people believe primates to be responsible, they might not take action against other animals which could also be causing significant damage, therefore losing even more of their crop. It is necessary to investigate attitudes towards primate pests, as well as the reality of their raiding actions to determine the extent of any mismatch between these perceptions and reality.

5.3 PERCEPTIONS OF PRIMATES

Cultural perceptions vary enormously, through both space and time. Colonialism has had a particular impact. Historically primates have been revered as guardians of human settlements, as bringers of good and bad luck, as spirits of ancestors and as embodiments of sexuality, fertility, wisdom and fortune (Morris and Morris 1966) from Africa across to Tibet. However, primates are not as often revered as snakes, bulls or bears and often symbolise man's bestiality (ibid, 1966) or dubious morality despite their positive religious associations. This is most likely due to their obvious morphological similarity to humans and gives rise to the view that they straddle the line between human and animal and are therefore dangerous creatures (Knight 1999). European attitudes, which have no tradition of primates, have in some instances been imposed upon unsuspecting farmers. In India, the British attempted to translocate problem groups of langurs and macaques to other areas; this simply shifted the problem to other farms and villages (Morris and Morris 1966). The impact of a neo-colonial imperative for economic development and the push towards cash-cropping may have created or enhanced a context of conflict between subsistence farmers and primates. Previously crop losses may have been accepted as part of general crop returns, but in an evolving market economy these losses start to assume major perceptual importance (Lee and Priston in press). There is very little work on this area in relation to primates and the relative importance of loss of subsistence crops versus cash crops is unknown. However, there are indications that a Euro-centric attitude to wildlife is often at odds with indigenous attitudes (Adams 1996) which promotes contexts for negative perceptions and increases the potential for conflict. International and national level conservationist intervention in local issues can serve to alter perceptions of the animals such that they are no longer viewed as 'local' but as 'national' and thus their presence locally becomes 'illegitimate'. In some cases, local residents have demanded relocation of animals to the cities e.g. macaques in Japan (Knight 1999). Thus external conservation efforts can serve to destroy local conservation sentiment rather than encourage it. This is when issues of conflict become more problematic, with farmers demanding compensation for the destruction of their crops by these animals now classified as 'invaders'.

In general negative attitudes towards primates are a function of the degree of contact with primates as pests, and to a lesser extent with the risks perceived to result from direct contact. Brief contact in the absence of crop damage tends to promote positive attitudes (King and Lee 1987; Knight 1999), while even minimal experience of raiding leads to an attribution of blame that may greatly outweigh the damage (Chalise 2000; Chalise and Johnson 2001; De Boer and Baquette 1998; Hill 1997, 2000; Naughton Treves 1996, 1997; Priston 2001; Siex and Struhsaker 1999a). In fact in some cases, and in contrast to farmers' negative perceptions crop-raiding has actually been shown to increase crop yields, due to a pruning effect (Chalise 2000; De Boer and Baquette 1998; Hill 1997; Siex and Struhsaker 1999a). Primates are often perceived of as intelligent, cunning, well-organised, vindictive and malicious – causing damage for the sake of it (Chalise 2000; Hill 1997, 2000; Knight 1999; Naughton Treves 1996). . The conspicuous nature of primates in agricultural land may lead to false assumptions about their effect on the crops. Large size, large canines and aggressive raiding strategies used by key raiders such as adult males (Strum 1986), or the presence of large groups (Hill 2000), increase the perceptions of risk to people in contexts of human-primate conflict. The issues of risks of attack, injury or disease are all significant when attempting to assess attitudes towards wildlife crop pests and how these impact on conservation or management programmes. Perceptions of risk tend to focus on large, conspicuous or dangerous species such as elephants or primates, even when events of raiding are rare (Gillingham and Lee 1999; Sukumar 1990). The intensity of damage inflicted, however rarely, can significantly affect the perceptions formed, for example elephants are often regarded as the most significant crop pest because although they raid rather infrequently and overall losses caused are less, when they do crop-raid the entire field is destroyed at once (Hill 1998; Naughton Treves 1997).

Another key issue is that of compensation. When farmers have opportunities to claim financial compensation for crop damage, there is the potential for primates to be 'blamed' for damage that may be over and above the damage these species actually inflict (Chalise 2000; Naughton Treves 1997; Siex and Struhsaker 1999a). Despite their often frequent raiding activities, livestock are rarely complained about; in fact in one study livestock were the second most prolific crop-raider, yet were not mentioned by farmers (Naughton Treves 1997). Farmers' perceptions of crop vulnerability often do not match reality, with staple foods, and crops that ripen simultaneously often viewed as the pests' preferred crops when in reality fruits like bananas are raided preferentially (Naughton Treves 1997; Priston 2001). Local perceptions of risk are also increased by the constraints on coping strategies, for example in situations where animals come out of protected areas to raid and thus no legal action can be taken against them. Conversely, in comparison to nocturnal raiders such as pigs, primates may be viewed as somewhat easier to deal with owing to their diurnal habits and conspicuousness (Priston 2001).

5.4 METHODS

General field methods have been described in chapter 2 section 2.3. Any details relating to specific statistical methods or re-coding of data are described at the relevant point in the results sections below.

5.5 RAPID RURAL APPRAISAL

Results from the rapid rural appraisal discussions have been incorporated into the analysis of interview responses and used to inform the conclusions drawn. Discussions were only held in the village most heavily affected by crop-raiding and then were used to explore potential management strategies that would be welcomed by the villagers.

When discussing what farmers wanted for their village in terms of development most focused on their immediate situation:

"I am a farmer so I just need a parang (machete) *and a good life for farming. If I am not a farmer maybe I would need pen and paper etc"*

They farm for subsistence and make little effort to sell surplus

"Sometimes people come to the village and buy things, but there have been no traders here for a long time. I might go to Kapontori (local, small market village) *to sell but usually I just give to my family and friends"*

Discussions of seasons and planting times revealed no definite pattern; each farmer seemed to have their own preferred month for planting and continually planted.

"There is no bad time for growing plants. If you start in July and clean up the grass, then burn it, you can begin to plant in September to November"

However, some of the elders in the discussions mentioned using the phases of the moon to direct their planting and to choose a 'good day to plant crops'

"We count the appearance of the moon, the 4th day after the new moon falls on a Thursday it is bad luck, but if the 5th day is a Friday it is a good luck day and a good time to build a house, or plant new crops etc"

When discussing possible solutions to crop-raiding most concluded that there was no solution and were honest in their appraisal. Some methods of deterrence were suggested, such as growing citrus fruits. Farmers mentioned destruction of the monkeys as methods they had tried, but realised these methods were generally unsuccessful.

"There is no solution! Maybe if we can put netting around the farm and fence, over 2m high, then maybe it will stop them, but good net is very expensive"

"There is no point to waste money on poison, it doesn't work. Even if you put poison and traps down every day it won't be enough. 15 or 50 monkeys killed, but still more will come. They never stop!"

"Using a box trap, a big trap for maybe 10 monkeys, like a cage might work, but it only works as warning, so they know not to come to the farm. We tried it and they didn't come for a week, but then they came back. If we put poison in bananas they just eat different crops – they know!"

"Maybe we have to make an agreement with the monkey!"

"There's no solution, only to guard your farm"

"If we catch a monkey in the farm we paint it red, and then release it. It follows its group and scares the other monkeys. They run far away and don't come back for many months. Also try to tie the monkey to the farm to scare monkeys away but it doesn't work."

"We thought about planting chilli, which monkeys don't like, it's easy, but we can't eat chilli so we would rather plant food we can eat. We want to grow citrus fruits to sell but it's hard to get the seeds"

Discussion also considered forest products. The general consensus was that

"Over the last years it's been getting worse and worse. People depend on the forest for rattan, wood etc but it is getting less…we have to go further and work harder"

When asked if there was a solution to this problem of decreasing resources, there was recognition that the forest needed time to grow back, but that without alternative sources of income they had little choice.

*"Maybe we have to get another job and another income to solve the problem, so that it (*rattan*) has a chance to grow back, but at the moment 30 people go to harvest it in the forest every day!"*

"If we leave the rattan for maybe four years then maybe it will grow back"

"If the companies that buy rattan from us stop then we will stop taking it, but they always come to buy so we always take"

Although they recognised that products they used were decreasing, they did not link this to its effect on the forest and species living there as a whole

"Rattan and wood removal doesn't affect the animals. We have not hunted animals here for a long time. It's too far to go and find the animals… we just take wood, honey, rattan and traditional medicines,"

"The animals are always increasing – if you kill one, then they give birth to more! All of them increase – anoa, cuscus, wild pig, monkey, snakes and birds, but they just live farther away now"

There was some gender division in daily activities, although it was not always clear cut and both men and women would work on the farm.

"The old men tend to live in the farm huts; while the sons will live in the village…the men will go to the farm early in the morning and then return to the village to

play cards and relax while the women stay in the farm until late afternoon. Only men go to the forest to collect wood and rattan"

"Children work or play in the farm after school and on Sundays. Sometimes we sleep in the farm to stop pigs"

"As soon as a child can hold a parang they go to the farm to help"

The older men raised the issue of sacred places in the forest and believed the forest has some spiritual importance.

"Old men, long time ago, had magic knowledge, when they died they were buried in the forest, these are sacred graves in the forest – you are not allowed to touch or go near. You must not cut wood near the graves. It's like a test – the ghost is testing you, but if you take wood then you lose the test and that is bad."

"Some people believe there is magic in the forest, for example in the large fig tree. People believe it has a spirit so we don't cut it down. Only old people believe this now, young people don't".

"If we get harvest and we can't sell it in the market, we must make an offering to the tree. The old men of the village make smoke and everyone makes an offering. One man did not believe and now he is dead!"

"Every person goes to the old men in the village when they get their harvest. If you have sweet potato, you choose a big one and take it to the tree; one of every type of crop, and burn it. You cook food at the house, bring it to the tree to eat and if any food is left over you leave it there"

"Sometimes near the sacred places you see a white pig – that is a signal that something bad will happen, a warning"

5.6 DEMOGRAPHIC FACTORS

5.6.1 Farm Location

Farm location was associated with vulnerability to crop damage (chapter 4 section 4.3) based on the results from 73 farms surveyed. In this chapter, the interview responses will be used to explore this association further. Perceived damage was related to measured damage (chapter 4 section 4.3.2) but not in a straightforward way, and therefore the factors influencing perceived damage will be examined in detail here.

Farm location for interview data

Farms were between 0 and 5km from the forest, and from the village. Most were about 1km from both; the mean distance from the forest was 876.1m and 944.3m from the village (Table 5.1).

Distance from forest (log-transformed) was categorised according to the three modal peaks of the distribution as near (< 100m), average (101 – 775m) and far (over 776m). Distance from the village (logged) was categorised similarly as near (<200m), average (201 – 999m) and far (> 1000m).

Farms were between 0.01ha to 5ha in size; mean farm size was 0.88 ha (N = 153) (Table 5.1). Farms closer to the village were small (<1ha), while those far from the village were average or large. This may be due to availability of land close to the village and also the pattern of land allocation. Land is allocated by the village head and every family is entitled to land, thus plots nearer the villages are smaller so that more people can have farms close to the village (pers. obs.).

Village affinity was an important predictor of measured damage (chapter 4 section 4.3.6) and of perceived damage in the pilot study.

Table 5.1 Farm location and size according to village

Village	Number of Farms (NB includes paddy farms)	Mean Farm Area (ha) ± SD	Mean distance from village (m) ± SD	Mean distance from forest (m) ± SD
Kawelli	30	0.68 ± 0.31	471.1 ± 373.3	242.7 ± 413.2
Wakangka	44	0.61 ± 0.45	598.6 ± 603.1	732.9 ± 707.2
Wakalambe	47	1.14 ± 1.0	982.1 ± 787.2	1409.7 ± 2888.5
LaBundo Bundo	32	1.04 ± 0.84	1807.8 ± 1349.8	882.9 ± 1561.8
Total for all villages	**153**	**0.88 ± 0.78**	**944.3 ± 961.7**	**876.1 ± 1835.7**

Despite being close to one another, these four villages each have unique aspects to their geographic location. Farms in Kawelli and Wakangka lie very close to the village ($?^2$ = 30.37, df = 6, $p << 0.001$). Wakangka is in a flat plain, thus paddy fields start just metres behind the village (Figure 5.1), and the few dry-crop fields are situated almost within the village itself. Kawelli has little access to land, being close to the forest reserve on one side, and therefore farms must be situated as close to the village as possible. On the other side of Kawelli the edge of the production forest is located some distance from the village, allowing some farms to be established further from the village. In Wakalambe, the rice fields are situated in a plain 100m from the village and LaBundo Bundo, despite being near to the reserve, has access to farm lands in a flat valley 1km away from the village on the other side of the Kakenauwe reserve.

Figure 5.1 View of the paddy fields in Wakangka taken from the edge of the village.

More farms are closer to the forest in Kawelli and LaBundo Bundo, whereas in Wakangka and Wakalambe more farms are far from the forest (?^{2} = 33.34, df = 6, p << 0.001) (Table 5.1). This may be due to a high proportion of paddy fields in Wakangka and Wakalambe, which are located together in large, flat areas generally further from the forest. Kawelli and LaBundo have mainly dry land crops and are both situated next to the forest reserves.

Most farms were 1ha or less in size since farms are allocated by the head man in plots of approximately 1ha or ½ ha with a similar pattern in all the villages (Table 5.1). Most individual farmers owned a single farm of 1 ha, while some owned as many as four farms (Table 5.2). Log-transformation did not normalise the data and farm size was re-coded as '1ha or less' and 'over 1 ha', based on the modal peak of the distribution. Farmers with more than 1ha tended to have several separate plots which were often widely dispersed owing to the shortage of land close to the village. Such farmers tended to have one farm which they devoted most of their time and care too, while the others were left or lent to other family members. Kawelli's and Wakangka's farmers tended to own 1ha or less, while farmers in Wakalambe and LaBundo owned over 1ha (?^{2} = 10.83, df = 3, p = 0.013) (Table 5.3).

Table 5.2 Total area of farmland owned against number of farms owned by individual farmers.

Total area of farmland owned	Number of farms owned				Total
	1	2	3	4	
1ha or less	101	11	2	0	**114**
Over 1ha	9	17	10	3	**39**
Total	**110**	**28**	**12**	**3**	**153**

The dispersed nature of plots has implications for crop-raiding since a farmer cannot possibly guard all his farms simultaneously and because the farms are all too small there is less opportunity for planting crops away from the forest edge to minimise crop damage. Farmers with three or fours farms tended to have these furthest from the forest (mean of 1504.6 ± 1471.8 and 1333.3 ± 1154.7 respectively) and village (mean of 791.8 ± 514.1 and 1003.3 ± 995.0 respectively). This can be explained both through choice and circumstance; a desire to buy extra farmland further from the forest, and the limited amount of land available close to the village (pers. obs.). Farmers with two or three farms also tend to have them next to the road ($?^2 = 17.13$, df = 4, p = 0.002) possibly because when buying new farmland it is advantageous to get land which has easy access (pers. obs and interview respondents).

Table 5.3 Further farm information for each village and totals for all villages combined

Village	Mean Total area of farm owned	Mean number of farms owned by each farmer	Mean Number surrounding farms	Number with Road present (number without)	Number with River present (number without)
Kawelli	0.80 ± 0.52	1.13 ± 0.43	2.30 ± 1.12	3 (28)	3 (28)
Wakangka	0.81 ± 0.61	1.41 ± 0.69	3.05 ± 1.33	12 (32)	3 (41)
Wakalambe	1.25 ± 0.99	1.38 ± 0.68	3.81 ± 0.45	3 (44)	0 (47)
LaBundo Bundo	2.13 ± 2.54	1.62 ± 0.98	3.13 ± 0.75	5 (27)	3 (29)
Total for all interviews	**1.22 ± 1.42**	**1.39 ± 0.73**	**3.15 ± 1.09**	**23 (131)**	**9 (145)**

Village and surrounding farms, road and river

In Kawelli and LaBundo Bundo, farms tended to have only two or three other farms surrounding them, whereas in Wakangka and Wakalambe most were surrounded by farms on four sides ($?^2$ = 70.27, df = 12, p << 0.001). Farms in Wakangka and Wakalambe are mostly paddy fields, and as mentioned above, are situated in large plains. For LaBundo and Kawelli farms are situated wherever they can be and many border the forest, a road or scrubland.

Wakalambe had more farms which did not border roads ($?^2$ = 8.66, df = 3, p = 0.034). In Wakangka most of the dry-land farms were situated within the village itself, and thus were almost all next to a road. Villages did not differ in the number of farms which were next to rivers ($?^2$ = 4.56, df = 3, p = 0.208) but sample sizes were very low (N = 7). Irrigation channels running around paddy fields were not considered 'rivers'; only water courses over 2m wide which could be potential barriers to crop-raiding were considered. 'Village' was used as a variable in subsequent analysis, as independent characteristics of farms did not explain all the variation.

5.6.2 Religion

Religion affects perceptions of monkeys as pests (see Eudey 1994; Knight 1999; Southwick *et al.* 1998; Southwick *et al.* 1983). In Buton religion is confounded by transmigrant status and crop type grown (Priston 2001). Most native Butonese are Muslim. However there is a considerable Hindu population who moved here from other islands, such as Bali, in government transmigration schemes in the early 1980s. As part of these schemes families were given a plot of land, usually a rice field, and a small house. Hence the majority of paddy fields belong to the non-native Hindu population, not the Butonese

Muslims. Thus transmigrant status and religion were related (p << 0.001, Fisher's exact test). Of the 154 respondents, all the Hindus but only 15 of the Muslims were transmigrants (Table 5.4). Of these 15, some were originally Hindus from Bali who had married into a Muslim family, but others had migrated from different parts of Sulawesi or Java.

Table 5.4 Farmers' religion against transmigrant status

Religion		Part of transmigrant Program		Total
		Yes	No	
Muslim	Observed	15	93	**108**
	Expected	42.8	65.2	
Hindu	Observed	46	0	**46**
	Expected	18.2	27.8	
Total	Observed	**61**	**93**	**154**

Hindus were more likely to grow rice of any type (?^{2} = 55.32, df = 3, p << 0.001) and wet-field rice particularly (p << 0.001, Fisher's exact test). As expected, transmigrants were also more likely to grow rice of any type (?^{2} = 81.16, df = 3, p << 0.001) and particularly wet-field rice (p << 0.001, Fisher's exact test).

The villages of Wakalambe and Wakangka had large Hindu communities, whereas all farmers in LaBundo Bundo and Kawelli were Muslim (Table 5.5). This may explain some of the differences among the villages in terms of perceptions, and measured damage.

Table 5.5 Percentage of Muslim, Hindu and transmigrated farmers in each village

Village	Number of Farmers	Percentage Muslim	Percentage Hindu	Percentage Transmigrant
Kawelli	31	100	0	0
Wakangka	44	57	43	45
Wakalambe	48	44	56	85
LaBundo Bundo	32	100	0	0

Monkeys raided rice fields much less frequently than dry-land crops (pers. obs. and interview respondents), therefore Hindus were less likely to experience problems with crop damage from monkeys. More Muslim farmers perceived monkeys as a problem than did Hindus ($p << 0.001$, Fisher's exact test); in fact only two Hindu farmers said they felt monkeys were a problem. Many said that this was because they farmed rice and their farms were too far from the forest to be bothered by monkeys, although some said it was due to their culture of dog-keeping,

"Monkeys are scared because we keep dogs, Balinese have dogs so monkeys don't come to paddy field"

"Dogs guard until they're dead, and chase monkeys until they're dead. Local people look after their farm every day but if Balinese people have a farm we don't need to guard because the monkey knows we have dogs. A long time ago monkeys used to be big problem, so the Balinese got very cruel and killed them so now they know not to come here."

Muslims were more likely to rate the problem of monkeys as serious or very serious (?^{2} = 61.44, df = 4, $p << 0.001$), whereas most Hindus said there was no problem or that it was not serious. Only one Hindu farmer considered the problem very serious and this was someone who grew coconut, cocoa and banana, as well as wet-rice and whose farm was 1km from the village and only 50m from the forest (Table 5.6). This farmer highlights a number of confounding factors.

Table 5.6 Farmers' religion against their perception of the severity of monkey crop-raiding in their farms

Religion		**How bad is the problem?**					**Total**
		No Problem	Not Serious	Fairly Serious	Serious	Very Serious	
Muslim	Observed	27	23	13	18	27	**108**
	Expected	49.1	17.5	9.1	12.6	19.6	
Hindu	Observed	43	2	0	0	1	**46**
	Expected	20.9	7.5	3.9	5.4	8.4	
Total	Observed	**70**	**25**	**13**	**18**	**28**	**154**

Farmers were asked for their opinion of the monkey. This was an open question, but responses were coded into pre-defined responses. Farmers were also asked why they felt that way. All comments made by the farmers were recorded and the adjectives expressed about monkeys used to further explore attitudes (see chapter 2 and appendix 1 for questionnaire). Muslim farmers tended to express hatred for the monkeys, although a large number claimed to like and dislike them, whereas most Hindu farmers liked the monkey (?^{2} = 32.60, df = 5, p << 0.001).

Table 5.7 Religion of the farmers against their opinion of the monkeys

Religion		Opinion of Monkeys						Total
		Hate	Dislike	Like and Dislike	Like	Love	No Opinion	
Muslim	Observed	42	15	24	14	7	6	**108**
	Expected	31.6	17.5	21.0	25.2	5.6	7.0	
Hindu	Observed	3	10	6	22	1	4	**46**
	Expected	13.4	7.5	9.0	10.8	2.4	3.0	
Total	Observed	**45**	**25**	**30**	**36**	**8**	**10**	**154**

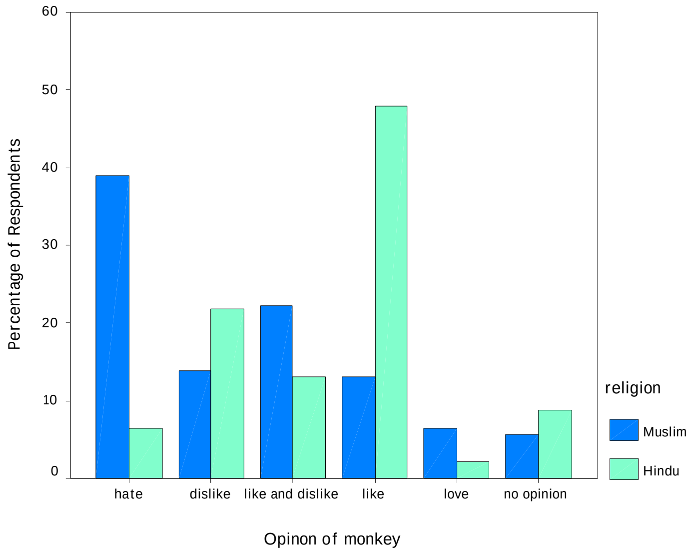


Figure 5.2 Opinion of the monkey expressed by Muslim (N = 108) and Hindu (N = 46) farmers (percentage of respondents)

Twenty six percent of farmers said that monkeys were in some way 'like humans'. No Muslim farmers admitted to eating monkeys; however 22% of Hindu respondents said they ate monkeys. This seemed surprising as greater tolerance was expected from Hindus owing to the worship of the monkey god; Hindus were more likely than Muslims to kill monkeys if given the chance, despite the fact that monkeys do not damage their crops. Monkeys were often killed in the forest, when people were hunting for pig. Muslims, by contrast, claimed monkeys were like humans and needed food, therefore despite hating them, they did not want to kill them and certainly would not eat them as they considered them to be '*Haram*'. Attitudes towards the monkeys will be addressed in more detail in section 5.13.

"Monkeys are very like humans, but monkeys damage crops. But in my heart I like monkeys, it's hard for me – I like and dislike them… if you don't want monkeys to damage crops, don't make a garden!".

"I like monkeys when not in the farm – clever and funny".

"I realise the monkey is hungry, so I just have to guard all day, everyday, I don't want to kill them". (Quotes from Muslim farmers)

5.6.3 Gender

Gender is an important predictor of attitudes to wildlife (Bell 1984a; Gillingham and Lee 1999; Hill 1998) and women and children are often less successful at deterring raiding primates (Hill 2000; King and Lee 1987; Naughton Treves 1998a, b; Priston 2001; Strum 1994). Sixty percent of the respondents in this study were male. There was no effect of gender on the frequency of perception of monkeys as a problem (p = 0.43, Fisher's exact test), or of the severity of the problem ($?^{2} = 2.28$, df = 4, p << 0.68). More women than men claimed to dislike monkeys and fewer women said they liked and disliked monkeys than men, although this was not highly significant ($?^2 = 10.9$, df = 5, p = 0.053).

"I really hate monkeys, they are my enemy, I can't sleep because monkey eats my crops"

"They come right up to the house in the village – very very very serious – sometimes they chase us, we're scared."

"I dislike monkeys, scared of them, they scratch and growl".

Thirty percent of women said they were scared of monkeys, compared to only 18% of male respondents. Twice as many men as women (20%) claimed to want to kill monkeys but interestingly men were three times were more likely than women to describe monkeys as like humans (p = 0.002, Fisher's exact test). Twenty one percent of men described monkeys as thieves, and only 10% women did. Obviously the effects of religion are not considered here but will be discussed again using a multivariate approach.

5.6.4 Age

If the problem of monkeys as pests has altered over time, the age of respondents may affect their responses. Tolerance may also change with age. Respondents ranged from 15 to 100 years (self-reported ages), although most were aged about 40. T-tests and one-way ANOVAS were used to see if perceptions varied with age. Age was unrelated to whether farmers considered monkeys to be a problem (t = 1.45, df = 153, p = 0.15), the perceived severity (F = 1.03, df = 4, 151, p = 0.39) or opinion of the monkey (F = 1.36, df = 5, 150, p = 0.25). Those farmers who described monkeys as their enemy tended to be older, with a mean age of 51 (± 16.5), compared to those who did not (39 ± 14.8) (t = -2.37, df = 153, p = 0.04).

Mean reported residence in the village was 26 years, ranging from under a year to 90 years. Data were logged and outliers (over 70 years' residence) excluded to normalise data. Residence influences perceptions of pests (Gillingham and Lee 1999) such that problems may seem worse to a new villager than someone who has grown up with it. In fact, the reverse was seen. Those claiming monkeys were not a problem had been in the village 20 years (± 10) on average, whereas those perceiving a problem had lived there for 25 years (± 16) (t = -2.23, df = 140, p = 0.037), but both groups had resided there for a long time. There was no significant difference in perceptions of severity with residence (F = 1.50, df = 4, 144, p = 0.203); those claiming no problem had been resident in the village for 41 (± 12.5) years compared to 32.7 (± 10.98) for those who felt it was very serious (Figure 5.3).

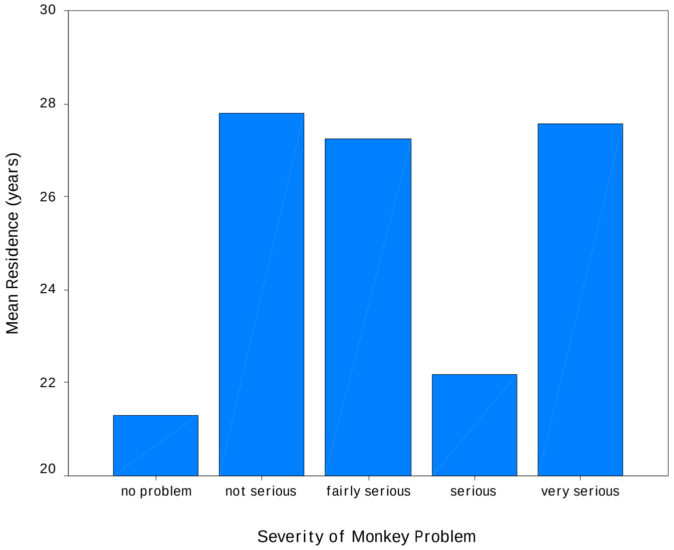


Figure 5.3 Mean duration of residence for respondents against perceived severity of the monkey crop-raiding problem

Differences existed in opinions of the monkey with duration of residence (F = 2.24, df = 5, 143, p = 0.04). Although the pattern is not clear, there is a trend towards greater polarisation of opinions with longer residence (Table 5.8). Those respondents who liked and disliked monkeys were resident for 19 years, and duration of residency increased for those who disliked monkeys, increasing further still for those who hated monkeys. A similar trend was seen for those farmers who liked and disliked, to liked and loved monkeys (Figure 5.4).

Table 5.8 Farmers' opinion of the monkey and the mean number of years they have lived in the same village

Opinion of monkey	Mean residency period in village (± SD) (yrs)	N
Hate	28.4 (± 16.9)	40
Dislike	24.7 (± 17.9)	25
Like and dislike	19.2 (± 13.5)	30
Like	21.0 (± 10.4)	36
Love	33.0 (± 11.9)	8
No Opinion	23.2 (± 17.4)	9

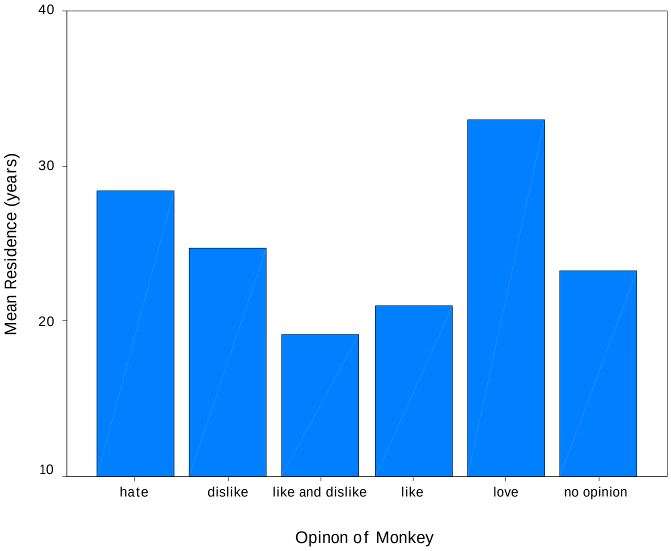


Figure 5.4 Mean duration of residence in village against opinion of monkeys

5.6.5 Occupation and Income

Income and land ownership were used as indicators of household wealth. However, as these are self-reported values there is a risk of both inaccuracy and misrepresentation. Many studies have sought to overcome this by using simple indexes of household wealth based on the level of material well-being using household possession scores (see for example Castro *et al.* 1981; Gillingham 1998; Sender and Smith 1990). A score is calculated based on the possession of specific items which are identified as indicators of wealth, through RRA discussions. Each item is then given a value based on its perceived status by the respondents relative to other items (after Gillingham 1998) and scored accordingly. The main advantage to using these scores is that they are based on definite answers to simple, factual questions (Sender and Smith 1990) or direct observation of the items. The items scored are listed in Table 5.9. Initially the power source utilised (for example kerosene, solar power, mains electricity, and generator) was included but could not be used owing to systematic differences in access to these. Wakalambe and Wakangka were connected to rudimentary mains electricity; solar panels were donated through a NGO to villagers in Kawelli and LaBundo Bundo and so on. The only item considered was ownership of a working generator as discussions revealed these to be prized items despite owning solar panels or being on the mains. As well as the items listed below a score was also given for overall house quality. This was added when it became clear some respondents had built expensive houses some years earlier but were no longer able to maintain them. A score was given from 1 – 5 (poor, below average, average, above average and excellent) for house condition.

Table 5.9 Items used for calculation of household possession score, the perceived importance of each item and the score

	Item	Perceived, relative importance to respondents (based on RRA discussions)	Score
House Material	Teak	Major	3
	Cement	Medium	2
	Brick	Medium	2
Flooring	Concrete	Medium	2
	Teak	Major	3
	Tile	Major	3
Roof	Iron	Medium	2
	Clay	Major	3
Door	Manufactured door	Medium	2
Livestock	More than 5 chickens or ducks	Minor	1
	Pig (Hindu) or Goat (Muslim)	Medium	2
	Cow	Major	3

Household manufactured goods	TV	Major	3
	CD/VCD player	Medium	2
	Radio/tape player	Minor	1
	Generator	Major	3

The final score was significantly positively associated with reported total income (r = 0.392, N = 138, p << 0.001) and reported amount of land owned (r = 0.445, N = 154, p << 0.001). Therefore reports of income and land ownership will be used as indicators of household wealth since they appear to be a reflection of respondents' general socio-economic standing in the study villages.

The main income was derived from farming for 74% of respondents. The remaining 26% also owned farms but this was not their main source of income (Table 5.10).

Table 5.10 Occupation providing respondents with their main income, against the mean income for each occupation and the average amount that farming contributes to that total income. N.B. £1 ~ 15,000 Indonesian rupiah at the time of the study.

Occupation which provides main income	Number of Respondents	Total Average Income (Indonesian Rupiah (rp))	Income from farming alone (rp)
Farming	117	2,062,864	1,683,689
Fishing	1	300,000	40,000
Working for conservation organization (local guides)	6	2,650,000	700,000
Forest products	1	3,000,000	600,000
Livestock	2	3,825,000	250,000
Odd job	2	4,250,000	1,000,000
Brick making	1	4,600,000	1,000,000
Rattan/wood collecting	6	4,780,000	924,000
Clothes trader	2	5,040,000	790,000
Shop	1	6,000,000	1,200,000
Carpenter	2	10,350,000	1,000,000
Teacher	2	13,200,000	1,700,000
Civil service	7	13,368,571	1,065,714
Doctor	2	16,866,250	116,250

Own rice processing machine	1	23,000,000	2,000,000
Overall Mean	**138**	**3,549,402.17** **± 5,710,857.49** **(£236.63)**	**1,481,539.86** **± 2,032,179.22** **(£98.77)**

About ? of the average income was from farming (Table 5.10). Fifty six percent of respondents relied exclusively on farming for their annual income. However those relying solely on crop sales earned less from farming than those who had other incomes as well. Those who included farming as a sideline earned more from farming on average than did those who relied solely on crop sales (Table 5.11). It is likely that those farmers with income from other sources would have spare money to buy machinery, pesticides and seeds, and may also have bought their farms, so may own better or larger plots.

Table 5.11 Average annual income for all respondents, those relying on farming as their main source of income, and those relying solely on farming and data from the 12 months preceding this study

	Average annual income rp (£)	**Min. rp (£)**	**Max. rp (£)**	**Percentage of total respondents**
All respondents (N = 155)	3,549,402 (£237)	0	40,800,000 (£2720)	100
All respondents income from farming alone (N = 155)	1,327,653 (£89)	0	18,000,000 (£1200)	100
Respondents whose MAIN income is from farming (N = 114)	2,038,350 (£136)	0	27,000,000 (£1800)	74
Respondents relying on farming for total income (N = 76)	1,348,223 (£90)	0	7,200,000 (£480)	56
Respondents relying on farming plus other sources of income (N = 59)	6,546,653 (£436)	120,000 (£8)	40,800,000 (£2720)	44
Respondents relying on farming plus other income sources – contribution of farming to total (N = 59)	1,674,364 (£112)	0	18,000,000 (£1200)	44
All respondents – crop sales for 12months preceding study (N = 155)	575,038 (£38)	0	6,000,000 (£400)	100

For the 12 months preceding the study (2002) the average income from crops was much lower than usual (Table 5.11), due to bad weather and a severe rat problem (interview respondents)

Table 5.12 Average household income, income from farming and income from crop sales for the previous 12 months for each village (ANOVA comparisons, F, df = 3, 134, p * = significant at the 0.05 level)

Village	Total average income of household (rp) ± SD	Average annual income from farming (rp) ± SD	Average income from crop sales for 12 months preceding study (rp) ± SD	N
Kawelli	1937307.69 ± 2610093.57	976851.85 ± 916608.66	525257.97 ± 591924.24	26
Wakangka	2757559.52 ± 4423104.06	1061130.95 ± 1107462.79	640806.75 ± 804388.32	42
Wakalambe	4373947.37 ± 7823890.14	1448918.92 ± 1481813.42	383478.70 ± 814649.55	38
LaBundo Bundo	4919375.00 ± 5822597.77	2496875.00 ± 3442006.58	814187.37 ± 1673172.28	32
F	1.873	4.078	1.228	138
Sig. value	0.137	**0.008***	0.302	

Villages differed in average household income (Table 5.12). Annual income from farming was much higher in LaBundo Bundo than the other villages (Tamhane, $p < 0.04$). This may be due to differences in soil fertility or pest levels. Farms in Kawelli were situated on slopes and hence very difficult to farm, Wakangka and Wakalambe (with more paddy fields) had suffered from a rat epidemic for several years, as well as bad weather (pers. obs. and interview respondents). However villages also differed in the average amount of village land[1] owned per household ($F = 8.56$, df = 3, 151, $p << 0.001$) and total farmland owned ($F = 7.30$, df = 3, 151, $p << 0.001$) all of which affected income (Table 5.13). Farmers in LaBundo owned more farmland than those in other villages (Tamhane, $p < 0.04$) while households in Kawelli owned much less village land (Tamhane, $p < 0.01$).

---

[1] Village land was defined as land owned within the village rather than farm land. It was generally used for building houses.

Table 5.13 Average amount of village and farm land owned per household for each village

Village	Average amount of village land owned per household (ha)	Average total farmland owned per household (ha)
Kawelli (N = 31)	0.023 ± 0.045	0.803 ± 0.520
Wakangka (N = 44)	0.118 ± 0.165	0.806 ± 0.609
Wakalambe (N = 47)	0.147 ± 0.084	1.251 ± 0.988
LaBundo Bundo (N = 32)	0.082 ± 0.091	2.125 ± 2.535

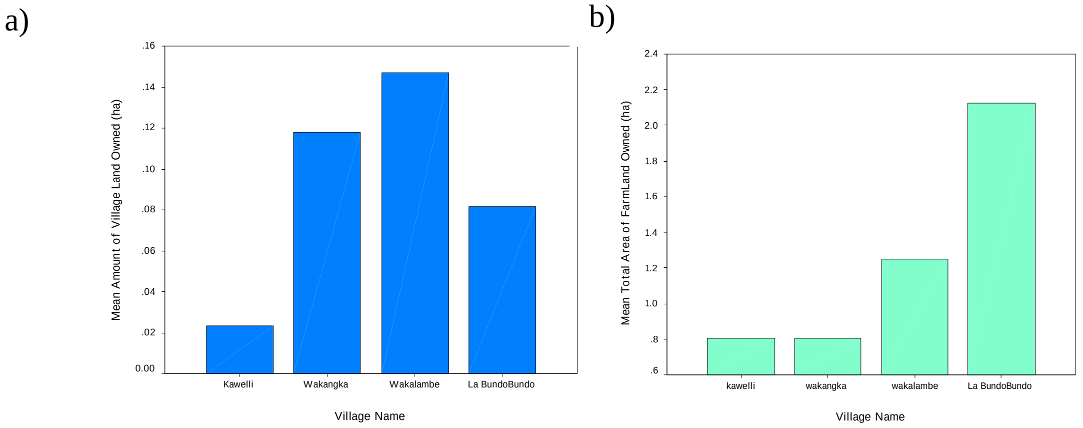


Figure 5.5 (a) Mean total area of village land owned for each village and (b) mean total farmland owned for each village

Income and amount of farm land owned were positively correlated (r = 0.176, N = 138, p < 0.039), as were total income and income from farming alone (r = 0.463, N = 137, p << 0.001) and amount of farmland and village land owned (r = 0.252, N = 154, p = 0.002), although all quite weakly.

Whether monkeys were perceived as a problem did not relate to total income (t = -.97, df = 136, p = 0.333), income from farming (t = 0.77, df = 136, p = 0.440,) or total amount of farm land owned (t = - 0.38, df = 152, p = 0.705). However, those who felt monkeys were a problem owned less village land (t = 4.69, df = 152, p << 0.001). The severity of the problem was also related to amount of village land owned (F = 5.35, df = 4, 150, p << 0.001), those owning least felt monkeys were a very serious problem (Table 5.14). This is interesting as amount of village land owned is positively correlated with amount of farmland owned. Once again, perceptions are related to human factors rather than factors which affect monkey behaviour, such as farm size. Overall opinion of the monkeys, whether they were liked or disliked, did not relate to any of the measures of income or land ownership.

Table 5.14 Farmers' perception of the monkey as a problem and the severity of that problem against amount of village land owned

	Are monkeys a problem?		How bad is the problem?				
	Yes	No	No problem	Not serious	Fairly serious	serious	Very serious
Amount of Village land owned (Ha)	0.058 ± 0.075	1.335 ± 1.339	0.132 ± 0.138	0.111 ± 0.113	0.099 ± 0.089	0.059 ± 0.068	0.038 ± 0.064

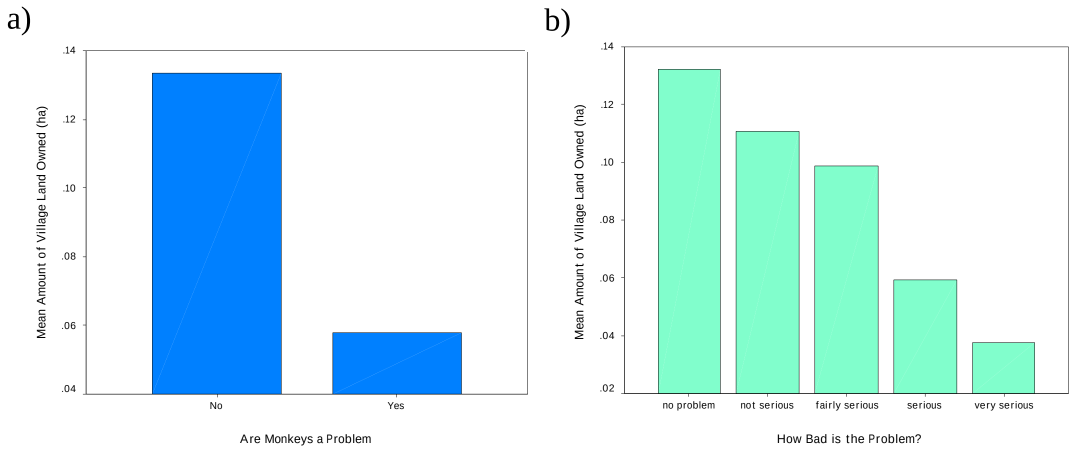


Figure 5.6 (a) Mean amount of village land out and whether monkeys are perceived as a problem and (b) amount of village land owned and the perceived severity of the monkey problem

Specific opinions of the monkeys given by the respondent are presented in Table 5.15. Only those opinions which were significantly related to income or land ownership have been presented (see appendix 7 for a full list of all opinions expressed). Farmers with less village land said they pitied the monkeys and also thought they were clever.

> *"I pity it too much to kill it, I just let it go",*

"Hate monkeys – I want to kill but can not, do not dare, I pity monkey",

"If I caught a monkey I would release it – I pity them".

"Monkeys are too clever. Monkeys see us before we see them",

"Sometimes monkeys sneak in silently – very clever",

"Can not trap them – too clever, so hard to catch. No one wants them so no one traps them. Even if you put up a huge fence they still get in – lose money, waste of time too".

Those who described the monkey as like human had more farmland, while those who used terms such as naughty had less farmland.

"Like the human race, they need food, monkeys need food too".

"I like monkeys very much – they are like the human race, but when they damage crops I hate them".

"Monkey is an animal, but it is like human, we can kill it but we are scared because the monkey is a kind of human".

"I dislike monkeys – dirty, too naughty".

"Monkeys are naughty – come to garden, pass through sometimes".

Annual income from farming was lower for those who felt monkeys were entertaining. Those pitying monkeys received more income from farming, although on closer inspection these tended to be respondents who did not rely totally on farming ($p = 0.030$, Fisher's exact test). Those scared of monkeys and those calling them thieves or complaining that they stole crops also received more income from farming. Farmers who relied totally on farming also described the monkeys as greedy ($p = 0.035$, Fisher's exact test).

"In the field the monkey is very dangerous – big teeth, I am scared".

"Scared of them, dangerous teeth, chase us".

"Monkey is like a thief – take and run away".

> *"Monkeys just steal and run away"*.
>
> *"Monkeys steal maize! Greedy! Come all the time!"*.
>
> *"They eat everything even chilli, greedy animal"*.
>
> *"I hate monkeys because they are very greedy, destroy maize, eat all the crops"*.

Many respondents would distinguish between monkeys in the fields and monkeys in the forest which may confound the results

> *"I hate monkeys when they damage crops, in the forest I do not hate them because they do not bother me, monkey looks for food just like human"*.

ome for various opinions of the monkeys expressed by the farmers (significant at the 0.01 level, * significant at the vere significantly related to at least one of the variables are presented here. See appendix 7 for full list of opinions**

illage Land (N)		Mean Amount of Farmland owned (ha) ± SD (N)			Mean Annual income from farming (rp) ± SD (N)		
ed	t /sig.	Mention	Not Mentioned	t / sig.	Mention	Not Mentioned	t /sig.
26	**-2.93 (0.004**)**	1.63 ± 2.07 (22)	1.15 ± 1.27 (132)	NS	3715625.00 ± 4411036.11 (16)	1188545.08 ± 1231763.16 (122)	**-5.20 (<<0.001**)**
27	**2.18 (0.031*)**	1.04 ± 0.85 (45)	1.29 ± 1.59 (109)	NS	1570488.00 ± 2841053.00 (41)	1443942.00 ± 1589193.00 (97)	NS
12	NS	1.62 ± 2.12 (40)	1.07 ± 1.05 (114)	-1.94 (0.054)	2390571.00 ± 3300881.00 (35)	1172646.00 ± 1238946.00 (103)	NS
12	NS	2.27 ± 3.00 (9)	1.15 ± 1.25 (145)	**-2.04 (0.043*)**	1756250.00 ± 1407997.00 (8)	1464635.00 ± 2067201.00 (130)	NS
09	NS	1.08 ± 1.19 (35)	1.26 ± 1.48 (119)	NS	1623387.10 ± 3187538.60 (31)	1440443.93 ± 1566631.89 (107)	**-3.10 (0.002**)**
13	NS	0.98 ± 0.75 (39)	1.30 ± 1.58 (115)	NS	1342727.27 ± 1164402.40 (33)	1525166.67 ± 2239406.05 (105)	**-2.72 (0.007**)**
	NS	0.910 ± 0.676 (25)	1.275 ± 1.515 (129)	NS	1690476.19 ± 3895954.92 (21)	1444038.46 ± 1500360.58 (117)	1.87 (0.075)

5.6.6 Education

The majority of respondents had received some schooling, at least at elementary school (Table 5.16), although 16% had not been to school at all. Literacy levels were high with most respondents saying they could both read and write (Table 5.16)[2]

Table 5.16 Educational background of farmers and self-professed levels of literacy

Education level	Number of Farmers	Percentage of Farmers
No education	25	16.2
Elementary School (7 – 12 years)	76	49.4
Junior High (13 – 15 years)	28	18.2
Senior High (16 – 18 years)	22	14.2
Higher education(University/vocational training/army) (> 18 years)	3	2
TOTAL	**154**	**100**
Literacy		
None	25	16.2
A little	25	16.2
Literate	104	67.6
TOTAL	**154**	**100**

Due to small sample sizes those with higher education were grouped together with senior high school level. Everyone who had been to junior high school or above was literate, although almost 40% of those who had attended only elementary school were illiterate or only partially literate (?^{2} = 62.75, df = 6, p << 0.001). Those who had attended school to junior high level or above said they had been taught about the forest and animals at school (?^{2} = 59.82, df = 6, p << 0.001), and also been taught biology (?^{2} = 48.69, df = 3, p << 0.001). Most people said they did not learn about protecting the forest in school or from the government.

---

[2] Literacy was assessed only by asking farmers how well they could read and write. RRA discussions revealed no apparent stigma attached to illiteracy thus it was felt that this method would yield suitably accurate results. Those whose literacy is classed as 'a little' were those who could only read, or described themselves as only partially literate.

Literacy rates were lowest in Kawelli (51.6% of respondents), compared to almost 85% in LaBundo Bundo (Table 5.17) (?^{2} = 21.44, df = 6, p = 0.002) but education level did not differ among villages (?^{2} = 13.22, df = 9, p = 0.153), although sample sizes are small.

Table 5.17 Literacy rates of farmers in each village as a percentage of total farmers per village

Literacy	**Percentage of farmers (N)**				**Total N**
	Kawelli	Wakangka	Wakalambe	LaBundo Bundo	
None	9.7% (3)	25.0% (11)	14.9% (7)	12.5% (4)	**25**
A little	38.7% (12)	6.8% (3)	19.1% (9)	3.1% (1)	**25**
Literate	51.6% (16)	68.2% (30)	66.0% (31)	84.4% (27)	**104**
Total N	**31**	**44**	**47**	**32**	**154**

Literacy, amount of land and income were related (Table 5.18) but post-hoc tests did not reveal where these differences lay; suffice it to say that those who were literate tended to have more land and income. Interestingly in terms of land ownership, those who were either illiterate or literate owned more than those who were only partially literate. There may be confounding factors such as the literacy of other family members or village differences, but this difference in land ownership may also indicate some sort of disadvantage for those who are only partially literate. Those with some skills tended to try to find work outside farming (interview respondents) but for those with poor literacy, such jobs tended to be as labourers or basic clerks in the headman's office which did not earn them enough to buy extra land. Those who were illiterate focused on farming and would invest in extra land when they could, or attempted to accrue as much as possible. Those who were fully literate had higher income from other jobs such as civil service jobs, and more disposable income to buy extra land.

