Behavioural Health of Reintroduced Orangutans (*Pongo abelii*) in Bukit Lawang, Sumatra Indonesia

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Abstract

It is well recognized that post-release monitoring is lacking in many reintroduction programs. The goal of this study was thus to assess the behavioural health of a semi-wild population of orangutans reintroduced at Bukit Lawang, North Sumatra, Indonesia. The area also hosts a wildlife tourism operation centered on orangutan viewing, which is part of the reason the reintroduction program at Bukit Lawang was terminated.

Though the effects of poorly managed reintroduction programs and/or unregulated tourism are somewhat predictable (higher rates of disease and mortality through increased contact with humans, inadequate foraging skills through a higher dependence on provisioning, etc.), they have seemingly yet been quantified and studied in detail. Therefore continuous focal sampling was conducted on fourteen of the orangutans in the area, noting any behaviours engaged in and chronicling any effects of the tourism industry on the population. In addition a Kernel Density Estimation was performed utilizing GPS points collected throughout the study so as to determine patterns of range use to assess potential effects due to provisioning.

Results showed the behavioural patterns of the orangutans were being significantly altered by the tourism operation in place. They were not only foraging less on days when tourists were present but were also restricting their range use to areas of high tourism use. There is also a serious risk of disease transmission between the apes and humans who come into close proximity with them. A high infant mortality rate was observed, and behavioral abnormalities were observed, such as two independent cases of mother-infant cannibalism. It is possible that the close unregulated contact between the orangutans and humans is potentially resulting in disease transmission.

The study concludes that a serious restructuring of the tourism operation is needed to better manage and protect this critically endangered species.

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List of abbreviations

GLNP	Gunung Leuser National Park
GIS	Geographic Information System
GPS	Global Positioning System
IUCN	World Conservation Union
KDE	Kernel Density Estimation
UD	Utilization distribution
WTO	World Tourism Organisation
WWF	World Wildlife Fund

Chapter 1: Introduction

1.1 Justification

Sumatran orangutans (*Pongo abelii*) are a critically endangered species (IUCN, 2006). With decreasing forest cover in Indonesia, it is vital to maintain as many free ranging populations of orangutans in the wild as possible. Unfortunately for conservation it may be best to plan for the worst, as the 'natural world' is shrinking by the day. In-situ reintroduction programs, wherein orangutans are confiscated from the pet trade are rehabilitated and then re-released into protected forests, can be posited as a means to bolster the population of animals living in the wild. It is thus vital that as much information is gathered regarding the maintenance of these populations, so that measures can be taken to ensure the continued existence of the species.

As the last remaining great forest tracts are exhausted, the priority effort (Mackinnon and Mackinnon, 1991; Yeager, 1997; Rosen *et al.*, 2001) to preserve large undisturbed wild populations of orangutans may come to an end, leaving only managed populations to survive in fragments and reserves (Russon, 2002; Cheyne, 2006; UNEP, 2007). This new approach will require a smaller area of conservation focus and therefore a greater emphasis on individual behaviour and fitness (Anthony and Blumstein, 2000). The action plan proposed by the World Wildlife Fund (WWF) aims to conserve orangutans by scaling up from a selection of small projects to create orangutan 'landscapes' which link together to form larger meta-populations (WWF, 2005). Reintroduced populations could thus be put forward as the basis for forming these landscapes and in the process result in more protected forests and better chances for survival of the species (Mackinnon and Mackinnon, 1991).

1.2 Species introduction

1.2.1 Orangutan sociality

Wild populations consist of solitary adult males, lone adult females usually accompanied by one or two dependent offspring, and independent subadults and adolescents (Rodman, 1988). There is a marked level of aggression between fully

adult males, with adult males exhibiting a level of tolerance for subadult males (Utami *et al.*, 1997). The main ecological factor resulting in orangutans' semisociality is food abundance; animals that are better fed have more time and energy for sociality (van Schaik, 2001). Females tend to stay near the range they were born, whereas males disperse and form a home range two to three times the size of females (McConkey, 2005). Sociality in orangutans can perhaps best be described as "neighborhoods, where residents know many others, but know them less well as the home range overlap decreases" (van Schaik, 2001, p.30).

1.2.2 Orangutan life history

Female orangutans have the longest interbirth interval of any primate, with a mean duration of eight years (Galdikas and Wood, 1990). The mother-infant bond is very strong in orangutans, with offspring remaining dependent for up to six years (Rodman, 1988). Both species of orangutans are reported to survive up to forty-five years of age (and potentially past fifty) (Leighton *et al.*, 1995; Singleton, 2004, cited in McConkey, 2005), with females not giving birth until approximately fifteen years of age (Galdikas, 1981). This equates to four to five surviving offspring per mother – perhaps the lowest reproductive potential of any mammal (van Schaik, 2001).

1.2.3 Sumatran orangutan distribution

Orangutans are restricted to the southeast Asian islands of Borneo (which is split between the Indonesian territory of Kalimantan and the Malayan territory of Sabah) and Sumatra, with over ninety per cent living in the territory of Indonesia, the world's fourth most populous nation (Rijksen and Meijaard 1999). The Sumatran orangutan is now recognized as a separate species from the Bornean orangutan (*P. pygmaeus*) (Zhang *et al.*, 2001).



Fig. 1.1 Extent of Pongo abelii occurrence (IEA, 2006)

Sumatran orangutans are restricted to 11–13 isolated units (Fig. 1.1), approximating 20,552 km² of forest, mostly to the north end of the island, with the most viable populations being in the Leuser Ecosystem (which covers 25,000 km² of land and includes contains Gunung Leuser National Park), as well as the coastal swamps and lowland parts of the Alas Valley (van Schaik *et al.*, 2001; Singleton *et al.*, 2004; IUCN, 2007). These ecosystems allow for orangutan densities of 3 to 6 individuals per square kilometer to occur with home ranges 5 to 25km² or larger for males and 1 to 10 km² for females (Rijksen and Meijaard, 1999).

1.3 Orangutan conservation

1.3.1 Current situation

With exponentially increasing habitat degradation, fragmentation, and transformation, orangutans are facing a number of threats (Kinnaird and O'brien, 1998; van Schaik *et al.*, 2001; Meijaard *et al.*, 2005; UNEP, 2007; Yuwono *et al.*,

2007). The timber industry and palm oil plantation development are the main driving forces behind the destruction of the forests. Between 1950-2000, 40% of Indonesia's forests were cleared, reducing ground cover from roughly 162 million hectares to 98 million (FWI/GFW, 2002). Although orangutans exhibit high behavioural and dietary flexibility that allows them to persist in secondary logged forest (Lackman-Ancrenaz et al., 2001), densities do decline following logging, particularly in the long term (reviewed in Rijksen and Meijaard, 1999; Meijaard et al., 2005). All current wild populations have already been deemed to be at their carrying capacity (Singleton and Aprianto, 2001). The Sumatran orangutan population has decreased by 86% over the past 100 years (van Schaik et al., 2001). The most recent estimate places the figure around 7,300 left in the wild, with steady losses occurring every year (van Schaik et al., 2001; UNEP, 2007). Thus the Sumatran orangutan is now classified as critically endangered (Cr A2bcd) and is also listed as one of the twenty-five most endangered primates in the world (IUCN, 2006). The Bornean orangutan, with a greater remaining habitat range, is at less risk of immediate extinction and classified as Endangered (EN A2cd) (IUCN, 2006).

1.3.2 Habitat loss

Forest cover in Sumatra alone was reduced by 61% from 1985-1997 due to logging, infrastructure development, internal migration, and plantation development (McConkey, 2005). Although the Leuser ecosystem is an officially recognized conservation area, it consists of almost entirely government forest land, approximately one third of which can be legally logged or transformed for agricultural use (van Schaik *et al.*, 2001). In addition, orangutan habitat is being illegally destroyed due to weak compliance with government regulations, weak law enforcement for catching perpetrators, and an inadequate legal environment for dealing with those people apprehended (van Schaik *et al.*, 2001).

1.3.3 Orangutans as flagship species

The orangutan has extraordinary potential for conservation through its ability to capture the attention of the general public. Whereas people may not lend much attention to conservation rhetoric, many would readily acknowledge that protecting the orangutan and its environment is an important task. Orangutans may thus be presented as flagship ambassadors as they are highly charismatic mega fauna

which can draw a great deal of attention to the rainforests of Indonesia and Malaysia. Orangutans can serve as a particularly strong flagship as they are also an umbrella species. An umbrella species is one whose home range and habitat requirements are large enough that when it becomes the focus of protective management, the entire structure of the original biological diversity of its range is automatically protected (Stork, 1995). The orangutan, with its predominantly arboreal existence and generalized frugivory, equate to no other species being able to match it in functional representation of the rainforest (Rijksen and Meijaard, 1999). If there is an orangutan population at regular density, the area is likely to host at least five other primates species, at least five hornbill species (Family Bucerotidae), at least 50 different fruit tree species, and 15 different lianas (Rijksen and Meijaard, 1999).

That the orangutan serves as both a flagship and an umbrella species can greatly help the conservation cause. Conservation projects linked with flagship species have a higher rate of success than those without (Kruger, 2005)

1.4 Reintroduction

Due to such levels of habitat transformation, an increasing number of orangutans are being displaced from the forest (Eudey, 1995; Rijksen, 1995; Wolfe and Fuentes, 2007). With the opening up of the forest, orangutans are often captured and sold into the pet trade. However it is illegal in Indonesia (Undang-Undang No 5 Tahun 1990) to obtain and keep orangutans (WWF, 2005), so upon discovery they are confiscated by the authorities and taken into reintroduction programs.

Rehabilitation and reintroduction (henceforth referred to as 'reintroduction') of orangutans began in the 1960s when it was thought that the orangutan was nearly extinct in the wild, with an estimated number of 5,000 (Harrison, 1962, cited in Singleton and Aprianto, 2001). It was intended for the purposes of fighting the illegal pet trade as well as to reinforce the free ranging populations living in the wild (Rijksen and Meijaard, 1999).

Reintroduction, as defined by the latest IUCN guidelines for nonhuman primates, is the "re-introduction of a primate taxon into an area from which it has been extirpated or become extinct" (Baker, 2002, p.7). In-situ reintroduction (as opposed to ex-situ reintroduction which is based on captive-bred individuals) involves animals confiscated from the pet trade, who upon maturation are returned to their natural environments to become free living animals.

There are multiple definitions for what constitutes 'success' in reintroduction projects (Bennett, 1992; Rosen *et al.*, 2001; Kleiman and Rylands, 2002; Goossens *et al.*, 2005; Cheyne, 2006; Farmer *et al.*, 2006; Grundmann, 2006). The latest IUCN guidelines for primate reintroductions do not state a definitive standard for success and instead defer to criteria set by each individual project's experts (Baker, 2002). There are many factors with serious implications for reintroduction programs, including disease risk, genetic matters, habitat viability, carrying capacity, behaviour, and the political climate of the area (Kleiman, 1990; Foose, 1991; May, 1991; Cunningham, 1996; Grundmann *et al.*, 2001; Custance *et al.*, 2002; Russon, 2002).

A large part depends on the suitability of the release site and the ability of the animals to establish a viable breeding population (May, 1991; Woodford and Rossiter, 1994; Cheyne, 2006). Individuals must undergo a complete cognitive restructuring and lose any learned dependence on humans to be able to return to natural life in the forest (Russon, 2002; Grundmann, 2006). Such dependence is fostered through maintaining contact with humans (Russon, 2001), a factor that has resulted in most orangutan reintroduction programs banning tourism ventures access to the ex-captives (Rijksen and Meijaard, 1999).

1.5 Tourism

Growing concern for conservation has resulted in a closer relationship between the environment and tourism, resulting in nature tourism becoming increasingly popular (Russell, 1995; Reynolds and Braithwaite, 2001; Orams, 2002). The annual worldwide value of ecotourism has become a major source of income in many countries (WTO, 1998; Reynolds and Braithwaite, 2001).

Ecotourism, although coined in 1972, lacks an agreed definition (Kruger, 2005), but for this project will be defined as: "responsible travel to natural areas which conserves the environment and improves the welfare of local people" (Cochrane, 1996, p.241, cited in Chin et al., 2000). A related concept, sustainable tourism, has been defined by the WTO (World Tourism Organisation) as a form of economic development designed to improve the quality of life in the host community, provide a high quality of experience for the visitors, and maintain the quality of the environment on which both the host community and the visitor depend (WTO, 1995).

Ecotourism has been recognized as being a potential savior for wildlife, as it can be a potentially viable industry that does not depend on physical resource extraction (Orams, 2002; Christ *et al.*, 2003). It may also result in an enhanced appreciation of wildlife and 'wild' (undeveloped by humans) environments, education, and work opportunities for the local people (Mackinnon and Mackinnon, 1991; Chin *et al.*, 2000; De La Torre *et al.*, 2000; Hill, 2002). Increasing conservation awareness can also serve as a major tool to generating momentum that can then convince government officials to take action (van Schaik *et al.*, 2001). Perhaps most importantly it can work to help change the attitudes of the local communities to better appreciate and value their environment and thus have them working to conserve their own land (Kruger, 2005)

It should not be confused with wildlife tourism, which is based solely on interactions with wildlife (e.g. viewing/photographing, direct contact, feeding) (Reynolds and Braithwaite, 2001). It differs in the sense that the interaction with wildlife is the primary focus and does not necessarily carry any sense of responsibility to the environment or local community in which the wildlife lives (Brandon and Margoluis, 1996, cited in Grossberg et al., 2003; Ceballos-Lascurain, 1996). Unfortunately, the vagueness of the concepts of sustainability and ecotourism has led to their widespread application by industry stakeholders, as a venture can be advertised as such without any need to apply the associated baseline concepts (Ross and Wall, 1999; Cohen, 2002).

