Behavioral Ecology of Wild Bornean Orangutans (*Pongo pygmaeus morio*): A Pilot Study at the Danau Girang Field Centre, Sabah, Malaysian Borneo

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1. Introduction

The Bornean orangutan (*Pongo pygmaeus*) faces serious anthropomorphic threats due to hunting, habitat loss, habitat degradation, and forest fragmentation (Goossens et al. 2005; Meijaard et al. 2007; Meijaard et al. 2011, Meijaard et al. 2012, Wich et al. 2012). The global demand for palm oil, timber, and agricultural products has resulted in the conversion of lowland forests, the primary habitat of orangutans, into industrial plantations for palm oil, pulp and paper, and other products (Meijaard et al. 2007; Wich et al. 2012). Particularly in Sabah, Malaysia, human pressures have been rising within the last 20 years, and large areas of forest have been converted to oil palm plantations (Goossens et al. 2005, Gaveau et al. 2014). Due to human threats on the habitat of these animals, the Bornean orangutan is classified as Endangered on the IUCN Red List (Ancrenaz et al. 2008).

Bornean orangutans are still widely distributed across Indonesia and Malaysia, while its Sumatran counterpart (*Pongo abelii*) only contains six viable populations (Goossens et al. 2005; Wich et al. 2008, Nater et al. 2013). Despite the wide distribution, the Bornean populations are fragmented, which risks low genetic diversity (Bruford et al. 2010). By simulating changes in genetic diversity over time, non-intervention strategies to genetic management of fragmented Bornean orangutan populations can result in a high extinction rate in a short period of time (Bruford et al. 2010). This demonstrates that the study and management of these populations are crucial to their survival, and that methods can be applied to prevent the loss of these populations.

With logging and conversion of forest for agriculture, there is a rapid decrease in suitable habitat for the Bornean orangutan, and it is therefore important to study the impacts of habitat conversion on orangutan behavior (Chapman et al. 2001**;** Ancrenaz et al. 2010). In 2007, the Kinabatangan Orangutan Conservation Project surveyed the impacts that varying degrees of logging has on orangutan densities (*P. p. morio*) in Ulu Segama Malua ,Sabah, Malaysian Borneo (Ancrenaz et al. 2010). Orangutan populations were stable in areas of lightly or sustainably logged forests, but declined at rates that could result in localized extinction in areas of heavily or quickly logged forests (Ancrenaz et al. 2010). This demonstrates that sustainable land use is key to orangutan population survival, and that the continuation of deforestation for human use will result in the loss of these populations. Humans and orangutans can share the same space, but we must carry out thoughtful land use practices and stop hunting.

Understanding genetic diversity and changes in population density in environments with different degrees of human impact play a key role to conservation of these large-bodied frugivores. Behavioral ecology plays another important role in understanding how the orangutan uses different environments, and how populations are able to adapt to changing habitats. Understanding how sites in Borneo and Sumatra differ can give insight into how human pressure may impact orangutan behavior, as well as how ecological, genetic, and social learning affect geographic variation between orangutan populations (Wich et al. 2009). Geographic variations in vocalization, such as acoustic variation within the same call type between populations, as well as the presence or absence of call types in populations, points to an interesting behavioral difference found between populations (Hardus et al. 2009, Wich et al. 2012). Comparing populations gives insight into how and why populations vary, and puts these biological variations into an adaptive framework (Wich et al. 2009).

Due to the quickly changing habitat of Borneo as a result of anthropogenic causes, it is important to examine how animals are reacting to these changes. The Danau Girang Field Centre (DGFC) serves as a vital habitat for researching how habitat fragmentation and disturbed forest impact animal behavior and movement. A pilot study on the Bornean orangutan (*P. p. morio*) residing in the vicinity of DGFC, located in Lot 6 of the Lower Kinabatangan Wildlife Sanctuary (LKWS) in Sabah, Malaysian Borneo, took place from September 2013 to February 2014. The study focused on general orangutan behavioral ecology and vocalizations. The aims of this pilot study were twofold. First, the main objective of the study was to provide the basis for a long-term orangutan research project at the DGFC. Second, the pilot study aimed to provide basic data on behavioral ecology at DGFC in order to add to existing data on orangutan behavior.