Table 5.18 Literacy against measures of land ownership (ANOVA comparisons F, df = 2, 151, p) and income (F, df = 2, 135, p) (significant at the 0.01 level, * significant at the 0.05 level)**

(N)	**Literacy**			**F**	**Sig.**
	None	A little	literate		
Mean amount of village land owned (ha) ± SD	0.098 ± 0.089 (25)	0.070 ± 0.082 (25)	1.079 ± 1.300 (104)	2.47	0.088
Mean amount of farmland owned (ha) ± SD	1.055 ± 0.719 (25)	0.675 ± 0.454 (25)	1.38396 ± 1.646 (104)	3.54	**0.032***
Mean total annual income (rp) ± SD	1560000.00 ± 1933553.35 (23)	2223157.89 ± 3563765.26 (19)	4260386.60 ± 6448079.31 (96)	7.95	**0.001****
Mean annual income from farming (rp) ± SD	917391.30 ± 992999.21 (22)	944473.68 ± 1056914.92 (19)	1722994.79 ± 2306919.84 (97)	4.00	**0.021***

Low literacy tended to be associated with low and variable income, while high literacy was associated with higher (and possibly less variable) income. Level of education was unrelated to amount of land owned, although income does vary as a function of education level (Table 5.19). However, there may be confounding factors such as age, as older people tended not to have continued on in education (pers. obs.). This will be investigated in the multivariate analysis. Farmers with no education earned significantly less money from farming than those who went to junior high school (Tamhane's, p = 0.025) and those who continued to higher education earned slightly less from farming than those who did not. This may be due to the reduction in farming effort for those who have gone to university and the fact that they have other, full time jobs.

Table 5.19 Level of Education against measures of land ownership (ANOVA comparisons, F, df = 3, 150, p) and income (F, df = 3, 134, p) (significant at the 0.01 level, * significant at the 0.05 level)**

(N)	**Education level**				**F**	**Sig.**
	Nothing	Elementary School (7 – 12 years)	Junior High (13 – 15 years)	Senior High (15 – 18 years) and above (University, Vocational training, army 18+ years)		
Mean amount of village land owned (ha) ± SD	1.07 ± 0.090 (25)	0.99 ± 1.139 (76)	0.98 ± 0.94 (28)	0.98 ± 0.98 (25)	0.18	0.910
Mean amount of farmland owned (ha) ± SD	0.910 ± 0.690 (25)	1.103 ± 0.854 (76)	1.3510 ± 2.526 (28)	1.534 ± 1.590 (25)	0.74	0.531
Mean total annual income (rp) ± SD	3843333.33 ± 8854318.34 (21)	2625514.71 ± 4030628.37 (68)	5217187.50 ± 7257081.60 (24)	4214400.00 ± 4390689.09 (25)	3.04	**0.031***
Mean annual income from farming (rp) ± SD	699545.45 ± 963656.12 (21)	1554477.67 ± 1427839.00 (67)	2238854.22 ± 3777690.90 (24)	1247200.02 ± 1507480.00 (25)	6.46	**<<0.001****

Levels of literacy did not differ with gender (?^{2} = 3.00, df = 2, p = 0.223) or religion (?^{2} = 4.77, df = 2, p = 0.092). Men and women also seemed to have received the same level of schooling since education did not differ by gender (?^{2} = 2.58, df = 3, p = 0.461), but differences did exist between Muslims and Hindus (?^{2} = 16.78, df = 3, p = 0.001). Fewer Muslims (13.9%) than Hindus (21.7%) had no education, and fewer Hindus continued past junior school level (44.4% Muslims vs. 10.9% Hindus).

No significant differences were found between levels of education or literacy and perceptions of monkeys as a pest, the perceived severity of monkey problems, or liking or disliking of monkeys. No relationship was found between education or literacy and adjectives used to describe the monkeys. Although those who had attended senior high school or above were somewhat more likely to describe monkeys as cunning (?^{2} = 9.54, df = 5, p = 0.023) or funny (?^{2} = 7.63, df = 5, p = 0.054).

5.7 PERCEPTIONS OF PEST SEVERITY

Farmers were asked which pests damaged their crops (Table 5.20) and to rank them according to pest severity (Figure 5.7). The top three most cited crop pests were pig, monkey and rat, although other pests were also cited frequently. The rat was the most commonly cited crop pest and was ranked as the most severe. As mentioned above (section 5.6.5), this response may be due to a particularly bad year concerning rats as pests according to the farmers. In fact *Rattus argentiventer*, the common rice-field rat, was recorded in forest traps near the farms for the first time in 2002 (Grimwood, pers. comm.); in previous years this species had not been seen. This suggests that there may have been increased numbers in farmland in the year of this study (2002). The monkey is the 3rd most commonly cited pest species, although the number of farmers citing it dramatically dropped between 2000 and 2002 (Table 5.20). This may also reflect the composition of the sample; the data from 2000 had a smaller proportion of Hindu (23% compared to 30%) and therefore rice farmers, although this difference is quite small.

Table 5.20 Animals cited by farmers as crop pests and the percentage of farmers citing each species compared to the pilot study *NB Disease and predators (to chickens/eggs) have been included as they were cited by farmers as the biggest problem on their farms.

Animals cited as crop pest	% farmers citing species as crop pest in present study, 2002 (N = 154)	% farmers citing species as crop pest in pilot study, 2000 (N = 310)
Rat	88.4	90.0
Pig	63.2	98.4
Monkey	53.9	88.7
Insects	50.6	21.3
Bird (parrot/munia)	28.4	35.2
Snail	12.9	3.9
Bat	9.0	5.5
Squirrel	9.0	6.1
Disease*	4.5	n/a
Livestock	1.9	n/a
Deer	0.6	3.2
Predators*	0.6	n/a

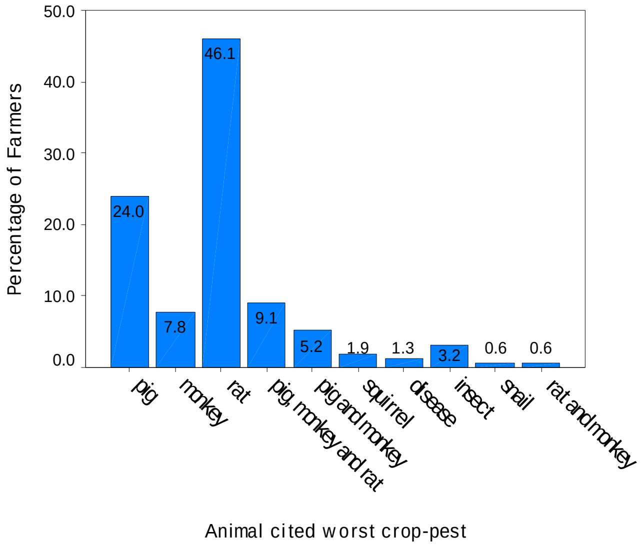


Figure 5.7 Percentage of farmers ranking each animal as 'worst pest' NB. Disease is also included as this was ranked as the worst problem by some farmers in answer to this question

When the 'worst pest' rankings are divided by religion, a clear effect emerges (?^{2} = 54.50, df = 6, p << 0.001). Hindu farmers, almost unanimously, considered rats to be the worst crop pest, unsurprising given their dependence on rice farming. Muslim farmers however considered pigs to be the biggest problem.

Table 5.21 Number of farmers citing each animal as the worst pest divided by religion of farmers

Worst Pest	**Number of Farmers Citing Animal**		
	Muslim	Hindu	**total**
Rat	30	41	**71**
Pig	36	1	**37**
Monkey	12	0	**12**
Pig, Monkey and Rat	14	0	**14**
Pig and Monkey	8	0	**8**
Rat and Monkey	1	0	**1**
Other (inverts, birds, bats, etc)	7	4	**11**
TOTAL	**108**	**46**	**154**

Muslim and Hindu farmers differed in those animals that they considered as 2nd (?^{2} = 41.57, df = 4, p << 0.001) and 3rd (?^{2} = 27.77, df = 5, p << 0.001) most serious pests as well (Table 5.22), which again reflects their reliance on different crops; insects and rats are a far greater problem for rice farmers, whereas pigs and monkeys are more of a problem for garden crops.

Table 5.22 The most frequently cited animals as worst, 2nd worst and 3rd worst crop pest by farmers. Number of farmers citing each pest is in brackets

Religion	**Worst Pest (N)**	**2nd Worst Pest (N)**	**3rd Worst Pest (N)**
Muslim	Pig (36)	Monkey (25)	Rat (26)
Hindu	Rat (41)	Insect (34)	Pig (7)

Each species was given a score based on their rankings by farmers. If ranked as 'worst pest' the species received three points, if ranked as 'second worst' two points, and if joint worst pest the species would score 0.5 each (if there were two joint) or 0.33 each (if there were three joint). If not ranked in the top three by an individual, the species would receive zero. This enabled an overall pest score to be calculated by summing these values across all respondents (Table 5.23). This took into account individual perceptions of ranks, so as to avoid the problem of certain species rarely being considered the most serious pest but always being ranked 2nd or 3rd, and therefore potentially being serious for the farming community at large. Once again, in general, rats were the biggest problem, followed by pigs and monkeys. It is worth noting that monkeys and insects assume roughly similar ranks.

Table 5.23 Overall pest score for each species

Species	Overall pest score
Rat	286.2
Pig	178.7
Monkey	117.7
Insect	112.0
Other (deer, squirrel, disease, bats)	70.0
Snail	24.0
Birds	15.0

Farmers were asked why a species was considered to be the worst pest. Of those farmers who reported monkeys (N = 33) the most common reason for citing monkeys was because they ate everything or were greedy (48.5% of farmers). They were also considered to be worst because they were difficult to stop or they climbed fences (36.4%), were clever (9.1%) or were regarded as thieves (6.0%). This was in common with Hill's (1997) findings for crop-raiding baboons in Uganda. Pigs however were generally considered to be the worst pest because they came at night (66%), and destroyed the entire crop whether it was ripe or not (20%). Like monkeys they were reported to be difficult to stop and could break through the fence (14%). Rats were thought to be too numerous, small and difficult to stop (77.5%), were expensive to stop (15.5%) and would eat everything (7%). All three pests were reported to be hard to stop, however it was only the monkey which was attributed with intelligence or almost malicious intent, with farmers describing the monkeys as greedy or as thieves.

5.8 FARMERS PERCEPTIONS OF MONKEY BEHAVIOUR AND GROUPS

Farmers were asked about the number of monkeys in the forest surrounding their village and farmland. These responses differed by village (Table 5.24). Wakangka reported the most groups of monkeys, while Kawelli reported the greatest number per group and overall (Scheffe, $p < 0.001$), although estimates of numbers were increased by some very large, and unlikely, suggestions of 1000 monkeys in a group. The perception of farmers in Kawelli was that there appeared to be many more monkeys than exist; this may be the result of the high degree of damage this village suffered (see chapter 4, section 4.3.6). Farmers were asked how long monkeys spent in the farms (on average) per raid. During RRA discussions, it became clear that farmers divided raids into those when people were present on the farm, working or guarding and those when people were either not there or not paying attention. LaBundo had the longest raid duration by monkeys when people were present, while Kawelli had the longest raid duration when people were not there or not paying attention (Tamhane's, $p < 0.007$). Raids were reported to be most frequent in Kawelli (Tamhane's, $p << 0.001$).

Table 5.24 Mean values for various 'monkey variables' reported by farmers in villages (ANOVA comparisons, F, df = 3, N - 4, p)

Village	No. monkey groups	No. of monkeys in a group	Total no. of monkeys	Time spent in the fields (no people present) (mins)	Time spent in fields (people present) (mins)	Frequency of raids per day	Frequency of raids per week	No. of monkeys raiding
Kawelli	11.9 ± 21.0	109.5 ± 241.9	1153.6 ± 2806.7	33.9 ± 27.2	7.4 ± 13.7	2.3 ± 0.9	12.8 ± 8.2	26.3 ± 18.8
Wakangka	19.2 ± 27.2	38.0 ± 27.6	820.5 ± 1407.5	9.8 ± 17.9	1.4 ± 4.6	0.4 ± 0.6	1.3 ± 3.5	6.9 ± 17.5
Wakalambe	11.9 ± 16.4	30.5 ± 23.9	335.8 ± 466.5	0.5 ± 2.0	0.1 ± 0.4	0.2 ± 0.5	0.3 ± 0.7	1.1 ± 3.2
LaBundo Bundo	2.8 ± 2.6	53.0 ± 90.6	169.0 ± 383.6	5.1 ± 13.1	21.9 ± 27.4	1.0 ± 0.5	3.0 ± 4.3	24.9 ± 28.2
Total N	125	143	140	147	153	153	153	153
F	10.681	4.299	8.586	38.814	35.794	72.257	80.865	57.082
Sig.	**<< 0.001**	**0.006**	**<< 0.001**	**<< 0.001**	**<< 0.001**	**<< 0.001**	**<< 0.001**	**<< 0.001**

Overall, farmers in Kawelli reported suffering the most from raiding, with more monkeys, more frequent raiding and longer spent in the farms. The farmers in LaBundo also reported longer raids, even when people were present, and a large number of raiding monkeys. As expected the reported frequencies and raid durations for Wakangka and Wakalambe were low, mainly due to the large proportion of rice farmers.

Although estimates of numbers from the farmers seem unrealistically high in certain cases (e.g. 12,500 monkeys around Kawelli), the majority of responses and variables tally well with personal observations and attempted counts made in the villages. Kawelli did indeed suffer the greatest amount of raiding and at least three troops regularly raided the farms there. Although some groups were instantly recognisable, for example, one troop contained a female and male with white heads and another had a very grey female (Figure 5.8), many were not, and since they did not always forage as a single unit, there is ample room for confusion. Some farmers were extremely accurate in their estimates of group sizes and duration of raiding. Twenty two percent of farmers said there were two types of raids; either only one monkey, or almost the entire group. Six percent said monkeys passed through their fields but did not damage them.

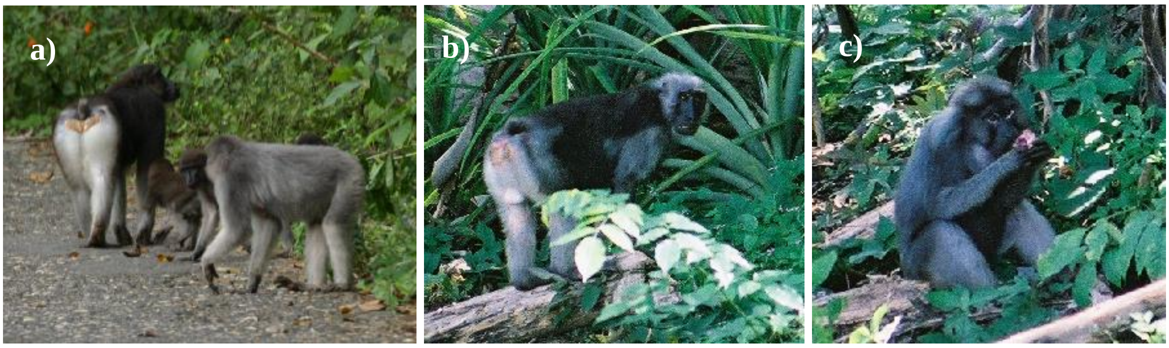


Figure 5.8 Very grey adult female from one troop (a) and adult male with grey head from another troop (b). Adult female with grey patches on head and rings around eyes from same troop as the male (c)

Farmers were asked what time of the day monkeys raided and this was divided into morning (6am – 11am), midday (11am – 2pm) and afternoon (after 2pm) to correspond with the Indonesian time periods of *pagi*, *siang* and *sore*. Of those farmers who reported monkeys passing through or raiding their fields (N = 86), most (52%) said monkeys raided anytime, while afternoon raids were reported to be infrequent (1%) (Figure 5.9). These reports will be compared to the observations of raiding in (chapter 6 section 6.6.2).

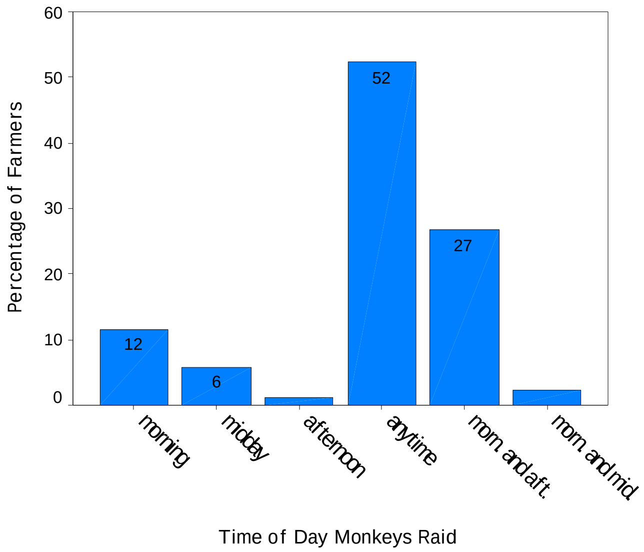


Figure 5.9 For farmers who experience raiding the percentage of those reporting monkeys raiding at various times of the day

Many of the reported monkey variables were, unsurprisingly, correlated (Table 5.25). When farmers reported larger numbers of monkeys they also stated that monkeys spent less time in the fields when people were present, but more time when people were not in the farm or were not paying attention. Reported frequency of raids per day and week were strongly positively correlated with reported duration of raiding and numbers of monkeys raiding. The rank of the monkey as a pest was positively correlated with reported frequency of raids, number of raiding monkeys and time in the fields.

Table 5.25 Correlations of farmers reports of numbers of monkeys and frequency of raiding (significant at the 0.01 level, *significant at the 0.05 level)**

	No. of monkeys in a group	Total no. of monkeys	Time spent in the fields (no people present) (mins)	Time spent in fields (people present) (mins)	Frequency of raids per day	Frequency of raids per week	No. of monkeys raiding	Rank of monkey (measure of pest rank)
No. monkey groups	0.147	**0.822****	-0.103	**-0.332****	**-0.204***	-0.143	**-0.258****	**-0.179***
No. of monkeys in a group		**0.654****	**0.224****	0.015	**0.207***	**0.234****	**0.259****	**0.167***
Total no. of monkeys			0.064	**-0.245****	-0.027	0.036	-0.053	-0.056
Time spent in the fields (no people present) (mins)				**0.429****	**0.728****	**0.715****	**0.688****	**0.516****
Time spent in fields (people present) (mins)					**0.530****	**0.477****	**0.617****	**0.547****
Frequency of raids per day						**0.900****	**0.837****	**0.591****
Frequency of raids per week							**0.770****	**0.547****
No. of monkeys raiding								**0.581****

5.9 PERCENTAGE DAMAGE

Reported estimates of percentage damage were compared to the measures of damage in the farms in chapter 4. Here I investigate how perceptions of damage relate to perceptions of the monkeys and attitudes towards them, in the context of other socio-demographic factors. It was predicted, as was found in the pilot study (Priston 2001), that perceived damage would be a function of religion, transmigrant status, farm size and location, crop type, worst reported pest and the numbers and patterning of monkey raiding.

Farmers were asked for their estimates of damage by monkeys, both at the time of interview and also for an estimate for total loss over the previous 12 months (see chapter 4). Perceived damage ranged from 0 – 90% for current damage and 95% for annual damage, with overall means of 8.7% current damage and 12.5% annual. Reported estimates of present percentage damage and reported annual percentage damage were positively correlated ($r = 0.699$, $N = 154$, $p << 0.001$), however since r^2 is less than 0.50 (0.49) the two can be analysed separately, although the significance values must be raised to 0.025 as the same set of data are contributing to two separate tests (Bonferroni correction for repeated tests[3]).

A large number of respondents reported zero damage and thus the distribution was non-normal, even after log-transformation. It was predicted that those who reported zero damage would be homogeneous with respect to certain socio-economic factors. Thus perceptions of damage were re-coded into no-damage and damage groups to explore overall damage.

---

[3] Bonferroni correction states that if testing n independent hypotheses, a significance level of 0.05/n should be used. Thus for two independent hypotheses a result would be declared significant only if $p < 0.025$.

Table 5.26 Categorical socioeconomic factors against the number of farmers perceiving present damage versus no damage (* significant at the 0.025 level)

Variable		**Number of Farmers (N = 154)**		**?^{2}**	**Sig.**
		No Damage	**Damage**		
Village	Kawelli	5	13	51.49	<< **0.001***
	Wakangka	36	5		
	Wakalambe	42	8		
	LaBundo Bundo	19	26		
Gender	Male	59	33	0.45	0.603
	Female	43	19		
Religion	Hindu	45	1	29.27	<< **0.001***
	Muslim	57	51		
Part of transmigrant program	Yes	47	5	29.53	<< **0.001***
	No	46	56		
Literacy	None	16	9	3.05	0.218
	A little	13	12		
	Literate	73	31		
Education	Nothing	17	8	1.67	0.644
	Elementary	53	23		
	Junior high	18	10		
	Senior high and above	14	11		
Wet rice grown?	Yes	72	9	39.22	<< **0.001***
	No	30	43		
Farming main income?	Yes	79	35	1.84	0.180
	No	23	17		

Table 5.27 Mean values for continuous socioeconomic factors against farmers who perceive present damage and those who don't (t, df, p *significant at the 0.025 level)

Variable	**Mean percentage damage ± SD (N)**		**t**	**df**	**Sig.**
	No Damage	**Damage**			
Age	40.28 ± 13.90 (102)	39.73 ± 17.33 (52)	0.62	150	0.536
Years in village	23.89 ± 15.89 (102)	30.49 ± 21.25 (52)	-0.86	150	0.391
Amount of village land owned (ha)	0.12 ± 0.13 (102)	0.07 ± 0.09 (52)	3.12	150	**0.002***
Total amount of farmland owned (ha)	1.13 ± 1.24 (102)	1.39 ± 1.72 (52)	-0.83	150	0.406
Total annual Income (rp)	2887663.04 ± 4043072.52 (92)	4872880.43 ± 7971780.40 (46)	-1.17	136	0.244
Annual income from farming (rp)	1395439.56 ± 1347867.17 (91)	1648244.68 ± 2949901.20 (47)	1.67	136	0.101

Those farmers perceiving no present damage or annual damage shared the following features – they were generally Hindu, rice-farmers, who were part of the transmigrant program, living in Wakalambe or Wakangka (Table 5.26 and Table 5.28). They also owned more land in the village than did those who perceived any current damage (Table 5.27 and Table 5.29), once again demonstrating that perceptions are related to human factors rather than as a function of monkey behaviour

Table 5.28 Categorical socioeconomic factors against the number of farmers perceiving annual damage versus no damage (* significant at the 0.025 level)

Variable		**Number of Farmers (N = 154)**		**?^{2}**	**Sig.**
		No Damage	**Damage**		
Village	Kawelli	0	31	78.72	<< **0.001***
	Wakangka	35	9		
	Wakalambe	45	5		
	LaBundo Bundo	10	22		
Gender	Male	51	41	0.10	0.868
	Female	36	26		
Religion	Hindu	44	2	40.92	<< **0.001***
	Muslim	43	65		
Part of transmigrant program	Yes	55	6	46.59	<< **0.001***
	No	32	61		
Literacy	None	14	11	3.48	0.176
	A little	10	15		
	Literate	63	41		
Education	Nothing	16	9	2.96	0.397
	Elementary	46	30		
	Junior high	13	15		
	Senior high and above	12	13		
Wet rice grown?	Yes	69	12	57.23	<< **0.001***
	No	18	55		
Farming main income?	Yes	66	48	0.35	0.582
	No	21	19		

Table 5.29 Mean values for continuous socioeconomic factors for farmers who perceive annual damage and those who do not (* significant at the 0.025 level)

Variable	Mean percentage damage ± SD (N)		t	Sig.
	No Damage	Damage		
Age	41.2 ± 13.7 (87)	38.7 ± 16.7 (67)	1.47	0.143
Years in village	28.9 ± 14.9 (87)	28.9 ± 21.3 (67)	-0.29	0.769
Amount of village land owned (ha)	0.13 ± 0.13 (87)	0.06 ± 0.08 (67)	4.13	<< **0.001***
Total amount of farmland owned (ha)	1.14 ± 1.26 (87)	1.32 ± 1.60 (67)	-0.50	0.617
Total annual Income (rp)	2934740.26 ± 4191269.74 (77)	4325286.89 ± 3549402.17 (61)	-1.37	0.172
Annual income from farming (rp)	1299276.32 ± 1308656.23 (76)	1704959.68 ± 2660312.31 (62)	1.27	0.207

Although Hindus, rice farmers and transmigrants tended to perceive no damage, this does not account for all those who perceived no damage. For example, approximately 50% of Muslims perceived no damage as well. Similarly, of those who were not transmigrants or who did not grow rice approximately 30% also perceived no damage. Attitudes and perceptions of damage are clearly more complex than merely a by-product of crops grown. Although farmers vary in their accuracy of estimates of damage, perhaps social factors such as distance to village are more predictive than are geographic or crop factors (chapter 4 section 4.3.3).

Since Hindus perceived no damage and also tended to be transmigrants and rice farmers living in Wakangka and Wakalambe (see section 5.6.2), they have been excluded from the following analysis in order to explore other factors that might affect perceived damage. In this data set (log-transformed for normalisation) mean present damage is now 12.1% and annual damage is 17.6% (N =107).

Reported present and annual damage were not correlated with age, years resident in village or any measures of income or land ownership with the exception of amount of village land owned (present r = -0.195, p = 0.008, annual r = 0.270, p = 0.005) (Figure 5.10a and b). Those perceiving zero damage showed no obvious pattern in relation to amount of land owned.

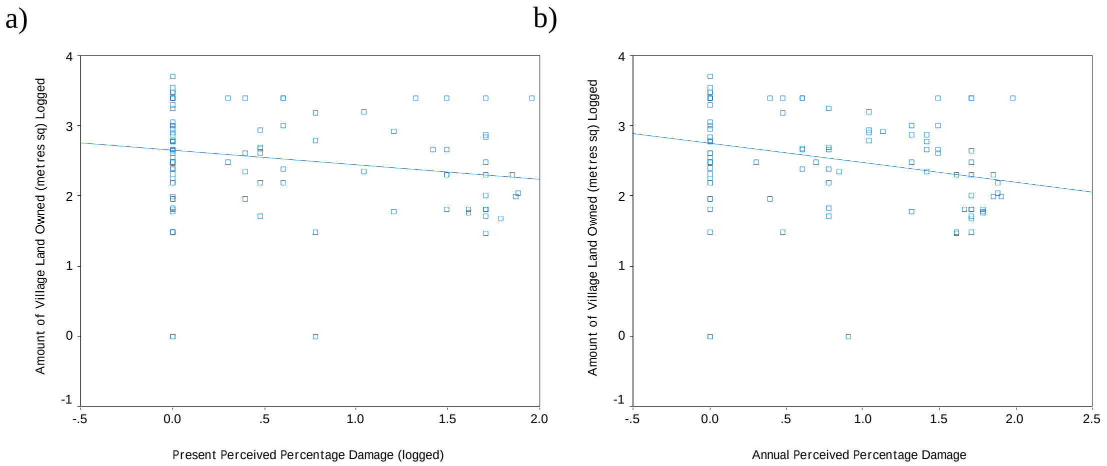


Figure 5.10 Amount of village land owned (m^2) against present (a) and annual (b) perceived damage estimates from the farmers. Regression line added to indicate trend

Farmers in Kawelli perceived far greater levels of present and annual damage than did those in other villages (Table 5.30) (Tamhane, p << 0.001) and Wakangka had lower estimates than LaBundo Bundo (Tamhane, p << 0.001). Muslim wet rice farmers also perceived less damage, as did those whose main income was not from farming. Farmers who were transmigrants, (again often wet rice farmers), and those who were literate perceived the least damage (Table 5.30).

Table 5.30 Mean present and annual percentage damage for categorical socioeconomic variables (* significant at the 0.025 level)

Variable		Mean percentage damage ± SD (N)					
		Present	**Statistic**	**Sig.**	**Annual**	**Statistic**	**Sig**
Village	Kawelli	34.27 ± 26.33 (30)	F = 26.92	<< **0.001***	43.67 ± 23.84 (30)	F = 35.77	<< **0.001***
	Wakangka	0.70 ± 1.32 (25)			3.360 ± 9.72 (25)		
	Wakalambe	5.30 ± 13.11 (20)			6.950 ± 16.20 (20)		
	LaBundo Bundo	4.56 ± 12.34 (32)			10.828 ± 16.42 (32)		
Gender	Male	12.23 ± 21.17 (64)	t = 0.32	0.749	18.67 ± 23.70 (64)	t = 0.75	0.457
	Female	11.97 ± 22.16 (43)			15.92 ± 24.74 (43)		
Part of transmigrant program	Yes	6.73 ± 14.93 (15)	t = 1.29	0.198	8.80 ± 18.40 (15)	t = 2.32	**0.022***
	No	13.01 ± 23.30 (92)			19.00 ±24.63 (92)		
Literacy	None	12.38 ± 26.99 (13)	F = 2.28	0.107	20.192 ± 26.86 (13)	F = 3.22	0.044
	A little	17.79 ± 21.04 (19)			27.74 ± 25.57 (19)		
	Literate	10.65 ± 20.59 (75)			14.53 ± 24.50 (75)		
Education	Nothing	11.03 ± 25.27 (15)	F = 1.09	0.357	14.567 ± 25.574 (15)	F = 0.92	0.432
	Elementary	17.389 ± 24.26 (45)			23.378 ± 26.31 (45)		
	Junior high	9.54 ± 20.10 (24)			15.13 ± 21.72 (24)		
	Senior high and above	5.26 ± 10.09 (23)			10.70 ± 19.00 (23)		

Wet rice grown?	Yes	3.069 ± 9.98 (36)	t = 4.55	<< **0.001***	4.43 ± 12.38 (36)	t = 6.24	<< **0.001***
	No	16.725 ± 24.18 (71)			24.23 ± 25.79 (71)		
Farming main income?	Yes	15.54 ± 23.24 (70)	t = -2.40	**0.018***	20.86 ± 25.06 (70)	t = -2.07	0.041
	No	5.69 ± 16.04 (37)			11.32 ± 20.91 (37)		

Despite removing the Hindu farmers, the remaining wet rice and transmigrant farmers still showed a similar response of low or no perceived damage. Those growing wet rice tended to own more village land (t = -4.09, df = 105, p << 0.001). Thus all wet-rice farmers were excluded. With both Hindu and rice farmers removed present damage no longer correlated with village land (r = -0.187, N = 72, p = 0.118). Annual damage was negatively associated with amount of village land, but only very weakly (r = -0.057, N = 72, p = -0.227). The village effect remains, with Kawelli perceiving the greatest damage (Figure 5.11a and b) (present F = 16.31, df = 3, 68, p << 0.001; annual F = 18.28, df = 3, 68, p << 0.001) compared to all other villages (Tamhane, p << 0.001). Those receiving their main income from farming also perceived greater damage (present t = -2.21, df = 70, p = 0.031, annual t = -2.41, df = 70, p = 0.019).

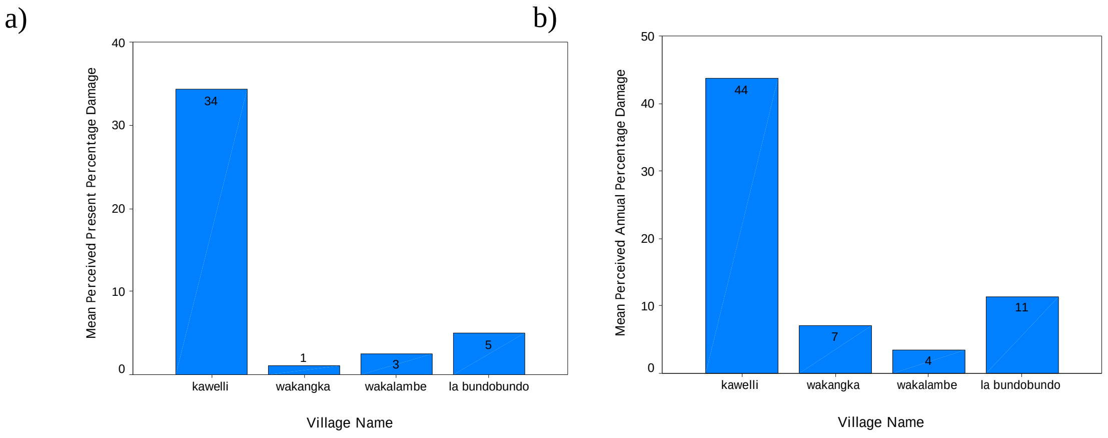


Figure 5.11 Mean perceived percentage damage, both current (a) and over the last year (b) for each village (excluding Hindu and wet-rice farmers)

5.9.1 Percentage Damage and Perceptions of Monkey Behaviour and Group Sizes

As seen in section 5.8 perceptions of monkey behaviour and group sizes vary by village; this may explain differences in perceptions of damage. Perceptions of damage were positively correlated with almost all of the perceptions of monkey behaviour, with the exception of the number of monkeys per group and time spent in fields. The pest rank of the monkey was unrelated to present damage, but was correlated with annual damage; this suggests that such views are built up over time rather than by immediate events (Table 5.31).

Table 5.31 Correlations of perceived percentage damage and 'monkey variables' (*significant at the 0.025 level)

Variable	Present Percentage Damage	Annual Percentage Damage
No. monkey groups N = 60	**0.324***	**0.297***
No. of monkeys in a group N = 70	0.148	0.084
Total no. of monkeys N = 67	**0.347***	**0.243***
Time spent in the fields (no people present) (mins) N = 65	**0.530***	**0.571***
Time spent in fields (people present) (mins) N = 71	0.162	0.193
Frequency of raids per day N = 71	**0.514***	**0.645***
Frequency of raids per week N = 71	**0.605***	**0.677***
No. of monkeys raiding N = 71	**0.332***	**0.446***
Rank of Monkey as a pest N = 71	0.167	**0.329***

The time of day that monkeys were thought to raid was unrelated to percentage damage (present F = 1.09, df = 5, 58, p = 0.376; annual F = 0.52, df = 5, 58, p = 0.758). Farmers who thought monkey numbers had increased perceived greater amount of annual damage (F = 4.61, df = 2, 68, p = 0.013), but there was no effect for present damage, once again suggesting certain attitudes are related to longer term experiences of raiding.

5.10 REPORTED TYPES OF CROP DAMAGED

The percentage of farmers growing specific crops (see appendix 6 for full list of crops grown) (other than rice which was excluded) was not associated with crops cited as those most seriously damaged by monkeys ($r = 0.220$, $N = 11$, $p = 0.516$). Maize, sweet potato and banana were considered to be the crops most preferred by monkeys (Table 5.32) and these correlate positively with observations of those crops most severely damaged by monkeys ($r_s = 0.799$, $N = 19$, $p << 0.001$) (see also chapter 4 section 4.3.5). Only 11% of farmers considered all crops to be equally seriously damaged. Some farmers specifically remarked that monkeys did not eat certain foods (Table 5.32), most notably rice[4] and chilli. Reported percentage damage was unrelated to the type of crop reported as most seriously damaged (present $F = 1.56$, $df = 4, 66$, $p = 0.196$; annual $F = 0.73$, $df = 4, 66$, $p = 0.575$, although those farmers reporting that all crops were equally seriously damaged tended to perceive more damage overall.

Table 5.32 Most seriously damaged crops by monkeys, the crops which monkeys do not damage and the percentage of farmers citing each crop

Most Damaged Crop	Percentage of Farmers Citing Crop
Maize	29.9
Sweet potato	21.4
Banana	20.8
All crops	11.0
Cassava	3.9
Coconut	3.9
Fruits	1.9
Papaya	1.9
Pumpkin	1.3
Cocoa	1.3
Aubergine	1.3
Cashew Fruit	0.6

---

[4] Other studies have shown that macaques do consume rice from fields e.g. *Macaca mulatta* (Goldstein and Richard 1989; Lindburg 1976; Makwana 1978; Malic and Johnson 1994; Mukherjee 1972; Neville 1968; Southwick *et al.* 1961a, b) so it seems unlikely that *Macaca ochreata brunnescens* would not eat rice, given the chance. On Buton, the lack of damage to rice is most likely due to the siting of the paddy fields in large plains away from the forest. In fact, many farmers said that in the past monkeys had raided rice fields, and that in Bali macaques (*Macaca fascicularis*) often damaged rice (interview respondents).

Crop monkeys don't damage	Percentage of farmers citing crop
Rice	37.0
Chilli	24.7
Cashew Nut (not Cashew fruit)	16.9
Tomato	6.5
Orange	4.5
Green, Leafy Vegetables (e.g. Sawi, Bayam)	4.5
Candle Nut	3.2
Taro	1.3
Wild Sweet Potato	0.6

In chapter 4 section 4.1.2, I suggested that there was a relationship between percentage of available monkey foods and damage, and that this relationship might influence farmers' perceptions of the monkeys especially between villages. However differences between villages in proportions of available monkey foods were not significant (F = 1.90, df = 5, 63, p = 0.139), and no significant differences were seen between those who felt monkeys were a problem and those who did not in relation to relative proportion of available food plants on their farms (t = 0.36, df = 67, p = 0.717). There were also no significant differences between opinions towards monkeys (like, love, hate or dislike of monkeys) and proportions of available food plants in the transect farms (F = 0.40, df = 5, 63, p = 0.850).

5.11 PERCEPTIONS OF MONKEY BEHAVIOUR AND GROUPS AND SOCIO-ECONOMIC/DEMOGRAPHIC FACTORS AS PREDICTORS FOR REPORTED DAMAGE

Those socio-economic and monkey behaviour variables which were found to relate significantly to perceived percentage damage (above) were entered into a multiple regression, creating dummy variables where necessary and using the 'Method=Tests' model and block method (as discussed in chapter 4). The variables used are shown in (Table 5.33). All variables except the one of interest were entered into block one and the variable of interest entered in block 2. Each variable was tested in turn in block 2 and the resulting R^2 and significance values compared. The entire data set was used and religion and wet-rice variables were included in the overall analysis as they are important factors in determining attitudes (see above).

Only village and frequency of raiding were significant in the model for present damage, resulting in a final model entering village first, then frequency of raiding per week and frequency per day (Table 5.33). This model explains 54.5% of the variance in perceived present damage, other factors such as opinions of the monkey may well explain some of the remaining 45% (see section 5.12).

Table 5.33 Multiple linear regression model summary for each predictor of perceived present percentage damage entered in block 2 and the final model (significant at the 0.01 level, * significant at the 0.05 level) (df)**

Variable entered in block 2 (df)	**Model summary**			
N = 120	Model Adjusted R^2	R^2 Change	F Change	**Sig. value**
Village (3)	61.5%	0.045	4.664	**0.004****
Literacy (2)	61.5%	0.0004	0.063	0.939
Monkeys Increasing? (2)	61.5%	0.001	0.084	0.919
Frequency of raids per week (1)	61.5%	0.021	6.472	**0.012***
Frequency of raids per day (1)	61.5%	0.013	3.988	**0.049***
Time spent in fields (no people present) (1)	61.5%	0.0005	0.148	0.701
Total number of monkeys (1)	61.5%	0.002	0.048	0.490
Total number of groups (1)	61.5%	0.001	0.190	0.664
Rank of monkey as pest (1)	61.5%	1.33×10^{-7}	4.13×10^{-5}	0.995
Amount of village land owned (1)	61.5%	0.003	0.954	0.331
Main income farming? (1)	61.5%	0.004	1.335	0.251
Part of transmigrant program (1)	61.5%	0.007	2.070	0.153

Religion (1)	61.5%	0.005	1.391	0.241
Wet rice (1)	61.5%	0.005	1.615	0.207
Number of raiding monkeys (1)	61.5%	0.0001	0.038	0.846
FINAL MODEL (village, frequency of raids per week, frequency per day entered in block 1) (df = 5, 147)	**54.5%**	**0.559**	**37.207**	**<< 0.001****

For annual damage, the rank of monkey as a pest, frequency of raids per week, transmigrant status, religion, frequency of raids per day and whether monkey numbers were increasing were significant and thus entered in the final model (Table 5.34). This model explains 64.7% of the variance in perceived annual damage. The two models for present and annual damage are quite different. Present as opposed to annual estimates of damage can be the result of very different factors. Present damage is likely to be influenced by proximate causes, such as the current state of crops in the farms. ‘Village’ may also strongly affect present estimates of damage due to differences in the growth phase of crops. In LaBundo, many farms had immature crops which were not raided at that time. However, annual damage is likely to be affected by longer term trends, for example whether numbers of monkeys are thought to be increasing or not and the general perception of monkeys as a pest or not.

Table 5.34 Multiple linear regression model summary for each predictor of perceived annual percentage damage entered in block 2 and the final model (significant at the 0.01 level, * significant at the 0.05 level)**

Variable entered in block 2 (df)	**Model summary**			
N = 120	Model Adjusted R^2	R^2 Change	F Change	**Sig. value**
Village (3)	68.4%	0.007	0.935	0.427
Literacy (1)	68.4%	0.003	0.620	0.540
Monkeys Increasing? (2)	68.4%	0.014	2.598	0.079
Frequency of raids per week (1)	68.4%	0.015	5.501	**0.021***
Frequency of raids per day (1)	68.4%	0.012	4.579	**0.035***
Time spent in fields (no people present) (1)	68.4%	0.001	0.417	0.520
Total number of monkeys (1)	68.4%	0.001	0.296	0.588
Total number of groups (1)	68.4%	0.0005	0.179	0.673
Rank of monkey as pest (1)	68.4%	0.015	5.778	**0.018***
Amount of village land owned (1)	68.4%	0.001	0.224	0.637
Main income farming? (1)	68.4%	0.003	1.273	0.262
Part of transmigrant program (1)	68.4%	0.015	5.528	**0.021***
Religion (1)	68.4%	0.013	5.017	**0.027***
Wet rice (1)	68.4%	0.004	1.444	0.232
Number of raiding monkeys (1)	68.4%	0.001	0.432	0.511
FINAL MODEL (rank of monkey, part of transmigrant program, frequency of raids per week, religion, frequency per day, monkeys increasing? entered in block 1) (df = 7, 145)	**64.7%**	**0.663**	**40.768**	**<< 0.0001****

5.12 PERCENTAGE DAMAGE AND OPINIONS OF MONKEYS

Those farmers who considered monkeys a problem perceived far greater amounts of damage (Figure 5.12), and those who felt the problem was more severe, perceived more damage (Figure 5.13). Those who hated or liked and disliked monkeys perceived greater damage and this was highest for annual damage (Figure 5.14), suggesting the possible conflicts some farmers feel towards monkeys

> *"I like monkeys, but not in my farm".*

Unsurprisingly, those who perceived less damage loved or had no opinion of the monkey.

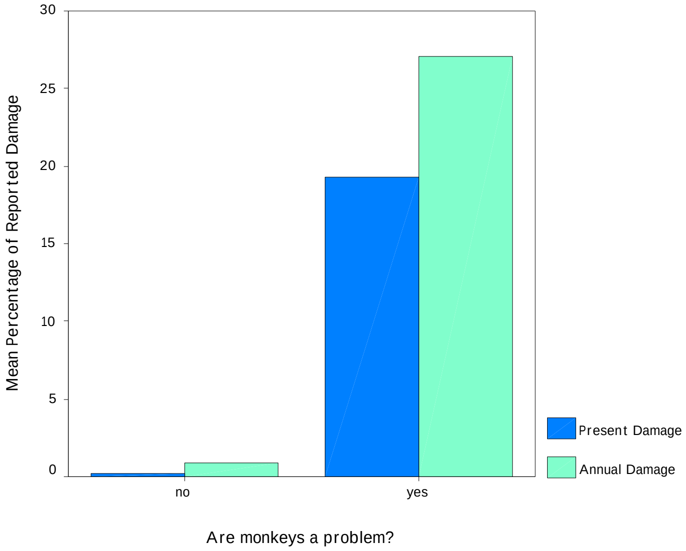


Figure 5.12 Whether monkeys were considered to be a problem against reported mean present percentage damage (t = 8.59, df = 151, p << 0.001) and mean annual percentage damage (t = 13.31, df = 151, p << 0.001)

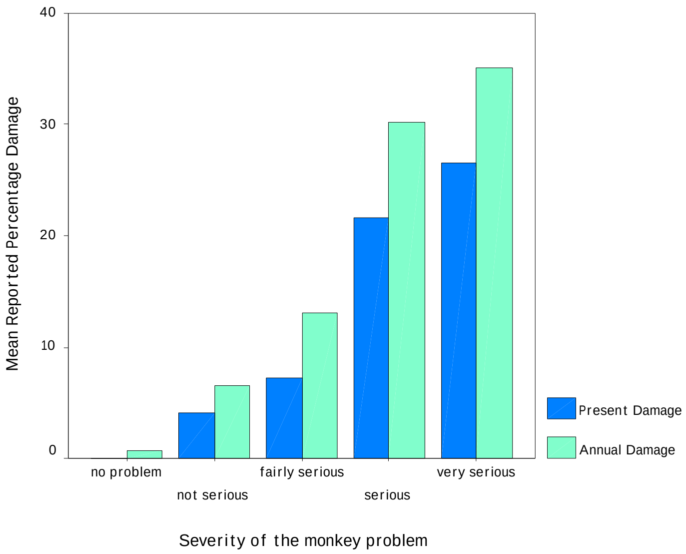


Figure 5.13 The severity of monkeys as a problem against reported mean present percentage damage (F = 29.55, df = 4, 148, p << 0.001) and mean annual percentage damage (F = 55.37, df = 4, 148, p << 0.001)

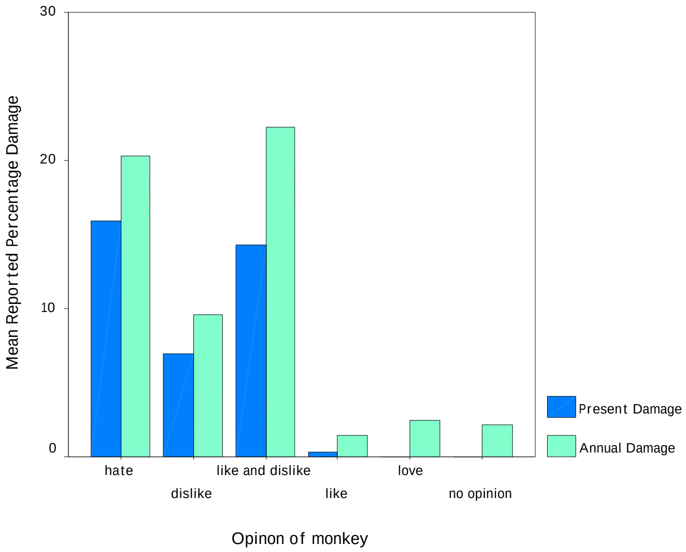


Figure 5.14 Opinion of monkeys by respondents against reported mean present percentage damage (F = 6.43, df = 5, 147, p << 0.001) and mean annual percentage damage (F = 7.22, df = 5, 147, p << 0.001)

Socio-economic factors were entered into the multivariate model for percentage damage and attitudes to explore their overall effects (Table 5.35). Whether the monkey was considered a pest and how serious it was were significant predictors of percentage damage and were therefore added to the final model.

Table 5.35 Multiple linear regression model summary for each predictor of perceived annual percentage damage entered in block 2 including opinion of the monkey and the final model (significant at the 0.01 level, * significant at the 0.05 level)**

Variable entered in block 2 (df)	Model summary			
N = 153	Adjusted R^2	R^2 Change	F Change	Sig. value
PRESENT DAMAGE				
Are monkeys a problem? (1)	58.4%	0.041	15.138	<< 0.001**
How bad is the problem? (4)	56.1%	0.029	2.470	0.047*
Opinion of monkey (4)	54.2%	0.014	0.926	0.466
FINAL MODEL (village, frequency of raids per week, frequency per day, are monkeys a problem, how bad is the problem entered in block 1) (df = 10, 142)	57.5%	0.603	21.556	<< 0.001**
ANNUAL DAMAGE				
Are monkeys a problem?	71.8%	0.070	37.606	<< 0.001**
How bad is the problem?	69.8%	0.057	7.110	<< 0.001**
Opinion of monkey	64.1%	0.007	0.567	0.725
FINAL MODEL (rank of monkey, part of transmigrant program, frequency of raids per week, religion, frequency per day, monkeys increasing?, are monkeys a problem, how bad is the problem entered in block 1) (df = 12, 140)	**73.6%**	**0.757**	**36.336**	<< 0.001**

For perceived present damage, village, frequency of raids, whether the monkey is considered a pest and how serious a pest explains 57.5% of the variance. For annual damage, pest rank of the monkey, transmigrant status, frequency of raids, whether monkeys are increasing, as well as whether or not they are a pest and how serious a problem they are, explain 73.6% of the variance. Clearly other factors are unaccounted for, such as subtler attitudes towards the monkeys. Although all statements of attitude were recorded, sample sizes of specific statements are too small to include in this multivariate analysis. General categories of attitudes will be explored below

5.13 ATTITUDES AND PERCENTAGE DAMAGE

Table 5.36 Present and annual perceived percentage damage against opinions of monkeys as pests (t, df = N-2, p ** significant at the 0.01 level, * significant at the 0.05 level)

Opinion expressed about monkeys		Mean Percentage Damage ± SD					
		Present	t	Sig.	Annual	t	Sig.
Useless	Not mentioned (142)	9.35 ± 19.41	6.31	<< **0.001****	13.10 ± 22.28	0.55	0.584
	Mentioned (11)	0.09 ± 0.30			4.73 ± 7.77		
Pest	Not mentioned (50)	0.96 ± 5.66	-5.97	<< **0.001****	2.11 ± 9.47	-7.18	<< **0.001****
	Mentioned (103)	12.43 ± 21.69			17.53 ± 24.03		
Doesn't damage crops	Not mentioned (144)	9.22 ± 19.30	7.59	<< **0.001****	13.26 ± 22.11	6.52	<< **0.001****
	Mentioned (9)	0			0.22 ± 0.67		
Greedy	Not mentioned (128)	7.15 ± 17.75	-2.26	**0.031***	10.86 ± 20.80	-2.02	0.052
	Mentioned (25)	16.50 ± 22.50			20.86 ± 24.38		
Pity	Not mentioned (131)	9.60 ± 19.75	1.96	0.058	13.91 ± 22.71	2.15	**0.038***
	Mentioned (22)	3.23 ± 10.93			4.07 ± 10.83		
Enemy	Not mentioned (143)	7.85 ± 17.64	-2.09	**0.039***	11.76 ± 20.74	-1.38	0.264
	Mentioned (10)	20.06 ± 30.34			22.95 ± 31.74		
Scared	Not mentioned (118)	9.65 ± 19.54	1.49	0.142	13.98 ± 22.45	1.95	0.056
	Mentioned (35)	5.41 ± 16.13			7.471 ± 18.17		
Funny	Not mentioned (86)	10.78 ± 20.22	1.69	0.092	14.78 ± 22.48	1.92	0.057
	Mentioned (67)	5.99 ± 16.68			9.58 ± 20.36		

Useful	Not mentioned (142)	9.33 ± 19.41	4.59	<< **0.001****	13.46 ± 22.20	9.74	<< **0.001****
	Mentioned (11)	0.27 ± 0.91			0		
Steal	Not mentioned (128)	6.89 ± 16.43	- 2.60	**0.014***	9.57 ± 18.45	- 3.00	**0.005***
	Mentioned (25)	17.86 ± 26.75			27.46 ± 29.87		
Want to kill	Not mentioned (132)	7.49 ± 17.42	- 1.66	0.110	10.90 ± 20.17	- 2.25	**0.026***
	Mentioned (21)	16.14 ± 8.68			22.52 ± 27.92		

Any opinions farmers expressed about the monkeys were noted (see appendix 7 for complete list). Some of these attitudes were shared across a number of respondents, and these were tested against perceptions of damage (Table 5.36). Since different individuals contributed to the sample of adjectives, these were treated as independent samples. Those who described the monkeys as pests, greedy, an enemy or stealing perceived greater amounts of present and annual damage. For those who wanted to kill monkeys this difference was only significant for annual damage again emphasising different concepts in relation to long term damage (Table 5.36). Those who described the monkeys as useless, pitied them, were scared of them or said they don't damage crops, tended to perceive less damage. Many of these attitudes are less directly related to damage itself (e.g. being scared), but some are related to exposure to monkeys during raids or to other factors not examined here, such as gender and age (see section 5.6.3 and 5.6.4).