Such tourism is widely recognized as potentially damaging if managed improperly (Christ *et al.*, 2003) and some have argued there is little evidence that wildlife tourism results in actual benefits for the wildlife (Mackinnon and Mackinnon, 1991; Tremblay, 2001). Negative impacts can include destruction of habitats, alteration of behaviours/activity budgets, altered patterns of habitat usage, disease transmission,

and increased chances of poaching through over-habituation (Chin *et al.*, 2000; Orams, 2002; Woodford *et al.*, 2002; Grossberg *et al.*, 2003).

1.6 Study Aims

Unfortunately, although the IUCN lists long term post-release monitoring as one of the most important facets of a reintroduction program (Baker, 2002), many primate release sites are reported to have poor monitoring records (Aveling and Mitchell, 1982; Woodford and Rossiter, 1994; Cunningham, 1996; Sarrazin and Barbault, 1996; Yeager, 1997; Cowlishaw and Dunbar, 2000; Kleiman *et al.*, 2000; Breitenmoser *et al.*, 2001; Goossens *et al.*, 2002). Therefore there is very little information published which equates to no readily available sources from which to learn from past successes and failures.

It is therefore imperative that reintroduction programs be better studied so as to help improve the process. There is an enormous amount of data available for specific reintroduction criteria (Kleiman, 1990; Kleiman *et al.*, 1994; Sarrazin and Barbault, 1996; Rosen *et al.*, 2001; Baker, 2002); the apparent problem thus being that few of these guidelines are being followed by many field programs. Clearly, these measures for increased success in reintroduction will only work if they are indeed carried out.

In addition, although current guidelines call for there to be only a few remnant or no existing wild population in the reintroduction site so as to avoid the risk of disease spread, social disruption, and introduction of alien genes (Kleiman, 1989; Mackinnon and Mackinnon, 1991; Smits *et al.*, 1995; Rosen *et al.*, 2001; Baker, 2002); in Bukit Lawang there is such a population within the area and this study has confirmed there is contact between the semi-wild and wild populations. Therefore, it is prudent that inquiries such as this project be made to help ensure that wild populations are as unaffected as possible, as well as to better prepare for what may come in the future of orangutan conservation.

This study thus serves to assess the behavioural health status of the reintroduced population at Bukit Lawang. The population is also made use of by a large part of the local tourism industry. With tourism's effect on wildlife recognized as being

understudied (Berman and Li, 2002; Grossberg *et al.*, 2003; Kruger, 2005), the effects of tourist presence on the population was also gauged and became inseparable from the initial aim of determining the behavioural health of the orangutans.

Chapter 2: Materials and Methods

2.1 Study site

2.1.1 Location

Field studies took place within Gunung Leuser National Park (GLNP) near Bukit Lawang, North Sumatra, Indonesia (Fig. 2.1). The two km² study area (03°32.770'N, 098°07.000'E), as designated by the trail system in place, comprised mixed, lowland, dipterocarp forest. GLNP is within the Leuser Ecosystem, which is considered the last place where potentially viable populations of the Sumatran orangutan, elephant (*Elephas maximus*), tiger (*Panthera tigris*), and rhinoceros (*Dicerorhinus sumatrensis*) exist, and the only place where they are all found together (McConkey, 2005). Other commonly sighted primate species are gibbons and siamangs (Family *Hylobatidae*), Thomas leaf monkeys (*Presbytis thomasi*) long tailed macaques (*Macaca fascicularis*), and pig tailed macaques (*M. nemestrina*). In addition there are greater slow lorises (*Nycticebus coucang*) and Malayan sunbears (*Helarctos malayanus*) in the area.



Fig. 2.1 Study site location

2.1.2 Bukit Lawang reintroduction program

The area hosted an orangutan reintroduction project (also referred to as the Bohorok Centre) from 1972-1991, with the issue to terminate the program being issued on 23 April 1991 (Rijksen and Meijaard, 1999).

Official figures dated up to April 2007 list 229 individuals as originally having been in the program (not including their offspring), with 51 confirmed as having died in the reintroduction process. Although no longer an official reintroduction project, a number of orangutans and their surviving progeny still remain in the area. There are two official scheduled supplementary feedings held per day for the population, consisting only of bananas and milk. Feedings are held on a raised wooden platform where national park rangers distribute the provisions (by hand) to each orangutan that chooses to attend.

2.1.3 Bukit Lawang tourism

Throughout the time the reintroduction project was running, Bukit Lawang was also host to a wildlife tourism industry centered on the orangutans. This took the form of passive viewing as well as direct interaction, which is part of the reason the project was terminated. Although no longer a center for reintroduction, the area still hosts an orangutan tourism industry based on the remaining population.

Official figures acquired from the Indonesian forestry department relate 206,963 foreign tourists from 1985-2003, with a mean of 10,893 per year; domestic numbers from 1990-2003 show 81,202 tourists, with a mean of 5,800 per year (Fig. 2.2). Thus the total amount of visitors to the area in 18 years is 288,165. This does not include any unregistered visitors, of which there may have been more than double the official figures (Rijksen and Meijaard, 1999).



Fig. 2.2 Official tourist numbers for Bukit Lawang, Sumatra Indonesia (1985-2003)

The tourism industry reached a low point in 2003, with numbers only now just starting to increase (official figures unavailable). The tsunami of 2004 did not directly affect the area, though it could be argued that along with the political climate (e.g.

Bali bombing of 2002, previous armed conflict in Aceh, commonly acknowledged levels of corruption) (van Schaik *et al.*, 2001; Christ *et al.*, 2003) and the occurrence of natural disasters in Indonesia (the Bohorok River which runs through Bukit Lawang flash flooded in 2003, killing approximately 300 people), a considerable drop in the numbers of tourists visiting the area has resulted.

Although it is forbidden to touch, feed, or disturb the orangutans, such practices have (Singleton and Aprianto, 2001) and still do occur in the forest for the enjoyment of the tourists. Many of the tourism operators bring rucksacks full of fruit into the forest that either they or the tourists then give to the orangutans.

2.2 Focal animals

The forest hosts both a wild and an ex-captive semi-wild population, with the current study concentrating on the latter and their offspring. Of the original reintroduced population, there are nine free-ranging individuals still regularly in and around the study area, from which there are three independent adolescent offspring in the region. The focal population consisted of individually recognizable (by physical characteristics) orangutans. Data were collected from fourteen habituated individuals: eight semi-wild adult females (two with offspring), one wild adult female with offspring, three semi-wild adolescent females, one semi-wild juvenile male and one wild juvenile male (Table 2.1).

Orangutan	Offenring	Sox/A go	Noturo
Orangutan	Unspring	Sex/Age	Nature
Borjong		♀Adult + Infant	Semi-wild
Edita		♀ Adult	Semi-wild
\rightarrow	Sepi	♀ Adolescent	Born to semi-wild
Jecky		♀ Adult	Semi-wild
Lucky		<pre> ♀Adult + Infant </pre>	Wild
\rightarrow	Damar	් Juvenile	Born to wild
Mina		♀ Adult	Semi-wild
\rightarrow	Juni	♀ Adolescent	Born to semi-wild
Pesek		↓ Adult+ Infant	Semi-wild
\rightarrow	April	♀ Adolescent	Born to semi-wild
Radaria		් Juvenile	Son of Cepi - deceased
Ratna		♀ Adult	Semi-wild
Sandra		♀ Adult	Semi-wild
Suma		♀ Adult	Semi-wild

Table 2.1 Focal population

Interestingly there remains only one semi-wild subadult male within the area, Abdul, who was only briefly seen during the beginning of the study and only again returned in August. The wild population of subadult males (three were encountered in the study area) was not included in the study. Ucok, the resident adult wild male, did come into close proximity with humans to be fed, but due to his propensity for aggression unless fed, he was not considered a focal animal. However, the wild mother with infant (Lucky) and her son (Damar), were included as they have become habituated and descend to be fed by humans.

2.3 Methods

2.3.1 Behavioural observations

The data reported are based on 796 hours of observations collected from 22 May 2007 to 31 July 2007. Focal animal sampling with continuous recording (Altmann, 1974; Martin and Bateson, 1993) was conducted on individual orangutans from dawn to dusk. Continuous recording was preferred over instantaneous sampling as this research was focused on not only the occurrence of certain behaviours but also the length of time engaged in such behaviours. Also with instantaneous sampling, novel behaviours would have been missed if they did not occur at the exact recording point.

Focal animals were chosen at random – the first encountered became the focal animal (initially – as the number of observation hours per individual increased, less observed individuals were sought out). Observations then took place until they entered a nest at night and began the following morning from the same nest, and again continued until entering a new night nest. Once a follow was initiated it was continued for three to five consecutive days. Observations consisted of recording an individual's activities (feeding, resting, traveling, sociality, playing, nest building, mating) throughout the entire day (see Appendices A and B for definitions of behaviour and sample data sheet). Any rare behaviour that occurred which was not included in the behavioural categories (such as cannibalism) was noted in the comments section of the data sheet. The slow and deliberate movements of orangutans facilitates continuous focal sampling of their behavior (Mitani, 1990). All

behaviours were registered after having engaged in the activity for at least fifteen seconds (except for sociality, time on the ground, and feeding, which were noted regardless of duration).

2.3.2 Observations on tourism practices

In addition, the impact of tourism on the behaviour of the orangutans was recorded. This was done through noting the various behaviours elicited through humans beings present in the forest (see Appendix B for list of behaviours). In addition, behaviours such as orangutans accosting humans in the forest, in attempts to secure food, were noted as events occurring in the day.

Data were also taken on the number of tourists encountered per day along with the number of different groups whilst following an individual orangutan. Data reported are non-inclusive of tourist guides who accompany each tourist group, of which the number ranges from one to ten people per group. Many of these guides made a type of whooping call that served to lure the orangutans. These calls were made from the main trail system and often succeeded in bringing the orangutans to the trails/tourists as oftentimes food provisioning accompanied a tourist encounter. Calls could be heard most days from up to approximately 300m and were recorded by the observer whilst following, as it was assumed if audible to a human, it was also likely to be to the orangutan.

2.3.3 Habitat use

The usage an animal makes of its environment, the variety of habitats it occupies and for how long are important variables determinant to its ecology (Johnson, 1980). Animal movements are therein often defined using the home range concept (reviewed in Börger *et al.*, 2006). There are various definitions as to what constitutes home range (Burt, 1943; Ostro *et al.*, 1999; Singleton and van Schaik, 2001). For this study, within the UD framework, home range was defined as "the smallest area of the utilisation distribution that accounts for a certain percentage of the animal's total space use" (E.P. Willems, pers. comm.). Daily routes taken by focal individuals were plotted by taking a Global Positioning System (GPS) data point with a handheld receiver every thirty minutes from each focal animal during each follow. The data represented are from 742 GPS points taken over the course of the study. Certain known locations (feeding platform, the area referred to as 'Damar tree', etc.) were recorded with previously collected points, rather than waiting to acquire a new accurate signal each time in the area. Estimates of height and distance (in meters) traveled were also recorded in a continuous fashion.

2.4 Analyses

2.4.1 Behavioural data

Mean rates per day were calculated for each study animal for all categories of behaviour to construct time budgets. Data were statistically analyzed with SPSS[©] software (version 13.0). Non-parametric statistics were utilized as the data were non-normally distributed. The Wilcoxon Signed Ranks test was used to determine whether there were significant differences in activity when tourists were present versus absent. The effect of provisioning to foraging was also assessed with this test. In addition the effect of tourists on the above main behavioural categories was assessed by comparing their rates during times with and without tourists present. All tests were two-tailed, with the significance level set at p < 0.05. Rates are reported as: mean rate ± standard deviation.

2.4.2 Habitat use

GPS positions were analyzed using the Kernel Density Estimation (KDE) tool in ArcGIS ArcMap[©] software to determine areas of high use/concentration in the forest. This was done individually per animal as well as all compiled into one cumulative analysis, so as to establish overlap in distribution. This information was then overlaid onto a trail map created by the author (by walking the trail system and recording its position with a GPS unit) so as to note any correlations in use. Mean height utilized per day by each individual was converted and calculated from continuous sampling data with the following spreadsheet formula: '=SUMPRODUCT

(Height of 0 meters:Height of 35 meters, Time at 0 meters:Time at 35 meters) / SUM (Time at 0 meters:Time at 35 meters)'. This formula weights the time spent at each height to its appropriate value and then calculates an average daily height utilized.