2. Methods

2.1 Study Site and Subjects

The pilot study was conducted over a period of six months (September 20th 2013 - February 28th 2014) in the vicinity of DGFC, located in the secondary dipterocarp forest of Lot 6 of the LKWS in Sabah, Malaysian Borneo.

Over the six-month period, fifteen individuals were identified, and nine individuals were followed. The habituation process and GPS data collection began on September 26th, 2013 and behavioral data collection began October 17th, 2013. Behavioral data collection ended on February 28th, 2014.

2.2 Habituation

The habituation process was carried out according to the University of Zurich's guidelines for new sites: http://www.aim.uzh.ch/Research/orangutannetwork /FieldGuidelines.html. The key habituation techniques used were not wearing bright colors, acting submissively, and leaving the area if the orangutan appeared stressed or agonistic levels were such that there was the threat of an attack. Signs that the orangutan was becoming habituated to the observer were a decrease in agonistic behaviors towards the observer, as well as a decrease in kiss squeaking, based on the previous follows with the individual. Natural behavior for each individual is still unknown, which is why a long-term study at this site would be beneficial for understanding when the wild orangutans are fully habituated, and natural behaviors can be observed.

2.3 Identification

A detailed identification sheet was created for the individuals found and followed during the six-month period of the study (Appendix 7.1). The sheet includes pictures from multiple angles of the individuals, a description of important identifying features of the individuals, and the date the individuals were first seen. Ages of the individuals were estimated using pictures by Felicity

Oram, an experienced field researcher working with the Kinabatangan Orangutan Conservation Project in Lot 2 of the LKWS.

2.4 Data collection

2.4.1 Behavioral sampling

Behavioral data were collected according to the guidelines outlined on the University of Zurich's website, http://www.aim.uzh.ch/Research/ orangutannetwork /Field Guidelines.html. The standardized field methods, behavioral data sheets, and ethogram were specifically used from the orangutan project in Tuanan, Central Kalimantan. Two-minute interval sampling took place, with a focus on behavior, length of time spent in a food patch, height of the individual, vocalizations heard by the observer, feeding tolerance of the focal to another individual, and the distance of the focal from other individuals. Behaviors observed were defined in the ethogram used for the orangutan project in Tuanan. Observations were recorded by the same researcher throughout the study to ensure consistency of observations.

Nest-to-nest focal sampling over a four-day period took place when possible. Full day follows began in the morning when the focal individual left the nest, and ended when it began nesting. Partial follows, considered anything three or more hours, occasionally occurred due to rain or losing the individual, and were included in the data set (Harrison et al. 2009). Any follows less than three hours were not used in the analysis.

Due to the difficulty of locating individuals, observations were carried out on an opportunistic basis. In order to find an individual, the observer walked the trails in the vicinity of DGFC, listening for movement or feeding. When an orangutan was found, the observer began behavioral data collection on that individual. If the observer's last follow was with the first individual found, the observer continued looking for another individual so that data collected were not biased towards one individual.

2.4.2 Vocal recordings

Vocalizations were opportunistically recorded using a Marantz professional handheld recorder, model PMD661, and a condenser shotgun microphone. Vocalizations heard were recorded on the behavioral sheet, noting the context of the vocalization and the response of other individuals in the vicinity. Audio equipment was carried at all times, but not taken out during times of heavy rain. Alarm calls towards observers and other disturbances (other orangutans, macaques, etc.) were recorded, as well as calls between mother and infants. Not all calls could be recorded with the audio device, but all vocalizations were noted on the focal sheet.

2.5 Graphs and calculations

Data of the activity budget, length of active period, and diet were all represented and analyzed according to Wich et al. (2009).