5.14 SUMMARY

Perceptions of crop-raiding and the monkeys are complex. In this chapter I have attempted to explore the socio-economic and demographic factors underlying some of these perceptions.

§ Religion

In Buton, religion affects perceptions of monkeys as crop pests, although not in the way at first expected. More Muslim farmers perceived monkeys as a problem than Hindus and were more likely to consider the problem serious or very serious. This was partly due to the fact that the Hindu farmers tended to grow wet-rice, which was not raided in this area. Muslim farmers tended to express hatred for the monkey, although a large number claimed to like and dislike them, whereas most Hindu farmers liked the monkey. Greater tolerance was expected for Hindus, owing to the worship of a monkey god but in fact, Hindus were more likely than Muslims to report killing monkeys if given the chance, despite the fact that monkeys are not a crop pest, as far as they are concerned. Muslims, by contrast, claimed monkeys were like humans and needed food therefore despite hating them did not want to kill them.

§ Gender

Although overall, no significant difference in perceptions with gender was found in this study, in contrast to other similar studies (Gillingham and Lee 1999; Hill 1998), more women than men did report feeling scared of the monkeys.

§ Income and Land-ownership

About a third of the average income was derived from farming and over half of respondents relied exclusively on farming for their annual income. Although income and amount of farmland owned (shown to be reasonable economic indices) was unrelated to perceptions of monkeys as crop pests, those farmers who owned less village land tended to feel monkeys were a more severe problem. Thus demonstrating once again, as in chapter 4, that perceptions are related to human factors rather than factors which affect monkey behaviour.

§ **Most Serious Pest**

The species rated as the most serious crop pests were pigs, monkeys and rats. The rat was reported to be the most serious pest overall. However there was a definite effect of religion (and hence crop type grown). Hindu farmers, considered rats and insects to be the worst crop pests, unsurprising given their dependence on rice farming. Muslim farmers however, considered pigs and monkeys to be the biggest problem.

§ **The Monkey as a Pest**

The rank of monkeys as pests was unrelated to farmers' reports of present damage, but was correlated with annual damage. Farmers who reported that the number of monkeys around their farms and villages had increased also reported greater amounts of annual damage, but not present damage. These results suggest such views are built up over time rather than by immediate or recent events and are related to long-term patterns of raiding

§ **Predictors of Perceived Damage**

Reported present percentage damage was predicted by 'village' and perceived frequency of raids, whether the monkey was considered a pest and how serious a pest. Long term (annual damage) was predicted by the pest rank of the monkey, whether the farmer was a transmigrant, perceived frequency of raids by monkeys, whether monkeys were thought to be increasing in number, whether they were considered a pest and how serious a pest. These models explained 57 – 74% of the variance in perceived damage. Other perceptions of the monkeys, such as whether they were considered greedy, as an enemy or as thieves, led to increased reports of damage. Those farmers expressing a desire to kill monkeys also reported greater long term damage to their farms. Those displaying more tolerant attitudes such as pity tended to report less damage. Of course, it could be that if the monkeys are a problem you will hate them. However, as I have shown in chapter 4, there was a significant mismatch between perceptions of these two factors and thus causality can not yet be determined. I will return to this issue in the final synthesis (chapter 8).

CHAPTER 6 - MONKEYS ON FARMS

The majority of studies on crop-raiding have assessed levels of damage through indirect observations, using the aftermath of crop damage to estimate frequency of raiding (Hill 2000; Naughton Treves 1998a, b). This study attempts to look at crop-raiding directly through the use of focal farm surveys, enabling a direct estimate of raiding frequency and duration, which offers an insight into the behaviour of crop-raiding monkeys in Buton. The farms surveyed will first be described (section 6.3), followed by the presentation of general raid information and the effect of amount of forested perimeter of farms (section 6.4). The impact of other aspects of farm geography will be discussed in section 6.5 and finally in section 6.6 behavioural patterns of raiding, including temporal variation, raiding party composition and activity profiles, will be examined.

6.1 MONKEY BEHAVIOUR AND SOCIO-ECOLOGY IN RELATION TO CROP-RAIDING

Troop size and individual characteristics of the primate (such as age, sex or experience) also influence raiding strategies. For example in olive baboons young, adolescent males are more frequent raiders (Forthman Quick 1986a; Oyaro and Strum 1984; Saj *et al.* 1999b; Strum 1986, 1994). Adult males are often cited as ‘leading’ the group into or out of the field and are usually the only individuals witnessed to raid alone (Oyaro and Strum 1984). Adult females, especially those with dependent infants, may be more conservative as a general characteristic but have also been shown to exhibit more caution and ‘protectiveness’ around humans (Fairbanks and McGuire 1993) and may be unwilling to incur risks associated with crop-raiding (Saj *et al.* 1999b). Juveniles of some species may be more risk prone than are adults (Fairbanks 1993; Saj *et al.* 1999a, b) as a result of lack of awareness of the outcomes of such behaviour, an inability to assess the level of risk accorded to a situation or the opportunity to learn and out-compete adults (Saj *et al.* 1999b). Thus a greater proportion of juveniles to adults might be expected in the fields (Saj *et al.* 1999b) and groups with a high proportion of juveniles are more likely to become agricultural pests (Forthman Quick 1986a) and, as they mature, continue such behaviour.

Crop-raiding itself influences, or is associated with, ecological species traits such as home range size (Musau and Strum 1984; Saj *et al.* 1999b; Strum 1986, 1987a, 1994). Overall group size and population density increase in some crop-raiding groups (Biquand *et al.* 1992b; Brennan *et al.* 1985; Siex and Struhsaker 1998) due to the effective increase in carrying capacity of such agricultural areas. Conversely, group fragmentation has also been witnessed (Forthman Quick 1986a; Mohnot 1971; Strum 1986, 1987a) and crop-raiding can lead to changes in the proportion of different age-sex classes as a result of mediation strategies, for example an increase in the proportion of juveniles in crop-raiding vervets owing to increased trapping of adults in Barbados (Boulton *et al.* 1996). Crop-raiding is a high-risk activity and while many primates can, and do adapt others suffer greater mortality and morbidity (Strum 1986) and some are simply eliminated (Naughton Treves 1998a).

Human crops generally have greater caloric and nutritional value than wild foods and have a predictable and clumped distribution (Fa 1986; Forthman Quick and Demment 1988). The caloric gain per unit of time and weight is assumed to be greater for such foods (Fa 1986). Such foods can also be more digestible than wild foods due to refinement of stock to suit human tastes and consumption (Forthman Quick and Demment 1988) thus primates might benefit by increased consumption, digestion and assimilation rates. These foods may, however, be lacking in certain essential nutrients such as protein which still need to be balanced from wild sources (Forthman Quick and Demment 1988).

Access to human foods (or provisioned foods) allows some freedom from the time constraints of foraging for wild food, (Altmann and Muruthi 1988) particularly in the dry season when wild foods are most scarce (Lee *et al.* 1986). Changes in activity budgets have been demonstrated in groups of vervets, baboons and macaques relying on large quantities of human food. Human food consumption seems to promote increased time spent being inactive or socialising and decreased feeding time (Asquith 1989; Biquand *et al.* 1992b; Forthman Quick 1986a; Malic and Johnson 1994; Musau and Strum 1984; Strum 1994; Warren 2003; Warren and Ross 2004) and also may lead to an increase in the rate of aggressive interactions (Asquith 1989; Lee *et al.* 1986; Mohnot 1971).

Overall it seems that human food consumption affects the frequency and duration of some activities within the group but does not change species-specific types of behaviours (Fa 1986; Fa and Southwick 1988; Lee 1988; Warren 2003; Warren and Ross 2004).

Raiding has been categorised as casual or systematic (Maples *et al.* 1976) reflecting the degree to which it is relied upon and attempts have been made to categorise specific behavioural types of raiding. Maples *et al.* (1976) described raiding as three distinct raid types for Kenyan baboons: rapid maize raids, gang raids, and sneak attacks. Rapid maize raids were characterised by a short raid duration during which raiders would run into the farm, grabbing maize or other crops and run out of the farm carrying the crops with them. These often coincided with times when a farm was heavily guarded by humans. Gang raids were considered to be more ‘relaxed’ and consisted of many members of the troop raiding an unprotected farm. These raids were of a longer duration. Finally, sneak attacks were carried out by individuals who entered a farm quietly and raided alertly while the farmer's attention was diverted. Crockett and Wilson (1980) categorised raiding by *M. fascicularis* (long-tailed macaques) and *M. nemestrina* (pig-tailed macaques) similarly, and noted that there were differences in the raiding behaviour of the two species. *M. fascicularis* raided as a group led by a few animals, exhibited 'general alertness', and the adult male gave the warning vocalisation if detected. *M. nemestrina* on the other hand would split into small sub-groups to raid and surveyed the farm for some time before entering it, one animal at a time. A sub-adult male would often act as a 'look out' and vocalise a warning bark on sight of the farmer. *M. nemestrina* also have a reputation for raiding during rainstorms, when farmers shelter in their huts (Crockett and Wilson 1980). Size differences between the species may account for some of these behavioural variations, an adult *M. nemestrina*, especially a male, can easily defend itself against humans whereas *M. fascicularis* seek the protection of a larger group when raiding (Crockett and Wilson 1980). Crockett and Wilson also suggest that crop preference explains the difference. For *M. nemestrina* to successfully consume preferred crops they require an uninterrupted period to reap the harvest, for example breaking of maize stalk, husking ears of maize, unearthing cassava roots. This extra time can be achieved by minimising the probability of detection through quieter raids by smaller groups. Not all studies described such typologies but owing to the similarity and possible evolutionary link between the Sumatran pig-tailed, *M. nemestrina,* and all the Sulawesi macaques, including *M. ochreata brunnescens* (Fooden 1969) it can be predicted that Buton macaques exhibit specific raiding behaviours. In cases where human activity on the farm is high stealth raids by sub-groups may be witnessed, whereas in farms where there is no activity more relaxed gang raids may be witnessed. Increased levels of food carrying may also be expected during such raids. Vigilance behaviour can be used to assess how ‘relaxed’ the macaques are in the field. A lack of vigilance behaviour suggests a lack of fear during raiding. Maples *et al.* (1976) found that levels of vigilance were greater during longer raids and that the baboons also split into sub-groups during such raids. Sentinel behaviour was also witnessed. These issues will be investigated in section 6.6.

6.2 METHODS

General field methods were described in chapter 2 section 2.4.3. All data were tested for normality and logged to normalise where appropriate. Where data were not normal, and could not be log-transformed, non-parametric statistics have been used. Means have been presented in some figures. When medians were used, the large number of zeros suggests that no events occurred; in such cases the mean value more clearly represents the ‘average’ tendencies present in the data. Details relating to specific statistical methods or re-coding of data are described at the relevant point in the result sections below.

6.3 FARM DESCRIPTIONS

Eleven farms in total (six in 2002, nine in 2003) from the village of Kawelli were chosen for focal farm surveys (see Figure 6.1 for map of farm locations). Farms were chosen on the basis of crops grown and local geography. Time constraints limited the numbers chosen. Farms differed in the amount and type of crop available (Table 6.1) with sweet potato generally being the most abundant crop overall.

farm during the observation period (Cells shaded green indicate that crop was present but not available as a food for r ripe or was a suitable food for monkeys). NB Total cover for a farm can be more than 100% because tree and shrub r crops.

La Musrifa 2002	La Musrifa 2003	La Sahili 2002	La Sahili 2003	La Ruhuni 2002	La Ruhuni 2003	Unknown 2002 (almost fallow)	La Ruhuni grandma 2002	La Darmin 2003	La Bau 2003	La Damaridi 2003	La Jonaidin 2003
< 1	0	1	0	0	0	0	0	0	0	0	0
0	40	0	<1	30	30	0	0	< 1	4	< 1	< 1
30	15	0	0	0	0	0	0	20	2	0	10
0	<1	0	0	0	< 1	0	0	< 1	1	3	0
1	<1	0	0	< 1	20	0	0	0	2	0	< 1
0	0	5	25	0	0	0	0	0	40	< 1 [1]	0
0	0	0	0	0	0	0	40	0	0	0	0
0	0	0	0	0	0	0	0	0	0	< 1	0
0	0	0	< 1	0	0	0	0	0	0	0	0
15	20	0	< 1	0	0	0	0	5	4	0	< 1
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	5	0	0	0	0	0	0
3	<1	0	0	0	0	0	0	< 1	0	< 1	< 1
2	3	0	< 1	4	0	0	0	< 1	0	0	0
98	30	53	60	95	20	0	0	70	50	50	80
0		0	0	0		0	0	0	1	0	0
0	< 1	0	< 1	0	0	< 1	0	< 1	< 1	< 1	0

is farm

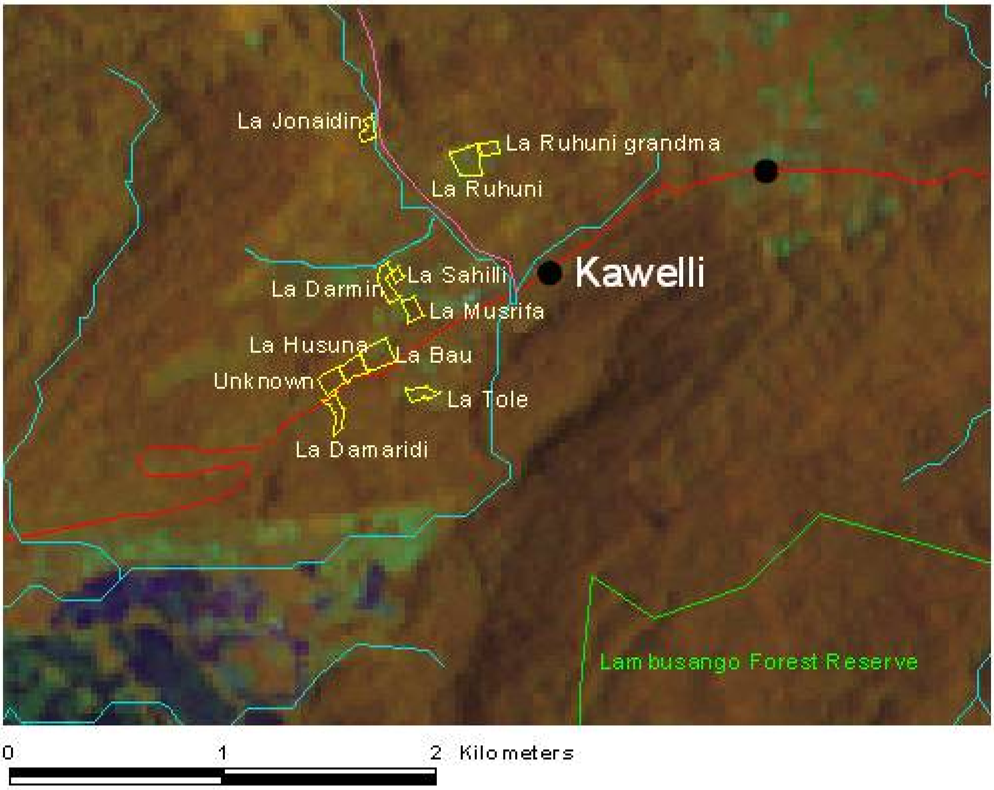


Figure 6.1 Satellite image of Kawelli area indicating focal farms (—) , rivers/streams (—), road (asphalt — or dirt —) . Created using Arcview 3.3 and ButonGIS2004 data set and satellite image (Carlisle 2005) .

Farms differed in their size, perimeter, and the amount of perimeter that was forested (Table 6.2). La Damaridi was enclosed by forest or plantation on all but one side, and had the highest percentage of forested perimeter. La Sahili and La Musrifa had no forested perimeters. Farms also differed from year to year. Five farms were studied in both 2002 and 2003. However, owing to the differences from year to year in crop type, and coverage (Table 6.2), as well as amount of forested perimeter ($Z = -2.032$, $N = 5$, $p = 0.042$) farms were treated as independent, giving a total of 16 farms used in the following analyses. Farms differed with respect to presence of physical features such as rivers and roads. Between 2002 and 2003 these remained the same for these farms. However road traffic did increase in 2003 (pers. obs.) and variation in rainfall meant that the rivers had variable widths and depths between years, and therefore again the farms were treated as independent. Rivers ran close to the perimeter on one side of La Darmin and La Jonaidin farms, while there was a major road bordering La Husuna, La Bau and La Damaridi, and a track bordering Jonaidin. These factors may well have had an impact on raiding frequency (see later).

Table 6.2 Farm characteristics

Farm	Area (m^2)	Perimeter length (m)	Forested Perimeter length (m)	Number of surrounding farms	River	Road
La Husuna 2002	9056	406	161	1	No	Yes
La Husuna 2003	9056	406	111	1	No	Yes
La Tole 2002	6375	364	256	2	No	No
La Tole 2003	6375	364	241	3	No	No
La Musrifa 2002	7527	358	50	2	No	No
La Musrifa 2003	7527	358	0	4	No	No
La Sahili 2002	2323	197	32	2	No	No
La Sahili 2003	2323	197	0	3	No	No
La Ruhuni 2002	15657	505	260	1	No	No
La Ruhuni 2003	15657	505	160	2	No	No
Unknown 2002 (almost fallow)	7950	421	175	1	No	No
La Ruhuni grandma 2002	3000	220	62	1	No	No
La Darmin 2003	8997	443	127	1	Yes	No
La Bau 2003	13641	470	137	1	No	Yes
La Damaridi 2003	9305	483	414	1 (plantation)	No	Yes
La Jonaidin 2003	4663	306	115	2	yes	Yes (track)

6.4 FARM GEOGRAPHY AND ITS IMPACT ON RAIDING

6.4.1 Raid Bouts and Raid Events

Raids were divided into bouts and events. Raid bouts were calculated from the first sighting of a monkey in the vicinity of the farm until the monkeys had been out of sight for at least thirty minutes. It was assumed that after 30 minutes with no sighting of a monkey near the farm, the troop had moved on. Raid events were individual incursions into the farm itself and the termination of an event was the exit of the entire troop from the farm for over five minutes. As long as at least one member of the troop was still in the farm the event was considered to be continuing. The raid was only considered to have stopped once all members had left the farm. Thus a raid bout could consist of several raid events and several raid bouts could take place in one day. It is also possible that a raid bout may not have involved an incursion into the farm, with monkeys remaining outside the farm itself. It was, however, still considered a raid bout as there was the potential for incursion and there may have been factors such as human activity in the farm which prevented access. Including such events enables the investigation of factors which may have prevented a potential raid. The total time spent in the vicinity of the farm (raid bout duration), the time spent within the farm itself (sum of event duration) and the time spent outside the farm before and after raiding could therefore be calculated for each raid on each day for the different farms. Farmers may have regarded monkeys sitting on a fence as being inside the farm perimeter; however for the purposes of this analysis the fence was considered as outside the farm so as to include only opportunities for actual crop damage.

6.4.2 Raiding Frequency

Raid bout frequency varied between farms, from 0 to 24 bouts in total. Bouts ranged in length from 11 seconds up to nearly two and a half hours for a single bout (Table 6.3).

outs overall, raid bout frequency and duration per day and amount of forested perimeter per farm

Minimum Raid Bout Duration	Maximum Raid Bout Duration	Sum of all Raid Bout Duration	Number of days of observation	Number of Raid bouts per day	Number of hours per day of observation	Forested Perimeter (m)	% forested perimeter
0:09	0:09	0:09	9	0.11	0:01:00	161	39.66
0:01:00	0:58:00	2:48:00	15	0.73	0:11:12	111	27.34
0:09:13	1:30:00	5:56:45	10	1.00	0:35:40	256	70.33
0:01:00	0:12:00	0:23:00	13	0.38	0:01:46	241	66.21
0:00:11	0:00:11	0:00:11	11	0.09	0:00:01	50	13.97
0:01:00	0:02:00	0:03:00	14	0.14	0:00:13	0	0.00
0:00:00	0:00:00	0:00:00	11	0.00	0:00:00	32	16.24
0:00:00	0:00:00	0:00:00	16	0.00	0:00:00	0	0.00
0:01:00	2:16:27	8:24:38	8	2.00	1:03:05	260	51.49
0:01:00	1:42:00	13:42:00	14	1.57	0:58:43	160	31.68
0:01:00	0:23:54	1:07:59	9	1.00	0:07:33	175	41.57
0:01:00	0:40:00	2:44:22	8	1.63	0:20:33	62	28.18
0:01:00	1:19:00	11:54:00	16	1.50	0:44:37	127	28.67
0:01:00	0:40:00	2:23:00	16	0.69	0:08:56	137	29.15
0:01:00	2:24:00	22:13:00	17	1.29	1:18:25	414	85.71
0:01:00	1:26:00	4:01:00	14	0.71	0:17:13	115	37.58
		75:49:55	**201**				

Although I attempted to observe all farms for the same number of days, this was not possible due to logistical constraints. Thus the duration and frequency of raid bouts was calculated per of day observation for each farm. This again differed markedly among farms (Table 6.3). La Ruhuni 2002 experienced the most frequent raid bouts (2 per day), while La Damaridi experienced the longest bouts (almost 1 hour 20 minutes per day). La Damaridi also had the greatest percentage of forested perimeter. Only 51.5% of La Ruhuni 2002 perimeter was forested. However it did have one of the longest sections of continuous forested perimeter (260m). Percentage of forested perimeter was significantly related to the duration of raid bouts per day ($R = 0.575$, $N = 16$, $p = 0.020$), although not to the frequency ($R = 0.439$, $N = 16$, $p = 0.089$). This may be due to confounding factors such as daily movements of the troop which are likely to affect frequency of visits. Length of forested perimeter was, however, related to both the duration of raids per day ($R = 0.701$, $N = 16$, $p = 0.002$) and also the frequency ($R = 0.504$, $N = 16$, $p = 0.047$), albeit weakly, suggestive that a longer absolute forest margin allows more frequent raiding due to increased numbers of entry points to the farm.

On average, across all farms, there were 1.12 raid events per raiding bout (excluding those bouts where there was no incursion into the farm). Within each raid bout there could be up to 4 raid events that lasted between 11 seconds and over 2 hours (Table 6.4). A total of 133 raiding events were observed for 42hrs and 36 minutes over 201 days of observation (2110 hours 30 minutes).

vents overall, raid event frequency and duration per day and amount of forested perimeter per farm

ent n	Minimum Raid event Duration	Maximum Raid event Duration	Sum of all Raid event Duration	Number of days of observation	Number of Raid events per day	Number minutes per day of observation	Forested Perimeter (m)	% forested perimeter
0	0:09:00	0:09:00	0:09:00	9	0.11	0:01:00	161	39.66
0	0:28:00	0:28:00	0:28:00	15	0.07	0:01:52	111	27.34
± 3	0:03:00	1:02:23	5:20:45	10	1.40	0:32:04	256	70.33
± 7	0:02:00	0:12:00	0:18:00	13	0.23	0:01:23	241	66.21
1	0:00:11	0:00:11	0:00:11	11	0.09	0:00:01	50	13.97
0	0:01:00	0:01:00	0:01:00	14	0.07	0:00:04	0	0.00
0	0:00:00	0:00:00	0:00:00	11	0.00	0:00:00	32	16.24
0	0:00:00	0:00:00	0:00:00	16	0.00	0:00:00	0	0.00
± 7	0:01:00	2:16:27	7:00:54	8	2.25	0:52:36	260	51.49
± 6	0:01:00	1:08:00	4:37:00	14	1.14	0:19:47	160	31.68
± 7	0:01:00	0:23:54	0:36:54	9	0.33	0:04:06	175	41.57
± 7	0:01:00	0:30:00	1:51:32	8	2.13	0:13:56	62	28.18
± 6	0:01:00	0:56:00	7:53:00	16	1.81	0:29:33	127	28.67
± 0	0:01:00	0:02:00	0:08:00	16	0.38	0:00:30	137	29.15
± 5	0:10:00	2:00:00	13:23:00	17	1.00	0:47:14	414	85.71
± 7	0:04:00	0:21:00	0:49:00	14	0.43	0:03:30	115	37.58
± 0			**42:36:10**	201				

Event duration and frequency were corrected for differences in the number of observation days. Once again La Ruhuni 2002 experienced the most frequent raid events and also the greatest number of minutes of raiding per day. La Musrifa and La Sahili had the lowest levels of raiding and also the least forested perimeter, while Unknown 2002 was almost fallow and yet still experienced over four minutes raiding per day (Table 6.4). This may well be due to the fact that although few crops were found there it was well covered with shrubs and grasses which may have offered shelter to the monkeys and provided a source of terrestrial insects and other foods. Its position may also be important as it was surrounded by forest on three sides and provided an entry route into La Husuna farm.

Across all farms frequency of events per day was unrelated to either the length ($r = 0.392$, $N = 16$, $p = 0.133$) or the percentage of forested perimeter ($r = 0.379$, $N = 16$, $p = 0.148$). Duration of events per day was, however, significantly related to both length ($r = 0.723$, $N = 16$, $p = 0.002$) and percentage of forested perimeter ($r = 0.625$, $N = 16$, $p = 0.010$). Mean event length was also highly significantly related to the length of forest bordering the farm ($r = 0.803$, $N = 16$, $p << 0.001$) and the percentage ($r = 0.709$, $N = 16$, $p = 0.002$). When there was a greater amount of forest close to the edge of the farm, monkeys spent longer raiding and ventured in and out of the farm more often. Alternatively if the forest was far from the farm or only bordered a small portion of the perimeter then if the monkeys were disturbed they left the area to the safety of the nearest forest rather than remaining close to the farm. The following personal observations support this latter suggestion. In La Darmin and La Damaridi farms, when disturbed, the monkeys would often remain in the forest surrounding the farm and then frequently re-enter. However in La Musrifa farm, once disturbed the monkeys fled the area and did not return. Thus, while event frequency reflects levels of disturbance and local conditions in the farm at a specific moment, raid bout frequency may be influenced additionally by troop movements throughout the monkeys' day and home range. Thus frequency of raid bouts was not related significantly to percentage of forested perimeter.

Time spent in the surrounding area when not actually engaged in raiding also varied among farms. Monkeys were observed in the area surrounding farms for a total of 34 hours 33 minutes. Time outside the farm varied from 0 minutes for some bouts, where the monkeys arrived at the farm, raided and immediately left, through to over 1.5 hours lurking in the surrounding forest or scrubland (Table 6.5).

Table 6.5 Time spent outside farms during raid bouts

Farm	Total number of Raid Bouts	Mean out of farm duration	Minimum out of farm duration	Maximum out of farm Duration	Sum of all out of farm Duration
La Husuna 2002	1	0:00:00	0:00:00	0:00:00	0:00:00
La Husuna 2003	11	0:15:05 ± 0:15:57	0:01:00	0:52:00	2:46:00
La Tole 2002	10	0:03:36 ± 0:05:48	0:00:00	0:13:00	0:36:00
La Tole 2003	5	0:01:00 ± 0:01:43	0:00:00	0:04:00	0:05:00
La Musrifa 2002	1	0:00:00	0:00:00	0:00:00	0:00:00
La Musrifa 2003	2	0:01:00 ± 0:01:24	0:00:00	0:02:00	0:02:00
La Sahili 2002	0	0:00:00	0:00:00	0:00:00	0:00:00
La Sahili 2003	0	0:00:00	0:00:00	0:00:00	0:00:00
La Ruhuni 2002	16	0:05:14 ± 0:13:15	0:00:00	0:40:51	1:23:44
La Ruhuni 2003	22	0:26:19 ± 0:32:10	0:00:00	1:36:00	9:39:00
Unknown 2002 (almost fallow)	9	0:03:27 ± 0:05:46	0:00:00	0:14:53	0:31:05
La Ruhuni grandma 2002	13	0:04:03 ± 0:08:21	0:00:00	0:24:00	0:52:50
La Darmin 2003	24	0:10:02 ± 0:13:35	0:00:00	0:45:00	4:01:00
La Bau 2003	11	0:12:27 ± 0:14:35	0:00:00	0:40:00	2:17:00
La Damaridi 2003	22	0:24:54 ± 0:29:06	0:00:00	1:32:00	9:08:00
La Jonaidin 2003	10	0:19:12 ± 0:21:20	0:00:00	1:01:00	3:12:00
Total	157	0:13:12 ± 0:21:04			34:33:39

Time spent in the surrounding area corrected for the number of observation days was greatest for La Ruhuni 2002 and La Damaridi (Table 6.6). This may again have related to the amount of forest bordering the farm. As previously mentioned, the greater the amount of forest bordering the farm the more opportunities there were for monkeys to wait nearby. However, no significant correlation was found between number of minutes spent outside the farm per day and length (r = 0.452, N = 16, p = 0.078) or percentage of forest perimeter (r = 0.320, N = 16, p = 0.228). When this time was considered as a percentage of the total duration of raid bouts a different pattern emerged. La Husuna 2003, La Bau 2003 and La Jonaidin showed the greatest percentage of time spent outside farms during raids. This may reflect human activity within the farms themselves (see chapter 7 section 7.4).

Table 6.6 Forested perimeter and time spent outside farms during raids

Farm	Number of days of observation	Number minutes per day of observation	Percentage of raid bout spent outside farm	Forested Perimeter (m)	% forested perimeter
La Husuna 2002	9	0:00:00	0.00	161	39.7
La Husuna 2003	15	0:11:04	98.81	111	27.3
La Tole 2002	10	0:03:36	10.09	256	70.3
La Tole 2003	13	0:00:23	21.74	241	66.2
La Musrifa 2002	11	0:00:00	0.00	50	14.0
La Musrifa 2003	14	0:00:08	66.67	0	0.00
La Sahili 2002	11	0:00:00	0.00	32	16.2
La Sahili 2003	16	0:00:00	0.00	0	0.00
La Ruhuni 2002	8	0:10:28	16.59	260	51.5
La Ruhuni 2003	14	0:41:21	70.44	160	31.7
Unknown 2002 (almost fallow)	9	0:03:27	45.72	175	41.6
La Ruhuni grandma 2002	8	0:06:36	32.14	62	28.2

La Darmin 2003	16	0:15:03	33.75	127	28.7
La Bau 2003	16	0:08:33	95.80	137	29.2
La Damaridi 2003	17	0:32:14	41.11	414	85.7
La Jonaidin 2003	14	0:13:42	79.67	115	37.6

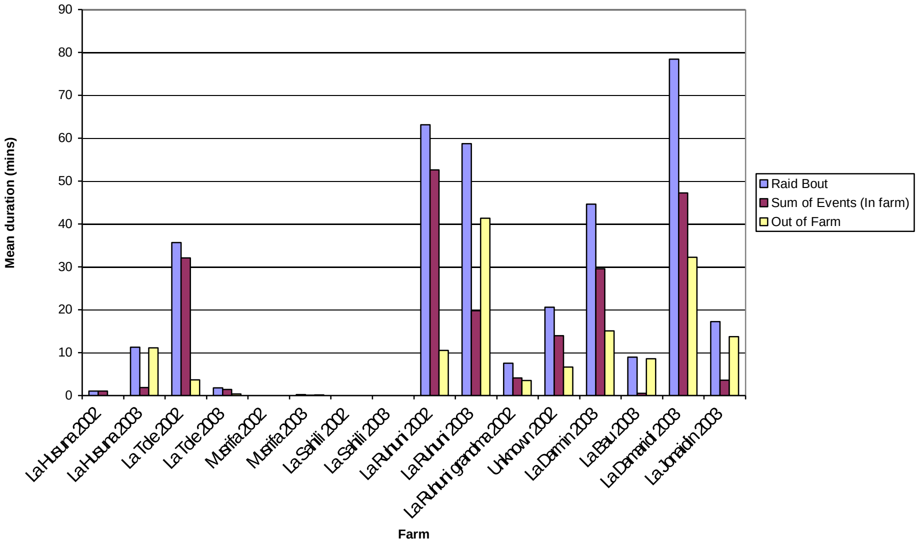


Figure 6.2 Mean duration of raid bout, sum of event (in farm) and out of farm duration for each farm corrected for the number of days each farm was observed

6.4.3 The Effect of Roads and Rivers on Raiding

The presence of roads and rivers, despite the potential risk they pose to monkeys, did not seem to affect raiding patterns. Sample sizes were too low to perform statistical analysis but raid duration and frequency varied greatly among farms sited next to such physical features (Table 6.7). La Damaridi, La Husuna and La Bau were all next to the same main road and yet showed extreme differences in raid frequency and duration. It may be that the risk of crossing the road was outweighed by the benefits of the large store of harvested maize in La Damaridi, while for the other two farms the risk of crossing the road was not worth it. The farms were sited on opposite sides of the road. It could be that two different troops were raiding on different sides of the road, however personal observations suggest it is the same troop as they were frequently sited crossing this road. Further analysis of the effect of traffic noise might shed more light on this (see chapter 7).

Figure 6.3 Troop crossing the road into forest next to La Damaridi farm. La Husuna farm can be seen at top of picture

Figure 6.4 Even passing traffic did not disturb the monkeys after crossing the road to reach La Damaridi farm

Only two focal farms were bordered by rivers. La Jonaidin was bordered by a larger and deeper river than La Darmin and did have somewhat less frequent and shorter raids (Table 6.7) however the differences are small. On comparison across all farms (Table 6.3 and Table 6.4) there does not seem to be much of an effect, suggesting that the risks of crossing a river may be outweighed by the benefits of raiding. With such a small sample size, however, it is impossible to test this.

Table 6.7 Summary of frequency and duration of raid bouts and events for those farms bordered by roads or rivers

Farm	Road	River	Mean bout duration	Frequency of bouts per day	Mean event duration	Frequency of events per day
La Husuna 2002	Yes	No	0:09:00	0.11	0:09:00	0.11
La Husuna 2003	Yes	No	0:15:16 ± 0:17:05	0.73	0:28:00	0.07
La Bau 2003	Yes	No	0:13:00 ± 0:14:14	0.69	0:01:20 ± 0:00:30	0.38
La Damaridi 2003	Yes	No	1:00:35 ± 0:42:12	1.29	0:47:14 ± 0:28:55	1.00
La Jonaidin 2003	Yes (track)	Yes	0:24:06 ± 0:25:32	0.71	0:08:10 ± 0:06:27	0.43
La Darmin 2003	No	Yes	0:29:45 ± 0:21:06	1.50	0:16:18 ± 0:15:26	1.81

6.5 OTHER ASPECTS OF FARM GEOGRAPHY

6.5.1 Farm Area

Farms varied between 2323 m^2 and 15657 m^2 (Table 6.2). Frequency and duration of raid bouts were related to farm area (Table 6.8), although not to raid events. This suggests that farm area may be important in determining whether a farm is visited by a troop of monkeys and how long they spend there, but once monkeys are present farm size has little impact on the actual number of raiding events. Thus larger farms may be visited more frequently, either by chance or by choice during the troop’s daily movements. Monkeys seemed to spend more time in the surrounding area of larger farms; this may be due to the risks associated with raiding a large open farm. Therefore monkeys either spent more time waiting in the forest, or troop movements could have been bringing monkeys close by farms without raiding.

Table 6.8 Correlation of Farm Area against Frequency and Duration of Raids (* significant at the 0.05 level)

N = 16	r	Sig.
Mean Raid Bout Duration	0.460	0.073
Frequency of Raid bouts per day	0.519	**0.039***
Number of minutes of Raid bout duration per day	0.546	**0.029***
Mean event duration	0.381	0.145
Frequency of events per day	0.314	0.237
Number of minutes of event duration per day	0.443	0.086
Mean out of farm duration	0.425	0.101
Number of minutes out of farm duration per day	0.550	**0.027***

6.5.2 Crop Choice

A variety of crops were taken during raids. The five main crops are recorded in Table 6.9. These were calculated, from the scan observations, as the five crops most frequently taken during raids across all farms. Other crops were occasionally taken including pumpkin, cocoa, coffee berries, coconut, kapok and dry rice. These were only taken on rare occasions and were not abundant on the farms in general (Table 6.1).

Type and number of each crop taken during raids were recorded where possible, ideally with each behaviour scan of an individual monkey (N = 8577 scans in farm, N = 800 scans on the farm edge in total, see appendix 9). This was not always possible and in such cases a total number of crops taken was estimated. Crops taken were recorded in a total of 127 raid events. The number of raid events in which each of the five main crops were taken was expressed as a percentage of the total events (Table 6.9). For each event, crops were also coded according to whether they were available in that farm at that time or not (Table 6.1). This produced a percentage of raids for which that crop was available as food for the monkeys. In order to account for the varying availability of crops (in terms of abundance and ripeness) in different farms the number of crops taken was expressed as a percentage of the number of events for which that crop was present and available in that farm. This was used to approximate crop preference as it accounts for the fact that not all crops are available in all farms.

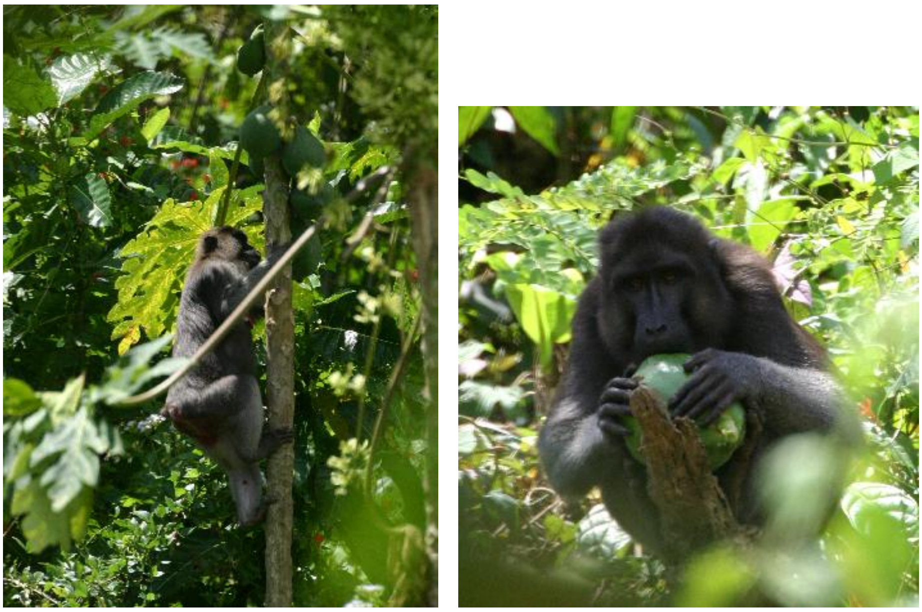


Figure 6.5 Adult raiding papaya tree (left) and eating the spoils (right) in the farm

Table 6.9 Summary of abundance of the five major crops across all farms and the percentage of raids for which each crop (N = 127)

Crop	Percentage of raids crop taken	Percentage of raids crop was available in farm	Percentage of raids the crop was taken when available	Abundance of crop (across all farms)
Maize	20.4	24.4	83.9	4.29 (NB does not include the store of harvested maize in La Damaridi farm)
Sweet potato	67.7	100	67.7	47.58
Banana	14.2	39.4	36.0	12.05
Papaya (leaves and fruit)	8.7	37.0	23.4	3.28
Cassava	3.1	37.0	6.4	6.67

Sweet potato was available in 100% of the raids in which crops were recorded, although it was only taken in 67.7% of those raids. Maize, on the other hand, was available in farms for only 24.4% of raids but when it was available it was taken 83.9% of the time. The majority of maize taken was from La Damaridi where there was a store of harvested maize. It is not surprising that monkeys seemed to target this store as it was a very easy source of food, being already removed from the plant. If maize was ignored on the basis that it was not actually growing in the field at the time of study, then sweet potato was the preferred crop, although it was not always targeted even when it was available. Banana was taken in 36% of raids when available, although in only 14.2% of the overall raids.

A preference for sweet potato may reflect the relative abundance of this crop. It was the most abundant crop (in terms of percentage ground cover of crop (Table 6.1)) across all farms, representing almost 50% of the total area of farmland, while banana was the next most abundant crop. Interestingly cassava was more abundant in the farms than papaya but taken much less often. This may be due to the difficulty involved in digging up a long, tuberous cassava root from under a shrub over a metre tall. It requires considerable time to unearth a cassava tuber; in most cases where cassava was eaten the monkeys would hurl themselves off the fence at cassava plants in attempts to break off the stem and leaves before digging out the tuber. In cases where other crops were readily available nearby it was likely these would be selected above cassava.

Nutritional content and character of crops will also govern preferences (Gautier-Hion *et al.* 1985). Vervets show preferences for sub-soil crops which are high in both protein and fats, while they choose tree crops which are yellow in colour and with high proportions of sugars (Horrocks and Baulu 1994). Maize has a very high energy content (365 Kcal/100g), and is also high in protein and lipids. Sweet potato is also high in protein but is also much higher in sugars than cassava (4.18g/100g compared to 1.70g/100g). Banana and papaya are, unsurprisingly, very high in sugars; banana more so with 12.23 g/100g compared to 5.90g/100g for papaya (see appendix 6.2 for full breakdown of nutritional content of the major crops). Combined with ease of access the high proportion of sugar in sweet potato, banana and papaya, and the high energy content of maize may well explain the monkeys' choice.

6.5.3 Crop Type and Raiding Frequency

Crop type was a major predictor of damage (see chapter 4) and thus crop preference is expected to influence raiding patterns. To assess the impact of crop type within farm and the frequency and duration of raids at that farm the predominant crop in each farm was noted (Table 6.10), as was the crop closest to the forest edge. In order to account for different numbers of observation days for each farm the unit of analysis was the day rather than the raid bout or event. Thus for each day of observation the number of bouts and events, and their total duration could be calculated. There were up to eight bouts per day lasting up to 6 hours 32 minutes and up to seven events lasting a maximum of 2 hours 34 minutes. Number and duration of raid bouts and event were not normally distributed and were therefore logged for all analysis.

Table 6.10 Main crop and main edge crop for each farm

Farm	Main crop	Main crop next to forest edge
La Husuna 2002	Papaya	Papaya
La Husuna 2003	Sweet Potato	Sweet potato
La Tole 2002	Sweet Potato	Sweet Potato
La Tole 2003	Banana	Banana
La Musrifa 2002	Sweet Potato	Banana
La Musrifa 2003	Banana	Banana
La Sahili 2002	Sweet Potato	Sweet Potato
La Sahili 2003	Sweet Potato	Sweet Potato
La Ruhuni 2002	Sweet Potato	Sweet Potato
La Ruhuni 2003	Banana	Banana
Unknown 2002 (almost fallow)	Shrubs	Shrubs
La Ruhuni grandma 2002	Dry Rice	Shrubs
La Darmin 2003	Sweet Potato	Sweet Potato
La Bau 2003	Sweet Potato	Sweet Potato
La Damaridi 2003	Maize	Sweet Potato
La Jonaidin 2003	Sweet Potato	Sweet Potato

Frequency of bouts differed significantly as a function of main crop in the farm (Table 6.11). Bouts were most frequent in the farm with dry rice or the fallow farm. This was somewhat unexpected and may result from the fact that the fallow farm provided shelter for the monkeys and a route for entering other farms. The farm with dry rice was raided on every day it was observed. The rice was partially harvested and stored around a watch hut and may have provided an easy source of food when passing near the farm. The farm with maize as the main crop showed a similar pattern. As mentioned previously the maize was harvested and stored in a hut and once again was an attractive source of food. However, posthoc tests revealed that the only significant difference was for farms with papaya versus all other crops (Tamhane, $p < 0.030$). Duration of bouts also differed significantly with main crop, although posthoc tests did not reveal where these differences lay. Maize once again stood out as having far longer bouts, while papaya is the shortest. As bouts also include time spent outside the fields it might be more revealing to look at raid events. Event frequency and duration showed a similar pattern (Table 6.11) with maize and dry rice having the most frequent and lengthy events, although increased event lengths were found for sweet potato compared to other crops.

Table 6.11 Main crop in field against frequency and duration of raid bouts and events per day (ANOVA comparisons, F, df = 5, 195, p)

Main Crop N = 201	**Papaya** (N = 9)	**Sweet Potato** (N = 117)	**Banana** (N = 41)	**Fallow/Shrubs** (N = 9)	**Dry Rice** (N = 8)	**Maize** (stored harvested) (N = 17)	**F**	**Sig.**
Mean no. raid bouts (± SD)	0.11 ± 0.33	0.71 ± 1.01	0.71 ± 1.35	1.00 ± 0.50	1.63 ± 0.92	1.29 ± 1.31	4.17	**0.001**
Mean duration of raid bout (± SD)	0:01:00 ± 0:03:00	0:18:03 ± 0:33:32	0:20:40 ± 1:04:22	0:07:33 ± 0:12:41	0:20:32 ± 0:24:32	1:18:24 ± 1:35:11	4.98	**<< 0.001**
Mean no. raid events (± SD)	0.11 ± 0.33	0.64 ± 1.24	0.49 ± 1.05	0.33 ± 0.50	2.13 ± 2.10	1.00 ± 0.79	4.79	**<< 0.001**
Mean duration of events (± SD)	0:01:00 ± 0:03:00	0:11:06 ± 0:26:40	0:07:13 ± 0:21:31	0:04:06 ± 0:08:24	0:13:56 ± 0:12:55	0:46:14 ± 0:47:08	7.26	**<< 0.001**

Placement of crops within a farm also influenced raiding. As it was not possible to compare overall placement of crops across the whole farm area, owing to the heterogeneous planting patterns, the effect of main crop next to the forest edge of the farm was explored. Sweet potato was the most common edge crop, followed by banana. As monkeys seemed to show a preference for these crops, this planting might be an odd choice for farmers (see chapter 8). Bout frequency and duration differed significantly by crop type at edge (Table 6.12), with sweet potato showing the greatest number and longest raids after fallow, as noted above (Tamhane, $p << 0.001$). Fallow included the farms with stored maize and dry rice which may explain the high number of raids. Event frequency and duration also differed significantly with crop at edge, showing a similar pattern. The longest events were recorded in fields with sweet potato at the forest edge (Tamhane, $p < 0.030$).

Table 6.12 Main crop next to forest edge of field against frequency and duration of raid bouts and events (ANOVA comparisons F, df = 3, 197, p ** significant at the 0.01 level, * significant at the 0.05 level)

Main edge crop N = 201	Papaya (N = 9)	Sweet Potato (N = 123)	Banana (N = 52)	Fallow/Shrubs (N = 17)	F	Sig.
Mean no. raid bouts (± SD)	0.11 ± 0.33	0.86 ± 1.09	0.58 ± 1.23	1.29 ± 0.77	5.78	**0.001****
Mean duration of raid bout (± SD)	0:01:00 ± 0:03:00	0:28:01 ± 0:51:20	0:16:18 ± 0:57:38	0:13:40 ± 0:19:42	4.22	**0.006****
Mean no. raid events (± SD)	0.11 ± 0.33	0.74 ± 1.23	0.40 ± 0.96	1.18 ± 1.70	3.49	**0.017***
Mean duration of events (± SD)	0:01:00 ± 0:03:00	0:15:05 ± 0:33:12	0:05:41 ± 0:19:17	0:08:43 ± 0:11:34	3.52	**0.016***

Harvested maize and dry rice clearly influenced raiding and their presence on a farm increased the amount of raiding experienced. Of growing crops, sweet potato again seemed to increase raiding; this may again reflect the relative abundance of sweet potato, its frequent positioning near the forest edge or the ease with which it can be extracted and processed by the monkeys.