2.4.2.1 Kernel Density Estimation review

KDE is a nonparametric, probabilistic method that calculates home range boundaries based on utilization distribution (UD) data (Silverman, 1986; Worton, 1989). UD, the relative amount of time an individual spends in any one place, thus provides a model for intensity and overlap of range use (Seaman and Powell, 1996). KDE works by computing a kernel (probability density) landscape from a set of Cartesian points (in this case GPS points collected every thirty minutes from each individual) (Worton, 1989; Seaman and Powell, 1996). KDE was preferred to other range size estimates (Singleton and van Schaik, 2001; Ganas and Robbins, 2005; Börger *et al.*, 2006) as it produces a density estimate without the influence of grid size and placement and because it is a nonparametric analysis, it is free from parametric assumptions and thus can estimate densities of any shape (Silverman, 1986; Worton, 1989; Seaman and Powell, 1996; Hansteen *et al.*, 1997; Ostro *et al.*, 1999). The density given is thus an estimate of the amount of time spent spatially, in this case as the amount of thirty minute GPS points recorded in each location.

Chapter 3: Results and Discussion

3.1 Follow totals

Eighty-eight days of following were included in the study (Table 3.1). Radaria was only followed for one day to determine whether or not he entered the forest at all, which he did not. He was wild-born to a semi-wild orangutan named Cepi who died in 2005. He was five years old and spent most of the day in the reintroduction project's old quarantine cage area, and was yet heavily dependent on food provisioning by the national park rangers each day. Thus he was excluded from the analyses.

	May	June	July	Total
April	3	5	4	12
Borjong		3		3
Damar			5	5
Edita	5	3	3	11
Jecky			4	4
Juni	2	1		3
Lucky			2	2
Mina	2		5	7
Pesek			7	7
Radaria		1		1
Ratna		5	1	6
Sandra		4	3	7
Sepi	5	2	1	8
Suma	5	7		12

 Table 3.1 Follow totals (in days)

3.2 The current situation at Bukit Lawang

3.2.1 Habitat use

Although no physical barriers were in place, there was a sort of range restriction in effect, as the cumulative range use of the population heavily coincides with areas of heavy tourist use as indicated by kernel density analyses (Fig. 3.1). The orangutans were consistently lured to the trails by the prospect of being provisioned by the tour operators. A total of 2,237 lure calls from the trail system were recorded throughout the study, with an overall mean 72 \pm 79 per day, and the maximum number heard in

one day was 324 calls. The two areas of highest usage intensity, the feeding platform and the area referred to as 'Damar tree', were areas where tourist groups often congregated. Studies have shown that orangutans remember where they acquire particular food items (Scheumann and Call, 2006), thus the population may be remaining near and returning to these areas to acquire these valued provisions. Although cumulatively the orangutans had a mean time of $0.18 \pm .09$ traveling, and a mean distance traveled of 594 ± 351 m (individual rates given in Fig. 3.2), the population is essentially not locomoting anywhere. These distances covered were only within the confines of the GPS points shown in Fig. 3.1; and with the furthest GPS point recorded for the length of the study only approximately .5 km from the nearest trail, a level of dependence on remaining near these trails where they are often provisioned is implied.



Fig. 3.1 Kernel Density Estimation overlaid onto study site trail map (Inlay shows a three-dimensional projection of KDE analysis)





Range restriction, as related specifically to provisioning, has been linked to increased intraspecific aggression (Berman *et al.*, 2007). Provisioned foods represent a much higher spatially concentrated resource than those found naturally in the forest and are available only at certain times, which can lead to increased proximity and aggressive competition for these limited high value resources (Hill, 1999). Such aggression was observed in the population in the form of higher ranking individuals chasing away conspecifics when being fed by guides and their tourists in the forest. Mina and Lucky have also been observed chasing away and/or biting their own dependent offspring on four occasions. These behaviours have never been recorded during this study with naturally occurring foods in the forest, nor at the feeding platform, where provisioning is more controlled and distributed evenly amongst those that arrive. Such behaviour only occurred during unscheduled provisioning events where the resources were limited and unevenly distributed.

The official feeding program is held every day at a set time and location and is meant only to supplement a natural forest diet (Lardeux-Gilloux, 1995; Yeager, 1997). It serves to ensure the semi-wild population's survival and its

continued existence is justified (Orams, 2002). Were this the only provisioning, there would be little incentive for the orangutans to remain near the trails and in proximity to humans. Yet to continue having the illegal, unscheduled feedings throughout the day only makes certain that the orangutans will never fully return to an independent life in the forest. As it stands, the population has too much to gain energetically through descending to tour operators to be fed, as the foods distributed (bananas, pineapples, and other local fruits) are highly caloric and easily obtained. In addition, diets high in fruit content have been linked to diabetes in captive orangutans, which is a further potential complication (Dierenfeld, 1997).

3.2.2 Provisioning

The use of food to attract wildlife is attractive in tourism as it increases the likelihood of encounters (Orams, 2002). This is particularly important in Bukit Lawang where almost all of the tourism is built on orangutans, so that without reliable sighting of the animals their business may be compromised. However, the impacts of such behaviours must be taken into account.



Fig. 3.3 Borjong being lured down from 'Damar tree'

With orangutans being the most arboreal of the apes, the ability to function optimally in a three-dimensional environment has been defined as a crucial point of re-adaptation to forest life, allowing for the individual to locate a variety of food sources and protection from predators (Russon, 2002; Grundmann, 2006). The population is using arboreal pathways, with the mean cumulative height utilized as 10.2 ± 3.87 m, with individual rates given in Fig. 3.4. However, by being consistently lured down from the trees with the promise of feeding (Fig. 3.3), these individuals are losing any vestiges of independence.



Fig. 3.4 Mean daily height utilized per individual

Food availability is the single most important factor in determining activity budgets (reviewed in Orams, 2002). The population at Bukit Lawang exhibited a cumulative mean daily rate of $0.32 \pm .16$ time spent foraging, with the mean rate of provisioning $0.03 \pm .04$ per day. By comparing individual mean daily rates (N=13) of foraging to associated rates of provisioning, it was shown that feeding via provisioning is significantly higher than feeding via foraging (Wilcoxon Signed Ranks test: Z = -3.183 = .001). Therefore this provisioning appears to be having a negative impact on natural feeding patterns.

The population has become so accustomed to provisioning that remaining motionless and watching humans in the forest, seemingly waiting to be fed, has absorbed much of their daily activity budgets (an overall mean daily rate of $.04 \pm .05$). Figure 3.5 shows a cumulative breakdown of behaviours engaged in when tourists are present (individual mean rates per day are listed in Appendix D) with this watching behaviour consuming more time than actually being fed. This time spent monitoring humans, in this case not in terms of vigilance but rather in seemingly waiting for provisioning, conflicts with time that could be instead used foraging naturally in the forest (Treves, 2000).



Fig. 3.5 Proportion of behaviours performed whilst tourists are present

Foraging is often determined by learned behaviours, such as where to go and what to eat, so that when an animal exhibits these behaviours less frequently, they become less efficient at them (Orams, 2002). Consequently the next generation of orangutans born to these semi-wild mothers is also affected. Two of the individuals with high rates of time logged in human activities are related: Pesek has been reported to regularly cross the river that borders the

national park and enter a nearby restaurant to be fed by the staff for the enjoyment of any patrons. April is Pesek's first offspring, and although she was an independent adolescent at the time of the study, it is not surprising that she also devoted much time to human related activities. Pesek also currently has a one year old infant, so that if this baby survives, it follows that he may adopt his mother's practices. Thus the provisioning may result in a self-propagating cycle of dependence in the orangutans.

3.2.3 Tourist presence

A total of 1,131 tourists were recorded, with an average mean per day of 31 ± 20 , with the maximum number encountered in one day being 84 tourists. The mean number of groups seen per day was 6 ± 3 , with the maximum in one day being 16. Average group size was 5 ± 2 , with the maximum observed consisting of 31 tourists (Fig. 3.6).



Fig. 3.6 An example of a tourist group in the forest (Damar is in the top right hand corner)

Figure 3.7 shows $.09 \pm .09$ of the cumulative activity budget was spent on human related activity (for individual percentages from each orangutan, see Appendix C), with individual rates of human related activity listed in Fig 3.8.

The most marked rates are from Mina, Pesek, and Damar, with nearly thirty per cent of a day spent with humans.



Fig. 3.7 Cumulative mean daily activity budget from all orangutans



Fig. 3.8 Mean daily rate of time spent with humans

A major type of unsustainability is recognized in those tourism sites which seriously alter the behaviours of the species of interest (Kruger, 2005). As it stands now, when tourists are present near the orangutans, virtually all activity stops. Of the five major behavioural categories measured (with cumulative means given in Table 3.3), three were shown to be significantly affected by tourist presence in the forest (Table 3.4). The orangutans did not forage in the presence of tourists, but instead spent the majority of their time watching the tourist group, again seemingly waiting to be fed. This time can best be attributed to resting or inactivity, thus this behaviour was not significantly affected (although it follows that the population would be engaging in another behaviour, if not waiting around watching tourist groups). There was no significant effect on play, which was not a common behaviour observed in the population (Fig. 3.7), with rates exhibited only in the younger population as well as in two mothers (Appendix C). Therefore, the tourism operation in practice significantly alters natural behaviour patterns and as such, may be considered unsustainable.

Table 3.3 Cumulative mean rates of behaviour with tourists absent vs. tourists present (N=13)

	Foraging		Inactivity		nactivity Traveling		Play	/ing	Soc	cial
Tourists	Absent	During	Absent	During	Absent	During	Absent	During	Absent	During
Mean rate	0.34	0.00	0.32	0.41	0.17	0.00	0.01	0.00	0.02	0.00
STD	0.08	0.00	0.09	0.22	0.06	0.00	0.02	0.02	0.04	0.00

Wilcoxon Signed					Social				
Ranks test	Foraging	Inactivity	Traveling	Playing	behaviour				
Z	-3.186	-1.329	-3.184	-1.890	-2.410				
Asymp. Sig. (2-tailed)	.001	.184	.001	.059	.016				

Table. 3.4 Effect of tourist presence compared to absence on mean hourly rates of behaviour

Some studies have presented evidence correlating numbers of tourists to effects on behaviours (Grossberg *et al.*, 2003; Treves and Brandon, 2005). However, the number or even the presence of people is not necessarily the issue. The problem is any inappropriate behaviours exhibited by those people (Burns and Howard, 2003). This could take the form of creating dependence in the population through calling and then feeding the population and/or it could drastically affect the population through potential disease transmission through close contact.

3.2.4 Disease transmission

Although this study does not include any direct research on physical health and disease status, much can be implied from the results. Close contact between two different species represents an opportunity for a pathogen to spread, as those carried by humans may spill over to species with no immunity, often with drastic effects (Wolfe *et al.*, 1998; Quammen, 2007). Proximity to nonhuman primates, especially the great apes, carries with it a considerable risk of exchange due to close phylogenetic relationships (Wallis and Lee, 1999; Adams *et al.*, 2001; Woodford *et al.*, 2002; Kilbourn *et al.*, 2003).



Fig. 3.9 Western tourists feeding Pesek (who is accompanied by her one year old infant)

Tourists, by their very nature being foreign to the local area, can bring in any number of alien pathogens that the local population has no level of immunity against (Adams *et al.*, 2001). Great apes and humans are susceptible to a plethora of communicable and parasitic diseases (reviewed in Wallis and Lee, 1999; Woodford *et al.*, 2002). Potential routes of transmission include direct contact (Fig. 3.9), aerosol (coughs and sneezes), sputum (spitting),

faecal-oral, water contamination , arthropod vectors, animal bites (Wolfe *et al.*, 1998; reviewed in Wallis and Lee, 1999; Adams *et al.*, 2001; Woodford *et al.*, 2002). The risk of aerosol infection is directly proportional to the proximity of contact (Wallis and Lee, 1999), thus with guides and tourists directly touching the orangutans as they have been observed, there is much inherent danger. Water contamination may be a particular problem in terms of the milk provided at the official feedings (which is simply dry milk powder mixed with water from an outdoor unfiltered tap in the quarantine area), particularly for the infants (R. Frey, pers. comm.). In addition, contact with contaminated objects (Singleton and Aprianto, 2001; Woodford *et al.*, 2002) (e.g. discarded tourist fruit skins, tissues, bags taken from tourists, raiding the rubbish bins at the quarantine area) may also play a role in disease transmission.

This is not to mention the potential for intraspecies disease transmission. Since there is a wild population just south of the main ranging area of the excaptives, habituated animals coming into close contact with people may later pass human pathogens onto the wild population. Ex-captives have also been known to exhibit higher levels of infection intensity as well as parasite community diversity than their wild counterparts (Frazier-Taylor *et al.*, 1984; Foitova, 2002). Time spent on the ground (Fig. 3.10) also carries with it an increased exposure to parasites (Mul *et al.*, 2007). Of the total time recorded in the study, a cumulative mean daily rate 0.05 \pm .08 was spent on the ground. Interestingly the only three individuals with zero time recorded as such were wild (Lucky and Damar) or considered as wild (Borjong is sparsely seen in the study area and has the lowest overall rate of time spent on humans (Fig. 3.8).


Fig. 3.10 Mean daily time spent on the ground

Any of these ailments/diseases acquired by the semi-wild population could spread to the wild population upon contact. In addition, three of the six wild orangutans encountered within the main study area were subadult males, who have the greatest ranging behaviours. Subadults consequently come into contact with more individuals, therefore the chances for disease outbreak into the wild population are that much more increased.

3.2.5 Mortality rates

3.2.5.1 Original reintroduced populations

The official mortality rate for all reintroduced orangutans in Bukit Lawang (229) from 1972-2007 is 22%. Whereas the official rate from the total released in Tanjung Puting National Park in Central Kalimantan (162) from 1971-1996 is 20%; and of the total taken into the Wanariset Samboja reintroduction program in East Kalimantan (208) from 1992-1996, the given mortality rate is 23% (Rijksen and Meijaard, 1999). Although possible, it is perhaps rather unlikely that all of the remaining orangutans survived. As it

stands now the rates of all of these sites (of which the Bukit Lawang and Tanjung Puting both entail tourism operations of differing degrees) are comparatively similar. However, these rates given are only from given official figures, of which accuracy is difficult to confirm (Russon, 2001).

3.2.5.2 Infant mortality

Of the thirty-two births recorded from 1988-2007, only eight individuals are confirmed as surviving (with two of these as infants with dead mothers). Four are reported to have survived to weaning and are assumed to be living wild (this cannot currently be confirmed). Fourteen are confirmed to have died, with an additional six presumed dead (due to an average interbirth interval of only two years between consecutive infants). Thus the mean mortality rate among infants is 62.5%, with mean age of death 1.6 years.

Three of these deaths were from August 2006 to June 2007 (infants born to Sandra, Edita, and Ratna, respectively). Potential causes may be disease, though whether naturally occurring or due to human/tourist presence is unknown. Tourism operators often cite the lack of solid evidence of negative impact on wildlife, which has been shown as difficult to produce, as in free living populations, often the problem is not noted until the effect becomes apparent, so that the cause could be one of any number of factors (Lerche, 1993; Wallis and Lee, 1999; Orams, 2002; Woodford *et al.*, 2002; Berman *et al.*, 2007). Though it is difficult to determine the absolute cause, in many documented cases there is a strong probable disease transmission link between humans and primates (reviewed in Singleton and Aprianto, 2001; Quammen, 2007).

Previous studies have shown that primate populations in close proximity to humans have higher prevalent levels of parasitic infection than those unexposed (Mueller-Graf *et al.*, 1997; Wallis and Lee, 1999). With host behaviour shown to correlate with exposure to parasites and pathogen exchange (Hart, 1990; Wolfe *et al.*, 1998; Moore, 2002; Ezenwa, 2004), it is thus possible that these semi-wild orangutans, with regular contact with

humans and time spent on the ground, are contracting illnesses that prove fatal to their infants.

Another potential cause to consider is poor mothering skills that would have resulted in poor nutrition and inadequate care for offspring. Indeed all of Sandra's (two) and Ratna's (a total of six) infants have died, with Edita having only one of three offspring surviving. Malnutrition can be ruled unlikely as all three mothers have exhibited a level of proficiency in foraging and again the entire population has access to supplementary provisioning (often with extra food given to mothers with infants). Also all of the mothers did not show any obvious signs of neglect towards their offspring, with each carrying around and protecting the remains for a period after death. Such carrying behaviour is not uncommon among primate mothers and may be part of a grieving process (reviewed in Shopland and Altmann, 1987).

Unfortunately, although the infant mortality rate appears to be very high, there are no readily available rates to compare with from other orangutan sites. Such information is both understandably sensitive and also difficult to acquire reliable figures of, and to the best of the author's knowledge remains unpublished and/or unknown.

However, the fact that three infants have died in such a relatively short amount of time suggests there are outside factors to consider. The likelihood of all of them dying from natural causes seems low (though of course it cannot be ruled out as definitive). Previous studies in nonhuman primates have shown that infant mortality can be an indicator of the impact of tourism (Berman *et al.*, 2007). Thus with three infant deaths in one year, and the seemingly high infant mortality rate previous, the population at Bukit Lawang can be said to be operating at less than capacity.

3.2.6 Cannibalism

On two separate occasions individual mothers were observed eating the remains of their own infant's corpses. Edita, after carrying around the body of her one year old infant for eight days, began consuming the remains on 28

May 2007 (Fig. 3.11). She ate the remains in small bouts, retaining and eating the corpse for three consecutive days until it was finished. Ratna, after carrying the corpse for four days, began consuming her seven month old infant on 13 June 2007 (Fig. 3.11) Ratna only ate parts of the corpse for one day, leaving the remains high in her night nest the following morning.



Fig. 3.11 Edita (left) and Ratna (right) engaging in cannibalism

Cannibalism is a rare event in primates, with observed cases documented in only a few species: chimpanzees (*Pan troglodytes*) (Kitahara-Frisch and Norikoshi, 1983; Nishida and Kawanaka, 1985; Takahata, 1985; Hamai *et al.*, 1992; Newton-Fisher, 1999; Watts and Mitani, 2000), chacma baboons (*Papio ursinus*) (Palombit *et al.*, 2000), common marmosets (*Callithrix jacchus*) (Melo *et al.*, 2003; Bezerra *et al.*, 2007), snub-nosed monkeys (*Rhinopithecus bieti*) (Xiang and Grueter, 2007), blue monkeys (*Cercopithecus mitis stuhlmanni*) (Fairgrieve, 1995), thick-tailed bushbabies (*Galago crassicaudatus umbrosus*) (Tartabini, 1991).

Orangutans have rarely been observed consuming meat (Sugardjito and Nurhada, 1981; Utami and Van Hooff, 1997). The observed cases are

considered to be results of opportunistic feeding upon a relatively easy target, the greater slow loris (*N. coucang*), rather than being the result of active hunting (Utami and Van Hooff, 1997). Yet in this case there are mothers consuming their own offspring, which requires a different explanation.

Infanticide from an external actor cannot be posited for either of the cases, as no such interactions were observed (nor are there any reasons/published reports to infer such actions took place). It is possible that these mothers might have killed their own babies, as there is no evidence to suggest it did not happen. However, this can be refuted by the fact that: firstly, both carried and protected the bodies after death; secondly, there were reports from the national park rangers that Ratna's baby appeared unresponsive and unwell two days before she was encountered with the corpse (they attempted to capture them at that point but were unsuccessful). Thus the babies seemingly were not killed by any individual.

None of the posited explanations for cannibalism in other primate species fits for these observed cases in orangutans. Clearly the mothers did not kill their own babies as a result of sexually selected infanticide (and thereafter gain the nutritional benefits from eating the corpse) (Hrdy, 1974; Newton-Fisher, 1999; Xiang and Grueter, 2007). Mothers killing their own offspring for consumption would make little evolutionary sense as the energy invested in each baby would not be regained by consuming portions of the corpse. Also there was no shortage of food availability in the area, with supplementary feeding in place and also at the time there were many trees fruiting, so that the limited resources hypothesis can be refuted (Melo et al., 2003). Nor were there crowding conditions in effect that would promote cannibalism (Nishimura and Isoda, 2004). The suggestion that this might be a new adaptation for energy re-uptake can be countered by the fact that the two mothers are unrelated so there is no genetic component. Finally, Edita and Ratna were not in contact (direct or within any observable proximity) with one another during the cannibalism events first performed by Edita, so it can be stated that Ratna did not observe and later imitate the behaviour.

Stress and/or energetic advantage are the most convincing arguments. Stress has been linked to the incidence of cannibalism (reviewed in Fox, 1975; Polis, 1981). Distress can spill out directly through behaviour in a higher ape just as it could in a person, however just as with people it can be very difficult to diagnose (Fabrega, 2006). It could very well be that with two out of three of Edita's and all six of Ratna's offspring dying, they have become impassive to their own progeny. Therefore simply the availability of what could be viewed as a food item could have resulted in cannibalism occurring (Fox, 1975). Through consuming the corpses, the mothers are regaining a portion of energy exerted on them. Yet none of the predicted conditions for cannibalism to occur were taking place (low availability of alternative prey, crowding of conspecifics, and fear of starvation: (Nishimura and Isoda, 2004), suggesting that these events were opportunistic feedings. This is similar to a situation which occurred in Ketambe, where multiple orangutans shared the portion of home range where the slow lorises were consumed, yet only one female was observed eating, suggesting it was an opportune rather than general behaviour (Utami and Van Hooff, 1997). However, these instances at Bukit Lawang were mother-infant or filial cannibalism, which is more common in non-primate species or primate species living under stressful laboratory conditions, such as galagoes (Rohwer, 1978; Izard and Simons, 1986; Tartabini, 1991). Hence that it was replicated in hominoids under free-ranging conditions elicits some major cause of concern for the population at hand. Moreover, that such behaviour has *never* been documented in orangutans suggests that there is more to the matter than opportunistic feeding.

The author is hesitant to make any definitive claims as to why the events of cannibalism occurred. Outside observers shall never be able to tell how natural an exhibited behaviour is, as our presence may or may not be having an effect on a focal animal's behaviour (Tutin and Fernandez, 1991; Grundmann, 2006). Also, the motives for these behaviours are beyond the inter-species level of understanding (Bernstein, 2003; Fabrega, 2006). We shall never know the full experience of ex-captive orangutans, thus whatever conditions they were held in may well have an effect on their psyche in later life. Semi-wild orangutans are all exposed to considerable traumas, such as

witnessing the deaths of their own mothers (upon being captured in the forest), as well as periods of social isolation (Rijksen and Meijaard, 1999). Studies have shown that early social deprivation can have deleterious effects on later levels of cognitive ability (Stoinski and Whiten, 2003), thus it is possible that the cannibalism events are an extension of these effects. The possibility that any of the concerned orangutans became accustomed to meat eating whilst in captivity though is refuted on the basis of diet typically fed to captive orangutans, as well as through examples of meat eating by wild born individuals at different study sites (Utami and Van Hooff, 1997).

For the purposes of this study, the important factor to consider is not why it happened, but that it *did* happen. The fact that two different mothers lost their maternal instinct and thereafter treated their offspring as consumable resources at the very least suggests serious behavioural abnormalities within the population. Therefore to reduce the amount of outside (human) influence on the orangutans would seemingly be beneficial as it would allow/force them to return to a natural forest life.

3.3 The factors to consider

3.3.1 Tourism

3.3.1.1 Tourism in Bukit Lawang

Tourism has the potential to contribute both to conservation as well as development goals through its self-generating administrative revenue, thus if managed correctly it should be a most welcome venture (Sherman and Dixon, 1991; Honey, 1999; Walpole and Goodwin, 2001). Tourism in Bukit Lawang can also be considered very inclusive of the local population, as its viability depends on the knowledge of the people as well as the natural and cultural environment, which nearly everyone can capitalize on (Christ *et al.*, 2003). It can thus be posited as one means of sustainable development that the people can embrace, but it must be done responsibly.

Biodiversity is fundamental for the continued existence and development of ecotourism (Christ *et al.*, 2003). However, Bukit Lawang has fallen into the ecotourism-related life-cycle conundrum of growing demand leading to more building and development, which ultimately works to destroy what it purports to be trying to protect (Russell, 1995; Chin *et al.*, 2000; Hillery *et al.*, 2001; Tremblay, 2001; Cohen, 2002; Adams and Infield, 2003; Burns and Howard, 2003; Kruger, 2005).

The problem can be viewed in terms of human-wildlife conflict, in that industry stakeholders are seeking greater access to the animals (Burns and Howard, 2003), while those in conservation are seeking to limit and control such access (De La Torre et al., 2000; Duchesne et al., 2000). Where stakeholders (defined following Ryan's description: 'simply any individual or identifiable group who is affected by, or who can affect the achievement of corporate objectives (2002, p.20)) are not supportive or resistant to such imposed limitations, it may be impossible to formally make changes to official policy (Wallis and Lee, 1999). With the volatile tourism situation as it stands in Bukit Lawang, stakeholders are seemingly hesitant to limit what the tourists will pay (and possibly give tips) to see. Yet with the risk of disease transmission so high, it is imperative that measures be taken to limit the level of interaction between orangutans and humans. It is well acknowledged that many of the problems stemming from human-wildlife interaction come in the form of human management, rather than animal management (Leopold, 1966; Reynolds and Braithwaite, 2001; Burns and Howard, 2003).

3.3.1.2 Problems with tourism

It is not uncommon to have a flagship species as the primary draw bringing tourists to an area (Adams and Infield, 2003; Burns and Howard, 2003). Yet to have such dependence on one resource is dangerous; if something were to go wrong, the entire tourist industry could be destroyed (Burns and Howard, 2003). There is a history of aggressive orangutans attacking people in the forests of Bukit Lawang (Rijksen, 1997, cited in Singleton and Aprianto, 2001). Mina, having the highest mean time spent engaged with humans (Fig. 3.4), is known to regularly attack tourist groups in the forest in pursuit of food (she

tears bags off of people) with six confirmed incidents during the course of this study (reportedly with injuries requiring surgery). These attacks are made on the tourist groups in the forest, who are often in possession of rucksacks full of fruit to be handed out (the orangutans distinguish between tourist groups and researchers – generally ignoring the latter). In order for tourism to be considered sustainable it is not acceptable to have the wildlife posing a risk to human life (Burns and Howard, 2003). If it becomes better known that orangutan treks are not always as safe as they are advertised, there may be serious problems for the stakeholders in the area.