6.5.4 Entry to the Farm

In an attempt to characterise raiding patterns, entry points to the farm were recorded. Farms were divided into eight sectors based on compass bearings (see chapter 2 figure 2.5). All sectors used by monkeys during a raid were noted. Total number of entry sectors used varied among farms (Figure 6.6). In total seven different entry sectors were used during all raids on La Ruhuni 2002 and La Damaridi. During each raid bout, the entire troop tended to enter the farm at a single sector, however on a few occasions in La Ruhuni 2002, 2003 and La Darmin two sectors were used during one raid. Monkeys would usually arrive at the farm close to the entry sector, although on some occasions they would arrive at the perimeter and move to a specific point before entering. For example in La Damaridi farm monkeys could enter directly from the roadside but despite frequently crossing the road to the farm they would move into the forested area adjacent to the farm before entering, as it presumably offered more shelter.

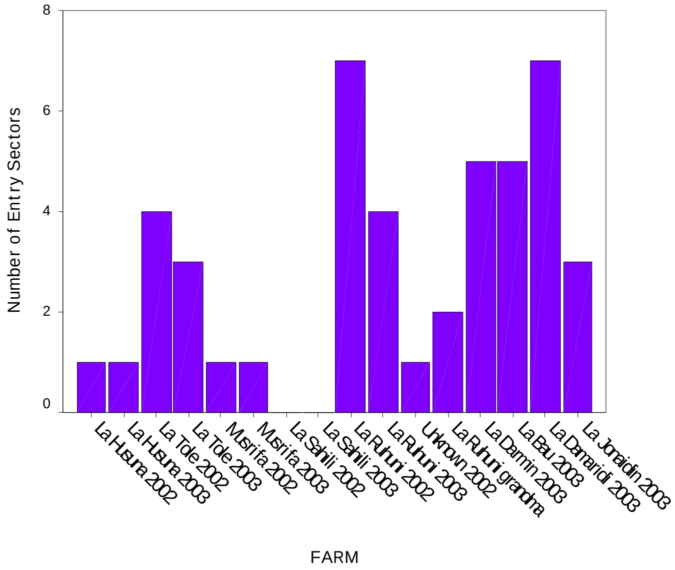


Figure 6.6 Number of entry sectors used during raids per farm

If forested perimeter offered shelter, it was expected that length of forested perimeter would influence the number of entry sectors used. More entry sectors were used in those farms with greater amounts of forested perimeter ($r = 0.793$, $N = 16$, $p << 0.001$). This may be the result of length of total perimeter, since on larger farms the probability of monkeys entering at more sectors increased. However, this pattern holds true when percentage of forested perimeter is used ($r = 0.680$, $N = 16$, $p = 0.004$) (Figure 6.7). This association suggests that entry at several points is not merely a by-product of size of farm but rather with more forest adjoining the farm, as well as a greater proportion of perimeter bordered by forest, opportunities for monkeys to enter that farm increased. As postulated earlier La Ruhuni 2002 and La Darmin had the greatest continuous stretch of forested perimeter and also the greatest number of entry sectors used.

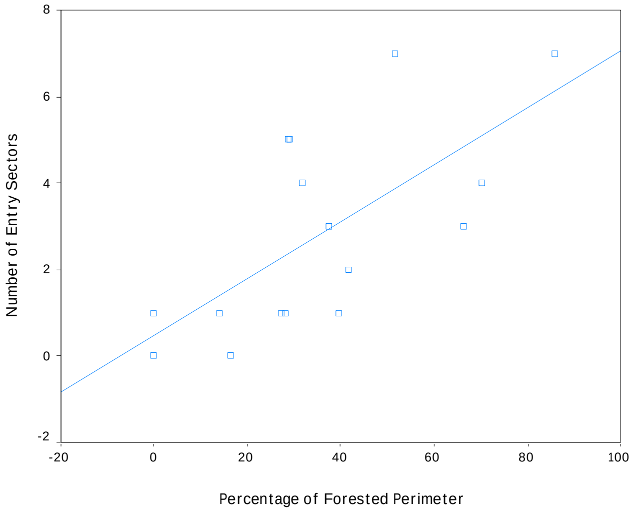


Figure 6.7 Scatterplot of total number of entry sectors used against percentage of forested perimeter (N = 16). Regression line is added to indicate positive trend

In most instances (83% of events) monkeys entered farms from forested sectors of the perimeter (Figure 6.8). For La Ruhuni Grandma and La Bau entry was sometimes from adjoining farms and scrubland and for La Damaridi entry was via an adjoining cashew plantation, where monkeys would sit and eat raided crops from the farm.

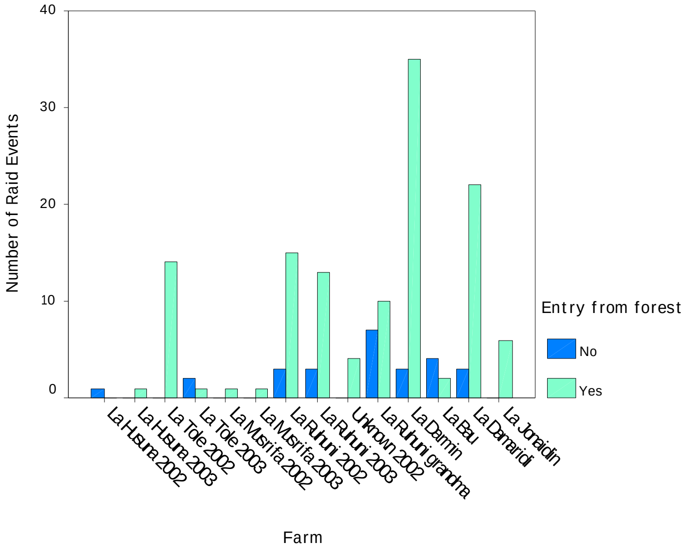


Figure 6.8 Number of raid events for which monkeys entered from the forest versus non-forested perimeter for each farm

Figure 6.9 Monkeys in the cashew plantation next to La Damaridi farm, enjoying the spoils of a recent raid event

6.6 BEHAVIOURAL PATTERNS OF RAIDING

6.6.1 Weather Effects

Based on the farmers' reports that monkeys disliked rain, climate was predicted to affect raiding patterns, both over the long term and through short term daily fluctuations. The weather on each observation day was categorised as dry or wet. Ideally more detailed patterns would be recorded but this was not possible within the scope of this study. These broad categories should nonetheless give an indication of patterns relating to local climate on that day. A 'wet' day was one with more than 30 minutes of continuous rainfall. Although this study was conducted during dry seasons, there were 49 days which were classed as wet, and on occasions it rained continuously throughout the day. During wet weather, human activity on the farms was lower and farmers were rarely observed working in the farms in the rain. This could have provided opportunities for monkeys to raid uninterrupted. Personal observations suggested that rain did not bother the monkeys much. In light rain showers they would raid as normal, in heavier downpours they would tend to huddle under some form of shelter but venture out to take a crop and return to eat it somewhere drier.

Table 6.13 Frequency and duration of raid bouts and events per day against weather conditions for each day (t, df = 199 p)

Mean	Dry (N = 152)	Wet (N = 49)	t	p
Number Raid bouts ± SD	0.76 ± 1.098	0.86 ± 1.1180	- 0.56	0.579
Bout Duration ± SD	0:19:27 ± 0:43:56	0:32:11 ± 1:06:18	- 1.26	0.214
Number Events ± SD	0.64 ± 1.193	0.71 ± 1.258	- 0.35	0.727
Event Duration ± SD	0:10:48 ± 0:25:31	0:18:37 ± 0:35:48	- 1.42	0.161

Frequency and duration of bouts and events were greater on wet than dry days but this was not significant (Table 6.13). Weather during the day does not seem to affect raiding on that day; of the two days with the longest bouts (over 6 hours each), one was a totally dry day and on the other, in La Damaridi, it rained non-stop all day.

Weather at the actual time of a raid was also noted. Once again events tended to be longer in wet conditions (Table 6.14). It is worth noting that in this context, the perceptions of the farmers appeared to be unrelated to the behaviour of the monkeys.

Table 6.14 Raid bout (t, df = 155, p) and raid event duration (t, df = 131, p) for dry or wet weather conditions

Mean	Dry	Wet	t	p
Bout Duration ± SD (N)	0:27:50 ± 0:32:34 (125)	0:33:24 ± 0:35:23 (32)	-0.85	0.399
Event Duration ± SD (N)	0:17:01 ± 0:21:10 (115)	0:33:16 ± 0:32:58 (18)	-2.03	0.057

Figure 6.10 A brief respite from the rain in La Damaridi farm

6.6.2 Temporal Patterns in Raiding

Interviews with farmers suggested raiding was more frequent in the morning and late afternoon (see chapter section 5.5.8). The observation day was divided into morning (6:00 – 11:00), midday (11:01 – 14:00) and afternoon (14:01 – 17:00); these periods corresponded to the divisions used in the questionnaire and therefore allow comparison. Raid bouts were most frequent in the morning (41% of bouts), followed by late afternoon (31%), mirroring the farmers' descriptions. It was hottest in the middle of the day and observations from troop follows confirmed that the monkeys were less active at that time, often resting during the heat of the day in the forest.

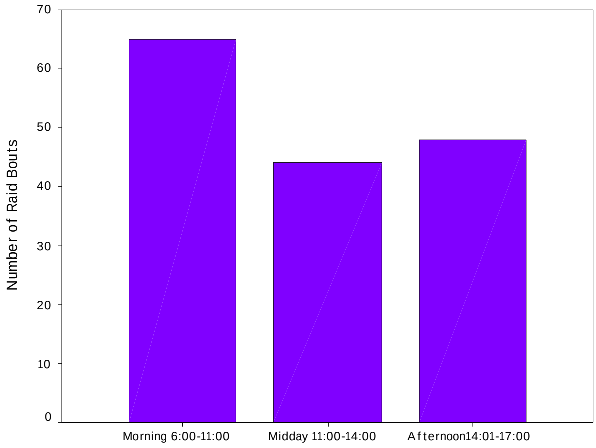


Figure 6.11 Temporal variation in raid bouts across the day

Duration of raid bouts varied markedly throughout the day too (Figure 6.12). Mean duration differed significantly between time blocks (F = 24.15, df = 2,149, p << 0.001). Bouts in the afternoon were much shorter than either those in the morning or midday (Tamhane, p << 0.001). Bouts may be longer in the morning due to a need to find food on waking.

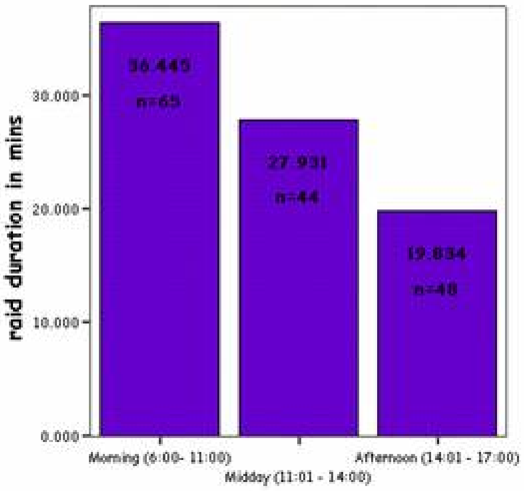


Figure 6.12 Mean raid bout duration during each time of day

However, grouping hours into broad time blocks can obscure patterns of raiding throughout the day. To see if there were any specific peaks of raiding throughout the day, the start time of raid bouts were grouped into hourly bands. Bouts were more frequent at

7 – 8am, 10 – 11am, 11 – 12pm but there was a noticeable peak in bouts between 2 – 3 pm. Few bouts occurred after 4pm or before 7am; at these times the monkeys were usually still near their sleeping trees or heading back to them (pers. obs.). The 2pm peak may be due to the fact that the temperature started to drop by then and the monkeys usually finished resting and went in search of food (pers. obs.), it may also coincide with a drop in human activity.

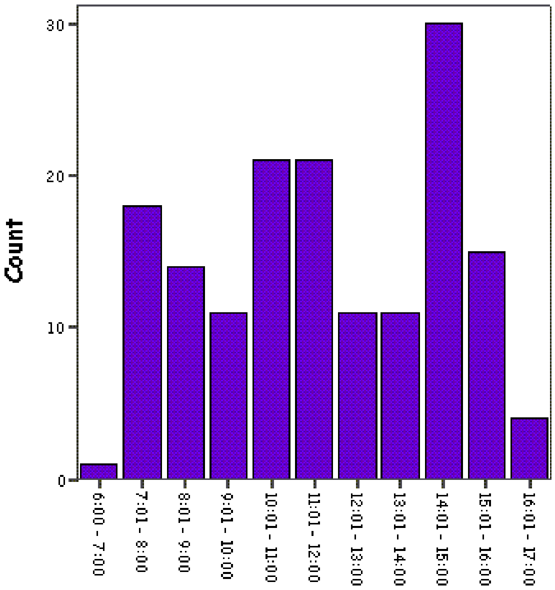


Figure 6.13 Number of raid bouts throughout the day (start time of raid bout grouped into hours)

Raid bout duration shows a different pattern, with the longest bouts tending to occur in the morning between 9 – 10am (mean of 51.97 minutes), however the differences are not significant (F = 1.58, df = 8, 143, p = 0.136).

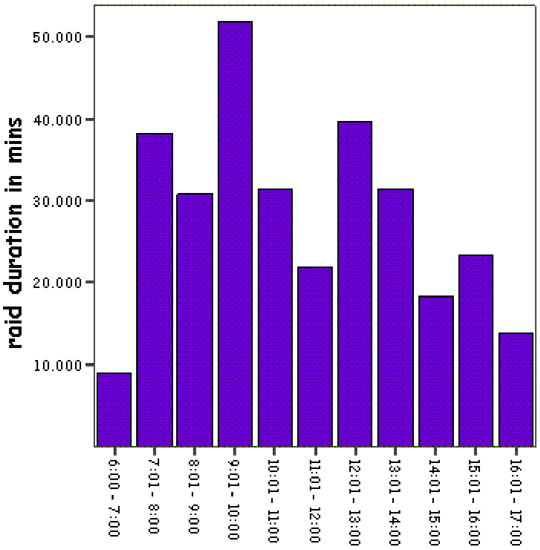


Figure 6.14 Mean Raid Bout Duration throughout the day (start time of raid grouped into hours)

6.6.3 Number of Monkeys Raiding

Raiding party size varied between one and 26 monkeys with a mean of 7.43 (N = 132). Raiding party composition varied between raid events, with adult males representing the majority of raiding individuals. Juveniles were the only age-sex class never to raid alone. Adult males were present in almost all raids, whereas other age-sex classes were frequently absent from raiding parties (Figure 6.15). Compared to mean group composition, based on follows of two crop-raiding troops in the same area (2002 (Slater, unpublished data)), adult males are heavily over-represented in raiding parties, while adult females and sub-adults are under-represented (Figure 6.15 and Table 6.15). This comparison suggests that adult males are raiding more than other age-sex classes.

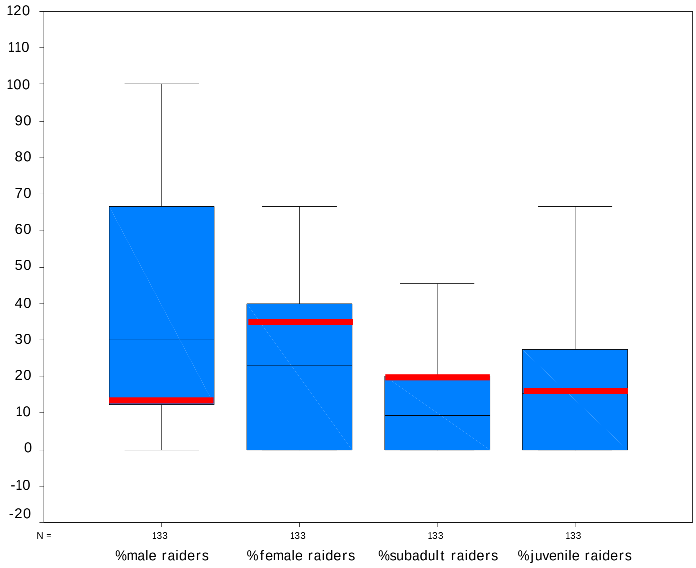


Figure 6.15 Percentage of each age-sex class in raiding parties (median, Inter-quartile range and 95% confidence limits). Red line indicates mean group composition based on follows of two troops

Table 6.15 Percentage of each age-sex class within raiding parties compared to group composition from troop follows.

	Adult Male %	**Adult Female %**	**Sub-Adult %**	**Juvenile %**
Mean within raiding parties (± SD) N = 133	40.32 ± 3.19	25.03 ± 2.09	12.12 ± 1.32	16.72 ± 1.50
Mean group composition from troop follows (N = 2)	13.51	35.14	18.92	16.22

6.6.4 Characterising Raid Duration

As mentioned in section 6.1, Maples et al, (1976) grouped raids by baboons in Kenya into three types: rapid maize raids, gang raids and sneak attacks based on the length and number of participating individuals in a raid. Crockett and Wilson (1980) also characterised raids of *Macaca nemestrina* and *Macaca fascicularis* and noted differences between the species. *M. nemestrina* would raid in sub-groups, surveying the farm for some time before entering (stealth raids), while *M. fascicularis* raided as a group led by a few individuals. Human activity and crop preferences may in part drive the raid type adopted. In order to see if raiding by *M. ochreata brunnescens* could be characterised in a similar way, event duration was categorised based on the frequency distribution of raids. Raids were then categorised as short; less than 2 minutes, mid; 2 – 10 minutes, long; 10 – 30 minutes and very long; over 30 minutes. These represented the 25%, 50%, 75% and 100% points of the cumulative frequency distribution. Different age-sexes participated in different raid types to differing degrees (Figure 6.17). Adult males participated in raids of all types but particularly dominated raids of short and mid duration. Once raids were over 30 minutes long however, all age-sex classes were equally represented. This suggests again that males were arriving at the farm first but were also leading raids.

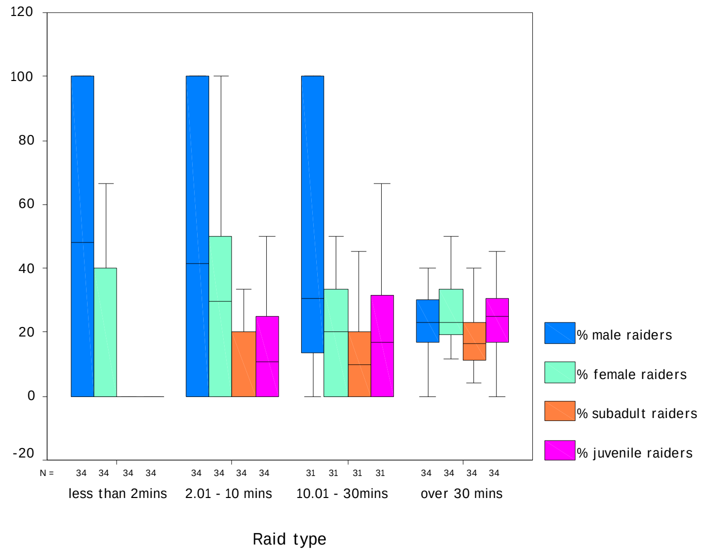


Figure 6.16 Raiding party composition during different raid types (median, inter-quartile range and 95% confidence limits)

6.6.5 Raiding Party Size and Duration

Larger party sizes were found during longer raids, where duration was the total time next to or in the farm ($r = 0.657$, $N = 133$, $p << 0.001$) (Figure 6.17) While the number of monkeys was highly variable for shorter raids (under 10 minutes) once raids were longer, the party size was linearly related to raid duration.

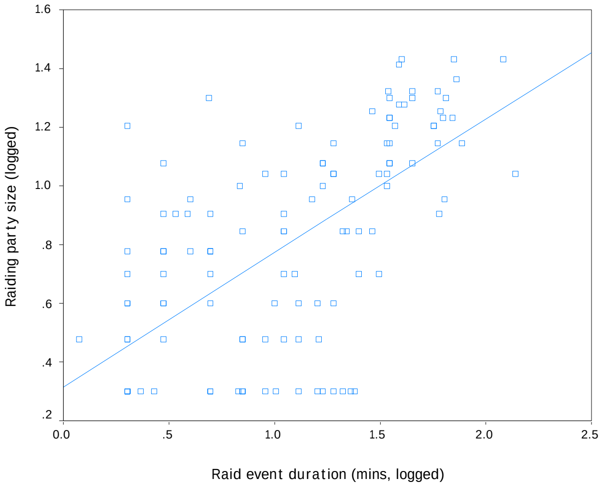


Figure 6.17 Raiding party size against raid bout duration (regression line added to indicate positive trend)

6.6.6 Penetration into Farms

Crop type at the edge of farms has been shown to affect frequency of raiding (above) but once attracted into a farm the monkeys will raid up to 50m from the farm edge. The distance monkeys ventured into the farm (penetration distance) was categorised as < 5m, < 10 m (between 5 – 10 m), < 20m, < 30m, (including all other distances). Deeper penetration was expected with longer raids as opportunities to venture into the farm and explore the foods were greater when more time was available. Penetration up to 10m into the farm followed this pattern; however beyond that distance raid duration did not seem to have the same influence (Figure 6.18). This essentially created a bimodal distribution. Penetration beyond 10 m was essentially a rare event and this may account for the differences seen. Remaining within 10 m of the fence might have been seen by the monkeys as the ‘safe zone’; thus as raid duration increased so more of the group spent time within that area, with only a relatively few individuals, such as adult males, venturing deeper into the farm during short raids (see later, Figure 6.20). Adult males and juveniles were frequently seen at the farm-forest boundary (0 m) which suggests they may be leading raids (Figure 6.18). Beyond that distance, differences between the sexes were hard to determine when considering overall mean event duration, without looking at the effect of party size and splitting raid duration into short vs. long raids (see later)

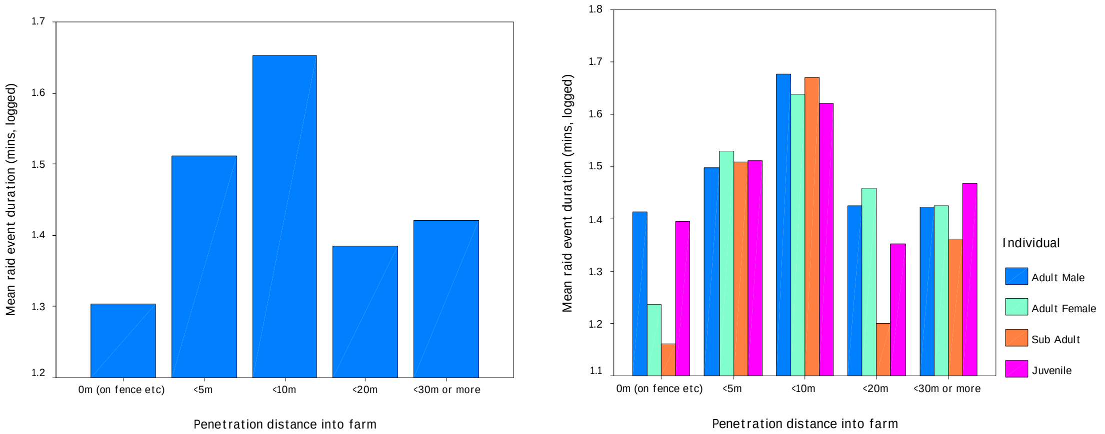


Figure 6.18 Raid event duration and penetration into farm for all age-sex classes (left) and split into separate age-sex classes (right)

Raiding party size showed a similar pattern. Up to 10m into the farm, raid party size increased, but beyond 10m raiding party size declined again, suggesting these were rare events with fewer participants (Figure 6.19). Larger parties stayed longer in farms but still tended not to risk moving beyond 10m into the farm. This could therefore be considered as a primary raiding threshold which could have implications for managing crop-raiding. However, if there was an interaction between crops near the perimeter and crop selection, then this 10m pattern may simply reflect the ease of extracting favoured foods through short distance sorties into a field. Although sweet potato was frequently found at the edge of farms and was also a preferred crop, it tended to be found over large areas of those farms where it was present rather than growing exclusively next to the edge.

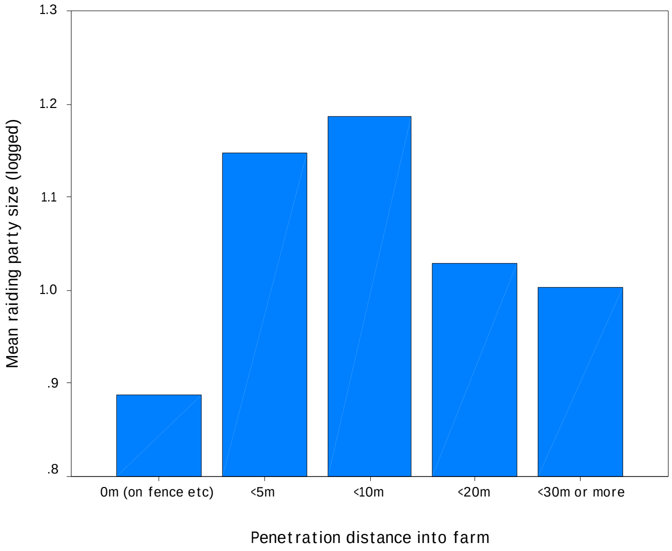


Figure 6.19 Raiding party size and penetration into farm

The factors influencing raid duration were explored in univariate GLM ANOVA. There was a positive relationship between duration and party size (see Figure 6.17) so size was removed as a covariate. Both the category of age-sex class (F = 3.80, df = 3, 4610, p << 0.001) and category of penetration distance (F = 29.03, df = 4, 4610, p = 0.010) had main effects on raid duration. Age-sex and penetration accounted for 75.2% of the variation in duration of raid event. Duration of a raid will influence which individuals are seen in the farm and how far they go into the farm. There were few age-sex differences for long raids at any penetration distance, although both males and juveniles were more frequently seen deeper into the farm than other age-sex classes during very long raids (Figure 6.20). Males dominated at all penetration distances in shorter raids. Sub-adults seemed to show preferences for middle distances (10 – 20m) during middle length raids (2 – 10 min). In the slightly longer raids (10.01 – 30 minutes) adult males ventured deep into the farms, while most age-sex classes remained close to the fence.

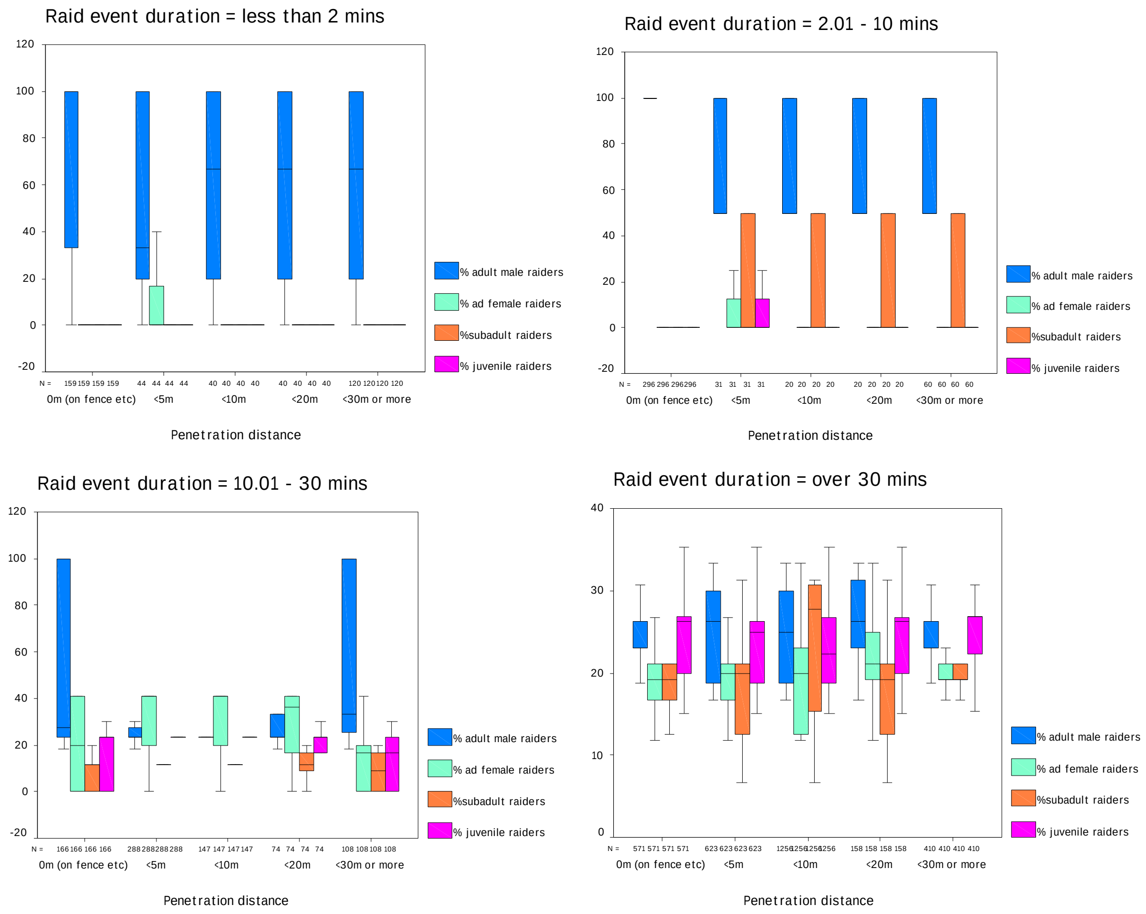


Figure 6.20 Age-sex class as a percentage of the total raiding party at different penetration distances for short, middle, long and very long raids

6.6.7 <u>Who Leads the Raid?</u>

It is clear from the above analysis that males appeared to lead raids. This may have been a product of them arriving at the farm first. The age-sex class of the first monkey to arrive at a farm and the first to enter the farm were recorded. Adult males entered first on 83% of raid events, while they arrived at the farm first in only 53% (Figure 6.21). A McNemar paired test was used to test for differences between age-sex classes first seen and first to enter. Adult males entered the farm significantly more frequently than would be expected by their frequency of arrival at the farm first alone ($p << 0.001$). All other age-sex classes entered first less frequently than would be expected, especially juveniles, who arrived at the farm first in 15% of events but only initiated raids in 4% of events.

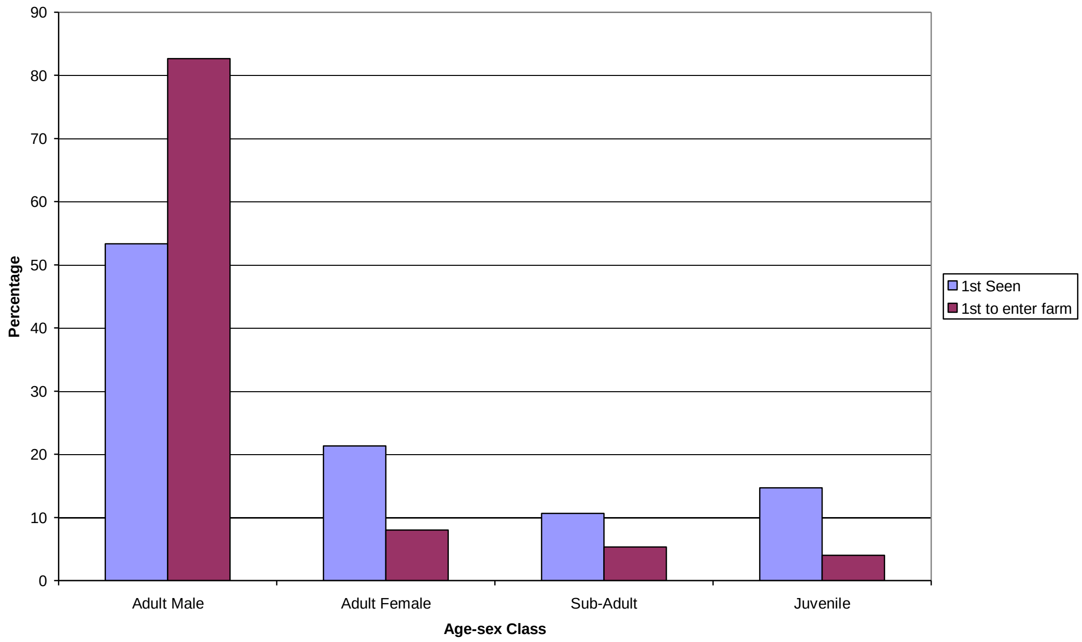


Figure 6.21 Percentage of each age-sex class to arrive first at the farm and to enter the farm first during a raid event (N = 75)

6.6.8 Behaviour Inside vs Outside the Farm

Behavioural scans were taken every 2 minutes outside and inside the farm (see chapter 2 section 2.5.3). This could lead to dependence of data, since if the monkey is doing behaviour A at scan 1, the probability of that behaviour occurring at scan 2 is increased. However as the majority of raid events were under 10 minutes (Figure 6.22) a longer scan interval would under-represent activities for short duration raids. Therefore the 2 minute scans interval were analysed as independent events, although it is recognised that some dependence of data might exist.

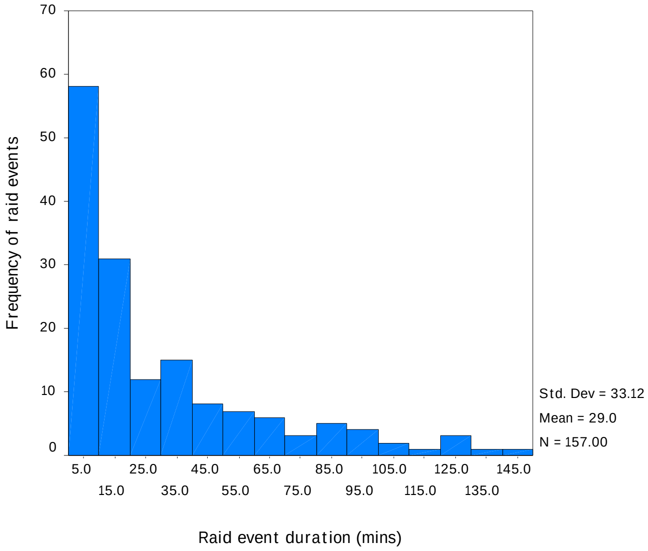


Figure 6.22 Frequency histogram of raid event duration

To increase the independence of the data, the unit of analysis was the raid event and percentages were used to account for differing observation times in different raid events Behaviour inside the farm was compared to behaviour outside specifically at the time of the raid, using matched samples. This reduces any biases introduced due to varying activity patterns over the course of the day or over the study period and allows for some internal consistency. Data on activities were not normally distributed, and as such a Wilcoxon matched pairs test was used to compare behaviour inside to behaviour outside the farms. As noted earlier, data are presented as means, rather than medians, since for some behaviour there was a large number of zeros. Medians suggest that these behaviours did not occur, which is misleading.

Behaviour (see appendix 5 for full ethogram) was grouped into main categories of feeding (including foraging), locomotion, resting, social (including grooming, aggression, copulation), play and vigilance.

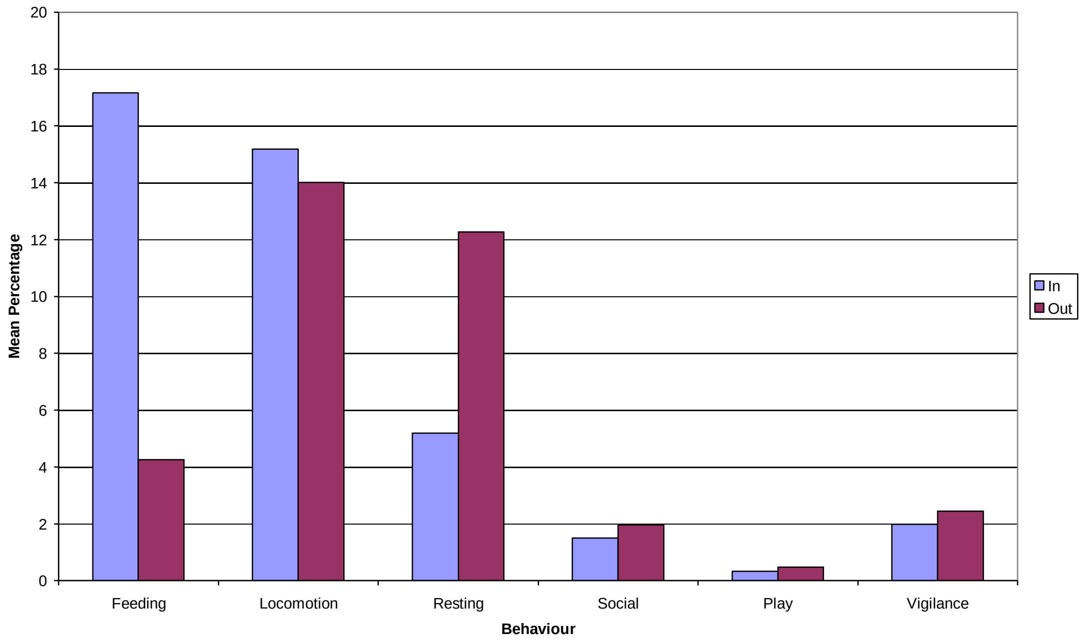


Figure 6.23 Mean percentage of each behaviour within the farm compared to outside the farm (N = 4631 scans)

Feeding and locomotion occurred more frequently within farms than outside farms (Figure 6.23), although only feeding was significant (Z = -11.41, N = 904, p << 0.001). Resting was significantly more prevalent outside the farms (Z = -6.69, N = 904, p << 0.001), as were social behaviour and vigilance, although not significantly.

Behaviour observed in and out was compared for each raid type as defined above. For raids of short duration (under 2 minutes, N = 403) almost all behaviour occurred more frequently outside the farm, which is to be expected, especially for locomotion (Z = -3.76, N = 403, p << 0.001), which is because the monkeys tended to be active, running in and out of the farm. Only feeding was slightly more frequent within the farm (Figure 6.24)

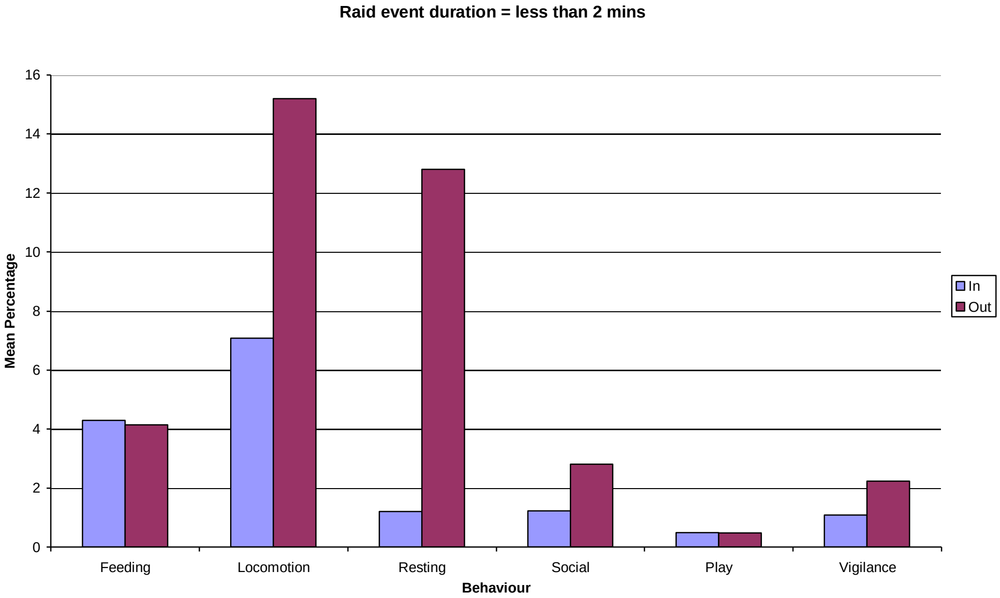


Figure 6.24 Mean percentage of each behaviour within and outside the farm for raids under 2 minutes

During raids of 2 – 10 minutes (N = 427) locomotion (Z = -3.88, N = 170, p << 0.001) and feeding (Z = -5.54, N = 170, p << 0.001) were more frequent within the farm, with monkeys moving rapidly around the farm and gathering as much crop as possible (Figure 6.25).

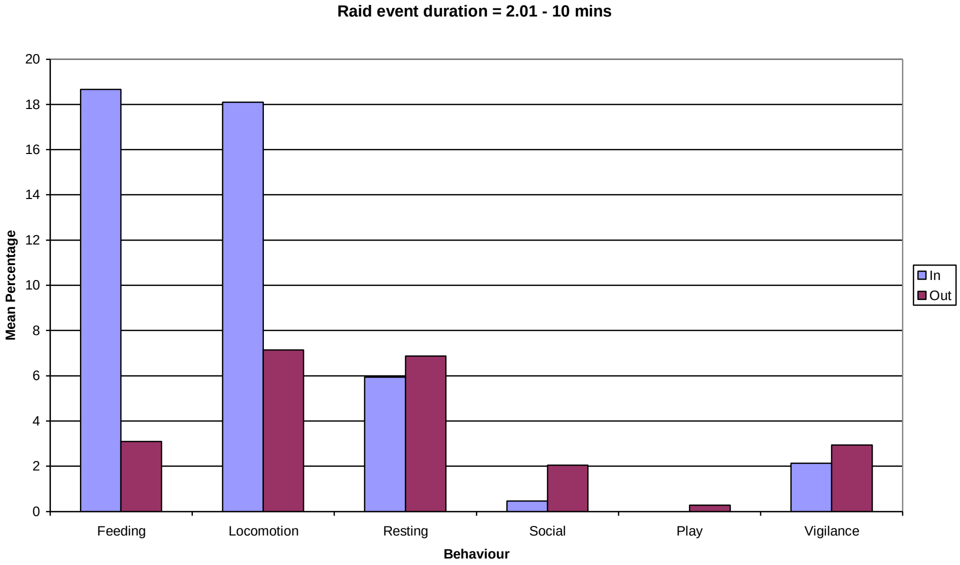


Figure 6.25 Mean percentage of each behaviour within and outside the farm for raids of 2.01 - 10 minutes

Long raids of 10 – 30 minutes (N = 783) were similar to medium raids; however vigilance behaviour started to be exhibited with somewhat greater frequency within the farm (Figure

6.26). Locomotion decreased and feeding increased, suggesting the monkeys were relaxed in the farm but the increase in vigilance behaviour suggests they remain wary of their surroundings.

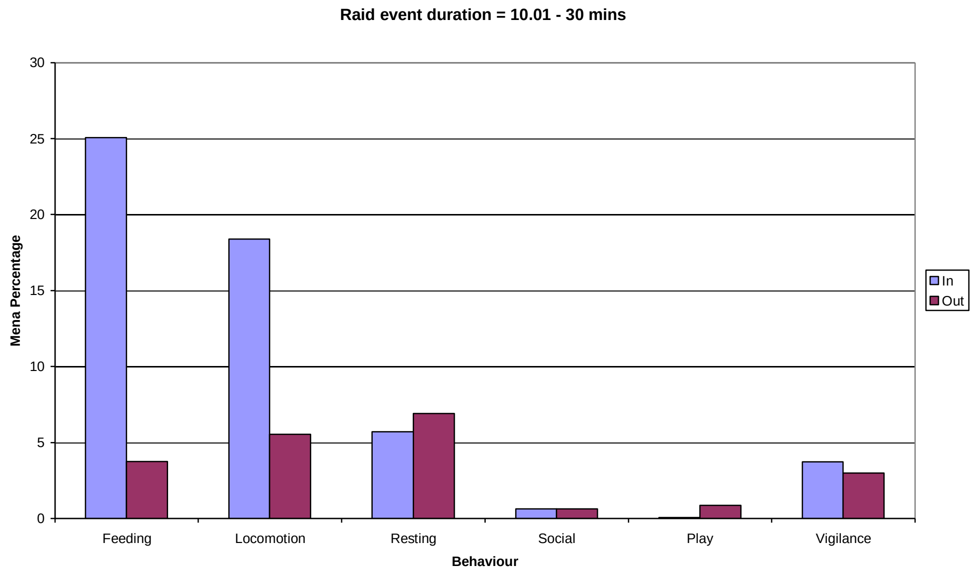


Figure 6.26 Mean percentage of each behaviour within and outside the farm for raids of 10.01 - 30 minutes

In very long raids, over 30 minutes (N = 3018), feeding was much more frequent in the farm than outside (Figure 6.27) (Z = -9.63, N = 170, p << 0.001). Monkeys remained in the farm to feed, rather than grabbing what they could and retreating to the fence or forest. Furthermore social behaviours within the farm increased (Z = -5.34, N = 170, p << 0.001) suggesting the monkeys were more relaxed during these longer raids. Although an in-frequent behaviour within and outside the farm, play behaviour was more frequent within the farm during very long raids. Vigilance behaviour, however, was still greater within the farm suggesting the monkeys were not totally relaxed (Z = 2.74, N = 170, p = 0.006).

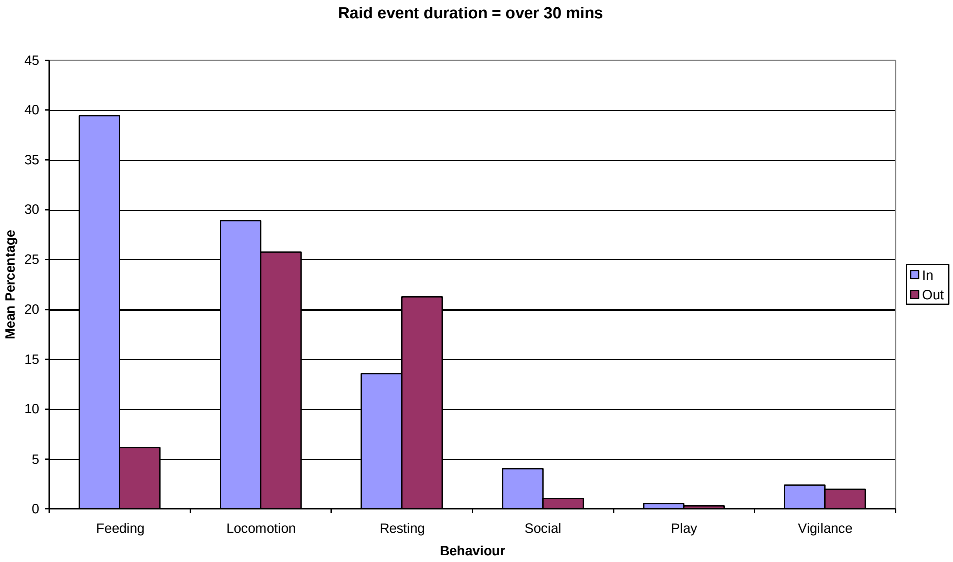


Figure 6.27 Mean percentage of each behaviour within and outside the farm for raids of over 30 minutes

6.6.9 Age-sex Class and Behaviour

Frequency of behaviour within compared to outside the farm did not vary much among the age-sex classes. Feeding behaviour was greater inside the farm for all ages and sexes and resting was more frequent outside the farms (Figure 6.28) as seen before.

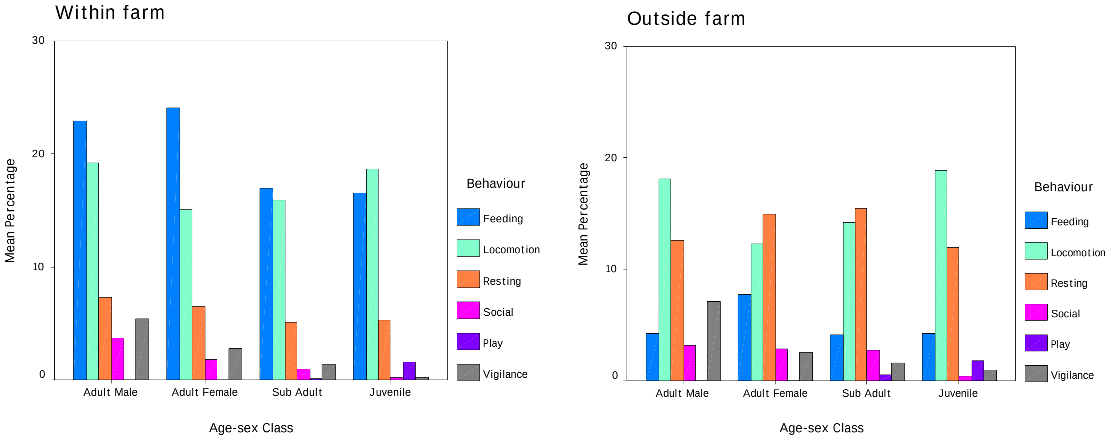
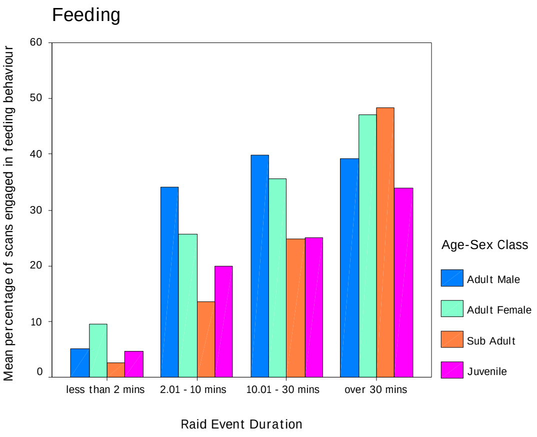


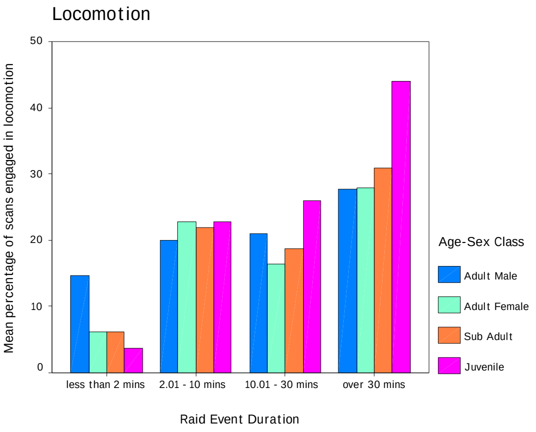
Figure 6.28 Mean percentage of each behaviour for each age-sex class within and outside the farm

A Kruskal-Wallis test was used to examine differences between age-sex classes for each of the behaviours within the farm. Frequency of feeding, social, play and vigilance behaviour all varied with age-sex class. Adult females engaged in feeding significantly more frequently than did sub-adults or juveniles (?^{2} = 11.06, df = 3, p = 0.011). Adult males engaged in social behaviours more than any other age-sex class (?^{2} = 20.66, df = 3, p << 0.001) which was somewhat surprising (see chapter 3). Social behaviour included acts of aggression, alarm calls and being groomed; these activities, from personal observations, were those in which the males seemed to engage most, as opposed to grooming. This may explain why males seemed to engage in more social behaviour than other age-sex classes[2]. It may also suggest that males were more relaxed than other members of the group and therefore engaging in social behaviour (such as being groomed) more frequently. Within the farm play behaviour was only exhibited by juveniles (?^{2} = 20.66, df = 3, p << 0.001), while outside the farm both sub-adults and juveniles were seen to play (Figure 6.28). Adult males were vigilant much more frequently than other age-sex classes (?^{2} = 37.45, df = 3, p << 0.001).