In addition, with the mortality rates as they are and the interbirth interval of the orangutan so lengthy, there is the possibility that the population is in jeopardy due to problems associated with small population genetics (Lande and Barrowclough, 1987; Vasarhelyi and Martin, 1994; Simberloff, 1998; Kalinowski and Waples, 2002). It is dangerous for a population to be operating on a relatively small scale, as these threats are inherent with low numbers. This is not to mention other factors, such as stochastic demographic (predation, skewed sex ratio, etc.) and environmental events (natural disasters) which could further upset the population (Cowlishaw and Dunbar, 2000; Frankham *et al.*, 2002). Finally, were the population to further decrease in size, it will result in increased tourist pressure on those individuals remaining. As fewer orangutans are left in the forest, each will have to be sought out and observed more often each day by tourist groups, which may further exacerbate all of the above problems.

Ultimately then the conditions are not beneficial to anyone and only serve short term wants and needs. In the process, the tourism practices are potentially harming the orangutan population, which is the one thing that the industry depends on. Quite simply, as it stands right now, without the orangutans there would be no tourists.

3.3.1.3 Shift focus from orangutans

A shift in the focus in Bukit Lawang from it being simply an orangutan viewing centre to it becoming a gateway into GLNP would greatly reduce the pressure

on the orangutan population, as well as raise the conservation status of the area in general (Singleton and Aprianto, 2001). It is after all a national park and therein has much intrinsic beauty to be appreciated; treks could be made into the forest and if an orangutan is encountered, it would simply be a bonus. It would greatly benefit the area to have tourists simply experiencing the entire park and having a more holistic experience, as opposed to just an 'orangutan tour', as it would better serve both the tourists, the local community, and the forest.

There are many other sights and species in the forest which are commonly ignored by the guides, and are thus not pointed out to the tourists. Furthermore, with all of the focus on orangutans, who have become habituated to such human traffic, little concern is given to these other species. With only the presence of researchers in the forest, animals such as the tiger, rhinoceros, and sun bear have changed their ranges and activity periods (Griffiths and van Schaik, 1993), thus the tourist levels must be having an incredible impact on the area.

There are other non-wildlife related tourist industry ventures in Bukit Lawang, so that the area need not be so dependent on orangutan viewing. An ability to provide different activities will not only cater to different sorts of tourists, but could also entice primarily orangutan based tourists to participate in different activities and thus pay more into the local community (Tremblay, 2001).

3.3.2 Conservation has to pay its way

Wildlife and conservation needs are now recognized as having to 'pay their own way' to exist (Eltringham, 1994). As development projects are now widely expected to consider the environmental consequences of their actions, so are conservation agencies equally expected to consider theirs on the people around the target area (Sutherland, 2000). Although by conserving forests they provide a number of environmental services benefiting not only local areas but also the globe (e.g. seed dispersal by orangutans, water catchment areas, forests as carbon sinks) (Rijksen and Meijaard, 1999; FWI/GFW, 2002), the people living alongside protected areas are bearing most of the costs of conservation programs (Hill, 2002). The local people adjacent to protected area/species deserve to benefit from conservation (Adams and Infield, 2003), as they are foregoing valuable resources in the process of not developing. In general it is more profitable to convert and/or sell the land and invest towards development than to leave it undeveloped (Norton-Griffiths and Southey, 1995; Adams and Infield, 2003; ITTO, 2005).

This is also not to mention the amount of palm oil plantations surrounding Bukit Lawang, so that without the tourist industry the level of cultivation/plantations could well increase and further degrade the forest (Russell, 1995; Christ et al., 2003). The conservation community is fortunate that tourism is as popular as it is, as the incentives do not reach everyone in the community (Bookbinder et al., 1998), yet the venture is widely supported and the forest conserved by the local people regardless. As noted in the introduction, law enforcement has proven inadequate in protecting the forests, thus a large part of the future of conservation depends on the people living in proximity to orangutan habitats. The local economy has been centered on orangutan tourism for decades and has grown in scale with the increasing numbers of tourists. Consequently to ask that all tourism stop in Bukit Lawang would only further endanger the population as a result of increasing human pressure. A system of community management is perhaps the only viable hope for wildlife conservation (Sutherland, 2000). There are problems associated, effective implementation being the most prominent (Hackel, 1999; Campbell and Vainio-Mattila, 2003). However if a program is attempted without the consent of the local people, it is most likely doomed to failure.

It is important to note that although it is vital for local people to be involved, pure local autonomy is not necessarily the answer, as it eliminates national representation and along with it management knowledge, which may result in conservation being phased out in lieu of short-term gains (Salafsky *et al.*, 2001; van Schaik *et al.*, 2001). On that note, it could be argued that just as the human political sphere must become a key aspect of any orangutan conservation efforts at Bukit Lawang, so too must conservation become a large part of the tourism program in order to ensure the long-term survival of

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the population. The national government, operating through the forestry department, needs to better regulate the activities taking place within the forest. A compromise is therefore in order for the orangutans of Bukit Lawang, between their own needs and that of the local community surrounding them (Singleton and Aprianto, 2001; Hill, 2002).

3.3.3 Education

The tourists at the moment are seemingly learning very little about the orangutans and their conservation situation. This is evidenced by their wanting to be close to the orangutans and feed them. Studies in Tanjung Puting National Park in Kalimantan have yielded similar results (Russell, 1995). Also seemingly many of the tour operators are only thinking in the short term, as if they continue to call and feed the orangutans there will be further negative effects on the orangutans' behaviour. The fact that there have been three infant deaths in the past year, and yet there is still regular close contact between orangutans and humans shows that the potential for disease transmission is not understood (in fact infants, although the most susceptible to disease, are often sought out as many tourists prefer seeing babies).

An education program is required for both the guides and tourists alike. Environmental education can help soften the impacts of tourism activities on the area through proffering proper practices towards local conservation and has potential to create a greater conservation constituency in general (O'leary, 1993; Chin *et al.*, 2000). Research has shown that tourism programs complete with a structured education program can be effective in changing peoples' behaviours (Orams, 1997).

Education as well as regulating the behaviour of tourists has been recognized as a vital factor in tourism projects (Singleton and Aprianto, 2001; Grossberg *et al.*, 2003). Tourists must be accompanied by a guide in order to enter the National Park, thus if the guides are properly educated and trained, they can regulate the behaviour of the tourists (Grossberg *et al.*, 2003). Although direct research was not conducted, comments overheard from guides to tourists in the forest were seldom regarding the conservation situation and oftentimes gave incorrect data regarding orangutan physiology and behaviour. As in other studies (Grossberg *et al.*, 2003), very few direct restrictions on tourist behaviour (feeding and/or close proximity to orangutans) were heard, although it is of paramount importance. Through properly educating the guides they can then better regulate the behaviour of their tourists (conversely, tourism operators would not give food to the orangutans if the paying tourists made it clear they did not approve of such behaviour).

A person who has traveled a long distance and made great expenditures may not readily accept being told they then cannot enter the forest should he/she have a cold upon arrival. However, such a person seemingly has interest in wildlife; and, being given the proper information on the appropriate matters should be more conducive to cooperation in that they would then be helping safeguard the wildlife they have come to see (Wallis and Lee, 1999; Chin *et al.*, 2000).

There is a visitor centre located adjacent to the forestry office where tourists must acquire permits to enter the national park, but the information presented is still out of date (Singleton and Aprianto, 2001). This centre needs to be updated but also further information distribution points are necessary. There are plans now in collaboration with the Sumatran Orangutan Society to install signboards and to circulate information pamphlets throughout the region. Since there is such a multitude of information to be distributed, there is always the danger with education that people become overloaded with information and thus simply ignore any provided materials (Burns and Howard, 2003). However, a program must be attempted as at the moment an almost complete lack of information available.

3.4 Limitations of the data

3.4.1 Time

The main limitation of the study was time. The data presented is limited as it only covers 88 days from one year. Consequently it is possible that the data collected was skewed as it was not from a wider ranging time scale. It also can not be forgotten that the study took place during busier tourist months, so there may have been more people in the forest than during other times of the year. Yet regardless if there are more tourists in certain months than others, it only requires one infected person coming into close contact with an orangutan to have a negative impact (Chin *et al.*, 2000). In addition, due to fluctuations in range use with the occurrence of mast fruiting and patterns of unstable individual home range stability (Te Boekhorst *et al.*, 1990; Singleton and van Schaik, 2001; McConkey, 2005), the ranging analysis should not be considered a full home range estimate for the population at Bukit Lawang. However the data still does reflect a core area that heavily coincides with areas of high tourist traffic.

3.4.2 Sample population

The focus on the semi-wild orangutans that are still found ranging in and around the study area designated by the trail system does result in a form of bias. Of the 229 original orangutans that purportedly passed through the reintroduction program at Bukit Lawang (of which 51 are confirmed dead), this study focused on 8 individuals from that original population (not including their offspring). These individuals all range within an area of heavy human use, thus as a result they are of course more prone to come into contact with them and potentially have their activity budgets altered. It is possible (however unlikely) that the remaining 164 orangutans (6 individuals have either been moved to other sites or are in quarantine) have completely assimilated back into the forest and developed natural activity budgets. Nevertheless, the focal population is still a protected species that was reintroduced into the forest to again become free-ranging individuals, and they are being affected to the degree that they are still a major conclusion in need of alleviation.

Regardless if the direct effects and alterations of behaviour are only on the focal population, indirectly the rest of the orangutan population in the region can be affected. In a sense there is little point in distinguishing between populations in Bukit Lawang, as what affects one may well affect the other. There is regular contact between the semi-wild and wild population, so whatever pathogens and ailments one population acquires can be passed on to the other. Also, three members of the wild population (Lucky, Damar, and Ucok) are near to being considered semi-wild at this point, as they regularly descend and await provisioning. Finally, even those orangutans born in the wild to semi-wild mothers, who have never been held in captivity, still behave mostly as if they were semi-wild orangutans.

3.5 Further studies

The study is ongoing so as to develop a more representative sample of the population. This will allow for the monitoring of differences occurring as a result of seasonality as well as collecting a more even distribution of follow data per each individual. Further valuable research could include collecting data on the wild population in and around Bukit Lawang, so that behavioural comparisons could be made with the semi-wild population. Although not included in this work, fecal samples were taken throughout the study for later analysis. It is hoped that this data will help determine whether the causes of the level of infant mortality seen in the area is related to parasitic infection.

Chapter 4: Conclusion and Recommendations

The three major findings of this study on the orangutans of Bukit Lawang are as follows:

- 1. The population's ranging behaviour is restricted.
- 2. The population's activity budget has been significantly affected by the wildlife tourism.
- 3. The infant mortality rates, and therein the two observed cases of mother-infant cannibalism, suggest the behavioural health and reproductive success of the population is poor.

Although no longer an official reintroduction program and the area is seen as a wildlife viewing centre now, the orangutans are still a critically endangered species living within the confines of a protected national park. With so few remaining free-ranging populations, every number counts and must be protected. There are far too many impediments to their returning to the forest to lead independent lives. Therefore, it is unsustainable to continue with current practices which significantly alter behavioural activities and potentially threaten the health of this free-ranging population.

Even with the problems of tourism, authorities in the field of conservation have recognized it as a potential force in helping to save the orangutans (Singleton and Aprianto, 2001). Perhaps best summed up by Carel van Schaik, who states, "Although I am well aware of the negative sides of ecotourism, they pale into insignificance compared to the threats that are now faced by the wild orangutan" and that "the best way to turn an initially indifferent person into an ardent conservationist is to give him or her the privilege to follow a habituated wild primate" (2001, p.34).

There is no reason that tourism in Bukit Lawang cannot be sustainable, as it does not necessarily carry any of the five main limits of ecotourism cited by Wells: lack of infrastructure, difficulties in access, political instability,

ineffective marketing, and absence of flagship species (1992, cited in Kruger, 2005) what can and must happen though is an overhaul of the tourism policy in place.

Immediate recommendations

1. The illegal feedings should cease immediately. This provisioning is significantly altering the activity budget of the population and may reinforce aggressive behaviour, as well as increasing the risk of disease transmission; this could have further deleterious consequences for both humans and orangutans.

2. An education program is needed. The guides and tourists alike will learn more about the conservation situation of the orangutans and the forest and can be educated on the importance of saving them. This could also serve to regulate human behaviours in the forest, as with improved education, the people may not only modify their own behaviours, but also regulate that of others.

3. The national government, through its local forestry office and rangers, needs to create a stronger presence in the park. Although the orangutans are a protected species within a national park, there is seemingly little government regulation with the daily running of the tours. Were they more involved, they could regulate behaviours directly. This need not be harsh, but some form of control is needed as poor tourism practices have become rampant in the forest.

If these recommendations were to be carried out, it could transform the area into a center of learning and a perfect location for educating the public about orangutans, reintroduction, and the importance of conservation. Bukit Lawang does not need to be the way it is now; it can be greatly changed for the better.