6.6.10 Raid Duration, Age-sex Class and Behaviour

It was shown above that the overall frequency of behaviour varied with raid duration and also that raid duration affected which age-sex classes participated in raids. Behaviour exhibited by each age-sex class also varied with raid duration.





---

[2] It is recognised that aggression, alarm calling and grooming are responses to very different stimuli. They have however been grouped under “social behaviour” and the specific differences between age/sex classes and raid lengths discussed on the basis of personal observations.

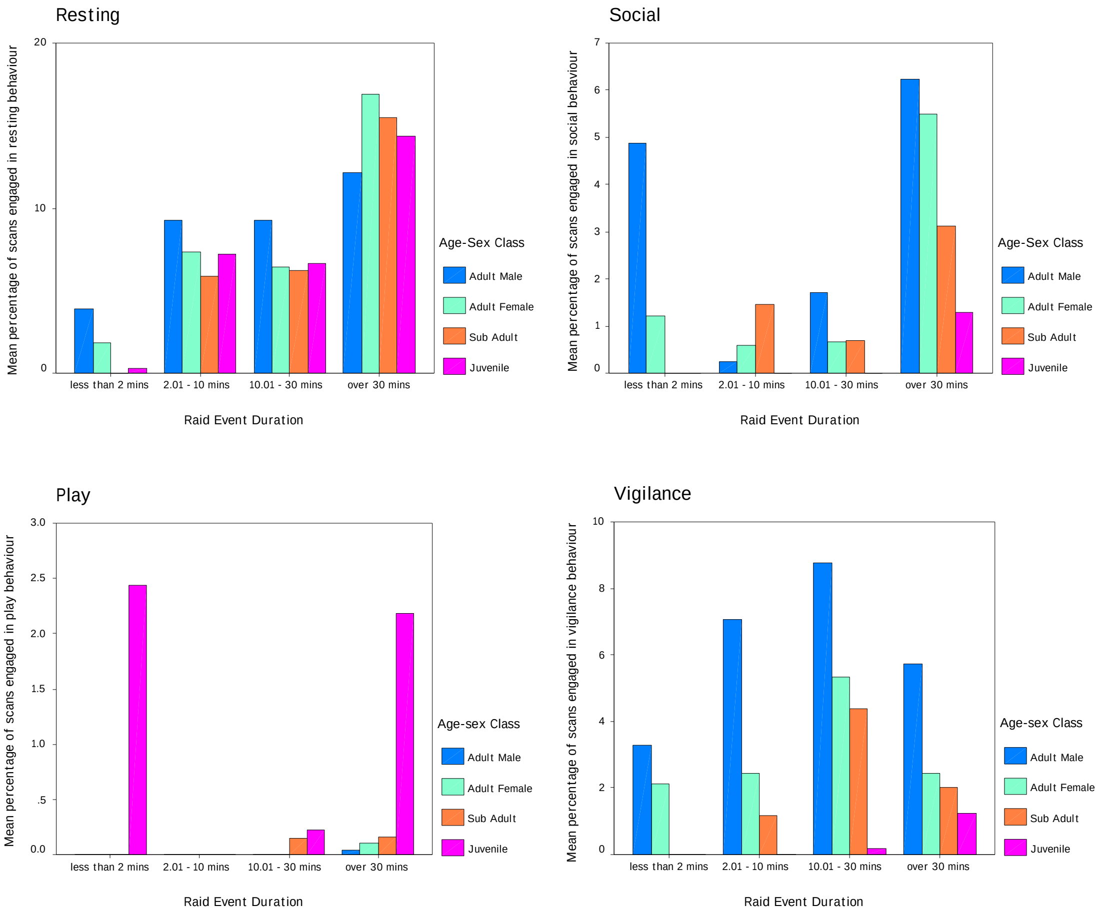


Figure 6.29 Mean percentage of scans for which each of the behaviours is exhibited within the farm for each age-sex class and each raid event duration

Feeding increased with raid duration for all age-sexes. During short raids, adult males exhibited more locomotion, which may be because they were leading raids and therefore moving in and out the farm. In raids over 30 minutes juveniles also spent more time locomoting which may indicate they were relaxed and exploring the farm. Resting increased with raid duration for all sexes as they became more relaxed in the farms. Social behaviour was exhibited most by males during short raids, which appeared to consist mainly of aggressive behaviour and alarm calling. In longer raids, all sexes engaged in more social behaviour. Juveniles, as expected, exhibited the most play behaviour, but this was either during short raids of under 2 minutes or in those over 30 minutes. Much of the play exhibited in short raids was close to the fence as they leapt in and out of the farm (pers, obs.), while that exhibited in longer raids was within the farm itself. Vigilance behaviour was primarily exhibited by the adult males and increased with raid duration up to 30 minute raids. It appears that it is only in those longest raids, over 30 minutes, that all monkeys were more relaxed. During short raids there was less time to be vigilant as they were too busy running about gathering food. In longer raids all age-sex classes exhibited some vigilance behaviour.

6.6.11 Unusual Behaviour Observed in the Farms

Some rare behaviour was observed on the farms. Copulation (or attempted copulation, i.e. mounting) was seen on seven occasions. Two of these events occurred outside the farm but surprisingly the rest occurred during raid events (during raids longer than 10 minutes). On one occasion a sub-adult was observed mounting (Figure 6.30). It can be suggested that general arousal levels were high during raids, leading to some increase in sexual interactions. It might also imply a level of relaxation in the farms during raids. Food carrying was observed relatively frequently and accounted for 2.5% of all scans recorded. The majority of this food carrying was tripedal and occurred most frequently inside the farm and during longer raids (Figure 6.31). Bipedal food carrying only occurred three times, always during 10 – 30 minute raids. Carrying food with the mouth (that is carrying a whole tuber or large item of food as opposed to full cheek pouches (Figure 6.32)) occurred 17 times, mostly during the shortest raids (under 2 minutes). Bipedal standing was observed 13 times, mostly performed by sub adults, during raids over 10 minutes (Figure 6.33). Bipedal walking was recorded only twice, by a juvenile and an adult male during raids over 30 minutes.

Figure 6.30 Sub-adult mounting a juvenile during a long raid

Figure 6.31 Food carrying tripedally (sweet potato)

Figure 6.32 Examples of food carrying in the mouth. In all instances they are carrying papaya.

Figure 6.33 Examples of bipedal standing during raiding

6.7 OVERALL RAID CHARACTERISATION – DURATION AND PARTY SIZE

Raids could be *very short* (under 2 minutes) and *short* (under 10 minutes) with only a few participants (mostly adult males) who penetrated only limited distances (under 10 m) into the farms. On short raids monkeys typically grabbed food and retreated to the forest. Alternatively raids were longer (over 10 minutes), with most of the troop participating being led by a few individuals (adult males) and venturing deep into the farm (over 30 m).

Raids were characterised on the basis of duration and party size, which also reflect the depth of penetration into the farm. Categories of duration and party size were determined from the frequency distribution, as used above.

Table 6.16 Party size and raid duration crosstabulation. Number of scans for each party size is presented as a percentage of total scans for each raid duration category. Colours indicate subsequent raid categories

Raid Duration	**Party Size**			
	1	2 - 6	7 - 16	17 or more
Less than 2 mins (N = 539)	79.2	20.8	0	0
2.01 – 10 mins (N = 525)	59.4	21.9	18.7	0
10.01 – 30 mins (N = 1244)	16.2	13.0	38.7	32.2
0ver 30 mins (N = 3746)	0	0	49.9	50.1

Table 6.16 shows a cross-tabulation for the number of behavioural scans for each duration and party size and this was used to characterise raids into four types:

Grab raids – very short (less than 2 minutes) with six or less participants.

Assault raids – short (2.01 – 10 minutes) with 16 or less participants.

Mob raids – medium (10.01 – 30 minutes) with any number of participants.

Relaxed raids – long (over 30 minutes) with more than seven participants.

These categories correctly classify 96.7% of all raids, with only five raids falling outside these categories, for example a raid of 2 minutes involving nine participants.

Age-sex class and penetration distance both relate to party size and raid duration. Since different age-sex classes exhibit different activities during raiding, and each penetrates to different distances, penetration distance was not explicitly incorporated into these categories. For example, adult males tend to predominate in short raids and venture further into the farm than do other age-sex classes.

6.8 SUMMARY

The major findings presented in this chapter can be summarised in relation to the factors that make some farms likely to experience raiding, which individuals take the risk of raiding, and what do the monkeys gain from raiding.

§ **Farm vulnerability**

Greater length and percentage of forested perimeter around a farm increased the frequency with which it was raided by monkeys. Length of forested perimeter also increased the duration of individual raid events and time the monkeys spent waiting outside the farm between raids. This suggests that the monkeys use the cover of the surrounding forest as a refuge while raiding. Farms with little or no forest bordering the farm experienced much less frequent and shorter raids, presumably due to the increased costs of raiding an open farm, surrounded by other farms with no immediate refuge to escape to.

Farm area was important in determining whether or not a farm was visited by a troop of monkeys and how long they spent there, but once in the farm, area had little impact on the actual number of raiding events. Monkeys spent more time in the surrounding area of larger farms; which again may be the result of risks associated with raiding a large open farm. Thus they either spent more time waiting in the forest, or troop movements could have brought monkeys close by farms without subsequently raiding.

The risk of crossing a road or river to reach a farm did not seem to affect the frequency or duration of raids; the benefits of raiding seemed to outweigh the associated costs of crossing these potential barriers.

§ **Who participated in raids? Who took the risks?**

Adult males were shown to lead raids. Although they were the age-sex class that arrived first at farms in the majority of raids, they were also first to enter the farm in 30% more raids than expected. So even when adult males did not arrive at the farm first they frequently led the incursions into farms. Compared to mean group composition outside the farms, males were heavily over represented in raiding parties. Adult females and sub-adults were under-represented, while juveniles formed a similar proportion of raiding parties and of groups outside farms; if juveniles were present then they would raid. Adult males dominated raiding parties for short, medium and long raids, and only at the very long raids, over 30 minutes, were all age-sex classes represented. However, juveniles and adult males were still more frequently represented in very long raids. Adult males penetrated deeper into the farms during short raids, and once again only during very long raids did these age-sex differences disappear. Sub-adults showed a preference for middle length raids and middle penetration distances. Adult males certainly seemed to be the risk takers, while adult females and sub-adults took fewer risks in raiding. Juveniles raided when the opportunity arose but did not lead raids, suggesting they were taking more risks than females and sub-adults but not as many as were the adult males. During raids when the troop retreated to the forest due to disturbance, it was often the juveniles who would remain close to the farm, playing on the fence or in the nearby trees. However it was usually the adult males who led the next incursion into the farm (pers. obs). This is consistent with observations of crop-raiding baboons in Kenya (Oyaro and Strum 1984; Strum 1994) where males (although in these studies they were young or adolescent males) were shown to initiate raids, with the rest of the troop following. As in baboons males play a critical role in determining foraging strategy and in shifts towards crop-raiding. After the poisoning event of 2002 (see chapter 3) the Kawelli troop was left without any adult males and were not witnessed to crop-raid, or in fact move around their home range much at all (pers. obs., Slater, unpublished data 2002). Thus the males may be directing or leading troop movements in the Buton macaque.

Figure 6.34 Juveniles sitting on the fence amongst the 'monkey-proof' bamboo netting at La Darmin farm. The rest of the troop have retreated to the surrounding forest

§ <u>Food Choice – the rewards</u>

When available, maize was the preferred crop although the majority of maize stolen was in the harvested store on La Damaridi rather than growing. However, farmers reported (see chapter 5 section 5.10) that maize was indeed targeted by monkeys, and in La Bau, where maize was available only in one corner of the farm, the monkeys would cross the road and raid from that corner, rather than entering the farm from the forested side away from the maize. Maize also seemed to relate to more frequent and longer raids. Of those crops growing in the farms, sweet potato and banana were the most frequently taken crops and this again tallied with farmers' reports. Sweet potato and banana were the most abundant crops which may explain the monkeys' choices; however they were also high in sugars and other nutrients and easy to access. Cassava was more abundant than many crops but was rarely chosen, perhaps due to the difficulty of extraction or to its somewhat lower nutritional content.

Figure 6.35 Entry point at La Bau farm at corner where maize was planted (arrows indicate discarded maize husks from previous raids) (left) and view of la Bau farm and that entry point from road (arrow indicates entry point) (right)

Although a rare crop in the farms, when present, dry rice seemed to attract monkeys, which may be because of its high nutritional value. Sweet potato, both as a main crop on the farm, and near the edge attracted monkeys into the farm more often and for longer than other crops. When papaya was the main crop, however, raids were short and less frequent. Personal observations suggest that papaya was often targeted in short duration raids when humans were present. The monkeys would rush in the farm, grab a fruit or leaves and return to the fence to consume them. Crop choice has implications for management of crop-raiding. Despite farmers reporting that monkeys preferred maize, sweet potato and banana, preferences supported by the data presented above, these crops were often those planted next to the forest edge of the farms. Crops were also stored unguarded on farms, for example the maize store on La Damaridi. Planting preferred crops towards the centre of farms and removing harvested crops could increase the perceived risks of raiding for the monkeys and therefore reduce incursions into farms.

Figure 6.36 Juvenile raiding banana palm planted right next to fence on La Ruhuni farm

Figure 6.37 Monkeys raiding close to fence in La Ruhuni farm. Banana palms and sweet potato are planted close to the edge of the farm despite farmers recognising that monkeys target these crops

Figure 6.38 Another example of monkeys raiding close to the fence (in La Damaridi farm). Again note the planting of sweet potato (much of which has already been raided) and banana close to the fence

§ <u>Characterisation of raids</u>

Raids were characterised into four types. These were: *Grab* raids (less than 2 minutes and six or fewer participants), *Assault* raids (2.01 – 10 minutes and 16 or fewer participants), *Mob* raids (10.01 – 30 minutes with any number of participants) and *Relaxed* raids (over 30 minutes with seven or more participants). Grab raids most closely matched those described by Maples *et al.* (1976) as 'rapid maize raids', in that a few individuals (typically males) entered the farm, grabbed food such as papaya and then retreated to the forest carrying this food in their mouths, presumably so as not to hinder their locomotion by carrying it in their hands. This tactic of raiding is expected to be associated with high human activity on the farm, and will be examined in the next chapter. Assault raids might be considered most similar to the 'stealth raids' of *M. nemestrina* (Crockett and Wilson 1980) and once again predicted for farms with high human activity. During raids of longer duration such as the mob and relaxed raids, with greater penetration distance, 'relaxed' behaviour such as socialising, resting and play was observed in significant amounts. These raids might be classed as 'gang raids', similar to those witnessed in Kenyan baboons (Maples *et al.* 1976) and *M. fascicularis* (Crockett and Wilson 1980). These could potentially occur in response to lower levels of human activity. Levels of vigilance were highest for all age-sex classes in longer raids, which agrees with Maples *et al.*'s findings (1976) and suggests that although more relaxed during long raids, the monkeys remain more alert within the farm than outside. Bipedal standing and walking were also most frequently observed in long raids, which are suggestive of high levels of alertness.

CHAPTER 7 - HUMAN ACTIVITY ON FARMS AND THE EFFECT ON RAIDING BY MONKEYS

Human activity affects raid frequency and duration (see for example Crockett and Wilson 1980; Maples *et al.* 1976). In this chapter the effect on monkeys of human and dog activity on the farms will be investigated. Differences between raided and non-raided farms will be discussed in section 7.3.1 followed by an assessment of the impact of amount of human activity on raid frequency in section 7.3.3. Section 7.4 will address how human activity changes monkey behaviour and influences who raids and where raids occur. Finally, section 7.5 will look at the perceptions of deterrents and effectiveness of active deterrents.

7.1 INTRODUCTION

Human activity is not always a clear predictor of damage levels (Hill *et al.* 2002; Naughton Treves 1996, 1998a) and in many cases animals are observed to await the departure of farmers before moving into fields to raid (Horrocks and Baulu 1988; Kavanagh 1980). Animals respond differently to men as opposed to women and there is evidence that women and children are not effective deterrents to some primates such as baboons (Hill 2000). Guarding farms or other human activities may be effective only in that farmers *perceive* guarding as effective. An alternative explanation may be that a combination of different factors has to come together before there is a predictable human influence on raiding. Although several aspects of raiding are affected by the degree of guarding done by farmers, for example the duration of raids and whether the troop enter at single or multiple points (Maples *et al.* 1976), raiding problems are never fully solved simply by humans guarding their fields (Forthman Quick 1986a; Maples *et al.* 1976). Raiders instead often adapt their behaviour to avoid the problem of human vigilance (Maples *et al.* 1976). In this study personal observations suggest the possibility of learned behaviour on the part of the macaques. For example, on a farm where farmers were nearly always present and quickly detected entering macaques, the macaques remained close to the farm edge to ensure a quick escape and they usually returned soon after being chased out. This is in contrast to the only farm on which macaques ventured into the centre and on which the farmer was only seen once. Obviously this difference is merely anecdotal and may be due to a host of other factors, but these farms were similar in size, forested perimeter, crop type (and availability) and location.

Guarding is costly in terms of time and lost opportunities for other activities (be they social, domestic or economic) (Biquand *et al.* 1994; Hill 1997, 1998, 2000; Naughton Treves 1998a). Another problem is that of immigration away from rural areas by the younger generation, leaving only the elderly or very young to guard the farms (Japan; (Sprague 2002)). Monkeys are able to cross into human territory easily and farmers feel powerless to stop them. Many farmers in this study were also observed to be elderly, and many people of the younger generation leave to make money in the city (pers. obs).

Although dogs can be a useful deterrent against raiding, some studies have been unable to correlate dog activity with raiding (Sprague 2002). Dogs were witnessed on several occasions to chase and scare monkeys and even to attack them (pers. obs). Even if they are effective, however, they can also be very expensive for the ordinary farmer, as dogs must be fed and cared for (Biquand *et al.* 1994) and they require a culture of dog keeping.

They also pose a risk to small children when trained to chase monkeys. Only one farmer interviewed in this study claimed to actively train his dogs to chase monkeys.

7.2 METHODS

General field methods were described in chapter 2 section 2.4.3. Here, all data were tested for normality and logged to normalise where appropriate. Where data were not normal, and could not be transformed by logging, non-parametric statistics have been used.

7.3 RESULTS

7.3.1 The Impact of Human Activity on the Likelihood of Raiding

All human and dog presence and activity on the farms were recorded (see appendix 4). Observation of the responses of monkeys to humans suggested that the type of human activity was important in determining whether or not it would affect raiding. Thus activities were classed as ‘active’ or ‘passive’. ‘Active’ included working on the farm such as mending fences or general maintenance of farm buildings, walking around the farm, and deterrence activities such as throwing stones. ‘Passive’ included resting in the house or farm and food collecting, planting or weeding. The latter was included as passive as it was a quiet activity, involving the farmer crouching low to the ground to harvest or plant crops. Observations indicated that in these circumstances monkeys were not deterred from entering a farm, even when a farmer was close to the entry point. The frequency of human and dog presence on the farm was calculated as the number of visits made to the farm during that day plus the number of shifts from active to passive behaviour (or vice versa). If a farmer arrived at the farm, engaged in active behaviour, went into the house (passive behaviour) only to emerge sometime later and begin active behaviour again, that was considered to be a frequency of two. Had the farmer arrived at the farm and engaged immediately in passive behaviour it would be considered as a frequency of one. Observations also indicated that the arrival at the farm by humans and dogs did affect monkeys raiding, while passive behaviours did not. Shifts from passive to active situations also affected monkey behaviour, therefore both were considered when calculating the frequency of activity.

Is there a difference between raided and non raided days on farms in terms of human activity?

The total duration of human presence on the farms was not found to be a significant predictor of whether a farm was raided or not (logistic regression, Wald = 1.471, p = 0.225). On raided days, however, all types of human and dog presence on the farm were lower than on non-raided days (Table 7.1). This difference is due to the presence of children on the farm, whether active or passive. This might be explained by the fact that children were much noisier and moved about much more on the farm. Total male presence tended to suppress raiding frequencies.

Table 7.1 Mean number of minutes of human and dog presence on the farm for raided and non raided days (t, df = 199, p significant at the 0.01 level, * significant at the 0.05 level, two tailed)**

Mean number of minutes	Raided Days (N = 103)	Non-raided Days (N = 98)	t	Sig.
Total Human Presence	169.47 ± 174.51	217.22 ± 221.09	1.215	0.226
Total Adult Presence	157.29 ± 173.06	202.39 ± 212.40	1.120	0.264
Total Male Presence	69.88 ± 115.90	112.62 ± 153.86	1.866	0.063
Total Female Presence	119.13 ± 169.61	148.80 ± 201.57	1.078	0.282
Total Child Presence	29.03 ± 91.38	92.88 ± 162.03	3.776	<< **0.001****

Total Dog Presence	52.69 ± 136.89	61.56 ± 164.95	-1.057	0.292
Total Active Human Presence	56.12 ± 62.26	95.30 ± 124.09	1.001	0.318
Total Active Adult Presence	50.97 ± 58.14	88.23 ± 117.74	0.958	0.340
Total Active Male Presence	23.68 ± 40.75	48.15 ± 84.76	1.531	0.128
Total Active Female Presence	29.71 ± 47.57	55.05 ± 99.72	1.224	0.223
Total Active Child Presence	6.72 ± 24.31	34.16 ± 85.78	2.896	**0.004****
Total Active Dog Presence	18.63 ± 72.72	9.43 ± 56.07	-2.009	**0.046***
Total Passive Human Presence	121.77 ± 162.45	126.17 ± 197.33	-0.163	0.871
Total Passive Adult Presence	111.50 ± 160.93	113.61 ± 186.20	-0.154	0.878
Total Passive Male Presence	40.33 ± 89.22	62.09 ± 134.02	0.766	0.445
Total Passive Female Presence	89.22 ± 153.13	85.24 ± 167.65	-0.320	0.750
Total Passive Child Presence	17.80 ± 73.34	50.09 ± 128.06	2.690	**0.008****
Total Passive Dog Presence	14.70 ± 78.64	20.15 ± 84.05	0.300	0.765

The maximum number of humans and dogs on the farm at one time was recorded for each day. Up to 14 humans were present on some days. The average maximum number of humans and dogs on farms was lower on raided days, significantly so for all but the number of dogs. Frequency of human presence each day was also recorded with human frequency ranging up to 160 per day. Once again frequencies were lower on raided days and this was significant for total and active human and adult presence, all child presence and active and passive male presence (Table 7.2).

Table 7.2 Average maximum number and frequency of humans and dogs present on the farm for raided and non raided days (t, df = 199, p significant at the 0.01 level, * significant at the 0.05 level)**

Mean (range)	Raided Days (N = 103)	Non-raided Days (N = 98)	t	Sig.
Max Humans Present	2.06 ± 1.70 (0 - 8)	3.50 ± 3.25 (0 - 14)	3.94	**<< 0.001****
Max Adults Present	1.55 ± 1.20 (0 - 6)	2.17 ± 1.85 (0 - 8)	2.81	**0.006****
Max Men Present	0.95 ± 0.89 (0 – 5)	1.43 ± 1.34 (0 – 7)	2.99	**0.003****
Max Women Present	1.05 ± 1.17 (0 – 5)	1.53 ± 1.75 (0 – 8)	2.31	**0.022***
Max Children Present	0.47 ± 1.04 (0 – 4)	1.29 ± 1.85 (0 – 8)	3.912	**<< 0.001****
Max Dogs Present	0.58 ± 0.76 (0 – 3)	0.54 ± 0.97 (0 – 6)	-0.301	0.760
Frequency of Human Presence	10.67 ± 12.47 (0 – 71)	22.39 ± 34.66 (0 – 166)	3.22	**0.002****
Frequency of Adult Presence	10.77 ± 12.69 (0 – 71)	21.89 ± 35.75 (0 – 166)	2.97	**0.004****
Frequency of Male Presence	4.47 ± 8.65 (0 – 62)	7.60 ± 12.12 (0 – 68)	1.86	0.065
Frequency of Female Presence	6.85 ± 11.35 (0 – 60)	8.32 ± 19.40 (0 – 130)	0.58	0.562
Frequency of Child Presence	2.08 ± 5.72 (0 – 35)	10.53 ± 25.38 (0 – 142)	3.24	**0.002****
Frequency of Dog Presence	3.03 ± 8.56 (0 – 64)	4.00 ± 18.26 (0 – 142)	0.47	0.636
Frequency of Active Human Presence	6.85 ± 6.77 (0 – 28)	15.76 ± 27.80 (0 – 137)	2.98	**0.004****
Frequency of Active Adult Presence	5.78 ± 5.67 (0 – 23)	11.88 ± 21.56 (0 – 25)	2.62	**0.010****
Frequency of Active Male Presence	2.33 ± 2.43 (0 – 12)	3.63 ± 4.65 (0 – 20)	2.06	**0.042***
Frequency of Active Female Presence	3.66 ± 5.14 (0 – 21)	2.97 ± 3.93 (0 – 17)	-0.88	0.381
Frequency of Active Child Presence	2.07 ± 4.26 (0 – 22)	10.82 ± 27.91 (0 – 137)	2.97	**0.004****
Frequency of Active Dog Presence	1.31 ± 2.47 (0 – 13)	0.92 ± 1.99 (0 – 11)	-1.15	0.253
Frequency of Passive Human Presence	3.33 ± 4.86 (0 – 23)	4.64 ± 7.04 (0 – 34)	1.46	0.146
Frequency of Passive Adult Presence	2.88 ± 4.53 (0 – 23)	3.46 ± 5.22 (0 – 25)	0.80	0.427
Frequency of Passive Male Presence	0.87 ± 1.38 (0 – 7)	1.56 ± 2.47 (0 – 10)	2.01	**0.047***
Frequency of Passive Female Presence	2.36 ± 4.41 (0 – 20)	1.63 ± 2.86 (0 – 15)	-1.15	0.253
Frequency of Passive Child Presence	0.76 ± 2.14 (0 – 16)	2.28 ± 5.79 (0 – 34)	2.36	**0.020***

Frequency of Passive Dog Presence	0.28 ± 1.16 (0 – 9)	0.39 ± 1.28 (0 – 7)	0.59	0.558

7.3.2 The Impact of General Noise on Raiding

Noises from inside and outside the farms were also recorded and while noise levels were lower on raided days (Table 7.3) this difference was not significant for any specific types of noise. However in seven out of eight cases greater noise was associated with non-raided days (binomial, p = 0.035, one-tailed). One of the most frequently raided farms was right next to the road, La Damaridi 2003 and on raided days road traffic was slightly more frequent than on non-raided days. This demonstrates however, how little effect the presence of a major road has on raiding.

Table 7.3 Duration of noise within and outside the farms on raided and non-raided days

Mean number of minutes	Raided Days (N = 90)	Non-raided Days (N = 93)
Total Noise	24.58 ± 45.80	43.23 ± 76.89
Total Noise Within Farm	3.50 ± 11.46	13.31 ± 42.27
‘People’ Noise Within Farm	1.72 ± 7.84	7.87 ± 30.67
‘Shouting’ Noise Within Farm	1.70 ± 7.55	5.91 ± 23.94
Total Noise Outside Farm	21.08 ± 41.30	29.92 ± 57.02
‘Chainsaw’ Noise Outside Farm	5.34 ± 24.43	12.12 ± 38.48
‘Dog Barking’ Noise Outside Farm	0.89 ± 5.34	0.89 ± 5.36
‘People’ Noise Outside Farm	5.23 ± 23.63	8.21 ± 32.73
‘Road Traffic’ Noise Outside Farm	9.34 ± 17.25	8.30 ± 18.06

7.3.3 On Raided Days do Raid Length and Human Duration Correlate?

Certain aspects of human presence on a farm differ between raided and non raided days (see above) but does human presence actually affect raid duration?

Table 7.4 Correlations of raid bout and event duration and frequency per day against human and dog activity on the farm and noise levels (Correlation significant at the 0.01 level, *Correlation significant at the 0.05 level). NB frequencies of some categories are lower as there are missing variables for one set of observations**

	Raid Bout Duration (mins)	**Number Raid Bouts**	**Raid Event Duration (mins)**	**Number Raid Events**
Duration Male Presence (N = 201)	-0.028	-0.012	**-0.202***	-0.109
Duration Passive Male Presence (N = 201)	0.000	- 0.070	**-0.308****	**-0.247***
Duration Active Child Presence (N = 201)	**-0.223****	**- 0.229***	**-0.209****	**-0.185***
Duration Passive Child Presence (N = 201)	**-0.212***	- 0.053	-0.083	-0.030
Max Children Present (N = 201)	-0.155	- 0.114	**-0.197***	-0.116
Duration Passive Dog Presence (N = 201)	0.155	**0.238***	0.135	**0.216***
Frequency Adults (N = 98)	0.035	0.108	-0.018	**0.208***
Frequency Active Men (N = 70)	-0.082	0.024	**-0.231***	-0.071
Frequency Passive Men (N = 70)	-0.153	- 0.050	**-0.379****	**-0.252***
Frequency Dogs (N = 95)	0.106	**0.226***	-0.016	0.074
Frequency Passive Dogs (N = 88)	0.166	**0.255***	0.135	0.205
Duration 'People' Noise Outside Farm (N = 90)	-0.005	0.041	**-0.253***	**-0.281****
Duration 'Road Traffic' Noise Outside Farm (N = 90)	0.127	0.027	-0.021	**-0.230***

Increased duration and frequency of men and children correlated with shorter raid duration and reduced frequency (Table 7.4), as did increased 'people' noise outside the farm. Traffic noise outside the farm correlated with fewer raid events only. However with increased frequency of human and dog presence, the number of raid bouts and events also increased. With greater frequency of human activity, raids were more likely to be interrupted and thus more monkeys entered and exited the farm in between periods of human presence and activity. This is supported by personal observations; in farms with a large amount of human activity monkeys would often wait just outside the farm and the re-enter once the human had left or resumed passive activities.

7.4 RAID TYPES AND HUMAN ACTIVITY

Assessing the impact of human presence on raids is difficult as most raids take place when humans are absent from the farm. Closer inspection of sequences in the data suggests that monkeys were slotting their raids in between human activity. Many raids started within minutes of humans leaving the farm, and ended again on their return. It is therefore difficult to examine any direct relationship between human activity and raiding, however by considering frequency of human activity across the day and number of humans present on a farm at the actual time of a raid it is hoped this can be approached.

Raids were grouped into four types (grab, assault, mob and relaxed) based on the duration and number of participants (see chapter 6). It has been shown that a relationship exists between age-sex class of raiders, penetration distance and raid duration and party size; these groupings reflect that (see chapter 6). The number of humans and dogs on the farm during the raid was recorded, together with whether they were active or passive. The frequency of human and dog activity on the farm for that whole day was also included.

Table 7.5 Number and frequency of human presence on the farms for raid types (ANOVA comparisons F, df = 3, 141, p *significant at the 0.05 level)

Mean	Raid Type				F	Sig.
	Grab (N = 32)	Assault (N = 35)	Mob (N = 38)	Relaxed (N = 40)		
Number Humans in Farm	0.72 ± 0.89	0.43 ± 0.92	0.37 ± 0.71	0.20 ± 0.61	3.35	**0.021***
Number Men in Farm	0.19 ± 0.47	0.17 ± 0.51	0.05 ± 0.23	0.00 ± 0.00	3.80	**0.025***
Number Women in Farm	0.41 ± 0.61	0.23 ± 0.55	0.32 ± 0.66	0.15 ± 0.48	1.64	0.184
Number Children in Farm	0.13 ± 0.55	0.03 ± 0.17	0.00 ± 0.00	0.05 ± 0.22	1.00	0.395
Number Dogs in Farm	0.16 ± 0.37	0.14 ± 0.36	0.03 ± 0.16	0.05 ± 0.22	1.89	0.135
Frequency of Human Presence	15.91 ± 17.00	13.94 ± 13.16	13.97 ± 14.87	9.72 ± 11.91	3.12	**0.048***
Frequency of Active Human Presence	9.20 ± 7.72	8.13 ± 6.57	9.81 ± 8.83	6.26 ± 7.12	2.72	**0.048***
Frequency of Passive Human Presence	5.40 ± 7.00	4.45 ± 5.60	4.82 ± 6.33	2.91 ± 4.73	1.92	0.131
Frequency of Adult Presence	16.34 ± 17.22	15.54 ± 14.28	14.87 ± 14.95	10.35 ± 12.58	2.49	0.063
Frequency of Active Adult Presence	8.47 ± 7.27	7.06 ± 6.40	9.24 ± 8.10	5.88 ± 6.39	3.31	**0.040***
Frequency of Passive Adult Presence	6.13 ± 6.37	4.23 ± 5.82	6.52 ± 6.97	3.91 ± 5.56	2.71	**0.048***
Frequency of Male Presence	5.62 ± 12.34	7.35 ± 11.87	4.00 ± 8.18	4.47 ± 8.28	1.91	0.133
Frequency of Active Male Presence	2.35 ± 1.77	3.05 ± 2.01	2.12 ± 2.11	1.97 ± 2.65	2.49	0.065
Frequency of Passive Male Presence	0.83 ± 1.34	0.89 ± 1.15	0.44 ± 0.96	0.89 ± 2.38	0.74	0.529
Frequency of Female Presence	13.38 ± 16.57	11.96 ± 15.50	12.77 ± 14.36	6.09 ± 10.56	1.99	0.129
Frequency of Active Female Presence	6.26 ± 6.63	5.42 ± 6.94	7.12 ± 7.56	3.31 ± 5.22	1.96	0.125
Frequency of Passive Female Presence	5.09 ± 7.24	4.21 ± 6.40	4.44 ± 6.11	2.03 ± 4.11	1.36	0.259
Frequency of Child Presence	1.81 ± 6.38	3.52 ± 8.12	1.38 ± 5.24	1.19 ± 4.89	1.21	0.308
Frequency of Active Child Presence	2.47 ± 5.66	2.84 ± 5.11	2.76 ± 6.01	1.76 ± 5.05	0.74	0.531
Frequency of Passive Child Presence	0.87 ± 1.57	2.76 ± 6.01	1.12 ± 2.06	0.41 ± 1.35	1.58	0.198
Frequency of Dog Presence	3.87 ± 11.87	4.53 ± 10.82	3.12 ± 8.25	3.14 ± 8.37	0.34	0.796
Frequency of Active Dog Presence	1.17 ± 1.98	1.3548 ± 2.35	1.27 ± 2.05	0.79 ± 1.49	0.37	0.778
Frequency of Passive Dog	0.70 ±	0.65 ± 1.76	0.58 ±	0.35 ± 1.57	0.36	0.782

Presence	2.29		1.80			

Human presence on the farms affected the types of raids monkeys engaged in, with raids lasting for longer periods when there were fewer humans, and specifically fewer males, present (Tamhane, $p < 0.015$). The frequencies of human, active human and active adult presence were also lower for longer, larger raids (Tamhane, $p < 0.048$) and the frequency of active male presence was also lower in long, large raids, although not significantly.

7.4.1 Effect on Raid Participation and Loitering Time

It was speculated in chapter 6 (section 6.4.2) that greater human presence on a farm may lead to more time being spent outside the farm during raid bouts, as monkeys might enter and exit the farm frequently and loiter on the borders to the farm until the coast was clear to raid (personal observations support this). Human activity may also impact on the composition of raiding groups. As already shown (chapter 6) adult male macaques are the ‘risk takers’ and would therefore be expected to be disproportionately represented when human activity was high. Percentages of each age-sex class in a raiding party were found to inter-correlate, although as discussed in chapter 6, this is because difference age-sex classes are behaving in different ways during different raid types e.g. adult males dominate during shorter raids, while sub-adults and females tend to be under-represented in raiding parties for all but the longest raids. Each age-sex class was compared to human activity on the farm separately, although the interactions between raid-type and composition should be borne in mind.

Table 7.6 Correlations of percentage of each age-sex class present in raiding parties (Correlation is significant at the 0.01 level)**

	Percentage Male Raiders (N = 152)	Percentage Female Raiders (N = 152)	Percentage Sub-adult Raiders (N = 152)	Percentage Juvenile Raiders (N = 152)
Percentage Male Raiders (N = 152)		**-0.523****	**-0.232****	**-0.388****
Percentage Female Raiders (N = 152)	**-0.523****		**0.414****	**0.632****
Percentage Sub-adult Raiders (N = 152)				**0.525****

The number of men, women, children and dogs on the farm were not significantly intercorrelated. Time spent outside the farm by monkeys during raid bouts and group compositions were indeed found to relate to certain measures of human activity (Table 7.7). Monkeys spent more time outside the farm when frequency of men, children and dog activity was higher in the farm. More dogs in the farm and a greater frequency of all human activity (except females) also led to a greater proportion of males in raiding groups but fewer sub-adults and juveniles. This confirms the suggestion that adult males are the biggest risk takers as they actually raided even when human deterrents were present.

Table 7.7 Correlations of the percentage of a raid bout spent outside the farm and percentage of each age-sex class in the raiding party against human and dog activity on the farm (Correlation significant at the 0.01 level, *Correlation significant at the 0.05 level)**

	Percentage of Time Outside Farm Per Bout (N = 203)	Percentage Male Raiders (N = 152)	Percentage Female Raiders (N = 152)	Percentage Sub-adult Raiders (N = 152)	Percentage Juvenile Raiders (N = 152)
Number Humans in Farm	0.038	0.077	-0.030	-0.043	**-0.191***
Number Dogs in Farm	0.036	**0.158***	-0.202	**-0.139****	**-0.225***
Frequency of Human Presence	-0.031	**0.260****	-0.119	**-0.181***	-0.152
Frequency	-0.046	**0.262****	-0.149	**-0.181***	**-0.171***

of Active Human Presence					
Frequency of Passive Human Presence	0.056	**0.256****	-0.109	-0.123	-0.155
Frequency of Adult Presence	-0.068	**0.162***	-0.081	**-0.166***	-0.115
Frequency of Active Adult Presence	-0.038	**0.232****	-0.127	-0.158	-0.163
Frequency of Passive Adult Presence	0.072	**0.289***	-0.120	-0.080	-0.151
Frequency of Passive Male Presence	**0.237****	0.084	0.048	0.061	-0.018
Frequency of Child Presence	-0.128	**0.220***	-0.025	-0.037	-0.039
Frequency of Active Child Presence	**0.208****	-0.047	-0.011	-0.096	0.024
Frequency of Passive Child Presence	**-0.242****	-0.026	-0.065	-0.150	-0.004
Frequency of Dog Presence	-0.117	**0.256****	-0.136	-0.028	-0.148
Frequency of Active Dog Presence	**0.306****	0.034	-0.007	0.150	-0.044
Frequency of Passive Dog Presence	**-0.344****	-0.008	0.028	**-0.164***	-0.023

7.5 HUMAN PERCEPTIONS OF DETERRENCE

During the semi-structured interviews farmers were asked which deterrent methods were used against monkeys and which they felt were most successful (see table 2.3 for examples of types of deterrent from the literature). Deterrents were grouped into four types – Noise, Physical, Lethal and Dog (after Priston 2001). Twenty one different deterrent methods were reported (Table 7.8) (see appendix 8 for detailed description of all methods).

Table 7.8 Methods reportedly used to deter monkeys and the percentage of farmers reporting each method.

Method	Type of Method	% Farmers Citing Method (N = 139)
Stones	Physical	42.6
Shout	Noise	49.0
Guard	Physical	26.6
Dog	Dog	26.0
Chase	Physical	21.4
Poison	Lethal	17.5
Wrist trap	Lethal	13.6
Box trap	Lethal	11.0
Klanger	Noise	8.4
Gun noise	Noise	3.9
Red Paint	Physical	2.6
Fence	Physical	1.9
Slingshot	Physical	1.4
T-shirt	Physical	1.3
Pig trap	Lethal	1.3
Net	Physical	1.3
Tyre	Physical	0.7
Blades in food	Lethal	0.7
Firecracker	Noise	0.7
Wrap bananas in cloth	Physical	0.7
Knives	Lethal	0.7

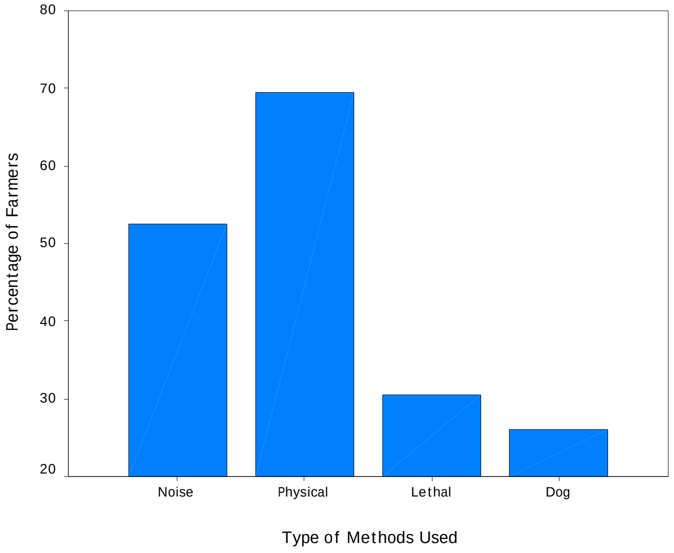


Figure 7.1 Percentage of farmers reporting the use of different types of method (N = 139). Note than more than one method could be used.

Physical methods were reported used by the majority of farmers (69.5%), followed by noise methods (52.6%) (Figure 7.1). Farmers mentioned up to six methods of deterrence on their farms but reported actually using only up to four. Number of methods mentioned and number actually used was positively correlated ($r = 0.727$, $N = 139$, $p << 0.001$). In the pilot study it was demonstrated that the methods perceived as most successful were dependent on those actually used (Priston 2001); thus ‘most successful method’ was used as a proxy for method used in further analysis.

Fifty-nine percent of farmers reported that deterrence methods were generally successful, 27.3% sometimes successful and 12.3% said methods were not successful. This in contrast to the pilot study during which 95.8% farmers thought methods were successful (Priston 2001). The failed poisoning attempt in 2002 may have influenced this, or it may simply reflect fluctuations in attitudes or success over time.

Table 7.9 Methods reported to be most successful at deterring monkeys and the percentage of farmers reporting each method.

Most Successful Method	Type of Method	% Farmers Citing Method (N = 139)
Guard	Physical	21.6
Stones	Physical	20.1
Dog	Dog	20.1
Shout	Noise	8.6
Chase	Physical	7.2
Poison	Lethal	6.5
Stones and shout	Physical and Noise	2.2
Box trap	Lethal	2.2
Air gun	Noise	2.2
Stones, shout and chase	Physical and Noise	1.4
Slingshot	Physical	1.4
Stones, chase and dog	Physical and Dog	0.7
Firecracker	Noise	0.7
Wrap bananas in cloth	Physical	0.7
Shout and chase	Physical and Noise	0.7
Fence	Physical	0.7
Klanger	Noise	0.7

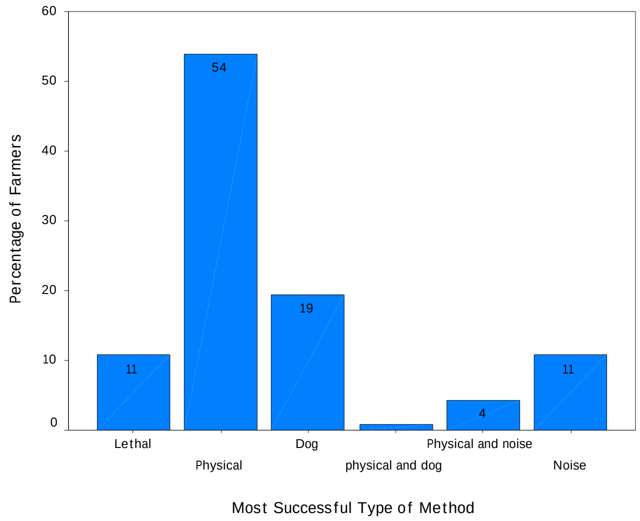


Figure 7.2 The percentage of farmers (N = 139) reporting each type of method to be the most successful monkey deterrent

The use of guarding, throwing stones or having dogs were considered to be the most successful deterrents (Table 7.9), and physical methods were considered the most successful type of method overall (Figure 7.2).

The type of deterrent employed and the time, effort and money spent to protect crops may be affected by the perceived seriousness of the problem. Farmers regarding monkeys as a problem tended to use physical or noise methods (?^{2} = 16.79, df = 5, p = 0.005). These methods are pro-active and require time and effort to implement. Those who considered monkeys not to be a problem tended to use dogs which can be left alone in the farm and require less individual effort. The fact that fewer farmers reported monkeys to be a problem when using dogs implies either greater success or less of a problem in the first place. Those who reported that the problem was not serious also used dogs (?^{2} = 16.74, df = 12, p = 0.028). Hindu farmers used dogs significantly more than Muslim farmers (?^{2} = 26.36, df = 5, $p << 0.001$) and as already shown (chapter 5), they also grow wet rice which is raided less frequently. Dogs were rarely kept by Muslim farmers, while the Hindu farmers often had several large dogs that guarded their house and farm (pers. obs.). There was no significant difference between men and women in terms of which method they employed (?^{2} = 1.62, df = 3, p = 0.658), however a slightly greater proportion of men (12.5% vs. 8.6%) used lethal methods and more women used noise methods (15.4% vs. 8.8%).

7.6 SPECIFIC DETERRENCE AND PREVENTATIVE MEASURES USED IN THE FOCAL FARMS

A variety of preventative measures were used in the 16 focal farms, including fences, klangers, traps and netting. These farms were chosen as they experienced high levels of crop-raiding and therefore may have used different methods from those prevalent in the larger interview sample. Although farmers would say fences were occasionally helpful in deterring monkeys, their main purpose was to prevent pigs gaining access to the farms at night. Fencing around the farms was usually wooden, although stones were occasionally used at the base of fences. Fences were either constructed using poles in the ground or planks, the latter being stronger, with fewer gaps. Poles used for fencing would often continue to grow and become a much taller, living fence. This however was little deterrent to the monkeys (Figure 7.6). Where possible, fences adjoining the forest would be constructed using planks. T-shirts and old clothes, usually of bright colours (Figure 7.5), were often hung on the fence and on sticks pointing outwards from the fence. They were also hung on banana palms or used to cover the fruit. They were said to act as deterrents owing to the smell of humans and bright colours. Some fences also had netting (Figure 7.4) or bamboo lattices attached to the top of them and, although these were not always successful (Figure 7.6) they were directed at preventing monkeys gaining access. Trip-wires were also laid around the outside of fences to stop pigs gaining access (Figure 7.5).

Figure 7.3 Various types of fencing employed in the farms. Pole fencing with wide netting (a), pole fencing and cloth (b) and pole fencing, some of which is beginning to grow to form a living fence (c)

Figure 7.4 Bamboo lattice atop plank fencing (a) and fine netting used together with plank fencing (b) (also note presence of noose trap, indicated by arrow)

Figure 7.5 Clothing (a) and plastic bags (b) hung outside farm to deter pigs and monkeys. Trip-wire (indicated by arrow) also placed outside fence (b). Banana fruit covered in bags (c) and old clothing wrapped around stem to deter raiding, although it is not very effective (d)

Figure 7.6 Monkeys demonstrating the ineffectiveness of pole fencing (a), plank fencing and bamboo lattice (b), netting (c) and living fences (d) as deterrents

Klangers (noise-makers operated by string; Figure 7.7) were present on some farms as were noose traps. These traps were usually situated around the perimeter of the farm and were used to deter rather than catch pigs and jungle fowl (often they were not even properly set and would use bright blue cord designed to deter rather than trap Figure 7.8). Although they were occasionally successful at catching small pigs (Figure 7.9). Specific monkey traps (wrist or basket traps Figure 7.8) were only used on one farm once during the study period and a total of two monkeys were trapped on the farms between 2000 and 2004 (Figure 7.9). Poison specifically intended for monkeys[1] was used only once on one farm in 2002. It was successful in that 11 monkeys were killed, however it did not deter raiding as the rest of the troop continued to raid the next day.