List of References

- Adams, H. R., Sleeman, J. M., Rwego, I. and New, J. C. (2001). Self-Reported Medical History Survey of Humans as a Measure of Health Risk to the Chimpanzees (*Pan troglodytes schweinfurthii*) of Kibale National Park, Uganda. *Oryx* 35 (4), pp.308-312.
- Adams, W. M. and Infield, M. (2003). Who Is on the Gorilla's Payroll? Claims on Tourist Revenue from a Ugandan National Park. *World Development* 31 (1), pp.177-190.
- Altmann, J. (1974). Observational Study of Behavior: Sampling Methods. *Behaviour* 49 (3), pp.227-267.
- Anthony, L. L. and Blumstein, D. T. (2000). Integrating Behaviour into Wildlife Conservation: The Multiple Ways That Behaviour Can Reduce *Ne. Biological Conservation* 95 (3), pp.303-315.
- Aveling, R. and Mitchell, A. (1982). Is Rehabilitating Orang Utans Worth While? *Oryx* 16 (1), pp.263-271.
- Baker, L. R. (2002). IUCN/SSC Re-Introduction Specialist Group: Guidelines for Nonhuman Primate Re-Introductions. *Re-introduction News* 21, pp.29-57.
- Bennett, J. (1992). A Glut of Gibbons in Sarawak: Is Rehabilitation the Answer? *Oryx* 26 (3), pp.157-164.
- Berman, C. M. and Li, J. (2002). Impact of Translocation, Provisioning and Range Restriction on a Group of *Macaca thibetana*. *International Journal of Primatology* 23 (2), pp.383-397.
- Berman, C. M., Li, J., Ogawa, H., Ionica, C. and Yin, H. (2007). Primate Tourism, Range Restriction and Infant Risk among *Macaca thibetana* at Mt Huangshan, China. *International Journal of Primatology* In press.
- Bernstein, I. S. (2003). The Study of Things I Have Never Seen. American Journal of Primatology 60, pp.77-84.
- Bezerra, B. M., Souto, A. D. S. and Schiel, N. (2007). Infanticide and Cannibalism in a Free-Ranging Plurally Breeding Group of Common Marmosets (*Callithrix Jacchus*). *American Journal of Primatology* 69, pp.945-952.
- Bookbinder, M. P., Dinerstein, E., Rijal, A., Cauley, H. and Rajouria, A. (1998). Ecotourism's Support of Biodiversity Conservation. *Conservation Biology* 12 (6), pp.1399-1404.

- Börger, L., Franconi, N., Michele, G. D., Gantz, A., Meschi, F., Manica, A., Lovari, S. and Coulson, T. (2006). Effects of Sampling Regime on the Mean and Variance of Home Range Size Estimates. *Journal of Animal Ecology* 75, pp.1393-1405.
- Brandon, K. and Margoluis, R. (1996). Structuring Ecotourism Success: A Framework for Action and Analysis. In: Malek-Zadeh, E. (ed.) *The Ecotourism Equation: Measuring the Impacts*. New Haven: Yale School of Forestry and Environmental Studies, pp.28-38.
- Breitenmoser, U., Breitenmoser-Wüsten, C., Carbyn, L. N. and Funk, S. M. (2001). Assessment of Carnivore Reintroductions. In: Gittleman, J. L., Funk, S. M., Wayne, R. K. and Macdonald, D. W. (eds.) *Carnivore Conservation*. Cambridge: Cambridge University Press, pp.241-281.
- Burns, G. L. and Howard, P. (2003). When Wildlife Tourism Goes Wrong: A Case Study of Stakeholder and Management Issues Regarding Dingoes on Fraser Island, Australia. *Tourism Management* 24, pp.699-712.
- Burt, W. H. (1943). Territoriality and Home Range Concepts as Applied to Mammals. *Journal of Mammalogy* 24, pp.346-352.
- Campbell, L. M. and Vainio-Mattila, A. (2003). Participatory Development and Community-Based Conservation: Opportunities Missed for Lessons Learned? *Human Ecology* 31 (3), pp.417-437.
- Ceballos-Lascurain, H. (1996). *Tourism, Ecotourism, and Protected Areas: The State of Nature-Based Tourism around the World and Guidelines for Its Development.* Gland: IUCN.
- Cheyne, S. M. (2006). Wildlife Reintroduction: Considerations of Habitat Quality at the Release Site. *BMC Ecology* 6 (1), pp.1-8.
- Chin, C. L. M., Moore, S. A., Wallington, T. J. and Dowling, R. K. (2000). Ecotourism in Bako National Park, Borneo: Visitors' Perspectives on Environmental Impacts and Their Management. *Journal of Sustainable Tourism* 8 (1), pp.20-35.
- Christ, C., Hillel, O., Matus, S. and Sweeting, J. (2003). *Tourism and Biodiversity: Mapping Tourism's Global Footprint.* Washington, DC: Conservation International.
- Cochrane, J. (1996). The Sustainability of Ecotourism in Indonesia: Fact and Fiction. In: Parnwell, M. J. G. and Bryant, R. L. (eds.) *Environmental Change in South-East Asia: People, Politics and Sustainable Development*. London and New York: Routledge, pp.237–259.
- Cohen, E. (2002). Authenticity, Equity and Sustainability in Tourism. *Journal* of Sustainable Tourism 10 (4), pp.267-276.

- Cowlishaw, G. and Dunbar, R. (2000). *Primate Conservation Biology.* Chicago: University of Chicago Press.
- Cunningham, A. A. (1996). Disease Risks of Wildlife Translocations. *Conservation Biology* 10 (2), pp.349-353.
- Custance, D. M., Whiten, A. and Fredman, T. (2002). Social Learning and Primate Reintroduction. *International Journal of Primatology* 23 (3), pp.479-499.
- De La Torre, S., Snowdon, C. T. and Bejarano, M. (2000). Effects of Human Activities on Wild Pygmy Marmosets in Ecuadorian Amazonia. *Biological Conservation* 94, pp.153-163.
- Dierenfeld, E. S. (1997). Orangutan Nutrition. In: Sodaro, C. (ed.) *Orangutan SSP Husbandry Manual*. Brookfield, Illinois: Orangutan SSP and Brookfield Zoo.
- Duchesne, M., Cote, S. D. and Barrette, C. (2000). Responses of Woodland Caribou to Winter Ecotourism in the Charlevoix Biosphere Reserve, Canada. *Biological Conservation* 96, pp.311-317.

Eltringham, S. K. (1994). Can Wildlife Pay Its Way? Oryx 28 (3), pp.163-168.

- Eudey, A. A. (1995). The Impact of Socioeconomic Decisions on the Status of the Orangutan and Other East Asian Fauna. *The Neglected Ape*. New York: Plenum Press, pp.23-27.
- Ezenwa, V. O. (2004). Host Social Behavior and Parasitic Infection: A Multifactorial Approach. *Behavioral Ecology* 15 (3), pp.446-454.
- Fabrega, H. (2006). Making Sense of Behavioral Irregularities of Great Apes. *Neuroscience and Biobehavioral Reviews* 30 (8), pp.1260-1273.
- Fairgrieve, C. (1995). Infanticide and Infant Eating in the Blue Monkey (*Cercopithecus mitis stuhlmanni*) in the Budongo Forest Reserve, Uganda. *Folia Primatologica* 64, pp.69-72.
- Farmer, K. H., Buchanan-Smith, H. M. and Jamart, A. (2006). Behavioral Adaptation of *Pan troglodytes troglodytes*. *International Journal of Primatology* 27 (3), pp.747-765.
- Foitova, I. (2002). *Parasites in Orangutans (Pongo pygmaeus) under Different Ecology and Ethology Factors. PhD Thesis.* Brno, Czech Republic: Veterinary and Pharmaceutical University.
- Foose, T. J. (1991). Viable Population Strategies for Reintroduction Programmes. *Symposia of the Zoological Society of London* 62, pp.165–172.
- Fox, L. R. (1975). Cannibalism in Natural Populations. *Annual Review of Ecological Systems* 6, pp.87–106.

- Frankham, R., Briscoe, D. A. and Ballou, J. D. (2002). *Introduction to Conservation Genetics.* Cambridge: Cambridge University Press.
- Frazier-Taylor, H., Galdikas, B. M. F. and Karesh, W. B. (1984). A Survey of Intestinal Parasites in Wild, Ex-Captive, and Captive Orangutans (Pongo pygmaeus). An American Assocation of Zoo Keepers Research Project. Seattle, WA: AZA.
- FWI/GFW (2002). *The State of the Forest: Indonesia.* Bogor, Indonesia: Forest Watch Indonesia: Washington, D.C.: Global Forest Watch.
- Galdikas, B. M. F. (1981). Orangutan Reproduction in the Wild. *Reproductive Biology of the Great Apes: Comparative and Biomedical Perspectives*. New York: Academic Press, pp.281-300.
- Galdikas, B. M. F. and Wood, J. W. (1990). Birth Spacing Patterns in Humans and Apes. *American Journal of Physical Anthropology* 83 (2), pp.185-191.
- Ganas, J. and Robbins, M. M. (2005). Ranging Behavior of the Mountain Gorillas (*Gorilla beringei beringei*) in Bwindi Impenetrable National Park, Uganda: A Test of the Ecological Constraints Model. *Behavior Ecology and Sociobiology* 58, pp.277-288.
- Goossens, B., Funk, S. M., Vidal, C., Latour, S., Jamart, A., Ancrenaz, M., Wickings, E. J., Tutin, C. E. G. and Bruford, M. W. (2002). Measuring Genetic Diversity in Translocation Programmes: Principles and Application to a Chimpanzee Release Project. *Animal Conservation* 5 (3), pp.225-236.
- Goossens, B., Setchell, J. M., Tchidongo, E., Dilambaka, E., Vidal, C., Ancrenaz, A. and Jamart, A. (2005). Survival, Interactions with Conspecifics and Reproduction in 37 Chimpanzees Released into the Wild. *Biological Conservation* 123 (4), pp.461-475.
- Griffiths, M. and van Schaik, C. P. (1993). The Impact of Human Traffic on the Abundance and Activity Periods of Sumatran Rain Forest Wildlife. *Conservation Biology* 7 (3), pp.623-626.
- Grossberg, R., Treves, A. and Naughton-Treves, L. (2003). The Incidental Ecotourist: Measuring Visitor Impacts on Endangered Howler Monkeys at a Belizean Archaeological Site. *Environmental Conservation* 30 (1), pp.40-51.
- Grundmann, E. (2006). Back to the Wild: Will Reintroduction and Rehabilitation Help the Long-Term Conservation of Orang-Utans in Indonesia? *Social Science Information* 45 (2), pp.265-284.

- Grundmann, E., Lestel, D., Boestani, A. N. and Bomsel, M. C. (2001). Learning to Survive in the Forest: What Every Orangutan Should Know. *The Apes: Challenges for the 21st Century*. Brookfield: Brookfield Zoo, pp.300-304.
- Hackel, J. (1999). Community Conservation and the Future of Africa's Wildlife. *Conservation Biology* 13 (4), pp.726-734.
- Hamai, M., Nishida, T., Takasaki, H. and Turner, L. A. (1992). New Records of within-Group Infanticide and Cannibalism in Wild Chimpanzees. *Primates* 33, pp.151-162.
- Hansteen, T. L., Andreassen, H. P. and Ims, R. A. (1997). Effects of Spatiotemporal Scale on Autocorrelation and Home Range Estimators. *Journal of Wildlife Management* 61 (2), pp.280-290.
- Harrison, B. (1962). The Immediate Problem of the Orang-Utan. *Malayan Nature Journal* 16, pp.4-5.
- Hart, B. L. (1990). Behavioral Adaptations to Pathogens and Parasites: Five Strategies. *Neuroscience and Biobehavioral Reviews* 14 (3), pp.273-294.
- Hill, C. M. (2002). Primate Conservation and Local Communities—Ethical Issues and Debates. *American Anthropologist* 104 (4), pp.1184-1194.
- Hill, D. A. (1999). Effects of Provisioning on the Social Behaviour of Japanese and Rhesus Macaques: Implications for Socioecology. *Primates* 40 (1), pp.187-198.
- Hillery, M., Nancarrow, B., Griffin, G. and Syme, G. (2001). Tourist Perception of Environmental Impact. *Annals of Tourism Research* 28 (4), pp.853-867.
- Honey, M. (1999). *Ecotourism and Sustainable Development: Who Owns Paradise?* Washington DC: Island Press.
- Hrdy, S. B. (1974). Male-Male Competition and Infanticide among the Langurs (*Presbytis entellus*) of Abu, Rajasthan. *Folia Primatologica* 22, pp.19-58.
- IEA (2006). Southeast Asian Mammal Databank. IEA Italy. [Online]. Retrieved on September 4, 2007 from: <u>http://www.ieaitaly.org/samd/</u>
- ITTO (2005). Annual Review and Assessment of the World Timber Situation. Yokohama, Japan: International Tropical Timber Organization.
- IUCN (2006). 2006 IUCN Red List of Threatened Species. IUCN. [Online]. Retrieved on March 5, 2007 from: <u>www.iucnredlist.org</u>
- IUCN (2007). Sumatran Orangutan (Pongo abelii). In: Species Survival Commission, ed. 2007 IUCN Red List of Threatened Species.

- Izard, M. O. and Simons, E. L. (1986). Infant Survival and Litter Size in Primigravid and Multigravid Galagos. *Journal of Medical Primatology* 15, pp.27-35.
- Johnson, D. H. (1980). The Comparison of Usage and Availability Measurements for Evaluating Resource Preference. *Ecology* 61 (1), pp.65-71.
- Kalinowski, S. T. and Waples, R. S. (2002). Relationship of Effective to Census Size in Fluctuating Populations. *Conservation Biology* 16 (1), pp.129-136.
- Kilbourn, A. M., Karesh, W. B., Wolfe, N. D., Bosi, E. J., Cook, R. A. and Andau, M. (2003). Health Evaluation of Free-Ranging and Semi-Captive Orangutans (Pongo pygmaeus pygmaeus) in Sabah, Malaysia. *Journal of Wildlife Diseases* 39 (1), pp.73-83.
- Kinnaird, M. F. and O'brien, T. G. (1998). Ecological Effects of Wildfire on Lowland Rainforest in Sumatra. *Conservation Biology* 12 (5), pp.954-956.
- Kitahara-Frisch, J. and Norikoshi, K. (1983). Infant Cannibalism in Chimpanzees and Its Implications for Our Understanding of the Paleoanthropological Record. *Perspectives in Primate Biology*. New Delhi: Today & Tomorrow's Printers and Publishers, pp.103-107.
- Kleiman, D. G. (1989). Reintroduction of Captive Mammals for Conservation. Guidelines for Reintroducing Endangered Species into the Wild. *Bioscience* 39 (3), pp.152-161.
- Kleiman, D. G. (1990). Decision-Making About a Reintroduction: Do Appropriate Conditions Exist? *Endangered Species Update* 8 (1), pp.18-19.
- Kleiman, D. G., Price, M. R. S. and Beck, B. B. (1994). Criteria for Reintroductions. In: Olney, P. J. S., Mace, G. M. and Feistner, A. T. C. (eds.) Creative Conservation: Interactive Management of Wild and Captive Animals. London: Chapman & Hall, pp.287-303.
- Kleiman, D. G., Reading, R. P., Miller, B. J., Clark, T. W., Scott, J. M., Robinson, J., Wallace, R. L., Cabin, R. J. and Felleman, F. (2000). Improving the Evaluation of Conservation Programs. *Conservation Biology* 14 (2), pp.356-365.
- Kleiman, D. G. and Rylands, A. B. (2002). *Lion Tamarins: Biology and Conservation.* Washington, DC: Smithsonian Institution Press.
- Kruger, O. (2005). The Role of Ecotourism in Conservation: Panacea or Pandora's Box? *Biodiversity and Conservation* 14, pp.579-600.

- Lackman-Ancrenaz, I., Ancrenaz, M. and Saburi, R. (2001). The Kinabatangan Orangutan Conservation Project (KOCP). In: *The Apes: Challenges for the 21st Century*. Brookfield: Brookfield Zoo.
- Lande, R. and Barrowclough, G. F. (1987). Effective Population Size, Genetic Variation, and Their Use in Population Management. In: Soule, M. E. (ed.) Viable Populations for Conservation. Cambridge: Cambridge University Press.
- Lardeux-Gilloux, I. (1995). Rehabilitation Centers: Their Struggle, Their Future. *The Neglected Ape*. New York: Plenum Press, pp.61-68.
- Leighton, M., Seal, U. S., Soemarna, K., Adjisasmito and Wijaya, M. (1995). Orangutan Life History and Vortex Analysis. In: Nadler, R., Galdikas, B., Sheeran, L. and Rosen, N. (eds.) *The Neglected Ape*. New York: Plenum Press, pp.97-107.
- Leopold, A. (1966). A Sand County Almanac with Other Essays on Conservation from Round River. New York: Oxford University Press.
- Lerche, N. W. (1993). Emerging Viral Diseases of Nonhuman Primates in the Wild. In: Fowler, M. E. (ed.) *Zoo and Wild Animal Medicine*. Philadelphia: Saunders, pp.340-344.
- Mackinnon, K. and Mackinnon, J. (1991). Habitat Protection and Re-Introduction Programmes. *Symposia of the Zoological Society of London* 62, pp.173-198.
- Martin, P. and Bateson, P. (1993). *Measuring Behaviour.* New York, NY, USA: Cambridge University Press
- May, R. M. (1991). The Role of Ecological Theory in Planning Re-Introduction of Endangered Species. *Symposia of the Zoological Society of London* 62, pp.145-163.
- Mccarthy, J. (1999). *Nature Based Tourism Case Study: Gunung Leuser, Indonesia*. Perth: Murdoch University. [Online]. Retrieved on August 11, 2007 from: <u>http://www.science.murdoch.edu.au/teach/n279/n279content/casestudi</u> <u>es/g-leuser/leuser.html</u>
- McConkey, K. (2005). Sumatran Orangutan (*Pongo abelii*). In: Caldecott, J. and Miles, L. (eds.) *World Atlas of Great Apes and Their Conservation*. University of California Press, pp.184-204.
- Meijaard, E., Sheil, D., Nasi, R., Augeri, D., Rosenbaum, B., Iskandar, D., Setyawati, T., Lammertink, M., Rachmatika, I., Wong, A., Soehartono, T., Stanley, S. and O'brien, T. (2005). *Life after Logging: Reconciling Wildlife Conservation and Production Forestry in Indonesian Borneo.* Jakarta: Center for International Forestry Research.

- Melo, L., Mendes Pontes, A. R. and Monteiro Da Cruz, M. A. O. (2003). Infanticide and Cannibalism in Wild Common Marmosets. *Folia Primatologica* 74, pp.48-50.
- Mitani, J. C. (1990). Experimental Field Studies of Asian Ape Social Systems. International Journal of Primatology 11 (2), pp.103-126.
- Moore, J. (2002). *Parasites and the Behavior of Animals.* New York: Oxford University Press
- Morrogh-Bernard, H., Husson, S. and Mclardy, C. (2002). Orang-Utan Data Collection Standardisation. In: *Orang-utan Culture Workshop*. San Anselmo, USA.
- Mueller-Graf, C. D. M., Collins, D. A., Packer, C. and Woolhouse, M. E. J. (1997). Schistosoma mansoni Infection in a Natural Population of Olive Baboons (*Papio cynocephalus anubis*) in Gombe Stream National Park, Tanzania. *Parasitology* 115 (6).
- Mul, I. F., Paembonan, W., Singleton, I., Wich, S. A. and Bolhuis, H. G. V. (2007). Intestinal Parasites of Free-Ranging, Semicaptive, and Captive *Pongo abelii* in Sumatra, Indonesia. *International Journal of Primatology* 28, pp.407–420.
- Newton-Fisher, N. E. (1999). Infant Killers of Budongo. *Folia Primatologica* 70, pp.167-169.
- Nishida, T. and Kawanaka, K. (1985). Within-Group Cannibalism by Adult Male Chimpanzees. *Primates* 26 (3), pp.274-284.
- Nishimura, K. and Isoda, Y. (2004). Evolution of Cannibalism: Referring to Costs of Cannibalism. *Journal of Theoretical Biology* 226 pp.291-300.
- Norton-Griffiths, M. and Southey, C. (1995). The Opportunity Costs of Biodiversity Conservation in Kenya. *Ecological Economics* 12, pp.125-139.
- O'leary, H. (1993). Monkey Business in Gibraltar. Oryx 27 (1), pp.55–57.
- Orams, M. B. (1997). The Effectiveness of Environmental Education: Can We Turn Tourists into 'Greenies'? *Progress in Tourism and Hospitality Research* 3, pp.295-306.
- Orams, M. B. (2002). Feeding Wildlife as a Tourism Attraction: A Review of Issues and Impacts. *Tourism Management* 23, pp.281-293.
- Ostro, L. E. T., Young, T. P., Silver, S. C. and Koontz, F. W. (1999). A Geographic Information System Method for Estimating Home Range Size. *Journal of Wildlife Management* 63 (2), pp.748-755.

- Palombit, R. A., Cheney, D. L., Fischer, J., Johnson, S., Rendall, D., Seyfarth, R. M. and Silk, J. B. (2000). Male Infanticide and Defense of Infants in Chacma Baboons. *Infanticide by Males and Its Implications*. Cambridge: Cambridge Univ Press, pp.123-152.
- Polis, G. A. (1981). The Evolution and Dynamics of Intraspecific Predation. Annual Review of Ecology and Systematics 12, pp.225-251.
- Quammen, D. (2007). *Deadly Contact: How Animals and Humans Exhange Disease.* October ed. National Geographic.
- Reynolds, P. C. and Braithwaite, D. (2001). Towards a Conceptual Framework for Wildlife Tourism. *Tourism Management* 22, pp.31-42.
- Rijksen, H. D. (1995). The Neglected Ape? NATO and the Imminent Extinction of Our Close Relative. *The Neglected Ape*. New York: Plenum Press, pp.13-21.
- Rijksen, H. D. (1997). Orang Utan Viewing Centre in Sumatra: Recommendations for Improving of the Bohorok Facility. PHPA.
- Rijksen, H. D. and Meijaard, E. (1999). *Our Vanishing Relative: The Status of Wild Orang-Utans at the Close of the Twentieth Century.* Dordrecht: Kluwer Academic Publishing.
- Rodman, P. S. (1988). Diversity and Consistency in Ecology and Behavior. . *Orang-Utan Biology*. New York: Oxford University Press, pp.31-51.
- Rohwer, S. (1978). Parent Cannibalism of Offspring and Egg Raiding as a Courtship Strategy. *The American Naturalist* 112 (984), pp.429-440.
- Rosen, N., Russon, A. and Byers, O. (2001). *Orangutan Reintroduction and Protection Workshop: Final Report.* Apple Valley, MN: IUCN/SSC Conservation Breeding Specialist Group.
- Ross, S. and Wall, G. (1999). Ecotourism: Towards Congruence between Theory and Practice. *Tourism Management* 20, pp.123–132.
- Russell, C. L. (1995). The Social Construction of Orangutans: An Ecotourist Experience. Society & Animals Journal of Human-Animal Studies 3 (2).
- Russon, A. E. (2001). Rehabilitating Orangutans (*Pongo pygmaeus*): Behavioral Competence. *Laboratory Primate Newsletter* 40 (4), pp.8-9.
- Russon, A. E. (2002). Return of the Native: Cognition and Site-Specific Expertise in Orangutan Rehabilitation. *International Journal of Primatology* 23 (3), pp.461-478.
- Ryan, C. (2002). Equity, Management, Power Sharing and Sustainability Issues of the 'New Tourism'. *Tourism Management* 23 23, pp.17-26.

- Salafsky, N., Cauley, H., Balachander, G., Cordes, B., Parks, J., Margoluis, C., Bhatt, S., Encarnacion, C., Russell, D. and Margoluis, R. (2001). A Systematic Test of an Enterprise Strategy for Community-Based Biodiversity Conservation. *Conservation Biology* 15 (6), pp.1585-1595.
- Sarrazin, F. and Barbault, R. (1996). Reintroduction: Challenges and Lessons for Basic Ecology. *Trends in Ecology and Evolution* 11 (11), pp.474-478.
- Scheumann, M. and Call, J. (2006). Sumatran Orangutans and a Yellow-Cheeked Crested Gibbon Know What Is Where. *International Journal of Primatology* 27 (2), p.1996.
- Seaman, D. E. and Powell, R. A. (1996). An Evaluation of the Accuracy of Kernel Density Estimators for Home Range Analysis. *Ecology* 77 (7), pp.2075-2085.
- Sherman, P. B. and Dixon, J. A. (1991). The Economics of Nature Tourism: Determining If It Pays. In: T.Whelan (ed.) *Nature Tourism: Managing for the Environment*. Washington DC: Island Press, pp.89–131.
- Shopland, J. M. and Altmann, J. (1987). Fatal Intragroup Kidnapping in Yellow Baboons. *American Journal of Primatology* 13, pp.61-65.
- Silverman, B. W. (1986). *Density Estimation for Statistics and Data Analysis.* London, UK: Chapman and Hall.
- Simberloff, D. (1998). Small and Declining Populations. In: Sutherland, W. J. (ed.) *Conservation Science and Action*. Oxford: Blackwell Science, pp.116–134.
- Singleton, I. (2004). Personal Communication Via Email to Lera Miles.
- Singleton, I. and Aprianto, S. (2001). *The Semi-Wild Orangutan Population at Bukit Lawang; a Valuable 'Ekowisata' Resource and Their Requirements.Unpublished paper presented at a "workshop on ecotourism development at Bukit Lawang" held in Medan, April 2001.* Medan, Indonesia: PanEco and Yayasan Ekosistem Lestari.
- Singleton, I. and van Schaik, C. P. (2001). Orangutan Home Range Size and Its Determinants in a Sumatran Swamp Forest. *International Journal of Primatology* 22 (6), pp.877-911.
- Singleton, I., Wich, S., Husson, S., Stephens, S., Utami Atmoko, S., Leighton, M., Rosen, N., Traylor-Holzer, K., Lacy, R. and Byers, O. (2004).
 Orangutan Population and Habitat Viability Assessment: Final Report. Apple Valley, MN: IUCN/SSC Conservation Breeding Specialist Group.
- Smits, W. T. M., Heriyanto and Ramono, W. S. (1995). A New Method for Rehabilitation of Orangutans in Indonesia: A First Overview. *The Neglected Ape.* New York: Plenum Press, pp.69-77.