---

[1] The poison used was ‘temik’ (locally called temix) which is a systemic carbamate pesticide (aldicarb) with the chemical name 2-methyl-2-(methylthio) propionaldehyde O-methylcarbamoyloxime (American Bird Conservancy 2002). It is a highly toxic chemical and is directly toxic through oral or dermal contact and inhalation and secondarily toxic when systemically exposed plants, or prey items (insects etc) are consumed. It is one of the most acutely toxic pesticides to mammals in use today (American Bird Conservancy 2002). Its use in this manner against monkeys is banned in Indonesia under the Environmental Management and

Figure 7.7 Two types of klangers used in the farms; bamboo, wood and cans (a) and old cans (b)

Figure 7.8 Basket or wrist trap designed specifically for monkeys (a) and noose trap designed for jungle fowl and pig primarily (b)

Consumer Protection Laws (Laws No. 8/1999 and No. 23/1997) (APCEL 1998; Pesticide Action Network 1995).

Figure 7.9 Monkey caught in wrist trap (a) in 2002, and a juvenile caught in a noose trap (b) in 2000. The adult was released but the juvenile had died overnight. The intended prey (c), a young pig, in a noose trap. After this was caught the farmer went to the local Hindu community and invited them to come and remove the pig, The Muslim farmer could not do it himself as it is *haram*.

Figure 7.10 Poison used against monkeys in 2002. It was secreted inside bananas.

in each farm and the pest species they were intended to deter

Preventative Method							
Tripwire	T-shirt, cloth,bags	Bag over fruit/stem	Netting	Bamboo	Klanger	Noose, wrist Trap	Poison
	✓		✓				
	✓		✓			✓	
	✓	✓				✓ (wrist)	✓
	✓						
	✓						
✓	✓		✓	✓		✓	
	✓	✓			✓		
	✓				✓		
	✓						
Pig	**Pig**	**Monkey**	**Monkey and pig**	**Monkey and pig**	**Monkey**	**Pig (wrist trap for monkey)**	**Monkey**

7.7 DETERRENCE

An average of 0.78 raid bouts occurred per day. Therefore, on approximately three out of every 4 days a farm was likely to be raided, although this varied between farms (Table 7.11).

Table 7.11 Mean number of raid bouts per day and maximum number of bouts per day for each farm (Minimum number of raid bouts = 0 for all farms)

Farm	Mean Number Raid Bouts Per Day	Maximum Number Raid Bouts Per Day	Farm contd.	Mean Number Raid Bouts Per Day	Maximum Number Raid Bouts Pre Day
La Husuna 2002 (N = 9)	0.11 ± 0.33	1	**La Ruhuni 2002 (N = 8)**	2.00 ± 1.31	4
La Husuna 2003 (N = 15)	0.73 ± 0.79	2	**La Ruhuni 2003 (N = 8)**	1.57 ± 1.98	8
La Tole 2002 (N = 10)	1.00 ± 1.05	3	**Unknown 2002 (N = 9)**	1.00 ± 0.50	2
La Tole 2003 (N = 13)	0.38 ± 0.51	1	**La Ruhuni Grandma 2002 (N = 8)**	1.63 ± 0.92	3
La Musrifa 2002 (N = 11)	0.09 ± 0.30	1	**La Darmin 2003 (N = 16)**	1.50 ± 1.26	4
La Musrifa 2003 (N = 14)	0.14 ± 0.36	1	**La Bau 2003 (N = 16)**	0.69 ± 0.79	2
La Sahili 2002 (N = 11)	0	0	**La Damaridi 2003 (N = 17)**	1.29 ± 1.31	5
La Sahili 2003 (N = 16)	0	0	**La Jonaidin 2003 (N = 14)**	0.71 ± 0.91	3

The factors contributing to raid frequency included those due to the farm itself, such as farm geography, crop availability and variety (chapter 4), and those due to the monkeys (chapter 3 and 6), such as amount of food in the forest, troop movements about their range, composition of the troop, activity level, motivation (hunger), how long since they had last raided, level of human and dog activity on the farm, prior experience of deterrents and so on. The interactions of all these factors are exceedingly complex and diverse, and are reported here qualitatively. The monkeys did, however, appear to observers to slot their raid events and bouts in between human activity and entrance on the farm. Thus on days with high levels of human activity the monkeys might enter the farm five or six times (events within a bout) for short periods of time, returning again later in the day to raid further (a separate bout). In contrast, on days with little human activity, raids were generally longer. However, no simple or straightforward correlation was observed, with at most 10% of the variance being explained (Table 7.4 and Table 7.7).

The responses of the monkeys to human activity and any subsequent raid attempts will also depend on their degree of hunger. On days when monkeys had visited the farm frequently or for a long time prior to being disturbed by humans they tended to leave the area and not raid again, or at least not until some hours later. On days when the monkeys had been continually disrupted and thus had raided for only a short time, they tended to loiter in the surrounding forest and re-enter the farm as soon as the farmers’ attention was diverted or the farmers left the farm. Human activity also affected this pattern further; when humans were present but passive in the farm the monkeys would raid frequently, exiting only when the human changed activity or noticed their presence and deterred them. The monkeys entered the farm again as soon as human passive activities resumed or the human left. If humans were active on the farm, the monkeys tended to leave the area.

The same was true of deterrence. Sustained, active deterrence caused the monkeys to leave, for example a boy was witnessed shouting, throwing stones and chasing the monkeys out of the farm and then out of the surrounding forest. Single, one-off acts of deterrence, such as a half-hearted attempt to throw stones, caused them to remain in the forest-farm boundary and attempt further raids. On one occasion an elderly woman was witnessed attempting to deter monkeys by throwing small stones. The monkeys ignored her presence at first. She walked closer to the monkeys, although she was not shouting, and only when she was within 10m did they actually leave the farm, to return two minutes later when she had gone back to the house. It has not been possible to analyse these patterns statistically, because of their complexity.

One factor that it was possible to investigate was the effect of active deterrents. These included all human and dog activity directed towards the monkeys. Methods employed included shouting, throwing stones, walking towards the monkeys, chasing monkeys, banging on wood, dogs barking and chasing and a mixture of these. Due to the small sample size and in order to enable comparison with the interview data (see section 7.5) these were re-coded into physical methods (walking, chasing and throwing stones), noise (shouting and banging) and dog. These categories match those used for re-coding the interview responses (see section 7.5).

Forty three instances of active deterrence were recorded during the study period. For each incident the age-sex of the actor, method employed, duration of the deterrent action and time taken for the monkeys to leave the farm was recorded. Other variables were then calculated such as the time until the next raid, total number of raids that day, total duration of raiding preceding deterrent for that day, recovery time until next raid and so on.

7.7.1 Frequency and Duration of Raids Before and After Active Deterrent Events

Data could not be normalised through transformation therefore non-parametric statistics were employed. The sample size is small so these results should be viewed with caution; nevertheless they do suggest some interesting patterns.

Duration of raid events that followed an interrupted raid event were longer when recovery time (time between monkeys exiting a farm after a deterrence and the next raid event) was longer ($r_s = 0.747$, N = 19, $p << 0.001$). If the recovery time was short, the following raids were shorter which may suggest a degree of nervousness. If fewer raids had occurred before the interrupted raid, the following raid was longer ($r_s = -0.341$, N = 34, $p = 0.025$), as were all raids for the rest of the day ($r_s = -0.384$, N = 34, $p = 0.011$). Conversely when shorter raids had taken place before an interruption, duration ($r_s = 0.313$, N = 43, $p = 0.041$) and frequency of raiding was increased for the rest of the day ($r_s = 0.379$, N = 43, $p = 0.040$).

When the risks of raiding were high (active deterrence had occurred) and the farm had already been raided that day, the monkeys tended not to return for as long or as frequently. However, if disturbed after only a short time on the farm then the risks of returning were outweighed by the benefits of obtaining the food resource. Some level of caution seemed to operate and raids immediately subsequent to the time of deterrence were shorter.

Monkeys took longer to leave after an active deterrent when raids were longer ($r_s = 0.503$, N = 43, $p = 0.01$) and when more raiding had already taken place that day ($r_s = 0.357$, N =

43.p = 0.019). This may indicate that deterrence is less effective during longer raids when monkeys are more relaxed in the farm.

7.7.2 Gender and Deterrence

No significant differences were found between human age-sex classes in terms of their effectiveness at deterring monkeys (Kruskal-Wallis), which may be due to small sample sizes. Differences may exist in terms of the types of deterrents used by different human age-sex classes but again sample sizes were too small to examine this statistically. However the results can be discussed to indicate possible trends.

Table 7.12 Comparison between deterrent use by different human age-sex classes and dogs

Deterrent	**Noise**			**Physical**	**Physical and Noise**				**Dog**
Age-Sex	**Men (N = 4)**	**Women (N = 6)**	**Total (N = 10)**	**Women (N = 8)**	**Men (N = 1)**	**Women (N = 15)**	**Child (N = 1)**	**Total (N = 16)**	**Dog (N = 8)**
Mean Duration of Deterrent	2.25 ± 1.5	1.17 ± 0.41	1.60 ± 1.08	3.13 ± 2.36	1.00	1.73 ± 0.96	1.00	1.65 ± 0.93	7.00 ± 11.15
Mean Time taken for monkeys to leave farm	0.00	1.17 ± 2.86	0.70 ± 2.21	3.13 ± 6.45	0.00	0.20 ± 0.41	0.00	0.18 ± 0.39	1.75 ± 4.95
Mean Total raid Duration	2.13 ± 1.44	18.92 ± 25.10	12.20 ± 20.64	17.25 ± 20.89	6.00	6.87 ± 11.59	1.00	6.47 ± 10.94	22.44 ± 33.87
Mean Recovery time before next raid	84.33 ± 86.69	126.33 ± 186.83	105.33 ± 132.28	64.00 ± 39.66	No further raids that day	118.83 ± 183.93	No further raids that day	118.83 ± 183.93	227.25 ± 186.15
Mean Duration of next raid	9.50 ± 16.36	4.50 ± 8.31	6.50 ± 11.58	1.38 ± 2.33	0.00	8.13 ± 14.09	0.00	7.18 ± 13.45	7.00 ± 11.56

Mean Total duration of raids for the rest of the day	9.50 ± 16.36	15.67 ± 24.06	13.20 ± 20.51	0.63 ± 1.41	0.00	10.00 ± 14.90	0.00	8.82 ± 14.33	2.13 ± 3.80
Mean Total number of raids per day	2.25 ± 0.50	3.33 ± 1.63	2.90 ± 1.37	3.38 ± 2.33	1.00	3.13 ± 1.60	1.00	2.88 ± 1.65	2.13 ± 1.13
Mean Number of raids after deterrent	0.75 ± 0.50	1.17 ± 1.60	1.00 ± 1.25	0.29 ± 0.49	0.00	0.53 ± 0.83	0.00	0.47 ± 0.80	0.71 ± 0.95
Mean Number of raids before deterrent	1.50 ± 0.58	2.17 ± 1.47	1.90 ± 1.20	3.29 ± 2.36	1.00	2.60 ± 1.80	1.00	2.41 ± 1.77	1.57 ± 0.79
Mean Duration of raid up to point when deterrent employed	3.50 ± 3.87	1.83 ± 2.23	2.50 ± 2.92	10.88 ± 13.12	6.00	11.33 ± 14.79	1.00	10.41 ± 14.11	28.13 ± 27.15
Mean total duration of all raids that day before deterrent employed	4.75 ± 4.35	39.75 ± 36.46	25.75 ± 32.73	34.75 ± 22.54	6.00	31.13 ± 33.99	1.00	27.88 ± 33.10	32.25 ± 27.72

Women were involved in many more acts of deterrent than were people from other age-sex classes. This probably reflects the fact that they were most commonly present on the farms for long periods of time. Women did the majority of the crop work and were the ones who remained guarding the farm. It could of course be that men and children (as already shown above) tended to deter raiding through their normal activities and therefore did not need to engage in active deterrence in the same way that women did. Although only five instances of deterrence by men were witnessed, the mean time taken for monkeys to leave the farm was shortest in these cases and in the one instance of ‘physical and noise’ deterrence by a man the monkeys did not return to the farm again that day. The frequency of subsequent raids after ‘noise’ deterrence by men was also lower than for women despite the fact that the duration of all raids before the deterrent was shortest for those days when this occurred, suggesting a marked gender effect. Other studies have found similar effects and they are anecdotally described for a number of primate species; men frighten raiding monkeys, women get frightened (APCEL 1998; Bell 1984a; Hill 1997; King and Lee 1987; Naughton Treves 1998a, b; Priston 2001; Strum 1994). However, for ‘noise’, deterrence recovery time (time until next raid) was longest when women deterred, not men, so it is clearly not straightforward.

Physical methods were only ever witnessed being employed by females and proved the least successful in deterring monkeys quickly from the farm; however they also resulted in fewer raids later that day. This is somewhat surprising, since physical methods such as throwing stones or chasing were considered to be better deterrents than noise alone (see section 7.5 and King and Lee 1987). This anomaly may result from the fact that it is only women doing the deterring. There was one instance that may have affected these results, in this case stones were thrown but monkeys did not exit the farm for 19 minutes. Observations suggested that the stone throwing was rather half-hearted and stones fell far short of the monkeys’ location. The woman then returned to the harvesting she was engaged in, presumably accepting the loss that was taking place at the other end of her farm.

Physical and noise methods proved most successful overall in terms of getting monkeys out of the farm fast and delaying their return. This is probably due to the increased risk perceived by the monkeys from a combination of both loud noises and stone throwing or chasing. Dogs however were surprisingly poor deterrents in terms of causing monkeys to leave, with one instance of monkeys raiding for 14 minutes while a dog was present. However dogs did result in the longest recovery time, and duration and frequency of raids for the rest of the day did seem to reduce. This may be a result of the differences between individual dogs. On three occasions dogs actually chased monkeys out of the farm and into the forest, while on the other five occasions they merely barked at them from their present location (usually lying in the shade under the watch hut). On the occasions when monkeys were chased they left the farm quickly and did not return for longer. This might suggest a need for training of watch dogs to act as an effective deterrent.

7.7.3 Can We Predict if Monkeys Raid Again or Not

The goal of studying deterrent methods is to evaluate their success in terms of preventing further raiding. With that in mind, and recognising the data limitations, a discriminant function analysis (DFA) was used as an exploratory tool to investigate the inter-relationships between the variables discussed above. These results should be viewed as exploratory trends as data were not normally distributed and sample sizes were small.

For the 43 instances when a deterrent activity took place each farm was coded as to whether monkeys raided again that day (yes or no). All variables concerning raiding before the interruption, for example the number and duration of raids were then entered into DFAs. The categorical variables age-sex class and deterrent method used were re-coded as dummy variables (DAGE and DDET) and also entered. The best classification rate was achieved by entering the variables together (not stepwise). The resulting discriminant scores were then tested to see if they differed significantly between those occasions when farms were raided again and those when farms were not, using a Mann-Whitney U test.

Of the variables entered the number of raids before the deterrent, duration of raiding that had already taken place that day, and whether it was a woman doing the deterring showed the greatest negative association with the resulting discriminant function, while whether noise deterrence was used was positively related. This function was able to correctly classify 69.8% of the cases, and considering the sample size and data limitations this is a reasonable level. Given the sample group sizes (24 and 19) the proportional chance criterion (i.e. the probability of correctly classifying the cases by random) was 51%. A confusion matrix measure of classification accuracy (Kappa) was calculated to assess the discriminant function’s performance (Fielding and Bell 1997). Kappa measures the discriminant function’s proportions of specific agreements (the numbers of false positives and false negatives), and values of between 0.4 and 0.75 are considered ‘good’ (Landis and Koch 1977); in this case K = 0.4. Allowing for the data limitations this suggests the discriminant function correctly classified cases into the appropriate group (raided again or not).

The discriminant scores differed significantly between whether a farm was raided again or not (U = 91.50, p = 0.001). This suggests that raiding after deterrence tended to take place when few raids had already occurred that day, when total duration of raiding that day was short, when women performed the deterrence and when ‘noise’ methods were employed (as opposed to other means of deterrence). One factor which has not been considered due to small sample sizes, and which may influence the chances of re-raiding, is the time of day when the deterrence occurs.

This analysis should clearly be viewed with caution; however it does support earlier findings and interview data, and paves the way for more detailed examination of the effectiveness of deterrence methods in the future.

7.8 REGULAR PATROLLING AS A DETERRENT

Ad hoc deterrence has been examined above, however in order to recommend a management plan some form of standardised deterrence needs to be designed. Although it was not possible to fully test all deterrence methods in the remit of this project, one pilot study was conducted looking at regular patrols of farms as a method to deter raiding. Five farms were included in this study, La Husuna 2003, La Bau 2003, La Darmin 2003, La Sahili 2003 and La Damaridi 2003. Farms were chosen based on similarities in crop type, farm geography and close proximity (to increase the likelihood of it being the same troop raiding). Observation days were split into patrol and non-patrol days, each non-patrol day on a farm was separated by at least two days from a patrol day, in order to minimise any hang-over effect. On patrol days farms were observed as in focal farm surveys, but once an hour a fifteen minute walk of the perimeter of the farm was made. The patroller was always female and the same route was taken around the farm each time. In total there were 30 patrol days and 25 non-patrol days giving a total of 528 hours 39 minutes of farm observation (231 hours 20 minutes for patrol days, 201 hours, 19 minutes for non-patrol).

7.8.1 The Impact of Regular Patrolling on the Frequency and Duration of Raids

On patrol days it was expected that monkeys would enter and exit the farm more frequently in between patrols and thus spend longer waiting to raid. Frequency of raids did not differ significantly between patrol versus non-patrol days (Table 7.13). Event duration was slightly shorter on patrolled days which would be expected, while bout duration (which includes time spent outside the farm) did not differ significantly. If only those days when raids occurred are considered, mean event duration for non-patrolled days was 21.65 minutes compared to 15.82 minutes on patrolled days. However, this was still not significant.

Table 7.13 Mean frequency and duration of raids per day for patrol and non-patrol days

Patrol	Yes	No	t	Sig.
Mean Number Raid Bouts Per Day	0.87 ± 1.04	0.84 ± 1.03	0.011	0.991
Mean Number Raid Events Per Day	0.67 ± 0.92	0.56 ± 0.92	-0.396	0.693
Mean Bout Duration Per Day (mins)	26.43 ± 46.51	25.04 ± 40.27	0.021	0.983
Mean Event Duration Per Day (mins)	14.40 ± 22.49	18.58 ± 36.11	-0.071	0.944

7.8.2 The Impact of Patrolling on the Pattern of Raiding

Patrolling did not affect the time of day the monkeys raided ($?^2$ = 0.23, df = 2, p = 0.891) although it may have affected where they choose to enter the farm. On patrol days all entries were from forested perimeter, whereas on non-patrol days 37.5% of entries were from non-forested perimeters (roads and bordering farms) ($?^2$ = 7.79, df = 1, p = 0.007). This suggests that on patrol days, monkeys preferred the cover of the forest, which may in turn imply that a higher level of risk was being perceived. The age-sex class of the first monkey to enter a farm during a raid did not differ between patrol and non-patrol days; adult males formed the majority for both ($?^2$ = 2.45, df = 3, p = 0.485). Overall raiding group composition differed little between patrol and non-patrol days (Table 7.14), although slightly fewer females and sub-adults were present on patrol days, while juveniles formed a slightly greater proportion of raiders on those days.

Table 7.14 Mean percentage of each age-sex class in raiding parties on patrol and non-patrol days (t, df = 31, p)

Patrol	Yes (N = 17)	No (N = 16)	t	Sig.
Percentage of Male Raiders in Party	45.69 ± 31.60	45.05 ± 33.72	-0.26	0.795
Percentage of Female Raiders in Party	15.98 ± 12.77	17.30 ± 12.89	-0.39	0.699
Percentage of Sub-Adult Raiders in Party	10.14 ± 7.73	13.01 ± 13.34	-0.04	0.965
Percentage of Juvenile Raiders in Party	20.06 ± 16.13	17.08 ± 13.26	-0.23	0.823

Mean raiding party size was slightly greater (11.06 ± 8.16) for non-patrolled days than for patrolled days (9.35 ± 5.82), although not significantly (t = 0.09, df = 41, p = 0.933). Size of raiding party did, however, differ between patrol and non-patrol days for the largest party (Table 7.15). On patrolled days a higher percentage of raids contained one raider, between two and six raiders, or between seven and 16 raiders, while on non-patrol days there were 47.9% raids with 17 or more raiders, compared to only 14.5% on patrol days ($?^2$ = 41.61, df = 3, p = 0.001) (see also 7.8.4).

Table 7.15 Percentage of raiding parties for each party size on patrol and non –patrol days

Patrol	Yes (N = 17)	No (N = 16)
Percentage of parties with 1 raider	12.20	7.80
Percentage of parties with 2 – 6 raiders	7.40	3.70
Percentage of parties with 7– 16 raiders	66.00	40.60
Percentage of parties with 17 or more raiders	14.50	47.90

7.8.3 The Effect of Patrolling on Penetration Distance

Penetration distance into the farm was affected by whether the farm was patrolled or not (?^{2} = 22.88, df = 4, p << 0.001). Monkeys were on the fence and within 10m more often than expected, and were witnessed over 20m into the farm less often than expected during raids on patrol days (Table 7.16).

Table 7.16 Crosstabulation of penetration distance against patrol and non-patrol days

Patrol		Yes	No	Total
Fence	Observed	474	639	1113
	Expected	464.8	648.2	
0 - 5 m	Observed	274	448	722
	Expected	301.5	420.5	
5 - 10 m	Observed	522	593	1115
	Expected	465.6	649.4	
10 - 20 m	Observed	103	158	261
	Expected	109.0	152.0	
20 - 30 m	Observed	264	445	709
	Expected	296.1	412.9	
Total		1637	2283	3920

However, when the percentage of scans at each distance was compared between patrol and non-patrol days a higher percentage of scans tended to occur near the fence on patrol days than non-patrol days. The same is true, to a lesser extent for 0 – 5m and 5 – 10m too. For scans over 10m into the farm there were significantly more scans on non-patrol days than patrol days (Table 7.17). This again suggests a ‘primary raiding threshold’ (see chapter 4 and 6) and might indicate that at times of higher risks monkeys were less likely to go beyond it.

Table 7.17 Percentage of scans at each penetration distance for patrol and non-patrol days (t, df = 268, p significant at the 0.01 level)**

Patrol	Yes (N = 132)	No (N = 138)	t	Sig.
% scans at Fence	9.67 ± 18.05	6.99 ± 18.60	0.265	0.791
% scans 0 - 5 m	19.72 ± 27.87	19.59 ± 28.64	0.604	0.547
% scans 5 - 10 m	22.24 ± 33.35	19.24 ± 29.53	0.468	0.640
% scans 10 - 20 m	1.28 ± 4.73	4.37 ± 12.00	3.493	**0.001****
% scans 20 - 30 m	0	1.76 ± 8.10	2.803	**0.006****
% scans over 30 m	0	0		

7.8.4 The Impact of Patrols on Raid Type

Patrol and non-patrol days were compared to see if the types of raids (grab, assault, mob or relaxed) differed. Sample sizes were small, with for example only two instances of grab raids on patrol days and only three assault raids overall. Relaxed raids occurred less frequently than expected on patrol days, whereas on non-patrol days they formed the majority of raids (60%). Unexpectedly mob raids were more common on non-patrolled days; this may be due to small sample size or might indicate a preference for middle duration raids with many participants on days when deterrence was regular and predictable (patrols). It could also be due to levels of general activity on the farm on those days. Although human and dog activity on the farm also affects raiding, there was no significant difference between patrol and non-patrol days in terms of frequency and duration of general human activity.

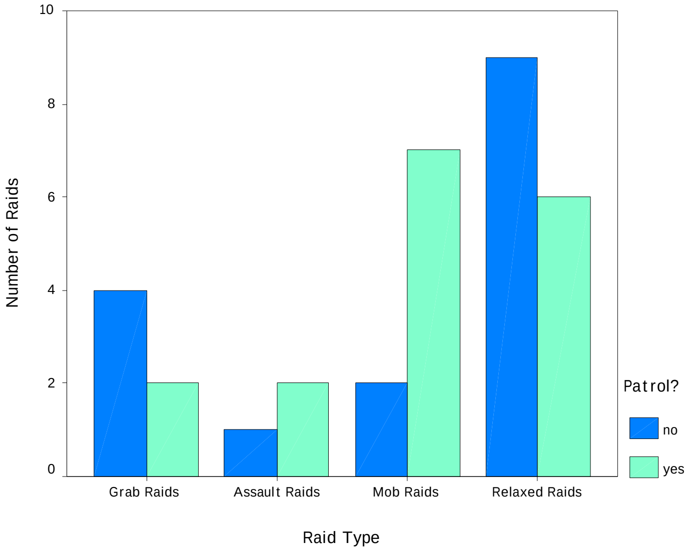


Figure 7.11 Number of raids of each type on patrol and non-patrol days

7.8.5 Patrols and Primate Behaviour

Activity budgets differed slightly between patrol and non-patrol days. Feeding and locomotion formed a higher percentage of scans on patrol days compared to non-patrol days. Feeding included foraging, so more feeding on patrol days may be explained by the monkeys rushing into the farms, grabbing food and then retreating back towards the fence. Percentage of social activities (especially play) was significantly lower on patrol compared to non – patrol days (Table 7.18).

Table 7.18 Percentage of scans of behaviour for patrol and non patrol days (t, df = 268, p **significant at the 0.01 level)

Patrol	Yes (N = 132)	No (N = 138)	t	Sig.
% scans feeding	21.32 ± 27.73	19.94 ± 28.00	-0.899	0.369
% scans locomotion	27.45 ± 32.25	21.86 ± 29.19	-1.037	0.301
% scans resting	7.44 ± 13.74	6.62 ± 11.05	0.236	0.814
% scans social	1.21 ± 4.03	1.93 ± 7.37	0.519	0.604
% scans playing	0.07 ± 0.43	1.45 ± 9.26	2.839	**0.005****
% scans vigilant	1.61 ± 5.16	1.83 ± 7.39	-0.303	0.762

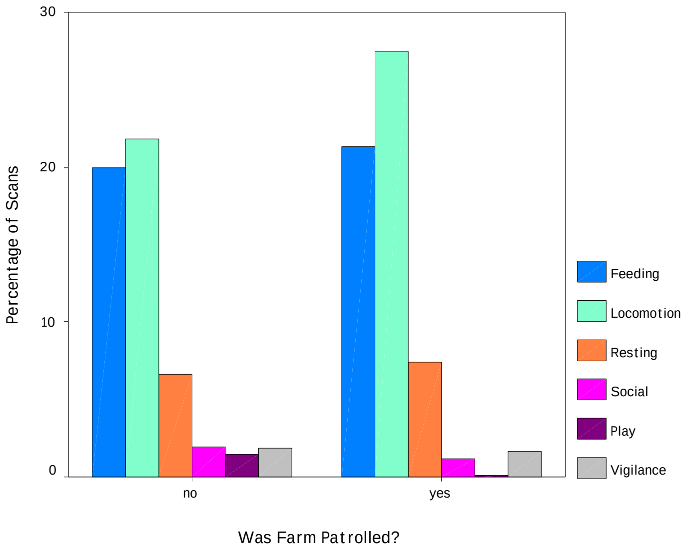


Figure 7.12 Percentage of scans of each behaviour on patrol and non-patrol days

7.9 SUMMARY

The main findings of this chapter can be summarised in terms of the influence of general human activity across the day, specific raid related human activity and the influence of active deterrence.

§ **Human activity across the day**

Although total duration of human activity was not a significant predictor of whether a farm was raided or not the presence of children and men on farms was greater on those days when raids did not occur, and in fact all types of human and dog presence were lower on raided days. The maximum number of any humans (but not dogs) and the frequency of children and men on farms were also higher on non–raided days. General noise however, had little effect on the likelihood of a farm being raided.

§ Duration of raiding and human activity

More men and children on farms for longer led to shorter and less frequent raids, as did increased ‘people noise’. Increased frequency of total adult presence on a farm and dog presence resulted in more frequent raiding, as monkeys slotted their raids in between bouts of human activity.

§ Raid type

Relaxed raids were associated with fewer humans, especially men, on the farm and less frequent activities or arrivals. Grab and assault raids occurred at times of more human activity. Monkeys also spent more time loitering on the boundaries of farms when frequency of men, children and dogs was higher on the farms and also led to adult male monkeys being disproportionately represented in raiding parties.

§ Deterrence

A farm was raided on average three out of every four days. When the risks of raiding were higher, for example after an active deterrence has taken place, and the monkeys had already raided that day (thus motivation was lower), subsequent raids tended to be shorter and less frequent. Conversely if they were disturbed after only a short time raiding, then these risks were outweighed by the benefit of the food resource and they returned to the farm regardless. Deterrence was also less effective if the monkeys were more relaxed in the farm and they would take longer to leave. Women were more frequently engaged in acts of deterrence; however men appeared to be most successful in preventing further raiding events. ‘Physical’ combined with ‘noise’ methods proved most successful, while dogs were surprisingly poor deterrents. It was predicted that further raiding after a deterrent would only occur if few raids had taken place already that day and duration of raids were short, women carried out the act and used ‘noise’ methods

§ **Patrolling as a deterrent**

Regular patrolling of a farm did not affect the frequency of raids, although it did reduce the duration of raiding in the farm. Raiding party size was reduced on patrol days and penetration distance into the farm tended to be short; within 10m. This suggests patrolling has some use as a deterrent, and combined with physical and noise methods and carried out by men, it could minimise the damage inflicted on farms. It is worth noting that the monkeys appeared to be able to predict regular patrol presence and thus patrols might be more successful if randomly spaced in time.

CHAPTER 8 – A SYNTHESIS OF PERCEPTIONS AND REALITY

8.1 CONFLICT AS AN ISSUE IN PRIMATE CONSERVATION

Areas of conservation importance are often sited in areas of high human density and impact (Balmford *et al.* 2001; Cincotta *et al.* 2000; Myers *et al.* 2000) and conservation efforts frequently conflict with local human development needs (Balmford *et al.* 2001; Infield and Namara 2001; Southwick and Blood 1979). Human-wildlife interaction is fast becoming recognised as one of the major problems facing conservation today. Interactions tend to result in human 'victory' over animal 'combatants' which are either excluded from traditional areas of use or eliminated altogether. This eco-war is subsumed under the concept of 'conflict' which only humans can ultimately win (Lee 2004). For species and habitats to be conserved effectively, this conflict must be addressed. Where local people are subject to wildlife damage and depredation this directly affects their perceptions of and support for conservation programmes and initiatives (Conover and Decker 1991; Hill 1998). Recent studies have started to addressh these issues and incorporate them into management plans for reserves and national parks. (see for example Bell 1984a; De Boer and Baquette 1998; Fiallo and Jacobson 1995; Gillingham and Lee 1999; Gillingham and Lee 2003; Hill *et al.* 2002; Naughton Treves 1997; Newmark *et al.* 1993; Newmark *et al.* 1994). Primates in particular are a significant threat to humans farming on the edge of protected areas and one of the most frequently cited crop pests (see for example Gillingham and Lee 2003; Hill 1997, 2000; King and Lee 1987; Naughton Treves 1998a, b; Priston 2001).

This study aimed to assess the degree to which the Buton macaque was a threat to farmers' livelihoods and how this affected perceptions of this species. It aimed to determine attitudes of the farmers and assess the actions of the monkeys with a view, in the future, to suggesting suitable management strategies for this primate.

8.2 ARE MONKEYS A REAL THREAT TO FARMERS' LIVELIHOODS, OR MERELY A PERCEIVED THREAT?

8.2.1 Assessing the Degree of Monkey-induced Loss

This study presents the first attempt to systematically measure the impact of monkey damage to crop yields. One other study (Rao *et al.* 2002) used similar exclosure plot techniques to assess crop damage by wildlife in the context of rural, subsistence communities. However, that study focused on damage by all vertebrate species simultaneously. Exclosure techniques are more commonly used to assess the impact of pest species in an intensive agriculture or forestry setting (see for example Borman *et al.* 2000; Borman *et al.* 2001; Conover 2002; Drake and Grande 2002; Gary *et al.* 2000; Hone 1994; Jenkins 2000; National Park Service 1997; WDACP 2003). Rao (2002) reported 50 – 60% of crop damage (in North India) was attributable to monkeys and boars. In this study the Buton macaque was responsible for 35% of damage to sweet potato crops, while pigs were responsible for 65%. However, this study has also shown that the exclosures themselves had an effect on crop yields, reducing yields by up to 50%, suggesting estimates of damage should actually be slightly greater.

8.2.2 Comparing Farmers Perceptions to Damage Measures

Other studies have conducted long term, quantitative and qualitative assessments of crop damage and linked this to perceptions (Gillingham and Lee 1999; Hill 2000; Naughton Treves 1997, 1998b), however few have carried out direct comparisons between farmers' estimates of damage at that time and damage in the field. Transect studies found that the Buton macaque was responsible for an average of 10% damage to crops in a farm, although this varied from zero to 70% per farm. Thus crop loss has the potential to be a significant problem for subsistence farmers. In common with other studies however, the majority of farmers experienced relatively low levels of loss (Gillingham and Lee 2003; Naughton Treves 1997). Overall perceptions of damage were surprisingly accurate. Farmers reported a mean of 15% damage to the farms at the time of interview, with reported damage ranging from zero to 90%. In chapter 4, I demonstrated that farmers' estimates of damage were not related in a straightforward way to actual damage. While perceptions and measured damage were positively correlated, those farmers experiencing lower amounts of damage were more likely to over-estimate and those experiencing high levels were much more accurate in their assessments. Thus brief contact with monkeys in the absence of crop damage may promote positive attitudes (King and Lee 1987; Knight 1999) while even minimal experience of raiding leads to an attribution of blame that may greatly outweigh the extent of the damage (Chalise 2000; Chalise and Johnson 2001; De Boer and Baquette 1998; Hill 1997; Naughton Treves 1996, 1997; Priston 2001; Siex and Struhsaker 1999a). Inaccurate assessments and exaggeration of crop damage have been reported in other studies (Gillingham and Lee 2003; Naughton Treves 1996) and is often due to the potential for disastrous crop damage events to occur, for example the loss of up to 70% of crops in one damage event.

In chapter 5, I discussed the relationships between attitudes and estimates of damage. In this synthesis, I explore how *actual* damage relates to attitudes. Farmers who experienced more damage tended to consider monkeys to be a problem, both in terms of damage to all plants and damage to available monkey food plants (Table 8.1). Perceived severity of the problem also increased with increased actual damage, although significantly so only when considering plants available to monkeys as food (Figure 8.1).

Table 8.1 Mean measured percentage damage to all plants and to those plants available to monkeys as foods for farms where farmers considered monkeys to be a problem or not (t, df = 67, p)

Are monkeys a problem	**Yes (N = 52)**	**No (N = 17)**	**t**	**p**
Mean Measured % damage of total plants (± SD)	9.05 ± 13.35	2.12 ± 6.00	-3.47	**0.001**
Mean Measured % damage of available monkey foods (± SD)	12.53 ± 15.31	3.69 ± 9.86	-3.60	**0.001**

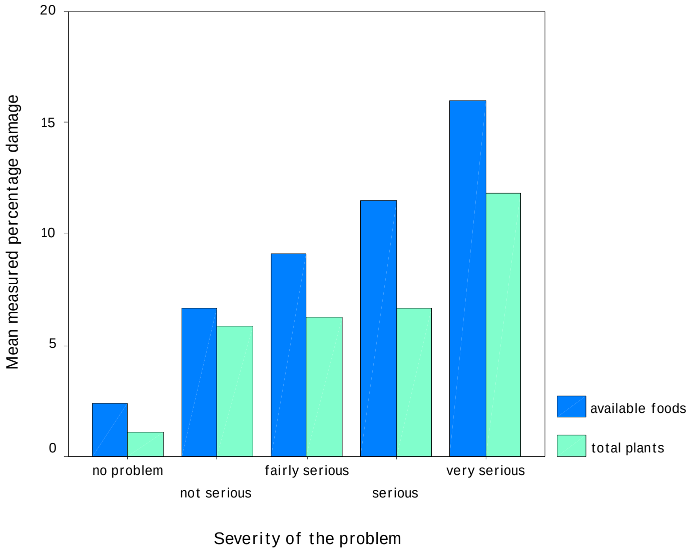


Figure 8.1 The severity of monkeys as a problem against measured damage to available monkeys foods (ANOVA comparisons, F = 2.27, df = 4, 64, p = 0.036) and total plants (F = 2.28, df = 4, 64, p = 0.070)

Opinions towards the monkeys (like, love, dislike and hate) varied with the amount of damage measured in the farms, although not significantly (Figure 8.2). Some polarisation of opinion was seen. Those farmers who hated monkeys had more damage in their farms than those who disliked, liked or loved them. However, farmers who claimed to love monkeys experienced more damage (to available foods) than those who liked them. Those who liked and disliked monkeys experienced high levels of damage, which were greater than damage for those who hated monkeys.

Overall perception of monkeys as a problem and the severity of that problem related to actual damage as well as to perceived damage (chapter 5). Although the general opinion of farmers towards monkeys was associated with perceived damage (chapter 5), it did not correlate with the actual levels of damage experienced by the farmer. Specific opinions towards the monkeys, in terms of the adjectives used to describe them did vary with the damage experienced (Table 8.2), although not in a simple way. Sample sizes were small but trends can be observed. Farmers who described monkeys as cruel, dangerous, or said they were scared of monkeys experienced significantly **less damage** than those who did not. Such negative perceptions might be expected to result from an experience of greater crop damage, rather than the opposite as observed above. However, farmers who described monkeys as useful also experienced less damage, as might be expected. Farmers expressing certain positive attitudes, such as describing the monkeys as cute or like humans, were actually experiencing more damage. Others expressing positive attitudes, such as describing the monkeys as funny or useful, experienced less damage. The same general associations were seen for negative attitudes (Table 8.2). That farmers experienced high levels of damage and yet were still positive about the monkeys suggests a degree of tolerance in this community that is unusual in such conflict situations. The key finding here is that when linking attitudes to perceptions of damage (chapter 5), negative attitudes were generally associated with increased perceived, as opposed to actual damage.

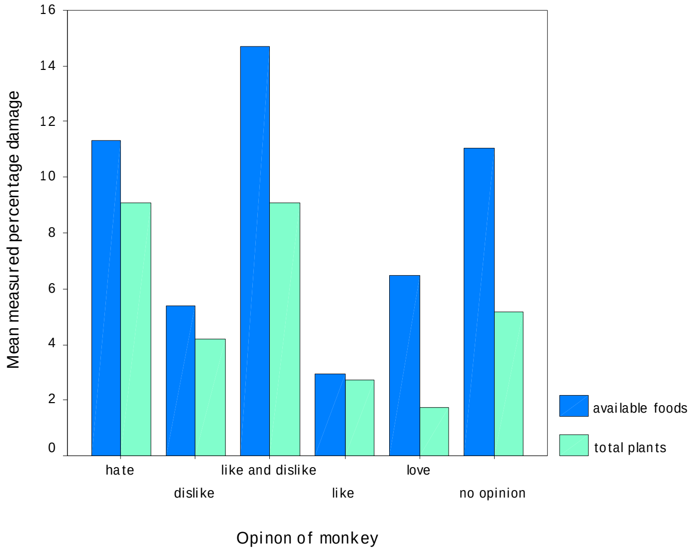


Figure 8.2 Opinion of monkeys by respondents against mean measured damage to available monkey foods (ANOVA comparison F = 0.79, df = 5, 63, p = 0.561) and total plants (F = 0.76 df = 5, 63, p = 0.584)

d about the monkeys against mean measured percentage damage of available foods and total plants. Adjectives are ho expressed that opinion experienced more damage, and those who received less damage. Only those opinions = 69) are included (for full list see appendix 7) (t, df = 67, p significant at the 0.01 level, *significant at the 0.05 level)**

	Mean Measured Percentage Damage (± SD)					
	Available foods	t	Sig.	Total plants	t	Sig.
Respondents expressing opinion experienced more damage						
ntioned (9)	3.4 ± 4.5	-1.44	0.155	2.5 ± 3.9	-1.19	0.237
oned (60)	11.4 ± 15.3			8.1 ± 12.9		
tioned (61)	9.7 ± 13.6	-0.81	0.423	6.4 ± 10.9	1.53	0.130
oned (8)	15.3 ± 21.5			14.9 ± 18.9		
tioned (55)	9.1 ± 13.7	-0.71	0.480	6.3 ± 11.9	-1.37	0.175
oned (14)	15.3 ± 17.5			11.4 ± 13.5		
tioned (63)	10.2 ± 14.8	-0.47	0.643	6.7 ± 12.1	-0.160	0.110
oned (6)	12.1 ± 13.8			14.6 ± 13.9		
tioned (68)	10.2 ± 14.7	-0.88	0.384	7.3 ± 12.4	-1.06	0.294
oned (1)	20.1			9.8		
tioned (50)	9.2 ± 12.5	-1.30	0.199	6.4 ± 9.4	-0.52	0.601
oned (19)	13.4 ± 19.3			9.9 ± 17.9		
tioned (50)	9.0 ± 12.8	-1.02	0.312	6.4 ± 10.8	-1.27	0.028
oned (19)	13.8 ± 18.4			9.9 ± 15.7		
tioned (63)	10.3 ± 14.6	0.12	0.902	7.3 ± 12.5	-0.15	0.884
oned (6)	11.3± 16.1			7.6 ± 10.6		
tioned (60)	10.3 ± 13.3	0.76	0.450	7.1 ± 10.9	0.32	0.749
oned (9)	10.7 ± 22.7			8.8 ± 19.8		
tioned (58)	10.3 ± 15.1	-0.55	0.585	7.5 ± 12.9	-0.34	0.739
oned (11)	10.4 ± 12.1			6.5 ± 8.6		

Respondents expressing opinion experienced less damage						
tioned (51)	12.9 ± 15.9	3.56	**0.001****	9.5 ± 13.6	3.97	**<<0.001****
oned (18)	3.01 ± 5.9			1.2 ± 2.6		
tioned (59)	11.7 ± 15.2	3.46	**0.003****	8.4 ± 12.9	2.99	**0.008****
oned (10)	2.4 ± 6.4			1.3 ± 2.9		
tioned (56)	10.8 ± 15.3	0.17	0.862	7.8 ± 12.8	0.21	0.836
oned (13)	8.6 ± 11.7			5.6 ± 9.8		
tioned (42)	10.6 ± 14.0	-0.22	0.828	7.4 ± 12.3	0.52	0.749
oned (27)	9.9 ± 15.7			7.2 ± 12.6		
tioned (65)	10.9 ± 14.8	9.54	**<<0.001****	7.8 ± 12.5	7.55	**<<0.001****
ioned (4)	0			0		
tioned (53)	10.7 ± 15.5	0.10	0.924	7.6 ± 13.4	-0.44	0.660
oned (16)	9.3 ± 11.0			6.5 ± 7.9		
tioned (53)	12.6± 15.7	3.13	**0.003****	8.8 ± 13.5	2.57	**0.015***
oned (16)	2.8 ± 5.4			2.4 ± 4.9		
tioned (66)	10.4 ± 14.9	-2.37	**0.075**	7.4 ± 12.5	-0.55	0.582
ioned (3)	9.5 ± 4.5			7.0 ± 6.3		
tioned (59)	11.3 ± 15.5	0.65	0.518	7.8 ± 12.5	1.05	0.298
oned (10)	5.0 ± 5.2			4.9 ± 10.9		
tioned (66)	10.4 ± 14.9	0.09	0.927	7.4 ± 12.5	-0.09	0.930
ioned (3)	9.5 ± 4.5			7.0 ± 6.3		

Thus a fascinating mismatch between perceptions and reality exists. To investigate this further the unstandardised residuals from the regression of measured damage against perceived damage (perceived present damage) (see chapter 4) were compared with attitudes. By using the residuals, it is possible to explore attitudes among those farmers who ‘got it wrong’, who were not accurately assessing damage in their farms (both under- and over-estimating). A value above zero indicates that the respondent’s estimate of damage is above that actually measured, while a value below zero indicates a relative under-estimate.

Farmers who considered monkeys to be a problem differed significantly from those who did not in their relative accuracy of estimating damage to both available foods ($t = -2.86$, $df = 67$, $p = 0.006$) and total plants ($t = -3.13$, $df = 67$, $p = 0.003$). Those who did not consider monkeys to be a problem tended to under-estimate damage (Figure 8.3). In terms of reported severity of the monkey problem, farmers who said there was no problem, or described the problem as not serious or fairly serious tended to under-estimate damage (available foods $F = 2.87$, $df = 4, 64$, $p = 0.030$, total plants $F = 3.03$, $df = 4, 64$, $p = 0.024$), while those describing it as serious or very serious tended to over-estimate (Figure 8.4). This difference was, however, only significant between farmers reporting the problem to be very serious and those reporting no problem (Tamhane, $p < 0.005$).

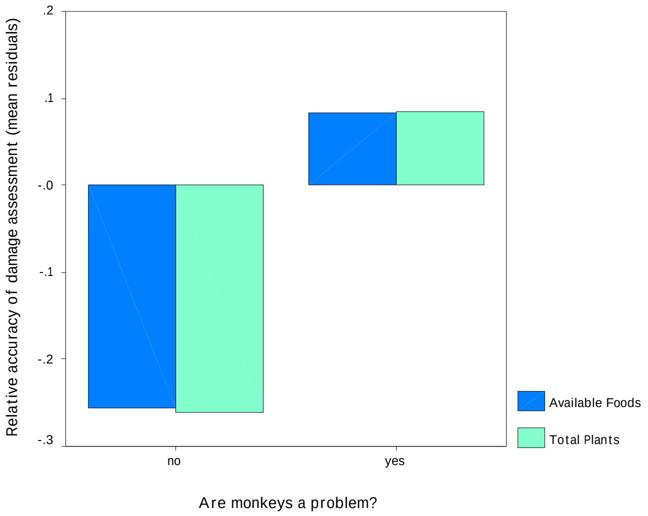


Figure 8.3 Relative accuracy of damage assessment against whether monkeys were considered to be a problem or not (mean residuals), for both measured damage to available monkey foods, and total plants.

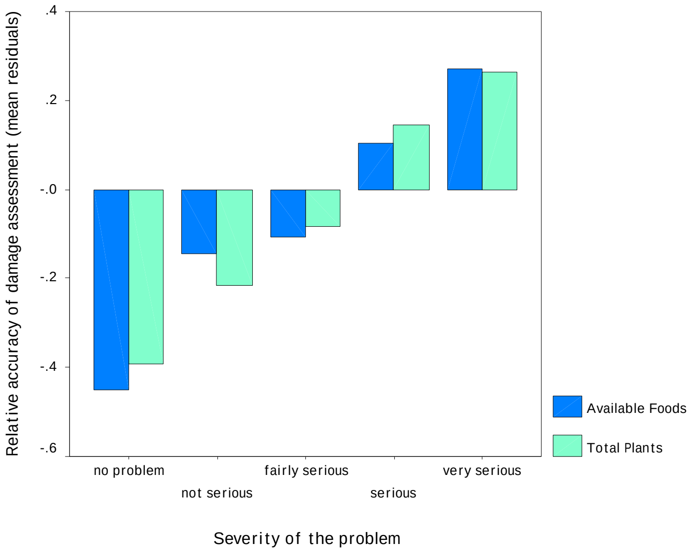


Figure 8.4 Relative accuracy of damage assessment against reported severity of the monkey problem (mean residuals), for both measured damage to available monkey foods, and total plants.

Opinions of the monkeys tended to relate to relative accuracy of damage assessments (available foods F = 2.08, df = 5, 63, p = 0.079, total plants F = 1.70, df = 5, 63, p = 0.148) (Figure 8.5). Farmers who liked, loved or had no opinion of the monkey tended to under-estimate damage, while those who hated or disliked monkeys were more likely to over-estimate damage. Those who reported both liking and disliking monkeys were generally fairly accurate at assessing damage.

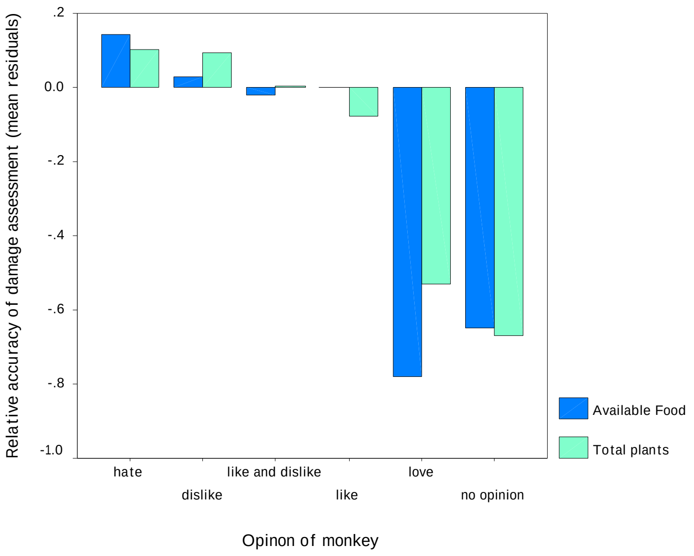


Figure 8.5 Relative accuracy of damage assessment against farmers' opinions of the monkey (mean residuals), for both measured damage to available monkey foods, and total plants.