- Stoinski, T. S. and Whiten, A. (2003). Social Learning by Orangutans (*Pongo abelii* and *Pongo pygmaeus*) in a Simulated Food-Processing Task. *Journal of Comparative Psychology* 117 (3), pp.272-282.
- Stork, N. (1995). *Inventorying and Monitoring of Biodiversity.* In: Heywood, V. H., ed. *Global Biodiversity Assessment.* Cambridge: UNEP.
- Sugardjito, J. and Nurhada, N. (1981). Meat-Eating Behaviour in Wild Orang-Utans. *Primates* 22 (3), pp.414-416.
- Sutherland, W. J. (2000). *The Conservation Handbook: Research, Management, and Policy.* Oxford, UK: Blackwell Publishing.
- Takahata, Y. (1985). Adult Male Chimpanzees Kill and Eat a Male Newborn Infant: Newly Observed Intragroup Infanticide and Cannibalism in Mahale National Park, Tanzania. *Folia Primatologica* 44, pp.161-170.
- Tartabini, A. (1991). Mother-Infant Cannibalism in Thick-Tailed Bushbabies (*Galago crassicaudatus umbrosus*). *Primates* 32 (3), pp.379-383.
- Te Boekhorst, I. J. A., Schurmann, C. L. and Sugardjito, J. (1990). Residential Status and Seasonal Movements of Wild Orang-Utans in the Gunung Leuser Reserve (Sumatera, Indonesia). *Animal Behaviour* 39.
- Tremblay, P. (2001). Wildlife Tourism Consumption: Consumptive or Non-Consumptive? *International Journal of Tourism Research* 3, pp.81-86.
- Treves, A. (2000). Theory and Method in Studies of Vigilance and Aggregation. *Animal Behaviour* 60, pp.711–722.
- Treves, A. and Brandon, K. (2005). Tourism Impacts on the Behavior of Black Howling Monkeys (*Alouatta pigra*) at Lamanai, Belize. In: Paterson, J. and Wallis, J. (eds.) *Commensalism and Conflict: The Human-Primate Interface* Norman, OK: American Society of Primatologists, pp.146-167.
- Tutin, C. E. G. and Fernandez, M. (1991). Responses of Wild Chimpanzees and Gorillas to the Arrival of Primatologists: Behaviour Observed During Habituation. *Primate Responses to Environmental Change*. London: Chapman & Hall, pp.187-197.
- UNEP (2007). The Last Stand of the Orangutan State of Emergency: Illegal Logging, Fire and Palm Oil in Indonesia's National Parks. In: Nellemann, C., Miles, L., Kaltenborn, B. P., and Virtue, M., and Ahlenius, H., eds. Norway: United Nations Environment Programme.
- Utami, S. S. and Van Hooff, J. (1997). Meat-Eating by Adult Female Sumatran Orangutans (*Pongo pygmaeus abelii*). *American Journal of Primatology* 43, pp.159-165

- Utami, S. S., Wich, S. A., Sterck, E. H. M. and van Hooff, J. (1997). Food Competition between Wild Orangutans in Large Fig Trees. *International Journal of Primatology, Vol. 18, No. 6, 1997* 18 (6), pp.909-927.
- van Schaik, C. P. (2001). Securing a Future for the Wild Orangutan. In: *The Apes: Challenges for the 21st Century*. Brookfield: Brookfield Zoo.
- van Schaik, C. P., Monk, K. A. and Robertson, J. M. Y. (2001). Dramatic Decline in Orang-Utan Numbers in the Leuser Ecosystem, Northern Sumatra. *Oryx* 35 (1), pp.14-25.
- Vasarhelyi, K. and Martin, R. D. (1994). Evolutionary Biology, Genetics and the Management of Endangered Primate Species. In: Olney, P. J. S., Mace, G. M. and Feistner, A. T. C. (eds.) *Creative Conservation: Interactive Management of Wild and Captive Animals*. London: Chapman & Hall, pp.118-143.
- Wallis, J. and Lee, D. R. (1999). Primate Conservation: The Prevention of Disease Transmission. *International Journal of Primatology* 20 (6), pp.803-826.
- Walpole, M. J. and Goodwin, H. J. (2001). Local Attitudes Towards Conservation and Tourism around Komodo National Park, Indonesia. *Environmental Conservation* 28, pp.160-166.
- Watts, D. P. and Mitani, J. C. (2000). Infanticide and Cannibalism by Male Chimpanzees at Ngogo, Kibale National Park, Uganda. *Primates* 41 (4), pp.357-365.
- Wells, M. P. (1992). Biodiversity Conservation, Affluence and Poverty: Mismatched Costs and Benefits and Efforts to Remedy Them. Ambio 21, pp.237-243.
- Wolfe, L. D. and Fuentes, A. (2007). Ethnoprimatology: Contextualizing Human and Nonhuman Primate Interactions. *Primates in Perspective*. New York: Oxford University Press, pp.691-702.
- Wolfe, N. D., Escalante, A. A., Karesh, W. B., Kilbourn, A., Spielman, A. and Lal, A. A. (1998). Wild Primate Populations in Emerging Infectious Disease Research: The Missing Link? *Emerging Infectious Diseases* 4 (2), pp.149-158.
- Woodford, M. H., Butynski, T. M. and Karesh, W. B. (2002). Habituating the Great Apes: The Disease Risks. *Oryx* 36 (2), pp.153-160.
- Woodford, M. H. and Rossiter, P. B. (1994). Disease Risks Associated with Wildlife Translocation Projects. In: Olney, P. J. S., Mace, G. M. and Feistner, A. T. C. (eds.) *Creative Conservation: Interactive Management of Wild and Captive Animals*. Vol. 12. London: Chapman & Hall, pp.115-135.

- Worton, B. J. (1989). Kernel Methods for Estimating the Utilization Distribution in Home-Range Studies. *Ecology* 70 (1), pp.164-168.
- WTO (1995). *Lanzarote Charter for Sustainable Tourism.* Madrid: World Tourism Organisation.
- WTO (1998). *Ecotourism, Now One-Fifth of Market*. [Online]. Retrieved on August 2, 2007 from: http://www.worldtourism.org/newslett/janfeb98/ecotour.htm
- WWF (2005). Wwf's Species Action Plan for the Conservation of Orang-Utans (Pongo pygmaeus and Pongo abelii) in the Wild. WWF.
- Xiang, Z. F. and Grueter, C. C. (2007). First Direct Evidence of Infanticide and Cannibalism in Wild Snub-Nosed Monkeys (*Rhinopithecus bieti*). *American Journal of Primatology* 69 (3), pp.249-254.
- Yeager, C. P. (1997). Orangutan Rehabilitation in Tanjung Puting National Park, Indonesia. *Conservation Biology* 11 (3), pp.802-805.
- Yuwono, E. H., Susanto, P., Saleh, C., Andayani, N., Prasetyo, D. and Utami, S. S. (2007). Guidelines for Better Management Practices on Avoidance, Mitigation and Management of Human-Orangutan Conflict in and around Oil Palm Plantations. WWF-Indonesia.
- Zhang, Y., Ryder, O. A. and Zhang, Y. (2001). Genetic Divergence of Orangutan Subspecies (*Pongo pygmaeus*). *Journal of Molecular Evolution* 52, pp.516-526.

Appendix

Appendix A Data sheet used for study

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Appendix B Codes and definitions of behaviour used (Page 1 of 2)

Feeding (F)

	F Fd Fdsb/Fdst FP *T	Any type of feeding behaviour in which the animal is actively eating, reaching for food, processing or preparing food items ¹ Foraging Drinking (water from stream/holes in trees, etc.) Foraging whilst in new nest/old nest Feeding Play - regurgitating food and then re-consuming Any of the above taking place on the ground
Human (H)	Hd Hf Hfp Hm Hp Hr Htf Hother *T	Any behaviour stemming from interaction with people Drinking milk Human provisioning (bananas, pineapple, etc.) Regurgitating human food and then re-consuming Moving after/towards humans (scored after focal ceased an activity and went to [calling] group on trail) Playing / in direct contact with humans (Guides, rangers, or tourists) Watching humans (similar to resting - no other discernible activity occuring. Scored only when focal <i>oriented</i> to human) Waiting for feeding (only scored when within 20m of feeding platform +/- 1 hour of 2 scheduled feeding times) Miscellaneous novel behaviours (scouring rubbish bin in quarantine area / time spent in Jungle Inn restaurant / etc.) Any of the above taking place on the ground
Resting(I)	Idsb Idst Idst+ Ip *T	Animal not moving and not engaged in other primary activity ¹ Resting in newly constructed nest Resting in old nest with no additions/modifications made Resting in old nest with additions/modifications made Resting in tree Any of the above taking place on the ground

Appendix B Codes and definitions of behaviour used (Page 2 of 2)

Moving (M) Mp MT	<i>Travel to another patch or area</i> ¹ Moving in treeways Moving on the ground
Nest buildi	ng (N) Nb N+	Actively making a new nest or rebuilding old nest ¹ Constructing new nest Modifying/adding to old nest
Playing (P))	
	Ps PsT	Engaging in a behaviour alone that is judged by the observer to represent play ¹ Playing alone (swinging/hanging from trees) Playing alone on ground (spinning and falling on ground)
Social (S)	Sa Sf Sg Sp	Direct contact/interaction with a conspecific Aggression against a conspecific Eating whilst touching a conspecific Holding/touching a conspecific Playing with a conspecific (wrestling)
Sex (Se)	Se	Any form of mating and/or genital manipulation
Out of Sigh	nt (OOS) OOS	Focal animal out of view/lost (travels along area unfit to follow/too high in canopy to view)

¹Taken directly from (Morrogh-Bernard *et al.*, 2002)

Orangutan	Sex/Age	F	±	R	±	н	±	М	±	S	±	Р	±	Ν	±	Se	±	00S	±
April	♀ Adolescent	.26	.18	.28	.10	.12	.09	.22	.13	.02	.06	.02	.03	.01	.00	.00	.00	.07	.04
Borjong	♀+ Infant	.41	.14	.48	.12	.02	.04	.07	.06	.00	.00	.00	.00	.00	.00	.01	.01	.00	.00
Damar	♂ Juvenile	.36	.08	.20	.10	.23	.04	.11	.03	.09	.11	.00	.00	.01	.00	.00	.00	.00	.00
Edita	♀ Adult	.33	.12	.47	.13	.03	.03	.16	.06	.00	.01	.00	.00	.01	.00	.01	.00	.02	.02
Jecky	♀ Adult	.32	.07	.34	.13	.12	.05	.16	.13	.02	.02	.02	.01	.02	.00	.00	.00	.02	.02
Juni	♀ Adolescent	.39	.11	.18	.10	.12	.03	.27	.12	.02	.02	.02	.02	.01	.00	.00	.00	.02	.02
Lucky	♀+ Infant	.39	.12	.37	.08	.03	.04	.20	.01	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00
Mina	♀ Adult	.18	.07	.39	.12	.21	.08	.18	.07	.00	.00	.00	.01	.02	.00	.00	.00	.02	.02
Pesek	♀+ Infant	.27	.19	.29	.13	.17	.12	.15	.04	.11	.14	.00	.00	.02	.00	.00	.00	.00	.00
Radaria	♂ Juvenile	.17		.16		.17		.12		.21		.15		.01		.00		.00	
Ratna	♀ Adult	.39	.12	.26	.05	.06	.04	.14	.03	.04	.04	.06	.00	.01	.00	.00	.00	.01	.10
Sandra	♀ Adult	.36	.11	.38	.10	.07	.05	.13	.05	.00	.01	.00	.00	.01	.00	.00	.00	.04	.04
Sepi	♀ Adolescent	.49	.17	.25	.10	.05	.07	.16	.08	.02	.03	.00	.00	.01	.00	.00	.00	.02	.02
Suma	♀ Adult	.26	.17	.33	.12	.03	.04	.28	.10	.00	.00	.00	.00	.03	.00	.00	.00	.07	.07

Appendix C Individual activity budgets (mean rates)

Orangutan	Sex/Age	Hd	±	Hf	±	Hfp	±	Hm	±	Нр	±	Hr	ŧ	Htf	±	Hother	±
	P																
April	Adolescent	0.00	0.00	0.04	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.05	0.07	0.01	0.02	0.00	0.00
Borjong	♀+ Infant	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00
Damar	∂ Juvenile	0.00	0.00	0.02	0.01	0.00	0.00	0.03	0.02	0.00	0.00	0.17	0.02	0.00	0.00	0.00	0.00
Edita	♀ Adult	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00
Jecky	♀ Adult	0.00	0.00	0.05	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.00	0.00	0.00	0.00
	P																
Juni	Adolescent	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.01	0.01	0.02
Lucky	♀+ Infant	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.06	0.00	0.00	0.00	0.00
Mina	♀ Adult	0.00	0.01	0.10	0.06	0.00	0.00	0.03	0.03	0.00	0.00	0.05	0.04	0.00	0.00	0.00	0.00
Pesek	♀+ Infant	0.01	0.01	0.03	0.02	0.00	0.00	0.02	0.03	0.00	0.00	0.08	0.06	0.00	0.01	0.03	0.07
Radaria	∂ Juvenile	0.01		0.13		0.00		0.00		0.03		0.00		0.00		0.00	
Ratna	♀ Adult	0.00	0.00	0.02	0.03	0.02	0.02	0.01	0.02	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
Sandra	♀ Adult	0.00	0.00	0.02	0.01	0.02	0.03	0.00	0.01	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00
	9																
Sepi	Adolescent	0.00	0.00	0.01	0.01	0.02	0.06	0.00	0.00	0.01	0.02	0.02	0.02	0.00	0.00	0.00	0.00
Suma	♀ Adult	0.00	0.00	0.02	0.02	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Appendix D Individual daily rates of behaviours performed whilst tourists are present