Thus a disjunction between perceptions and actual damage exists. The farmers who were over-estimating damage were those who felt that the monkeys were a problem and they tended to dislike monkeys, while those who under-estimated damage tended to be those who expressed positive attitudes towards monkeys. In terms of specific adjectives used to describe monkeys, farmers who used the terms greedy, enemy or thief over-estimated damage significantly (Figure 8.6). Those who described monkeys as useful were more accurate in their assessment of damage (Figure 8.7). Once again there is no clear pattern emerging overall. Although farmers expressing negative opinions were more likely to over-estimate damage, those expressing positive opinions, such as describing monkeys as entertaining, also over-estimated damage (Figure 8.3). The same is true of those who under-estimated damage. One of the commonly used descriptions was 'like humans'. Interestingly an unusual pattern emerges, with people who used that term under-estimating damage to available monkey foods, but over estimating (slightly) damage to total plants (Figure 8.7).

l about the monkeys against relative accuracy of damage assessment (residuals) for available foods and total plants. r damage was under or over-estimated by respondents (t, df = 67, p significant at the 0.01 level, *significant at the**

	Relative accuracy of damage assessment (mean residuals ± SD)					
	Available foods	t	Sig.	Total plants	t	Sig.
Respondents expressing opinion over-estimated damage						
ntioned (9)	- 0.11 ± 0.68	-0.58	0.564	- 0.13 ± 0.65	-0.70	0.487
oned (60)	0.02 ± 0.59			0.02± 0.58		
tioned (55)	-0.08 ± 0.58	-2.23	**0.029***	-0.06 ± 0.56	-1.77	**0.081**
oned (14)	0.31± 0.61			0.24 ± 0.61		
tioned (63)	-0.04 ± 0.61	-2.23	**0.061**	-0.02 ± 0.60	-1.17	0.281
ioned (6)	0.40 ± 0.44			0.21 ± 0.46		
tioned (68)	-0.01 ± 0.60	-1.08	0.286	-0.01 ± 0.58	-1.19	0.240
ioned (1)	0.64			0.69		
tioned (50)	-0.03 ± 0.61	-0.59	0.559	-0.02 ± 0.58	-0.39	0.698
oned (19)	0.07 ± 0.60			0.04 ± 0.59		
tioned (58)	-0.02 ± 0.58	- 0.49	0.629	-0.02 ± 0.58	-0.64	0.528
oned (11)	0.08 ± 0.72			0.10 ± 0.64		
tioned (59)	-0.01 ± 0.61	-0.62	0.535	-0.01 ± 0.59	-0.34	0.736
oned (10)	0.11 ± 0.55			0.06 ± 0.57		
tioned (56)	-0.003 ± 0.61	-0.09	0.925	-0.005 ± 0.60	-0.13	0.896
oned (13)	0.01 ± 0.58			0.02 ± 0.53		
tioned (53)	-0.08 ± 0.57	-2.12	**0.037***	-0.07 ± 0.54	-1.79	**0.078**
oned (16)	0.27 ± 0.64			0.23 ± 0.68		
tioned (53)	-0.04 ± 0.62	-1.00	0.320	-0.02 ± 0.61	-0.60	0.548
oned (16)	0.13 ± 0.55			0.08 ± 0.53		
tioned (66)	-0.05 ± 0.57	-1.62	0.110	-0.05 ± 0.54	-1.54	0.127
ioned (3)	0.25 ± 0.73			0.24 ± 0.75		

pinion over-estimated damage to total plants and under-estimated damage to available foods						
tioned (50)	0.02 ± 0.59	0.39	0.699	-0.003 ± 0.60	-0.07	0.941
oned (19)	-0.05 ± 0.64			0.01 ± 0.56		
Respondents expressing opinion under-estimated damage						
tioned (61)	0.03 ± 0.61	1.29	0.203	0.05 ± 0.60	1.88	**0.065**
oned (8)	-0.26 ± 0.5			- 0.36 ± 0.39		
tioned (51)	0.01 ± 0.63	0.20	0.840	0.01 ± 0.60	0.13	0.894
oned (18)	-0.02 ± 0.53			-1.60 ± 0.53		
tioned (42)	0.02 ± 0.67	0.48	0.637	0.06 ± 0.64	0.98	0.329
oned (27)	-0.04 ± 0.48			-0.09 ± 0.48		
tioned (65)	0.02 ± 0.62	3.40	**0.001****	0.02± 0.60	4.37	<<**0.001***
oned (4)	-0.25 ± 0.00			-0.31 ± 0.00		
tioned (60)	0.01 ± 0.61	0.52	0.602	-0.02 ± 0.59	0.81	0.421
oned (9)	-0.10 ± 0.52			-0.15 ± 0.50		
tioned (63)	0.02 ± 0.62	0.88	0.381	0.02 ± 0.60	1.09	0.279
oned (6)	-0.21 ± 0.45			-0.25 ± 0.41		
tioned (66)	0.02 ± 0.61	1.38	0.171	-0.02 ± 0.59	1.22	0.229
oned (3)	-0.47 ± 0.59			-0.40 ± 0.17		
tioned (59)	0.03 ± 0.60	0.89	0.372	0.02 ± 0.58	0.63	0.527
oned (10)	-0.15 ± 0.58			-0.10 ± 0.61		

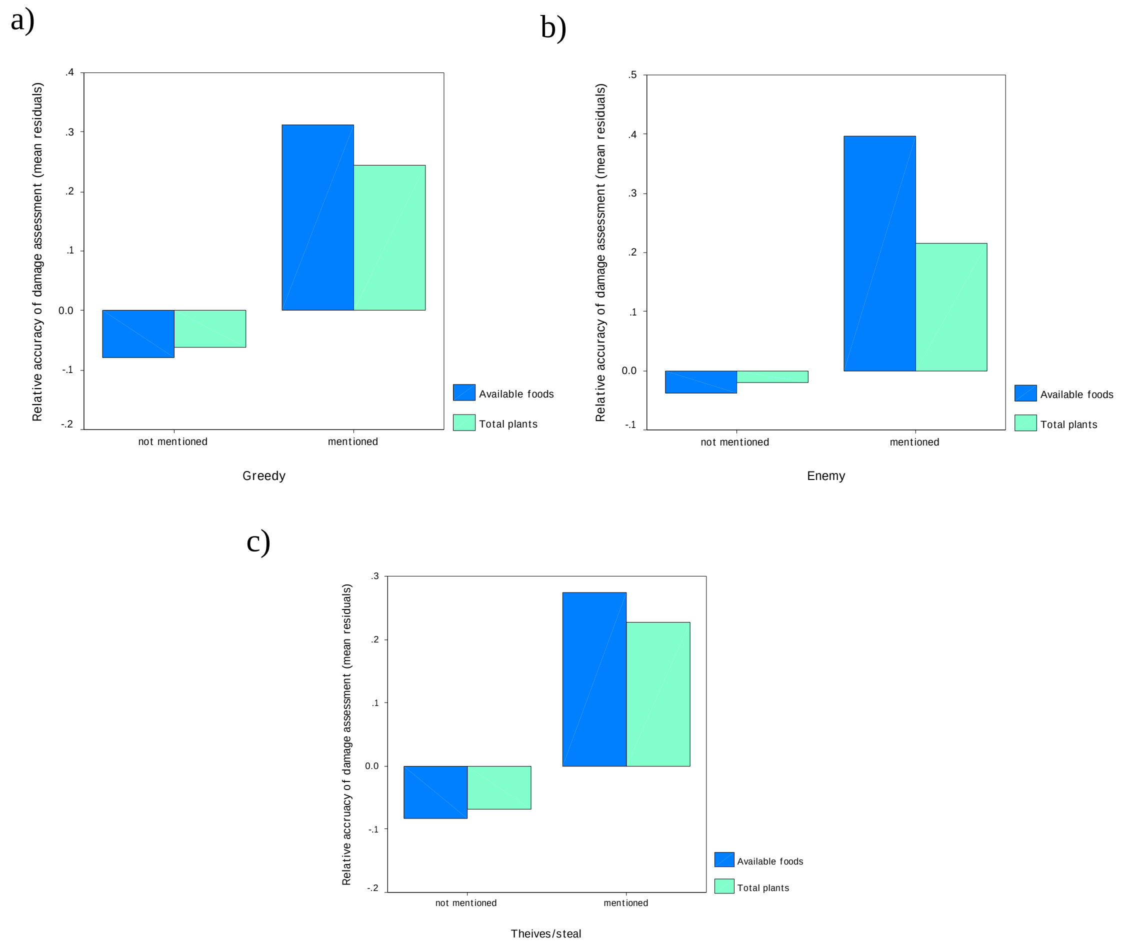


Figure 8.6 Relative accuracy of damage assessment by farmers (mean residuals) for those respondents using the terms (a) greedy, (b) enemy and (c) thieves/steal NB scales differ.; comparisons are internal rather than between adjectives.

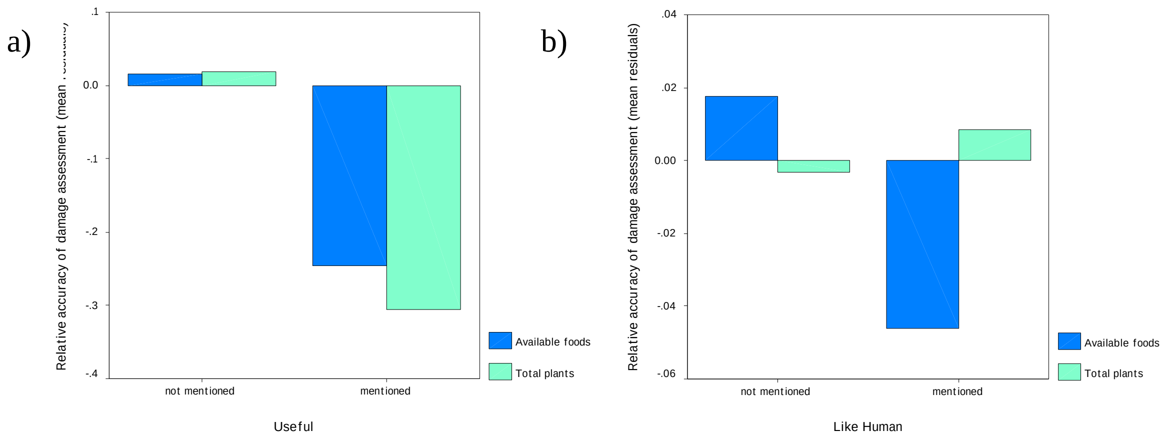


Figure 8.7 Relative accuracy of damage assessment by farmers (mean residuals) for those respondents using the terms (a) useful and (b) like human NB scales differ; comparisons are internal rather than between adjectives.

Attitudes towards and perceptions of the monkeys affected farmers' estimates of damage. Perceptions of primates as intelligent, vindictive and malicious – causing damage for the sake of damage (Chalise 2000; Hill 1997; Knight 1999; Naughton Treves 1996) will further serve to enhance perceptions of them as crop pests. Farmers in Buton who described monkeys as greedy, enemies or thieves, over-estimated damage; they were getting it wrong. This highlights a need to address such perceptions if one hopes to manage the situation and reduce conflict. There is no simple relationship between perceptions and crop damage. Positive perceptions were linked to over-estimates of damage in some cases, while negative perceptions were also expressed by those under-estimating damage. What is most surprising, and novel, is the high level of tolerance witnessed in this study. A number of farmers expressed pity towards the monkeys and likened them to humans. They were relatively accepting of the situation:

> *“If you don’t want monkeys to damage your crops, don’t make a garden”*
>
> “*In my heart I like monkeys*”.

These perceptions were not always linked to the actual crop damage. Those who described monkeys as like humans were both under and over-estimating damage. Perception and tolerance are not directly related to their experience of monkeys in their farms, but maybe related to religious beliefs and experiences of monkeys as pets.

Pet monkeys were previously owned by 18.2% of respondents (N = 155), but at the time of study no respondents still owned one (see below for detailed information on the pet trade). When asked about whether they would like a monkey as a pet, 44.8% of respondents would have liked a monkey as a pet if the opportunity arose. Of those farmers (N = 69), 66.7% said they felt monkeys were entertaining as pets, while 17.4% liked the fact that monkeys could be taught to do things and were intelligent. Other reasons included a love of monkeys, and a desire to have young monkeys but not adults.

While distance from farm to forest was the best predictor of actual crop damage, in common with many other studies (Hill 1997; Naughton Treves 1996; Warren 2003), it was social factors such as amount of village land owned and distance from the village to the farm which predicted human perceptions of damage. These discontinuities highlight the fact that perceptions are being directed not by the behaviour of the animals damaging the farms but by issues of most importance to the farmers. Farms which were further from the village were reported to be damaged more, presumably as they were harder to look after and monitor, while those with less land in the village (but interestingly not farm land) may have felt less advantaged and thus more affected by crop damage. Few gender effects were seen in terms of perceptions towards crop damage and monkeys (chapter 5), although women were more likely to report being scared of monkeys. However, women in general tended to slightly over-estimate crop damage, while men tended to slightly under-estimate damage (Figure 8.8), although this was not significant. The lack of a marked gender effect is also interesting in that typically women are reported to be far less tolerant of wildlife, or less willing to express an opinion (Flintan 2003). Again perhaps a lack of rigid, gender-specific social roles is indicative of greater social tolerance.

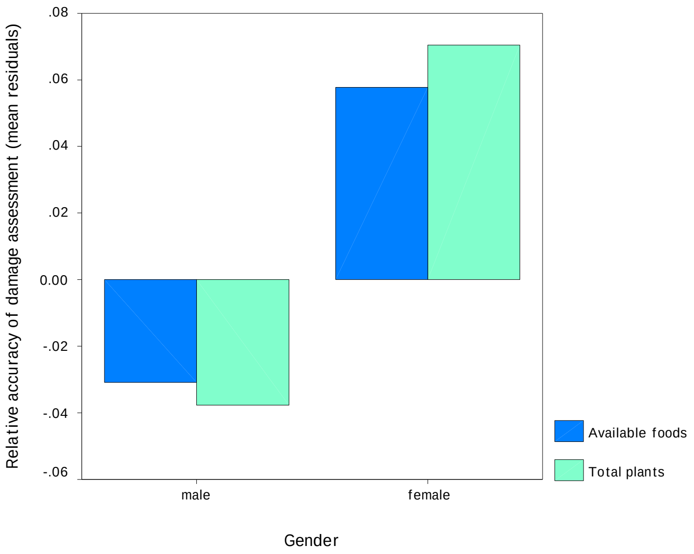


Figure 8.8 Relative accuracy of damage assessment (mean residuals) by males (N = 45) and female (N = 24) respondents for available foods (t = -0.578, df = 67, p = 0.565) and total plants (t = -0.725, df = 67, p = 0.471)

Religion was certainly an important factor in attitudes, but acted in an unexpected way. Hindu and Muslim farmers differed markedly in their attitudes towards the monkeys, in part as a function of crop varieties grown by the two groups. Hindus grew rice and therefore did not tend to report monkeys as a problem species. Despite this, Hindu farmers were more likely to report hating the monkeys and a desire to kill them. This was unexpected owing to the Hindu veneration for monkeys (Malic and Johnson 1994; Pirta *et al.* 1997) and the tolerance shown by Balinese Hindus (from which the populations on Buton originate) towards *M. fascicularis* on their home island (Wheatley and Harya Putra 1994) . By contrast, Muslim farmers were reluctant to kill the monkeys and compared them to humans. They were more accepting of their losses, in direct contrast to studies in African contexts (Hill 1997; Hill *et al.* 2002; Naughton Treves 1998a)

Thus perceptions of the Buton macaques are a function of the monkeys' similarities to humans, their intelligence (both in a positive and negative way), socio-economic standing of the farmers, actual crop damage and religious beliefs. Farmers' perceptions are a function of social factors rather than directly associated with monkey behaviour. More importantly, no matter what the monkeys do, they are liked, loathed or feared. Thus the behaviour of the people is more germane than that of the monkeys. While the ‘true’ extent of loss is an indicator of the potential costs to people, and they seem to be aware of these costs, costs alone do not define perceptions. The attitudes of these farmers suggest that neither livelihoods nor losses explain perceptions, and therefore no simplistic model for mitigating conflict will suffice.

8.3 WHAT THE MONKEYS ARE DOING

8.3.1 The Buton Macaque as a Weed Species

In their classification of macaques, based on their differing abilities to tolerate close association with human settlements, Richard *et al.* (1989) have classed all the Sulawesi macaques as ‘non-weed’ species. Others too have suggested that the crested Sulawesi macaque (*M. nigra*) is intolerant of human disturbance and reaches highest densities in less disturbed habitats (Rosenbaum *et al.* 1998; Sugardijto *et al.* 1989). *M. nigra* is, however, heavily hunted in Northern Eastern Sulawesi and the majority of the human population is Christian, (unlike the rest of predominantly Muslim Indonesia) and enjoys monkey meat on special occasions as a supplemental protein source, in fact it is a favourite for Christmas dinner (O'Brien and Kinnaird 2000).

The Buton macaque is under low pressure from hunting. They are occasionally killed during pig hunts by the Balinese, and some trapping occurs in the farms for pest-control. Poison is rarely used for pest-control and its use was witnessed only once in the study villages between 1999 and 2004. This poisoning event was catastrophic when employed in that one farm in 2002 and resulted in the death of 11 troop members. This is however a rare event as poison is expensive, its use against monkeys is illegal and its efficacy in terms of reducing overall raiding is questionable, as when used it did not prevent the remainder of the troop or other local troops raiding (see chapter 3 and 7). The farmers themselves admitted that it is a waste of money to use poison (see chapter 5).

Monkeys are sometimes captured for the pet trade. The trade is, however, generally limited (Priston 2001). In this study area only two macaques were seen caught in traps since 1999. Brief studies of the pet trade revealed between 14% (N = 162) (Dye 2005) and 30% (N = 130) (Wright 2005) of those surveyed owned or had previously owned a primate pet, and the phenomenon had increased over the last 45 years (based on reported ownership over the respondents' lifetimes (Wright 2005)). Ten pets were found at the time of these studies, in six villages (July – August, 2004). Sixty percent of the monkeys ever owned were caught on the farms as a by-product to crop-protection, although the majority were unintentionally caught, for example when infants were dropped by their mothers when chased or in bird or pig traps. Only 10% were bought or sold, suggesting that trade is limited. Extrapolating from the six study villages to the whole of Buton, Wright (2005) suggested 184 monkeys might be kept as pets on the island at any one time, with a reported average survival time of 12 months. However, as the majority of these are unintentionally caught this figure is likely to fluctuate dramatically over time. With a potential population of Buton macaques of several thousands, many of which (approximately 3000) are inside forest reserves, away from farms, the pet trade is unlikely to be a significant factor in this primate population's decline.

This study has demonstrated that Buton macaques adjust their behaviour to engage in crop-raiding and seem tolerant of disturbed habitats (chapter 3). No significant differences were found in population densities between protected areas and forest-farm mosaic habitats. Although these studies were short term, it might suggest that a re-classification of Buton macaque as a weed or semi-weed species is in order. It would not be surprising if they were able to tolerate and even thrive in disturbed habitats. Like other commensal weed macaque species, they can be predominantly terrestrial, are opportunistic frugivores (chapter 3) and are not hunted in this area. Consequently they can take advantage of crops and human food stores with lower mortality risks than perhaps *M .nigra* in north-east Sulawesi.

8.3.2 Characterising Raiding

Few other studies have attempted to characterise raiding behaviour, one on baboons (Maples *et al.* 1976) and another on macaques (Crockett and Wilson 1980). Crop-raiding by the Buton macaque was characterised into four raid types, based on duration and party size: *Grab* raids (less than 2 minutes and six or fewer participants), *Assault* raids (2.01 – 10 minutes and 16 or fewer participants), *Mob* raids (10.01 – 30 minutes with any number of participants) and *Relaxed* raids (over 30 minutes with seven or more participants). Grab raids most closely matched those described by Maples *et al.* (1976) as ‘rapid maize raids’, in that a few individuals (typically males) entered the farm, grabbed food and then retreated to the forest. This tactic of raiding was associated with higher human activity on the farm. Assault raids might be considered most similar to the ‘stealth raids’ of *M. nemestrina* (Crockett and Wilson 1980) and once again occurred at times of higher human activity. Relaxed raids were associated with low levels of human activity. These raids might be classed as ‘gang raids’, similar to those witnessed in Kenyan baboons (Maples *et al.* 1976) and *M. fascicularis* (Crockett and Wilson 1980). Mob and relaxed raids both involved greater penetration distance and ‘relaxed’ behaviour such as socialising, resting and play were observed in significant amounts. Levels of vigilance were highest however, for all age-sex classes, in these longer raids, which agrees with Maples *et al.*’s findings (1976) and suggests that although more relaxed during long raids, the monkeys remain alert.

8.4 POLICY AND PRACTICE – RECONCILING CONFLICT AND CO-EXISTENCE

The aim of this study was to assess the macaque – human interaction from as many perspectives as possible. Developing a management plan needs to be done in the context of direct interaction and engagement with farmers and not in academic isolation. Therefore, what follows here are suggestions for potential mechanisms for conflict mitigation that could be explored further in situ.

One of the most important elements in designing a management plan is that the people’s perceptions of the problem are tackled. The problem to be addressed is not only the actual loss, but also the element of loss that farmers perceive to be most important. Farmers in Buton reported that loss of crops, loss of food, loss of money and loss of time (via time spent guarding fields) were problems associated with crop-raiding by monkeys (Figure 8.9). Loss of time was the most frequently cited problem, followed by crop loss. Crop loss, of course, actually encompasses two of the other problems, money and food.

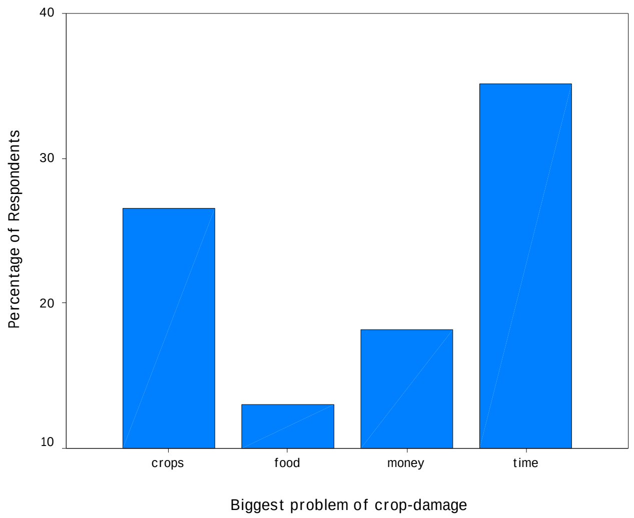


Figure 8.9 Percentage of farmers reporting loss of crops, food, money and time as the biggest problems associated with crop-raiding by monkeys (N = 155)

Although these farmers are poor, they are not starving. They grow a wide variety of crops and although damage can occasionally reach high levels (up to 70% of a farm) average losses are relatively small (10%). Most crops are not grown to sell; they are grown primarily for food and only the excess is sold (pers. obs.). There is also a culture of sharing and helping. In times of trouble neighbours, extended family and friends will help to feed and support families in difficulty (pers. obs). This may, in part, explain the relatively low perceptual conflict compared to African studies (for example Gillingham and Lee 2003; Hill 1997; Hill *et al.* 2002; Naughton Treves 1998a). There is a high degree of acceptance and tolerance of crop loss due to monkeys. Crop damage is accepted as a part of having a farm. So perhaps the question that should be asked is, ‘does this problem need to be solved?’ ‘Is there actually a conflict?’ By using the term conflict, and initiating management strategies and plans we could be elevating people’s perceptions to a state of increased conflict. Great care must be taken when dealing with these issues. Undoubtedly monkeys do damage crops. As populations increase, more farm land is cleared and the number of people farming close to the forest edge increases, more people will experience damage. Although farmers are not relying on crop-sales to survive it is an important extra source of income for these rural families. It enables children to be sent to school, allows improvements to be made to houses and so on. Farmers are also keenly aware of the time costs associated with monkey damage (see above).

Although perhaps little conflict, as such, exists now, the potential for conflict is significant. In the next four years the forest reserve around which these villages are situated will be subjected to a new management scheme (see chapter 2) and possibly upgraded to National Park Status. Farmers will be given incentives not to harvest timber and rattan from the reserves, in the form of plots of forest allocated to each village for sustainable extraction, investment into alternative sources of income such as Coir production (coconut fibre), agricultural improvements and small business loans (Operation Wallacea 2004)). Hunting of species such as pigs (*Sus celebensis*) (by the Hindu communities), and Anoa (*Bubalus depressicornis)* will also be restricted. Although incentives may serve to appease those villagers who lose access to forest timber and non-timber resources, other initiatives especially in Indonesia have served only to disenfranchise local people and to further increase conflict (Infield and Namara 2001; Struhsaker *et al.* 2005; Supriatna *et al.* 2002). Corruption is also endemic in the Indonesian system of protected area management, further alienating local people who do not benefit (Supriatna *et al.* 2002). In a recent review of African protected areas, Struhsaker (2005) found that although positive public opinion was the strongest correlate of protected area success, none of the community outreach programs designed to influence attitude through education and financial benefits were correlated with protected area success (see also Oates 1999). There is a need for potential management strategies to be designed, if not yet implemented, to avoid such problems in the future.

Suggestions for mitigation of monkey damage

The most heavily damaged crops were sweet potato, maize and bananas, in common with other studies. Farmers were accurate in their reports of preferred crops by monkeys, yet despite this they placed their crops close to the forest edge where the monkeys raided most prolifically. A pronounced edge effect was seen both between and within farms, such that areas within 10m of the forest edge in farms which were less than 100m from the forest suffered the greatest damage. This was confirmed in both vegetation transects and focal farm surveys. Hill (1997) also found that farmers persisted in growing maize, despite its vulnerability to crop damage. In her study, maize was a staple and preferred crop and was less vulnerable to other forms of damage. In Buton, rice is now the main staple food, however the traditional Butonese mainstay is maize and many people still like to eat it when possible. Only 8.4% respondents (N = 155) said that maize alone was their staple food, compared to 60% for rice. However 39% respondents mentioned maize in addition to other foods such as rice, sweet potato and cassava. It is clearly still a favoured food, although not heavily relied upon. There was always great excitement in the village when one of the householders had prepared maize (usually roasted on an open fire in its husks or boiled into a sort of soup) and it was relished (pers. obs.). This is reflected in the fact that most farmers grew some maize, although often it was rather limited, with a few plants planted in amongst other crops such as sweet potato and papaya (Figure 8.10 and Figure 8.11). Ten percent of farmers said sweet potato was their staple food and almost all farmers grew this over large areas of their farms, frequently next to the forest edge. Chilli and cassava (crops rarely damaged, and crops which farmers report that monkeys do not damage much) were usually grown near the watch hut towards the centre of the farm

(Figure 8.12). Clearly there is potential to manage conflict by altering cropping patterns (see later).

Figure 8.10 A few maize plants planted in amongst sweet potato, banana, green vegetables and weeds.

Figure 8.11 Maize plants interspersed with sweet potato and other crops. The majority of maize plants are concentrated right next to the forest edge, while cassava and chilli is planted near the hut.

Figure 8.12 Chilli growing next to the watch hut (a) and close up of chilli plant (b). Cassava grown in high density close to the watch hut in another farm (c)

Farmers could give me no reason for their chosen pattern of planting. Having banana palms dotted along the borders of farms was perhaps an aesthetic choice. Chilli and vegetables, not damaged by monkeys, were placed near to the hut for convenience when cooking. Farms were generally small sized (under 1ha), therefore shifting the placement of these crops would not inconvenience householders too much. By planting chilli, vegetables and cassava in the 10m zone and moving banana, maize and sweet potato towards the centre of the farm, near the watch hut there is the potential to reduce crop loss.

By increasing the risk to the monkeys, through what is a relatively minor cost to the farmer, crop loss might be substantially reduced. In order to achieve this effect some form of education program would need to be established. In a short program run in 2004 this recommendation was included in a leaflet about monkeys (see appendix 2). People seemed generally accepting of the suggestion, although clearly further work is required. The government arranges farmers' meeting within villages and regions, and offers advice on ways to tackle agricultural problems. This advice is usually focused on those growing rice, but strategies for pest control, ideas and seeds, are also offered to other farmers. People seemed to rely heavily on this advice. If recommendations for a buffer zone could be incorporated into the government's advice, this would aid dissemination and possible implementation.

"The rat problem has been very bad this year. We are waiting for the government to tell us what to do about it"

As well as altering crop-placement irregular patrols of farms, by men, could prove successful at reducing raiding. Human activity on the farm, including regular patrols, caused monkeys to spend more time loitering on the boundaries of farms and reduced party sizes. Of the deterrents used a combination of 'physical and noise' methods proved most likely to prevent further raiding, when carried out by men (chapter 7). Studies of elephants have shown that if the risks to elephants of raiding can be increased from the moment that they come near the farm, they are less likely to raid. Thus as soon as elephants are sighted people shout, whistle, and chase them to deter them (Hill *et al.* 2002). The same kinds of activities might be successful against monkeys. Often farmers would wait until monkeys were actually in their farm before they did anything to try to deter them. If, on first sighting the monkeys, farmers made noises, threw stones and chased them away from the surrounding area it may prove successful in deterring them. Although unlike elephants, due to their small size, early warning trip-wire systems would not be possible, it would be possible to encourage farmers to co-ordinate their farm protection.

Farmers' groups already exist and meet regularly. It might be possible to co-ordinate a patrol system, such that each farmer spends one day out of each month patrolling the village farms. Klangers (noise-makers) are used on a few farms. These could be set up on each farm with little expense (many use wood, stones or old cans which are ubiquitous around the villages). If the patrolman, or a farmer working in his farm, was to see monkeys the klanger could be used not only to deter monkeys from entering that farm but also to alert farmers in the village that the troop was nearby. Shouting could also be used, and is already used to a limited degree by some farmers to communicate the presence of monkeys, so there is scope to expand this into a more organised system.

The hardest issue to overcome is the generally relaxed attitude of the Butonese, especially that of the men. Although men will often carry out work on the farms when required (often in the early morning), for the rest of the day men like to relax on the porches of their houses playing cards, while the women work in the farms, look after the children and the house. Women were not as successful at deterring monkeys as men, so men need to be motivated to address this issue, if they want to. Motivating farmers without increasing their perception to 'conflict' level would be the ultimate challenge. When asked for their suggestions for preventing crop-raiding, although they recognised the difficulties (chapter 5) the farmers reported that they ultimately wanted a solution that did not impinge on their lives, did not cost money and yet reduced raiding. Crop placement combined with active deterrence of monkeys on sight might also significantly reduce raiding, and is the only solution that has the potential to meet all those criteria.

Given farmers’ tolerance and relaxed attitudes, co-existence between people and monkeys on Buton could be achieved for the benefit of the farmer and at little cost to the monkeys. Creating a ‘conflict’ in order to solve a ‘problem’ for relatively few people could endanger the monkeys, while not addressing the issue of crop losses. In the long run the monkeys will lose.

REFERENCES

Abrahamson, D. (1983). "What Africans Think About African Wildlife". *International Wildlife* **13**: 38 - 41.

Adams, W. M. (1996). *Future Nature: A Vision for Conservation*. London, Earthscan.

Adams, W. M., D. Brockington, et al. (2003). "Managing Tragedies: Understanding Conflict over Common Pool Resources". *Science* **302**(5652): 1915 - 1916.

Adams, W. M. and T. O. McShane (1992). *The Myth of Wild Africa: Conservation without Illusion*. New York, W. W. Norton.

Aldrich-Blake, F. P. G. (1980). Long-Tailed Macaques In. *Malayan Forest Primates. Ten Years' Study in Tropical Rainforest*. D. J. Chivers. New York, Plenum Press**:** 147 - 165.

Altmann, J. (1974). "Observational Study of Behaviour: Sampling Methods". *Behaviour* **48**: 1 - 41.

Altmann, J. (1980). *Baboon Mother and Infants*. Cambridge, Harvard University Press.

Altmann, J. and P. Muruthi (1988). "Differences in Daily Life between Semiprovisioned and Wild-Feeding Baboons". *American Journal of Primatology* **15**: 213 - 221.

Altmann, S. A. (1974). "Baboons, Space, Time, and Energy". *American Zoologist* **14**: 221 - 248.

American Bird Conservancy (2002). Pesticide Profiles, http://www.abcbirds.org/pesticides/profiles.htm, (Accessed 2005)

Anderson, D. R., J. L. Laake, et al. (1979). "Guidelines for Line Transect Sampling of Biological Populations". *Journal of Wildlife Management* **43**: 70 - 78.

Andrews, K. (2002). Activity Budgets and Feeding Behaviour of the Buton Macaque (*Macaca Brunnescens*). Bsc thesis, University of Aberdeen,

APCEL (1998). Law Concerning Environmental Management (Law No. 23/1997), http://sunsite.nus.edu.sg/apcel/dbase/indonesia/primary/inaem.html, (Accessed 2005)

Archbald, K. and L. Naughton-Treves (2001). "Tourism Revenue-Sharing around National Parks in Western Uganda: Early Efforts to Identify and Reward Local Communities". *Environmental Conservation* **28**(2): 135-149.

Aspelmeier, J. (2002). Multiple Comparisons, http://www.radford.edu/~jaspelme/611/Multiple%20Comparisons%20Handout.doc , (Accessed 2005)

Asquith, P. J. (1989). "Provisioning and the Study of Free-Ranging Primates: History, Effects and Prospects". *Yearbook of Physical Anthropology* **32**: 129-158.

Atmosoedarjo, S., L. Daryadi, et al. (1984). National Parks and Rural Communities In. *National Parks, Conservation and Development: The Role of Protected Areas in Sustaining Society: Proceedings of the World Congress on National Parks, Bali, Indonesia 11-22 October 1982*. J. A. McNeely and J. Mackinnon. Washington, D.C., Smithsonian Institution Press**:** 237 - 244.

Balakrishnan, M. and D. E. Ndhlovu (1992). "Wildlife Utilization and Local People: A Case Study in Upper Lupande Game Management Area, Zambia". *Environmental Conservation* **19**(2): 135-144.

Balmford, A., J. L. Moore, et al. (2001). "Conservation Conflicts across Africa". *Science* **291**(5513): 2616 - 2619.

Barnes, R. F. W. (2002). "The Bushmeat Boom and Bust in West and Central Africa". *Oryx* **36**(3): 236 - 242.

Barnett, A. (1995). *Expedition Field Techniques: Primates*. London, Expedition Advisory Centre, Royal Geographical Society.

Barraclough, R. K. (2000). *Distance Sampling: A Discussion Document Produced for the Department of Conservation*. Wellington, New Zealand, Department of Conservation.

Begon, M., J. L. Harper, et al. (1986). *Ecology, Individuals, Populations and Communities*. Oxford, Blackwell.

Bell, R. H. V. (1984a). The Man-Animal Interface: An Assessment of Crop-Damage and Wildlife Control In. *Conservation and Wildlife Management in Africa: The Proceeding of a Workshop Organised by the Us Peace Corps at Kasungu National Park, Malawi*. R. H. V. Bell and E. McShane-Caluzi, US Peace Corps**:** 387 - 416.

Bell, R. H. V. (1984b). Traditional Use of Wildlife Resources In. *Conservation and Wildlife Management in Africa: The Proceeding of a Workshop Organised by the Us Peace Corps at Kasungu National Park, Malawi*. R. H. V. Bell and E. McShane-Caluzi, US Peace Corps**:** 297 - 315.

Bennett, C. L., S. Leonard, et al. (2001). "Abundance, Diversity and Patterns of Distribution of Primates on the Tapiche River in Amazonian Peru". *American Journal of Primatology* **54**: 119 - 126.

Bernstein, I. S. and S. Baker (1988). "Activity Patterns in a Captive Group of Celebes Black Apes (*Macaca Nigra*)". *Folia Primatologica* **51**(2): 61 - 75.

Bertram, B. and J. Ginsberg (1994). *Monkeys in Mauritius: Potential for Humane Control*, Report commisioned by The Royal Society for the Prevention of Cruelty to Animals.

Bertrand, M. (1969). *The Behavioural Repertoire of the Stump-Tail Macaque*. New York, Karger (Basel).

Biquand, S., V. Biquand-Guyot, et al. (1992a). "The Distribution of Papio Hamadryas in Saudi Arabia: Ecological Correlates and Human Influence". *International Journal of Primatology* **13**(3): 223 - 243.

Biquand, S., V. Biquand-Guyot, et al. (1992b). "Group Composition in Wild and Commensal Hamadryas Baboons: A Comparative Study in Saudi Arabia". *International Journal of Primatology* **13**(5): 533 - 543.

Biquand, S., A. Boug, et al. (1994). "Management of Commensal Baboons in Saudi Arabia". *Revue D'Ecologie (Terre & Vie)* **49**(3): 213 - 222.

Biryahwaho, B. (2002). Community Perspectives Towards Management of Crop Raiding Animals: Experiences of Care-Dtc with Communities Living Adjacent to Bwindi Impenetrable and Mghaninga Gorilla National Parks, Southwest Uganda In. *Human-Wildlife Conflict: Identifying the Problem and Possible Solutions: Albertine Rift Techincal Reports Series. Vol. 1.* C. M. Hill, F. V. Osborn and A. J. Plumptre, Wildlife Conservation Society**:** 46 - 57.

Borman, M. M., M. Louhaichi, et al. (2000). Methods to Measure Geese Impacts on Grass Seed Production, http://cropandsoil.oregonstate.edu/seed-ext/Pub/2000/42.htm, (Accessed 2003)

Borman, M. M., M. Louhaichi, et al. (2001). Combining Photographic and Precision Farming Methods to Measure Geese Grazing Impacts on Grass Seed Production, http://cropandsoil.oregonstate.edu/seed-ext/Pub/2001/63.html, (Accessed 2003)

Boulton, A. M., J. A. Horrocks, et al. (1996). "The Barbados Vervet Monkey (Cercopithecus Aethiops Sabaeus): Changes in Population Size and Crop Damage, 1980 -1994". *International Journal of Primatology* **17**(5): 831 - 844.

Brennan, E. J., J. G. Else, et al. (1985). "Ecology and Behaviour of a Pest Primate: Vervet Monkeys in a Tourist-Lodge Habitat". *African Journal of Ecology* **23**: 35 - 44.

Bronikowski, A. M. and J. Altmann (1996). "Foraging in a Variable Environment: Weather Patterns and the Behavioural Ecology of Baboons". *Behavioural Ecology and Sociobiology* **39**: 11 - 25.

Bryman, A. and D. Cramer (1997). *Quantitative Data Analysis with Spss for Windows*. London, Routledge.

Buckland, S. T., D. R. Anderson, et al. (1993). *Distance Sampling: Estimating Abundance of Biological Populations*. London, Chapman and Hall.

Bulmer, M. (1983). Interviewing and Field Organisation In. *Social Research in Developing Countries: Surveys and Censuses in the Third World*. M. Bulmer and D. P. Warwick. Chichester, John Wiley and Sons Limited**:** 205 - 217.

Bulmer, M. and D. P. Warwick, Eds. (1983). *Social Research in Developing Countries: Surveys and Censuses in the Third World*. Chichester, John Wiley and Sons Limited.

Burnham, K. P., D. R. Anderson, et al. (1980). "Estimation of Density from Line Transect Sampling in Biological Populations". *Wildlife Monographs* **72**: 1-102.

Caldecott, J. and M. Kavanagh (1983). "Can Translocation Help Wild Primates". *Oryx* **17**(3): 135 - 139.

Caldecott, J. O. (1986a). "An Ecological and Behavioural Study of the Pig-Tailed Macaque". *Contributions to Primatology* **21**: 1 - 259.

Caldecott, J. O. (1986b). A Summary of the Ranging and Activity Patterns of the Pig-Tailed Macaque (*Macaca N. Nemestrina*) in Relation to Those of Sympatric Primates in Peninsular Malaysia In. *Current Perspectives in Primate Social Dynamics*. D. M. Taub and F. King, A. New York, Van Nostrand Reinhold**:** 152 - 158.

Calouro, A. M., P. A. Garber, et al. (2000). "Censusing a Primate Community in Brazil: A Multimethod Approach." *American Journal of Physical Anthropology* **suppl 30**: 117.

Carlisle, B. (2005). Butongis2004: Gis Data Sets of Buton Island, Sulawesi, Indonesia, http://online.northumbria.ac.uk/geography_research/bc_research/butongis, (Accessed

Carroll, S. (2003). Activity Budgets of the Buton Macaque (Macaca Ochreata Brunnescens): An Endemic Primate of Buton, Southeast Sulawesi, Msc thesis, Oxford Brookes University,

Casley, D. J. and D. A. Lury (1986). *Data Collection in Developing Countries*. Oxford, Clarendon Press.

Castro, A. P., N. Hakansson, et al. (1981). "Indicators of Rural Inequality". *World Development* **9**(5): 401 - 407.

Chalise, M. K. (2000). "Crop Raiding by Wildlife, Especially Primates, and Indigenous Practices for Crop Protection in Lakwuna Area, East Nepal". *Asian Primates* **7**(3): 4 - 9.

Chalise, M. K. and R. L. Johnson (2001). "A Preliminary Report on Farmer Attitudes toward Crop-Raiding Monkeys in Nepal,". *American Journal of Primatology* **54**(suppl 1): 73.

Chambers, R. (1992). "Rural Appraisal; Rapid, Relaxed and Participatory". *IDS Discussion Paper* **311**.

Chapman, C. A., F. J. White, et al. (1994). Party Size in Chimpanzees and Bonobos: A Reevaluation of Theory Based on Two Similarly Forested Sites In. *Chimpanzee Cultures*. R. W. Wrangham, W. C. McGrew and F. B. M. De Waal. Cambridge, MA, Harvard University Press.

Chapman, C. A., R. W. Wrangham, et al. (1995). "Ecological Constraints on Group Size: An Analysis of Spider Monkey and Chimpanzee Subgroups". *Behavioural Ecology and Sociobiology* **36**(1): 59 - 70.

Chatani, K. (2003). "Positional Behavior of Free-Ranging Japanese Macaques (*Macaca Fuscata*)". *Primates* **44**(1): 13 - 23.

Cheney, D. L. and R. M. Seyfarth (1990). *How Monkeys See the World. Inside the Mind of Another Species*. Chicago, University of Chicago Press.

Chiarello, A. G. and F. R. de Melo (2001). "Primate Population Densities and Sizes in Atlantic Forest Remnants in Northern Espirito Santo, Brazil." *International Journal of Primatology* **22**(3): 379 - 396.

Chivers, D. J. (1986). Southeast Asian Primates In. *Primates: The Road to Self-Sustaining Populations*. K. Benirschke. New York, Springer-verlag**:** 127 - 151.

Cincotta, R. P., J. Winewski, et al. (2000). "Human Population in the Biodiversity Hotspots". *Nature* **404**: 990 - 992.

Conover, M. R. (1994). "Perceptions of Grass-Roots Leaders of the Agricultural Community About Wildlife Damage on Their Farms and Ranches". *Wildlife Society Bulletin* **22**: 94 - 100.

Conover, M. R. (2002). *Resolving Human-Wildlife Conflicts: The Science of Wildlife Damage Management*. London, Lewis Publishers.

Conover, M. R. and D. J. Decker (1991). "Wildlife Damage to Crops: Perceptions of Agricultural and Wildlife Professionals in 1957 and 1987". *Wildlife Society Bulletin* **19**: 46 - 52.

Cooke, C., S. Shultz, et al. (2004). "A Taphonomic Analysis of Crowned Hawk-Eagle Nests from Tai National Forest, Ivory Coast." *American Journal of Primatology* **Suppl 38**: 79.

Cooper, G. (2001). The Behaviour and Ecology of the Buton Macaque (*Macaca Ochreata Brunnescens*), Undergraduate Dissertation thesis, University of Aberdeen, Aberdeen

Cowlishaw, G. and R. Dunbar (2000). *Primate Conservation Biology*. Chicago & London, The University of Chicago Press.

Crockett, C. and W. Wilson (1980). The Ecological Separation of Macaca Nemestrina and M. Fascicularis in Sumatra In. *The Macaques: Studies in Ecology, Behaviour and Evolution*. D. G. Lindburg. New York, Van Nostrand Reinhold Company**:** 148 - 181.

Daneel, A. B. C. (1979). "Prey Size and Hunting Methods of the Crowned Eagle." *Ostrich* **50**: 120 - 121.

De Boer, W. F. and D. S. Baquette (1998). "Natural Resource Use, Crop Damage, and Attitudes of Rural People in the Vicinity of the Maputo Elephant Reserve, Mozambique". *Environmental Conservation* **25**(3): 208 - 218.

de Thoisy, B. (2000). "Line-Transects: Sampling Application to a French Guianan Rainforest". *Mammalia* **64**(1): 101-112.

De Vaus, D. (2002). *Surveys in Social Research*. London, Routledge.

De Vos, A. and A. Omar (1971). "Territories and Movements of Sykes Monkeys (*Cercopithecus Mitis Kolbi*) in Kenya". *Folia Primatologica* **16**: 196 - 205.

Defler, T. R. and D. Pintor (1985). "Censusing Primates by Transect in a Forest of Known Primate Density". *International Journal of Primatology* **6**(3): 243-259.

Delson, E. (1980). Fossil Macaques, Phyletic Relationships and a Scenario of Deployment In. *The Macaques: Studies in Ecology, Behaviour and Evolution*. D. G. Lindburg. New York, Van Nostrand Reinhold Company**:** 10 - 30.

Drake, D. and J. Grande (2002). "Assessment of Wildlife Depredation to Agricultural Crops in New Jersey". *Journal of Extension* **40**(1).

Dunbar, R. (1992). "Time: A Hidden Constraint on the Behavioural Ecology of Baboons". *Ecology and Sociobiology* **31**: 35 - 49.

Dunbar, R. I. M. (1977). The Gelada Baboon: Status and Conservation In. *Primate Conservation*. Prince Rainier III and G. H. Bourne. New York, Academic Press**:** 363 - 383.

Dye, S. (2005). An Investigation into the Trade in Buton Macaques (Macaca Brunnescens) on Buton Island in South East Sulawesi, Indonesia, Bsc thesis, University of Birmingham, Birmingham

Eley, D. and J. G. Else (1984). "Primate Pest Problems in Kenya Hotels and Lodges". *International Journal of Primatology* **5**(4): 334.

Else, J. G. (1991). Nonhuman Primates as Pests In. *Primate Responses to Environmental Change*. H. O. Box. London, Chapman and Hall**:** 155 - 166.

Else, J. G. and P. C. Lee (1986). Primate-Human Conflict In. *Primate Ecology and Conservation: Vol. 2 of Selected Proceedings of the Tenth Congress of the International Primatological Society*. J. G. Else and P. C. Lee. New York, Cambridge University Press. **2:** 213 - 214.

Estrada, A., L. Castellanos, et al. (2002). "Survey of the Black Howler Monkey, *Alouatta Pigra*, Population at the Mayan Site of Palenque, Chiapas, Mexico". *Primates* **43**(1): 51-59.

Eudey, A. A. (1986). Hill Tribe Peoples and Primate Conservation in Thailand: A Preliminary Assessment of the Problem of Reconciling Shifting Cultivation Objectives In. *Primate Ecology and Conservation: Vol. 2 of Selected Proceedings of the Tenth Congress of the International Primatological Society*. J. G. Else and P. C. Lee. New York, Cambridge University Press. **2:** 237 - 248.

Eudey, A. A. (1994). "Temple and Pet Primates in Thailand". *Revue D'Ecologie (Terre & Vie)* **49**(3): 273 - 280.

Evans, B. J., J. C. Morales, et al. (1999). "Origin of the Sulawesi Macaques (Cercopithecidae: *Macaca*) as Suggested by Mitochondrial DNA Phylogeny". *Biological Journal of the Linnaean Society* **66**: 539 - 560.

Fa, J. E. (1986). Use of Time and Resources by Provisioned Troops of Monkeys: Social Behaviour, Time and Energy in the Barbary Macaque (*Macaca Sylvanus*) at Gibraltar. In. *Contributions to Primatology*. Basel, Karge. **23:** 1 - 377.

Fa, J. E. and C. H. Southwick, Eds. (1988). *Ecology and Behaviour of Food-Enhanced Primate Groups*. Monographs in Primatology. New York, Alan R. Liss Incorporated.

Fairbanks, L. A. (1993). "Risk-Taking by Juvenile Vervet Monkeys". *Behaviour* **124**(1-2): 57 - 72.

Fairbanks, L. A. and M. T. McGuire (1993). "Maternal Protectiveness and Response to the Unfamiliar in Vervet Monkeys". *American Journal of Primatology* **30**: 1 - 29.

Fashing, P. J. and M. Cords (2000). "Diurnal Primate Densities and Biomass in the Kakamega Forest: An Evaluation of Census Methods and a Comparison with Other Forests". *American Journal of Primatology* **50**: 139 - 152.

Feeroz, M. M. (1996). *Behavioural Ecology and Conservation of Pig-Tailed Macaque (Macaca Nemestrina Leonina) in Bangladesh*. Cambridge, University of Cambridge.

Feeroz, M. M. (1999). The Ecology and Behaviour of the Pig-Tailed Macaque (*Macaca Nemestrina Leonin*a) in Bangladesh, PhD thesis, University of Cambridge, Cambridge

Feistner, A. T. C. and R. Lee (2001). "Assessing the Status of Sulawesi Crested Black Macaques *Macaca Nigra* Outside Protected Areas". *Dodo* **37**: 96.

Fiallo, E. A. and S. K. Jacobson (1995). "Local Communities and Protected Areas: Attitudes of Rural Residents Towards Conservation and Machalilla National Park". *Environmental Conservation* **22**(2): 241 - 249.

Field, A. (2000). *Discovering Statistics Using Spss for Windows: Advanced Techniques for the Beginner*. London, Sage.

Fielding, A. H. and J. F. Bell (1997). "A Review of Methods for the Assessment of Prediction Errors in Conservation Presence/Absence Models". *Environmental Conservation* **24**: 38 - 49.

Fimbel, R. A., A. Grajal, et al. (2001). *The Cutting Edge: Conserving Wildlife in Logged Tropical Forests*. New York, Columbia University Press.

Fitter, R. (1974). "Most Endangered Mammals: An Action Programme". *Oryx* **12**: 436.

Flintan, F. (2003). *‘Engendering’ Eden Volume Iii: Women, Gender and Icdps in South and South East Asia: Lessons Learnt and Experiences Shared. Wildlife and Development Series No.18*. London, International Institute for Environment and Development.

Fooden, J. (1969). "Taxonomy and Evolution of the Monkeys of Celebes (Primates: Cercopithecidae)". *Bibliotheca Primatologica* **10**: 1 - 148.

Fooden, J. (1976). "Provisional Classification and Key to Living Species of Macaques (Primates: *Macaca*)". *Folia Primatologica* **25**: 225 - 236.

Fooden, J. (1980). Classification and Distribution of Living Macaques (*Macaca Lacepede* 1799) In. *The Macaques: Studies in Ecology, Behaviour and Evolution*. D. G. Lindburg. New York, Van Nostrand Reinhold Company**:** 1 - 9.

Fooden, J. (1986). "Taxonomy and Evolution of the Sinica Group of Macaques: 5. Overview of Natural History." *Fieldana Zoology* **29**: 1 - 22.

Forthman Quick, D. L. (1986a). Activity Budgets and the Consumption of Human Food in Two Troops of Baboons, *Papio Anubis*, at Gilgil, Kenya In. *Primate Ecology and Conservation: Vol. 2 of Selected Proceedings of the Tenth Congress of the International Primatological Society*. J. G. Else and P. C. Lee. New York, Van Nostrand Reinhold Company. **2:** 221 - 228.

Forthman Quick, D. L. (1986b). Controlling Primate Pests: The Feasibility of Conditioned Taste Aversion In. *Current Perspectives in Primate Social Dynamics*. D. M. Taub and F. King, A. New York, Van Nostrand Reinhold**:** 252 - 273.

Forthman Quick, D. L. and M. W. Demment (1988). Dynamics of Exploitation: Differential Energetic Adaptations of Two Troops of Baboons to Recent Human Contact In. *Ecology and Behaviour of Food-Enhanced Primate Groups*. J. E. Fa and C. H. Southwick. New York, Alan R. Liss Incorporated. **11:** 25 - 51.

Franklin, I. R. and R. Frankham (1998). "How Large Must a Population Be to Retain Evolutionary Potential". *Animal Conservation* **1**: 69 - 73.

Freese, C. H. and J. R. Oppenheimer (1981). The Capuchin Monkeys, Genus Cebus. In. *Ecology and Behaviour of Neotropical Primates Vol 1*. A. F. Coimbra-Filho and R. M. Mittermeier. Rio de Janeiro, Academia Brasileira de Ciences**:** 331 - 390.

Freitas, C. H., N. Gobbi, et al. (2002). Dieta Do Macaco-Prego (*Cebus Apella)* Em Fragmentos E Corredores De Mata Ciliar No Nordeste Do Estado De São Paulo. X Congresso Brasileiro de Primatologia, 2002, Belém - Pará.

FWI/GFW (2002). *The State of the Forest: Indonesia*, Bogor, Indonesia: Forest Watch Indonesia, and Washington DC: Global Forest Watch.

Ganzhorn, J. U. and J.-P. Abraham (1991). "Possible Role of Plantations for Lemur Conservation in Madagascar: Food for Folivorous Species". *Folia Primatologica* **56**: 171 - 176.

Gary, G., S. Kristi, et al. (2000). Deer Exclosure Research, http://www.dnr.cornell.edu/ext/nrmei/collaborative%20research/deer_exclosure_research.htm, (Accessed 2003)

Gautier, J.-P. and S. Biquand (1994). "Primate Commensalism". *Revue D'Ecologie (Terre & Vie)* **49**(3): 210 - 212.

Gautier-Hion, A., J.-M. Duplantier, et al. (1985). "Fruit Characters as a Basis of Fruit Choice and Seed Dispersal in a Tropical Forest Vertebrate Community". *Oecologica* **65**: 324 - 337.

Geisser, H. and H.-U. Reyer (2004). "Efficacy of Hunting, Feeding and Fencing to Reduce Crop Damage by Wild Boars". *Journal of Wildlife Management* **68**(4): 939 - 945.

Ghai, D. and J. M. Vivian, Eds. (1995). *Grassroots Environmental Action: People's Participation in Sustainable Development*. London, Routledge.

Gillingham, S. and P. C. Lee (1999). "The Impact of Wildlife-Related Benefits on the Conservation Attitudes of Local People around the Selous Game Reserve, Tanzania". *Environmental Conservation* **26**(3): 218 - 228.

Gillingham, S. G. (1998). Giving Wildlife Value: A Case Study of Community Wildlife Management around the Selous Game Reserve, Tanzania, PhD thesis, University of Cambridge, Cambridge

Gillingham, S. G. and P. C. Lee (2003). "People and Protected Areas: A Study of Local Perceptions of Wildlife Crop-Damage Conflict in an Area Bordering the Selous Game Reserve, Tanzania". *Oryx* **37**(3): 316 - 325.

Goldstein, S. J. and A. F. Richard (1989). "Ecology of Rhesus Macaques (*Macaca Mulatta*) in Northwest Pakistan". *International Journal of Primatology* **10**(6): 531 - 565.

Gonzalez-Kirchner, J. P. and M. Sainz de la Maza (1998). "Primates Hunting by Guaymi Amerindians in Costa Rica". *Human Evolution* **13**: 15 - 19.

Grambo, R. L. (1999). Eagles, http://www.baldeagleinfo.com/eagle/eagle6.html, (Accessed 2005)

Green, S. and K. Minkowski (1977). The Lion-Tailed Monkey and Its South Indian Rain Forest Habitat In. *Primate Conservation*. P. R. III and G. H. Bourne. New York, Academic Press**:** 290 - 337.

Grimwood, N. J. F. (2005). Microhabitat Preferences of Terrestrial Small Mammals in Lowland Rainforest on Buton Island, South-East Sulawesi, Indonesia, Msc thesis, Manchester Metropolitan University, Manchester

Grindley, J. (2003). "Python Constricts Vervet Monkey". *Ecological Journal* **5**: 270.

Groves, C. (1980). Speciation in *Macaca*: The View from Sulawesi, In. *The Macaques*. D. G. Lindburg. New York, Van Nostrand Reinhold Company**:** 84 - 124.

Groves, C. P. (2001). *Primate Taxonomy*. Washington DC, Smithsonian Institution Press.

Hackel, J. D. (1999). "Community Conservation and the Furture of Africa's Wildlife". *Conservation Biology* **13**(4): 726 - 734.

Hamada, Y., T. Watanabe, et al. (1988). "Morphological Studies on the Sulawesi Macaques I: Phyletic Analysis of Body Colour". *Primates* **29**(1): 65 - 80.

Hanya, G. (2004). "Seasonal Variations in the Activity Budget of Japanese Macaques in the Coniferous Forest of Yakushima: Effects of Food and Temperature". *American Journal of Primatology* **63**(3): 165 - 177.

Harding, R. S. O. (1973). "Predation by a Troop of Olive Baboons (*Papio Anubis*)". *American Journal of Physical Anthropology* **38**: 587 - 592.

Hauser, M. D. and D. A. Nelson (1991). "Intentional Signalling in Animal Communication". *Trends in Ecology and Evolution* **6**: 186 - 189.

Hershfield, A. F., N. G. Rohling, et al. (1983). Fieldwork in Rural Areas In. *Social Research in Developing Countries: Surveys and Censuses in the Third World*. M. Bulmer and D. P. Warwick. Chichester, John Wiley and Sons Limited**:** 241-252.

Hill, C. M. (1997). "Crop-Raiding by Wild Vertebrates: The Farmer's Perspective in an Agricultural Community in Western Uganda". *International Journal of Pest Management* **43**(1): 77 - 84.

Hill, C. M. (1998). "Conflicting Attitudes Towards Elephants around the Budungo Forest Reserve, Uganda". *Environmental Conservation* **25**(3): 244 - 250.

Hill, C. M. (1999). "Conflict of Interest between People and Baboons: Crop Raiding in Uganda,". *International Journal of Primatology* **21**(2): 299 - 315.

Hill, C. M. (2000). "Conflict of Interest between People and Baboons: Crop Raiding in Uganda,". *International Journal of Primatology* **21**(2): 299 - 315.

Hill, C. M., F. V. Osborn, et al. (2002). *Human-Wildlife Conflict: Identifying the Problem and Possible Solutions*, Albertine Rift Technical Report Series, Wildife Conservation Society. **1:** 137.

Hoelzer, G. A. and D. J. Melnick (1996). Evolutionary Relationships of the Macaques. In. *Evolution and Ecology of Macaque Societies*. J. E. Fa and D. G. Lindburg**:** 3 - 19.

Hone, J. (1994). *Analysis of Vertebrate Pest Control*. Cambridge, UK, Cambridge University Press.

Horrocks, J. A. and J. Baulu (1988). "Effects of Trapping on the Vervet (Cercopithecus Aethiops Sabaeus) Population in Barbados". *American Journal of Primatology* **15**: 223 - 233.

Horrocks, J. A. and J. Baulu (1994). "Food Competition between Vervets (*Cercopithecus Aethiops Sabaeus*) and Farmers in Barbados: Implications for Management". *Revue D'Ecologie (Terre & Vie)* **49**(3): 281 - 294.

Iida, T. (1999). "Predation of Japanese Macaque Macaca Fuscata by Mountain Hawk Eagle *Spizaetus Nipalensis*." *Japanese Journal of Ornithology* **47**(3): 125 - 127.

IIED (1994). *Whose Eden? An Overview of Community Approaches to Wildlife Management*. London, International Institute for Environment and Development.

Imam, E., H. S. A. Yahya, et al. (2002). "A Successful Mass Translocation of Commensal Rhesus Monkeys *Macaca Mulatta* in Vrindaban, India". *Oryx* **36**(1): 87 - 93.

Infield, M. (1988). "Attitudes of a Rural Community Towards Conservation and a Local Conservation Area in Natal, South Africa". *Biological Conservation* **45**: 21 - 46.

Infield, M. and Namara (2001). "Community Attitudes and Behaviour Towards Conservation: An Assessment of a Community Conservation Programme around Lake Mburo National Park, Uganda". *Oryx* **35**(1): 48 - 60.

IUCN (2004). 2004 Red List of Threatened Species, http://www.redlist.org/, (Accessed 2004)

Jachmann, H. (2001). *Estimating Abundance of African Wildlife: An Aid to Adaptive Management*. London, Kluwer Academic Publishers.

Jenkins, C. (2000). Monitoring Your Food Plot Program, http://www.alabamawildlife.org/stewardship/wildlife_management_tips.asp#, (Accessed 2003)

Johns, A. D. and J. P. Skorupa (1987). "Responses of Rain-Forest Primates to Habitat Disturbance: A Review". *International Journal of Primatology* **8**(2): 157 - 191.

Johnson, N. and B. Cabarle (1993). *Surviving the Cut: Natural Forest Management in the Humid Tropics*. Washington DC, World Resources Institute.

Johnson, S. E. and D. J. Overdorff (1999). "Census of Brown Lemurs (*Eulemur Fulvus* Sspp.) in Southeastern Madagascar: Methods-Testing and Conservation Implication". *American Journal of Primatology* **47**: 51-60.

Jones, E. L. (1983). The Courtesy Bias in South-East Asian Surveys In. *Social Research in Developing Countries: Surveys and Censuses in the Third World*. M. Bulmer and D. P. Warwick. Chichester, John Wiley and Sons Limited**:** 253-260.

Kahn, R. L. and C. F. Cannell (1957). *The Dynamics of Interviewing : Theory, Technique and Cases*. New York, Wiley.

Kamisse, A. and A. K. Turkalo (2002). Elephant Crop Raiding in the Dzanga-Sangha Reserve In. *Human-Wildlife Conflict: Identifying the Problem and Possible Solutions: Albertine Rift Technical Reports Series. Vol. 1.* C. M. Hill, F. V. Osborn and A. J. Plumptre, Wildlife Conservation Society**:** 114 - 120.

Karanth, K. U. and J. D. Nichols (1998). "Estimation of Tiger Densities in India Using Photographic Captures and Recaptures". *Ecology* **79**: 2852 - 2862.

Kavanagh, M. (1978). "The Diet and Feeding Behaviour of *Cercopithecus Aethiops Tantalus*". *Folia Primatologica* **30**: 30 - 63.

Kavanagh, M. (1980). "Invasion of the Forest by an African Savannah Monkey: Behavioural Adaptations". *Behaviour* **73**: 239 - 259.

Kilner, T. (2001). "A Preliminary Study of the Behaviour and Ecology of the Buton Macaque (*Macaca Brunnescens*)." *Primate Eye* **74**: 24 - 31.

King, F. A. and P. C. Lee (1987). "A Brief Survey of Human Attitudes to a Pest Species of Primate - *Cercopithecus Aethiops*". *Primate Conservation* **8**: 82 - 84.

Kinzey, W. G., M. A. Norconk, et al. (1988). "Primate Survey of Eastern Bolivar, Venezuela." *Primate Conservation* **9**: 66 - 70.

Knight, J. (1999). "Monkeys of the Move: The Natural Symbolism of People-Macaque Conflict in Japan". *The Journal of Asian Studies* **58**(3): 622 - 647.

Kohlhaas, A. and C. H. Southwick (1996). *Macaca Nigrescens*: Grouping Patterns and Group Composition in a Sulawesi Macaque In. *Evolution and Ecology of Macaqeu Societies*. J. E. Fa and D. G. Lindburg. Cambridge, Cambridge University Press**:** 132 - 145.

Krebs, C. J. (1972). *Ecological Methodology*. New York, Harper and Row.

Krebs, C. J. (1999). *Ecological Methodology*. California, Benjamin/Cummings.

Lahm, S. A. (1996). "A Nationwide Survey of Crop-Raiding by Elephants and Other Species in Gabon". *Pachyderm* **21**: 77 - 69.

Landis, J. R. and G. C. Koch (1977). "The Measurement of Observer Agreement for Categorical Data". *Biometrics* **33**: 159 -174.

Laurance, W. F. (1999). "Reflections on the Tropical Deforestation Crisis." *Biological Conservation* **91**: 109 - 117.

Lee, P. C. (1983). Ecological Influences on Relationships and Social Structures In. *Primate Social Relationships: An Integrated Approach*. R. A. Hinde. Oxford, Blackwell Scientific Publications.

Lee, P. C. (1984). "Ecological Constraints on the Social Development of Vervet Monkeys". *Behaviour* **91**(4): 245 - 262.

Lee, P. C. (1988). Ecological Constraints and Opportunities: Interactions, Relationships and Social Organisation of Primates In. *Ecology and Behaviour of Food-Enhanced Primate Groups*. J. E. Fa and C. H. Southwick. New York, Alan R. Liss Incorporated. **11:** 297 - 311.

Lee, P. C. (2004). "Who Wins? Human-Primate Conflict in the Context of Conservation, Development and Gender". *Primate Eye* **84**(15 - 16).

Lee, P. C., E. J. Brennan, et al. (1986). Ecology and Behaviour of Vervet Monkeys in a Tourist Lodge Habitat, In. *Primate Ecology and Conservation: Vol. 2 of Selected Proceedings of the Tenth Congress of the International Primatological Society*. J. G. Else and P. C. Lee. New York, Cambridge University Press. **2:** 229 - 235.

Lee, P. C. and N. E. C. Priston (in press). Perceptions of Pests: Human Attitudes to Primates, Conflict and Consequences for Conservation In. *Commensalism and Conflict: The Primate-Human Interface*. J. D. Paterson. Winniipeg, Manitoba, Hignell Printing.

Lee, P. C., J. Thornback, et al. (1988). *Threatened Primates of Africa: The Iucn Red Data Book*. Cambridge, IUCN Conservation Monitoring Centre.

Lindburg, D. G. (1976). "Dietary Habits of Rhesus Monkeys (*Macaca Mulatta Zimmerman*) in Indian Forests". *Journal of The Bombay Natural History Society* **73**: 261 - 169.

Lindburg, D. G. (1977). Feeding Behaviour and Diet of Rhesus Monkeys (*Macaca Mulatta*) in a Siwalik Forest in North India. In. *Primate Ecology: Studies of Feeding and Ranging Behaviour in Lemurs, Monkeys and Apes*. T. H. Clutton-Brock, Academic Press**:** 223 - 249.

Ludwig, G., N. R. Reis, et al. (2002). Dieta Sazonal De *Cebus Apella* (Linnaeus, 1758) (Primates, Mammalia) No Remanescente Florestal Mata Doralice, Ibiporã - Paraná. X Congresso Brasileiro de Primatologia, 2002, Belém - Pará.

Lynch, J. W. and J. Rimoli (2000). "Demography of a Group of Tufted Capuchin Monkeys (*Cebus Apella Nigritus*) at the Estaçáo Biológica De Caratinga, Minas Gerais, Brazil". *Neotrpical Primates* **8**(1): 44 - 49.

Lynch, M. and R. Lande (1998). "The Critical Effective Size for a Genetically Secure Population". *Animal Conservation* **1**: 70 - 72.

Mace, G. and A. Balmford (2000). Patterns and Processess in Contemporary Mammalian Extinction In. *Future Priorities for the Conservation of Mammalian Diversity*. A. Entwhistle and N. Dunstone. Cambridge, Cambride University Press.

MacKinnon, K. and T. Whitten (2001). Biodiversity Protection and Management. In. *Indonesia: Environment and Natural Resource Management in a Time of Transition*. Wahington DC, The World Bank**:** 32 - 50.

Mackinnon, K. S. (1986). The Conservation Status of Non-Human Primates in Indonesia In. *Primates - the Road to Self-Sustaining Populations*. K. Benirschke. New York, Springer-verlag New York incorporated**:** 99 - 126.

Magurran, A. E. (1988). *Ecological Diversity and Its Measurement*. New Jersey, Princeton University Press.

Makwana, S. C. (1978). "Field Ecology and Behaviour of the Rhesus Macaque (*Macaca Mulatta*): I. Group Composition, Home Range, Roosting Sites and Foraging Routes in the Asaori Forest". *Primates* **19**(3): 483 - 492.

Malic, I. and R. L. Johnson (1994). "Commensal Rhesus in India: The Need and Cost of Translocation". *Revue D'Ecologie (Terre & Vie)* **49**(3): 233 - 244.

Maples, W. R. (1969). "Adaptive Behaviour of Baboons". *American Journal of Physical Anthropology* **31**: 101 - 110.

Maples, W. R., M. K. Maples, et al. (1976). "Adaptations of Crop-Raiding Baboons in Kenya". *American Journal of Physical Anthropology* **45**: 309 - 316.

Marsh, C. (1982). *The Survey Method: The Contribution of Surveys to Sociological Explanation*. London, George Allen & Unwin.

Martin, P. and P. Bateson (2001). *Measuring Behaviour: An Introductory Guide*. Cambridge, Cambridge University Press.

Martin, R. B. (1984a). Communal Area Management Plan for Indigenous Resources (Project Campfire) In. *Conservation and Wildlife Management in Africa: The Proceeding of a Workshop Organised by the Us Peace Corps at Kasungu National Park, Malawi*. R. H. V. Bell and E. McShane-Caluzi, US Peace Corps**:** 279 - 295.

Martin, R. B. (1984b). Wildlife Human Interactions In. *Conservation and Wildlife Management in Africa: The Proceeding of a Workshop Organised by the Us Peace Corps at Kasungu National Park, Malawi*. R. H. V. Bell and E. McShane-Caluzi, US Peace Corps**:** 209 - 218.

Martin, R. B. (1984c). Wildlife Utilizations In. *Conservation and Wildlife Management in Africa: The Proceeding of a Workshop Organised by the Us Peace Corps at*

Kasungu National Park, Malawi. R. H. V. Bell and E. McShane-Caluzi, US Peace Corps**:** 219 - 231.

Mascarenas, A. (1971). Agricultural Vermin in Tanzania In. *Studies in East African Geography and Development*. S. H. Ominde. London, Heinemann Educational Books Limited**:** 259 - 267.

Matsumoto-Oda, A. (2002). "Behavioural Seasonality in Mahale Chimpanzees". *Primates* **43**(2): 103 -117.

Matsumura, S. (1998). "Relaxed Dominance Relations among Female Moor Macaques (*Macaca Maurus*) in Their Natural Habitat, South Sulawesi, Indonesia". *Folia Primatologica* **69**: 346 - 356.

Matsumura, S. (2001). "Yellow-Billed Malkohas (*Phaenicophaeus Calyorhynchus*) Following Moor Macaques (*Macaca Maurus*) in South Sulawesi, Indonesia". *Journal of Tropical Ecology* **17**: 619 - 623.

McShane, T. O. and M. P. Wells (2004). *Getting Biodiversity Projects to Work Towards More Effective Conservation and Development*. New York, Columbia University Press.

Melfi, V. A. and A. T. C. Feistner (2002). "A Comparison of the Activity Budgets of Wild and Captive Sulawesi Crested Black Macaques (*Macaca Nigra*)". *Animal Welfare* **11**(2): 213 - 222.

Melnick, D. J. and M. C. Pearl (1987). Cercopithecines in Mulitmale Groups: Genetic Diversity and Population Structure In. *Primate Societies*. B. B. Smuts, D. L. Cheney, R. M. Seyfarth, R. W. Wrangham and T. T. Struhsaker. Chicago, Univerity of Chicago Press**:** 121 - 134.

Ménard, N. and D. Vallet (1997). "Behavioural Responses of Barbary Macaques (*M. Sylvanus*) to Variations in Environmental Conditions in Algeria". *American Journal of Primatology* **43**(4): 285 - 304.

Menon, S. and F. E. Poirier (1996). "Lion-Tailed Macaques (*Macaca Silenus*) in a Disturbed Forest Fragment: Activity Patterns and Time Budget". *International Journal of Primatology* **17**(6): 969 - 985.

Mitani, J. C., T. T. Struhsaker, et al. (2000). "Primate Communities Dynamics in Old Growth Forest over 23.5 Years at Ngogo, Kibale National Park, Uganda: Implications for Conservation and Census Methods". *International Journal of Primatology* **21**: 269-286.

Mitchell, A. H. and R. L. Tilson (1986). Restoring the Balance: Traditional Hunting and Primate Conservation in the Mentawi Islands, Indonesia In. *Primate Ecology and Conservation: Vol. 2 of Selected Proceedings of the Tenth Congress of the*

International Primatological Society. J. G. Else and P. C. Lee. New York, Cambridge University Press. **2:** 249 - 260.

Mitchell, R. E. (1983). Survey Materials Collected in the Developing Countries: Sampling, Measurement, and Interviewing Obstacles to Intranational and International Comparisons In. *Social Research in Developing Countries: Surveys and Censuses in the Third World*. M. Bulmer and D. P. Warwick. Chichester, John Wiley and Sons Limited**:** 219-241.

Mittermeier, R. A. and D. L. Cheney (1987). Conservation of Primates and Their Habitats In. *Primate Societies*. B. B. Smuts, D. Cheney, L, R. M. Seyfarth, R. W. Wrangham and T. T. Struhsaker. Chicago, University of Chicago Press**:** 477 - 490.

Mittermeier, R. A., N. Meyers, et al. (1999). *Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions.* Mexico, CEMEX.

Mittermeier, R. A., I. Tattersall, et al. (1994). *Lemurs of Madagascar*. USA, Conservation International.

Mohnot, S. M. (1971). "Ecology and Behaviour of the Hanuman Langur, *Presbytis Entellus* (Primates: Cercopithecidae) Invading Fields, Gardens and Orchards around Jodhpur, Western India". *Tropical Ecology* **12**(2): 237 - 249.

Morales, J. C. and D. Melnick, J (1998). "Phylogenetic Relationships of the Macaques (Cercopithecidae: *Macaca*), as Revealed by High Resolutin Restriction Site Mapping of Mitochondrial Ribosomal Genes". *Journal of Human Evolution* **34**: 1 - 23.

Morris, R. and D. Morris (1966). *Men and Apes*. London, Hutchinson and Co.

Moser, C. A. and C. Kalton (1989). *Survey Methods in Social Investigation*. Guildford, Gower.

Mosse, D. (1995). *Authority, Gender and Knowledge: Theoretical Reflections on the Practice of Pra*. Swansea, Centre for Development Studies, University of Wales.

Mukherjee, R. P. (1972). "A Field Study on the Behaviour of Two Roadside Groups of Rhesus Macaque [*Macaca Mulatta* (Zimmerman)] in Northern Uttar Pradesh". *Journal of The Bombay Natural History Society* **66**(1): 47 - 56.

Musau, J. M. and S. C. Strum (1984). "Response of Wild Baboon Troops to Incursion of Agriculture at Gilgil, Kenya,". *International Journal of Primatology* **5**: 364.

Myers, N. (1984). *The Primary Source*. New York, W.W. Norton.

Myers, N., R. A. Mittermeier, et al. (2000). "Biodiversity Hotspots for Conservation Prorities". *Nature* **403**: 853 - 845.

Nakagawa, N. (2000). "Seasonal, Sex, and Interspecific Differences in Activity Time Budgets and Diets of Patas Monkeys (*Erythrocebus Patas)* and Tantalus Monkeys (*Cercopithecus Aethiops Tantalus*), Living Sympatrically in Northern Cameroon". *Primates* **41**(2): 161 - 174.

National Park Service (1997). *Yellowstone's Northern Range: Complexity and Change in a Wildland Ecosystem*, Yellowstone National Park, National Park Service, Wyoming, USA. **2003**.

Naughton Treves, L. (1996). Uneasy Neighbours: Wildlife and Farmers around Kibale National Park, Uganda, PhD thesis, University of Florida,

Naughton Treves, L. (1997). "Farming the Forest Edge: Vulnerable Places and People around Kibale National Park, Uganda". *The Geographical Review* **87**(1): 27 - 46.

Naughton Treves, L. (1998a). "Predicting Patterns of Crop Damage by Wildlife around Kibale National Park". *Conservation Biology* **12**(1): 156 - 168.

Naughton Treves, L. (1998b). "Temporal Patterns of Crop-Raiding by Primates: Linking Food Availability in Croplands and Adjacent Forest". *Journal of Applied Ecology* **35**: 596 - 606.

Neville, M. K. (1968). "Ecology and Activity of Himalayan Foothill Rhesus Monkeys (*Macaca Mulatta*)". *Ecology* **49**(1): 110 - 123.

Newmark, W. D., N. L. Leonard, et al. (1993). "Conservation Attitudes of Local People Living Adjacent to Five Protected Areas in Tanzania". *Biological Conservation* **63**: 177 - 183.

Newmark, W. D., D. N. Manyanza, et al. (1994). "The Conflict between Wildlife and Local People Living Adjacent to Protected Areas in Tanzania: Human Density as a Predictor". *Conservation Biology* **8**(1): 249 - 255.

Nichols, P. (1991). *Social Survey Methods: A Fieldguide for Development Workers*. Oxford, Oxfam.

NRC (1981). *Techniques for the Study of Primate Population Ecology*. Washington D.C., National Academy Press.

Oates, J. F. (1977). The Guereza and Man: How Man Has Affected the Distribution and Abundance of *Colobus Guereza* and Other Black Colobus Monkeys In. *Primate Conservation*. Prince Rainier III and G. H. Bourne. New York, Academic Press**:** 420 - 467.

Oates, J. F. (1999). *Myth and Reality in the Rain Forest: How Conservation Strategies Are Failing in West Africa*, University of California Press.

Oates, J. F., P. A. Anadu, et al. (1992). "Sclater's Guenon - a Rare Nigerian Monkey Threatened by Deforestation". *National Geographic Research and Exploration* **8**: 476 - 91.

O'Brien, T. G. and M. Kinnaird (1997). "Behaviour, Diet, and Movements of the Sulawesi Crested Black Macaque (*Macaca Nigra*)". *International Journal of Primatology* **18**: 321 - 351.

O'Brien, T. G. and M. F. Kinnaird (2000). Differential Vulnerability of Large Birds and Mammals to Hunting in North Sulawesi, Indonesia, and the Outlook for the Future. In. *Hunting for Sustainability in Tropical Forests*. J. Robinson, G and E. L. Bennet. New York, Columbia University Press**:** 199 - 213.

O'Donovan, G. (2002). Forest Structure Summary, htttp://www.Opwall.co.uk/2002%20forest%20structure%20summary.htm, (Accessed 2003)

Onderdonk, D. A. and C. A. Chapman (2000). "Coping with Forest Fragmentation: The Primates of Kibale National Park, Uganda". *International Journal of Primatology* **21**(4): 587 - 611.

Operation Wallacea (2003). The Biological Case for Enhancing the Conservation Status of Lambusango and Kakenauwe Forests, http://www.opwall.com/2004%20biological%20case%20for%20Lambusango.htm, (Accessed 2004)

Operation Wallacea (2004). Proposed Management for the Lambusango Forests, http://www.opwall.com/2004%20Lambusango%20index.htm, (Accessed 2004)

Oppenheim, A. N. (1992). *Questionnaire Design, Interviewing and Attitude Measurement*. London, Pinter Publishers.

Oryx (1964). "News and Views". *Oryx* **7**: 148.

Oyaro, H. O. and S. C. Strum (1984). "Shifts in Foraging Strategies as a Response to the Presence of Agriculture in a Troop of Wild Baboons at Gilgil, Kenya". *International Journal of Primatology* **5**: 371.

Parry, D. and B. Campbell (1992). "Attitudes of Rural Communities to Animal Wildlife and Its Utilization in Chobe Enclave and Mababe Depression, Botswana". *Environmental Conservation* **19**(3): 245 - 252.

Peres, C. A. (1999). "General Guidelines for Standardizing Line-Transect Surveys of Tropical Forest Primates". *Neotropical Primates* **7**(1): 11 - 16.

Perneger, T. V. (1998). "What's Wrong with Bonferroni Adjustments". *BMJ* **316**(7139): 1236-1238.

Pesticide Action Network (1995). Demise of the Dirty Dozen, http://www.panna.org/resources/documents/dirtyDozenChart.dv.html, (Accessed 2005)

Pirta, R. S., M. Gagil, et al. (1997). "The Management of the Rhesus Monkey *Macaca Mulatta* and Hanuman Langur *Presbytis Entellus* in Himachal Pradesh, India". *Biological Conservation* **79**: 97 - 106.

Post, D., G. Hausfater, et al. (1980). "Feeding Behavior of Yellow Baboons (*Papio Cynocephalus*): Relationship to Age, Gender and Dominance Rank". *Folia Primatologica* **34**: 170 - 195.

Post, W. and J. Baulu (1978). "Time Budgets of *Macaca Mulatta*". *Primates* **19**: 125 - 140.

Pratt, B. and P. Loizos (1992). *Choosing Research Methods: Data Collection for Development Workers*. Oxford, Oxfam.

Priston, N. E. C. (2001). Assessment of Crop Damage by *Macaca Ochreata Brunnescens* in Southeast Sulawesi - a Farmer's Perspective, Ba thesis, University of Cambridge, Cambridge, England

Pruetz, J. D. and H. C. Leasor (2000). "Comparison of Census Methods to Record Density and Group Size of *Ateles Geoffroyi*, *Alouatta Palliata* and *Cebus Capucinus* in Lowland Tropical Rainforest in Costa Rica". *American Journal of Physical Anthropology* **suppl 30**: 255.

Rao, K. S., R. K. Maikhuri, et al. (2002). "Crop Damage and Livestock Depredation by Wildlife: A Case Study from Nanda Devi Biosphere Reserve, India". *Journal of Environmental Management* **66**: 317-327.

Reed, C., T. G. O'Brien, et al. (1997). "Male Social Behaviour and Dominance Hierarchy in the Sulawesi Crested Black Macaque (Macaca Nigra) on Becan and Sulawesi, Indonesia: Effects of Habitat Disturbance and Hunting". *American Journal of Primatology* **44**: 89 - 106.

Richard, A. F. and S. J. Goldstein (1981). "Primates as Weeds: The Implications for Macaque Evolution". *American Journal of Physical Anthropology* **54**: 267.

Richard, A. F., S. J. Goldstein, et al. (1989). "Weed Macaques: The Evolutionary Implications of Macaque Feeding Ecology". *International Journal of Primatology* **10**(6): 569 - 594.

Rimoli, J. and S. F. Ferrari (2002). Ecologia De Macacos-Prego (*Cebus Apella Nigirtus*, Goldfuss, 1809) Na Estaçáo Biológica De Caratinga (Mg): Implicações Para a Conservação De Fragmentos De Mata Atlãntica. X Congresso Brasileiro de Primatologia, 2002, Belém - Pará.

Robinson, J., G and E. L. Bennet, Eds. (2000). *Hunting for Sustainability in Tropical Forests*. New York, Columbia University Press.

Rohlf, J. F. and R. R. Sokal (1994). *Biometry: Principles and Practice of Statistics in Biological Research*, W H Freeman.

Roonwal, M. L. and S. M. Mohnot (1977). *Primates of South Asia: Ecology, Sociobiology and Behaviour*. Cambridge, Massachusetts, Harvard University Press.

Rosenbaum, B., T. G. O'Brien, et al. (1998). "Population Densities of Sulawesi Crested Black Macaques (*Macaca Nigra*) on Bacan and Sulawesi, Indonesia: Effects of Habitat Disturbance and Hunting". *American Journal of Primatology* **44**: 89 - 106.

Ross, C. and K. E. Jones (1999). Socioecology and the Evolution of Primate Reproductive Rates In. *Comparative Primate Socioecology*. P. C. Lee. Cambridge, Cambridge University Press**:** 73 - 110.

Saj, T. L., P. Sicotte, et al. (1999a). "Age-Sex Class Differences in the Time Budget and Feeding Strategies of Members of a Crop and Food-Raiding Vervet Group in Entebbe, Uganda". *American Journal of Primatology* **49**(1): 96 - 97.

Saj, T. L., P. Sicotte, et al. (1999b). "Influence of Human Food Consumption on the Time Budget of Vervets". *International Journal of Primatology* **20**(6): 977 - 994.

Saj, T. L., P. Sicotte, et al. (2001). "The Conflict between Vervet Monkeys and Farmers at the Forest Edge in Entebbe, Uganda". *African Journal of Ecology* **39**(2): 195 - 199.

Salafsky, N. (1993). "Mammalian Use of a Buffer Zone Agroforestry System Bordering Gunung Palung National Park, West Kalimantan, Indonesia". *Conservation Biology* **7**: 928 - 933.

Sanders, W. J. and J. C. Mitani (2000). "Taphonomic Aspects of Eagle Predation of Primates from Kibale Forest, Uganda". *American Journal of Primatology* **Suppl 30**: 267 - 268.

Schoener, T. W. (1971). "Theory of Feeding Strategies". *Annual Review of Ecology and Systematics* **2**: 369 - 404.

Schroeder, L. D., D. L. Sjoquist, et al. (1986). *Understanding Regression Analysis: An Introductory Guide*. Thousand Oaks, CA, Sage Publications.

Sekhar, N. U. (1998). "Crop and Livestock Depredation Caused by Wild Animals in Protected Areas: The Case of Sariska Tiger Reserve, Rajasthan, India". *Environmental Conservation* **25**(2): 160 - 171.

Sender, J. and S. Smith (1990). *Poverty, Class and Gender in Rural Africa - a Tanzanian Case Study*. London, Routledge.

Siex, K. S. and T. T. Struhsaker (1998). "Ecology of Zanzibar Red Colobus Monkey: Demographic Variability and Habitat Stability". *International Journal of Primatology* **20**(2): 163 - 192.

Siex, K. S. and T. T. Struhsaker (1999a). "Colobus Monkeys and Coconuts: A Study of Perceived Human-Wildlife Conflicts". *Journal of Applied Ecology* **36**: 1009 - 1020.

Siex, K. S. and T. T. Struhsaker (1999b). "Ecology of Zanzibar Red Colobus Monkey: Demographic Variability and Habitat Stability". *International Journal of Primatology* **20**(2): 163 - 192.

Sillero-Zubiri, C. and D. Switter (2001). *Crop Raiding Primates in Tanzania: Searching for Alternative, Humane Ways to Resolve Conflict with Farmers*, People and Wildlife: Creating conservation solutions for living together. A Wildlife Conservation Research Unit. Born Free Foundation Partnership.

Singh, M. and S. Vinathe (1990). "Inter-Population Differences in the Time Budgets of Bonnet Monkeys (*Macaca Radiata*)". *Primates* **31**(4): 589 - 596.

Sitati, N. W., M. J. Walpole, et al. (2003). "Predicting Spatial Aspects of Human-Elephant Conflict". *Journal of Applied Ecology* **40**: 667 - 677.

Slater, K. (2002). Dominance Style, Grooming and Biological Markets in the Buton Macaque (*Macaca Ochreata Brunnescens*), thesis, University of Liverpool, Liverpool

Smith, R. J. and W. L. Jungers (1997). "Body Mass in Comparative Primatology". *Journal of Human Evolution* **32**(6): 523 - 559.

Smuts, B. B., D. L. Cheney, et al., Eds. (1987). *Primate Societies*. Chicago, University of Chicago Press.

SOCP (2002). *News from the Field*. Sumatran Orangutan Conservation Programme News. **2**.

Southwick, C. H., M. A. Beg, et al. (1965). Rheus Monkeys in North India In. *Primate Behaviour: Field Studies of Monkeys and Apes*. I. De Vore, Holt, Rinehart and Wilson**:** 111 - 159.

Southwick, C. H., M. A. Beg, et al. (1961a). "A Population Survey of Rhesus Monkeys in Northern India: Ii Transportation Routes and Forest Areas". *Ecology* **42**(4): 698 - 710.

Southwick, C. H., M. A. Beg, et al. (1961b). "A Population Survey of Rhesus Monkeys in Villages, Towns and Temples of Northern India". *Ecology* **42**(3): 538 - 547.

Southwick, C. H. and B. D. Blood (1979). "Conservation and Management of Wild Primate Populations". *Bioscience* **29**: 111 - 159.

Southwick, C. H. and D. G. Lindburg (1986). The Primates of India, Status, Trends and Conservation In. *Primates: The Road to Self-Sustaining Populations*. K. Benirschke. New York, Springer-verlag New York Incorporated**:** 171 - 187.

Southwick, C. H., I. Malik, et al. (1998). "Translocations of Rhesus Monkeys in India: Prospects and Outcomes". *American Journal of Primatology* **45**(209 - 210).

Southwick, C. H. and M. F. Siddiqi (1977). Population Dynamics of Rhesus Monkeys in Northern India In. *Primate Conservation*. Prince Rainier III and G. H. Bourne. New York, Academic Press**:** 339 - 362.

Southwick, C. H. and M. F. Siddiqi (1994). "Primate Commensalism: The Rhesus Monkey in India". *Revue D'Ecologie (Terre & Vie)* **49**(3): 223 - 232.

Southwick, C. H. and M. F. Siddiqi (1998). The Rhesus Monkey's Fall from Grace In. *The Primate Anthology: Essays on Primate Behaviour, Ecology and Conservation from Natural History*. R. L. Ciochon and R. A. Nisbett. New Jersey, Prentice Hall**:** 211 - 218.

Southwick, C. H., M. F. Siddiqi, et al. (1983). "Twenty-Year Changes in Rhesus Monkey Populations in Agricultural Areas of Northern India". *Ecology* **64**(3): 434 - 439.

Southwick, C. H. and M. R. Siddiqi (1967). "Population Trends of Rhesus Monkeys in Villages and Towns of Northern India,1959-65". *Journal of Animal Ecology* **37**: 199 - 204.

Sprague, D. (2002). Monkeys in the Backyard: Encroaching Wildlife and Rural Communities in Japan In. *Primates Face to Face: The Conservation Implications of Human-Nonhuman Primate Interconnections*. A. Fuentes and L. D. Wolfe. Cambridge, UK, Cambridge University Press**:** 254 - 272.

Struhsaker, T., T (1997). *Ecology of an African Rain Forest: Logging in Kibale and the Conflict between Conservation and Exploitation*. Gainesville, University Press of Florida.

Struhsaker, T., T (2002). *Guidelines for Biological Monitoring and Research in Africa's Rain Forest Protected Areas*. Durham, NC, Center for Applied Biodiveristy, Conservation International**:** 1 - 55.

Struhsaker, T. T. (1967). "Ecology of Vervet Monkeys (*Cercopithecus Aethiops*) in the Masai-Amboseli Game Reserve, Kenya". *Ecology* **48**(6): 891 - 904.

Struhsaker, T. T. (1981). Census Methods for Estimating Densities In. *Techniques for the Study of Primate Population Ecology*. S. o. C. o. N. Populations. Washington D.C., National Academy Press.

Struhsaker, T. T., P. J. Struhsaker, et al. (2005). "Conserving Africa's Rain Forests: Problems in Protected Areas and Possible Solutions". *Biological Conservation* **123**: 45 - 54.

Strum, S. C. (1986). A Role for Long-Term Primate Field Research in Source Countries In. *Primate Ecology and Conservation: Vol. 2 of Selected Proceedings of the Tenth Congress of the International Primatological Society*. J. G. Else and P. C. Lee. New York, Cambridge Univeristy Press. **2:** 215 - 220.

Strum, S. C. (1987a). *Almost Human: A Journey into the World of Baboons*. New York, Random House.

Strum, S. C. (1987b). *The Pumphouse Gang Moves to a Strange New Land*. National Geographic. **172:** 552 - 601.

Strum, S. C. (1994). "Prospects for Management of Primate Pests". *Revue D'Ecologie (Terre & Vie)* **49**(3): 295 - 306.

Strum, S. C. (1998). Moving the Pumphouse Gang, http://www.nationalwildlife.org/internationalwildlife/1998/baboon.html, (Accessed 2001)

Strum, S. C. (2005). "Measuring Success in Primate Translocation: A Baboon Case Study". *American Journal of Primatology* **65**(2): 117 - 140.

Strum, S. C. and C. H. Southwick (1986). Translocation of Primates In. *Primates: The Road to Self-Sustaining Populations*. K. Benirschke. New York, Springer-verlag New York Incorporated**:** 949 - 957.

Su, H. and L. Lee (2001). "Food Habits of Formosan Rock Macaques (*Macaca Cyclopis*) in Jentse,North-Eastern Taiwan, Assessed by Faecal Analysis and Behavioural Observation". *International Journal of Primatology* **22**: 359 - 377.

Sudman, S. and N. M. Bradman (1982). *Asking Questions: A Practical Guide to Questionnaire Design*. San Francisco; Oxford, Jossey-Bass.

Sugardijto, J., C. H. Southwick, et al. (1989). "Population Survey of Macaques in Northern Sulawesi". *American Journal of Primatology* **18**: 285 - 301.

Sukumar, R. (1989). *The Asian Elephant*. Cambridge, Cambridge University Press.

Sukumar, R. (1990). "Ecology of the Asian Elephant in Southern India. Ii. Feeding Habits and Crop-Raiding Patterns". *Journal of Tropical Ecology* **6**: 33 - 53.

Supriatna, J., I. Wijayanto, et al. (2002). The State of Siege for Sumatra's Forests and Protected Areas: Stakeholders View During Devolution, and Political Plus Economic Crises in Indonesia. IUCN/WCPA-EA-4 Taipei Conference, March 18 - 23, 2002, Taipei, Taiwan, Conservation International Indonesia.

Sutherland, W. J., Ed. (1996). *Ecological Census Techniques: A Handbook*. Cambridge, UK, Cambridge University Press.

Tappen, N. C. (1960). " Problems of Distribution and Adaptation of the African Monkeys". *Current Anthropology* **1**(2): 91 - 120.

Tattersall, I. (1998). "Lemurs of the Comoro Archipelago: Status of *Eulemur Mongoz* on Moheli and Anjouan, and of *Eulemur Fulvus* on Mayotte". *Lemur News* **3**: 15 - 17.

Tchamba, M. N. (1996). "History and Present Status of the Human/Elephant Conflict in the Waza-Logone Region, Cameroon, West Africa". *Biological Conservation* **75**: 35 - 41.

Teas, J., T. Ritchie, et al. (1980). Population Patterns and Behavioural Ecology of Rhesus Monkeys (*Macaca Mulatta*) in Nepal In. *The Macaques: Studies in Ecology, Behaviour and Evolution*. D. G. Lindburg. New York, Van Nostrand Reinhold Company**:** 384.

Terborgh, J. and C. H. Janson (1986). "The Socioecology of Primate Groups". *Annual Review of Ecology and Systematics* **15**: 111 - 136.

Thierry, B. (2000). Conflict Management Patterns across Macaque Species In. *Natural Conflict Resolution*. F. Aureli and F. B. M. De Waal**:** 106 - 128.

Thierry, B., J. R. Anderson, et al. (1994). "Tonkean Macaque Behaviour from the Perspective of the Evolution of Sulawesi Macaques". *Current Primatology* **2**: 103 - 117.

Thomas, L., J. L. Laake, et al. (1998). *Distance 3.5*. St. Andrews, UK, Research Unit for Wildlife Population Assessment, University of St Andrews, UK.

Tutin, C. E. G., R. M. Ham, et al. (1997). "The Primate Community of the Lope Reserve, Gabon: Diets, Responses to Fruit Scarcity, and Effects on Biomass". *American Journal of Primatology* **42**(1): 1 - 24.

Umapathy, G. and A. Kumar (2000). "Impacts of the Habitat Fragmentation on Time Budget and Feeding Ecology of Lion-Tailed Macaque (*Macaca Silenus*) in Rain Forest Fragments of Anamalai Hills, South India". *Primate Report* **58**: 67 - 82.

Vansina, J. (1990). *Paths in the Rainforests: Towards a History of Political Tradition in Equatorial Africa*. Madison, University of Wisconsin Press.

Vello, A. (1995). Primate Population and Conservation, PhD thesis, University of Cambridge,

Wakely and Mitchell (1981). "Blackbird Damage to Ripening Field Corn in Pennsylvania". *Wildlife Society Bulletin* **9**: 52 - 55.

Wang, S. and G. Quan (1986). Primate Status and Conservation in China In. *Primates: The Road to Self-Sustaining Populations*. K. Benirschke. New York, Springer-verlag New York Incorporated**:** 213 - 220.

Warren, Y. (2003). Olive Baboons (*Papio Cynocephalus Anubis*): Behaviour, Ecology and Human Conflict in Gashaka Gumti National Parl, Nigeria, PhD thesis, Roehampton University,

Warren, Y. and C. Ross (2004). "Baboon Crop Raiding: Pre-Adaptation and Success". *Folia Primatologica* **75**(suppl. 1): 425.

WDACP (2003). The Wildlife Damage Abatement and Claims Program (Wdacp), http://www.marinettecounty.com/lw_wdacp_home.htm, (Accessed 2003)

Wheatley, B. (1980). Feeding and Ranging of East Bornean *Macaca Fascicularis* In. *The Macaques: Studies in Ecology, Behaviour and Evolution*. D. G. Lindburg. New York, Van Nostrand Reinhold Company**:** 215 - 246.

Wheatley, B. and D. K. Harya Putra (1994). "The Effects of Tourism on Conservation at the Monkey Forest in Ubud, Bali". *Revue D'Ecologie (Terre & Vie)* **49**(3): 245 - 258.

White, C. M. N. and M. D. Bruce (1986). *A Guide to the Birds of Wallacea: Sulawesi, the Moluccas and Lesser Sunda Islands*, British Ornithologists Union.

Whitesides, G. H., J. F. Oates, et al. (1988). "Estimating Primate Densities from Transects in a West African Rain Forest: A Comparison of Techniques". *Journal of Animal Ecology* **57**(2): 345 - 367.

Whitten, A. J., M. Mustafa, et al. (1988). *The Ecology of Sulawesi*. Indonesia, Gadjah Mada University Press.

Williams, S. (2004). Population Ecology and Conservation of the Buton Macaque (Macaca Ochreata Brunnescens) on Buton Island, Southeast Sulawesi, Indonesia, Msc Thesis thesis, Manchester,

Woodman, J. (2004). Between Bureaucrats and Beneficiaries: The Implementation of Ecodevelopment in Pench Tiger Reserves, India, PhD thesis, University of Cambridge, Cambridge

Wrangham, R. W. (1980). "An Ecological Model of Female-Bonded Primate Groups". *Behaviour* **75**: 262 - 300.

Wright, J. (2005). The Primate Pet Trade in Indonesia: A Rural Perspective, Bsc thesis, University of Manchester, Manchester

Wuelker, G. (1983). Questionnaires in Asia In. *Social Research in Developing Countries: Surveys and Censuses in the Third World*. M. Bulmer and D. P. Warwick. Chichester, John Wiley and Sons Limited**:** 161-172.

Yanuar, A., D. Bekti, et al. (1993). "The Status of the Karimata Primates *Presbytis Rubicunda Carimatae* and *Macaca Fascicularis Carimatensis* in Karimata Island, Indonesia". *Tropical Biodiversity* **1**(3): 157 - 162.

Yeager, C. P. (1996). "Feeding Ecology of the Long-Tailed Macaque (*Macaca Fascicularis*) in Kalimantan Tengah, Indonesia". *International Journal of Primatology* **17**: 51 - 62.

Yongzu, Z., G. Quan, et al. (1989). "Extinction of Rhesus Monkeys (*Macaca Mulatta*) in Xinglung, North China". *International Journal of Primatology* **10**(4): 375 - 381.