Data from follows less than three hours long were excluded from the behavioral data analysis. The length of a follow was calculated by subtracting the total time the focal was out of view from the total follow time. The length of time an individual was out of view was calculated by adding up the total "OV" (out of view) points in the follow, and multiplying this by two, as each behavioral data point was taken at two minute intervals. This gives a better representation of whether a follow represents three hours or more of *observed* behaviors.

Although behavioral categories defined in the ethogram include feeding, resting, movement, social, nesting, etc., data analysis for the activity budget was grouped into four main categories: Feeding, resting, traveling, and other. The category "other" includes all other activities such as mating, social behavior, nesting, sexual behavior. The frequency for each category was calculated by taking the total number of times that behavior was observed during that follow, and dividing it by the total number of behaviors observed. Therefore each category is represented as a percentage of the total number of behaviors observed per follow, and could therefore be used in calculating averages.

The calculated active period length of the focal orangutan was defined by when they sat up in the previous-night's nest to when they began making their night-nest. The end of the active period was defined by when the orangutan began making the nest rather than at the end of nest construction. This is because the observer could not see modifications of the inside of the nest by the focal, or sometimes the focal would nest after sunset and therefore the observer could only hear nesting. In order to insure consistency within the data, the end of the active period was therefore considered to be when the focal began nest-building.

The monthly diet of the orangutans within the area of DGFC is represented as a percent of total feeding instances within that month. The food item categories represented are fruits, flowers, leaves, bark, invertebrates, and other. The "other" category includes all other possible feeding items, such as soil, seeds, and instances in which the feeding item was unknown.

Four age-sex classes were used to represent and compare data. These were: non-sexually active females, sexually active females, unflanged males, and flanged males. Non-sexually active females are defined as both adolescent females and nulliparous adult females. Sexually active females are defined as females with dependent infants. Unflanged males are defined as males who have not yet developed secondary sexual characteristics like cheekpads and long calls. Flanged males are defined as fully mature males with fully-developed secondary sexual characteristics such as cheekpads and long calls (Morrogh-Bernard et al. 2009). Infants are not included in the four age/sex classes represented. Therefore, although follows in which the infants were the focal occurred, they are not included in the behavioral analysis.

2.6 *Statistical analysis*

A Kruskal-Wallis statistical test was used to compare proportions of frequencies of behaviors represented in the activity budgets between the age-sex categories, the mean length of the active period between the age-sex categories, the mean start and mean end times between the age-sex categories, and the types of food that the orangutans ate for each month a focal follow occurred. Significance levels were set at 5%, and Tukey post-hoc comparisons were used in cases of significant results. All Kruskal-Wallis tests were done using R x64 3.0.2 software (2013, R Core Team).

3. Results

3.1 Individuals found

Over the six month time period of the pilot study, a total of 15 individuals were found in the vicinity of the DGFC: three non-sexually active females, five sexually active females with dependent offspring, one young individual not seen ranging with a mother, and one flanged male. No unflanged males were found at this site during the pilot study.

The individuals that were only followed for a few hours and then lost, such as the young individual not seen ranging with a mother were not included in the analysis of behavioral data. Table 1 outlines the individuals and their age/sex class, and Table 2 shows the individuals that were followed for three or more hours for each month of the study, which includes infants, not included in the behavioral analysis. In September, December, and March, there were no follows longer than three hours. The main reasons for this is the inability to find an individual, as well as high amounts of rain that would result in losing an individual during a follow, or forcing the observer to head back to the station. The largest number of follows occurred in February, with a total of sixteen follows.

Table 1: The individuals found between September 2013 and March 2014 for the DGFC Orangutan Pilot Study.

Name of Individual	Age/sex Class
Kawan	Non-sexually active female
Lari	Non-sexually active female
Kekasih	Non-sexually active female
Minnie	Sexually active female
Carlos (offspring of Minnie)	Infant female (1-2 years)
Galdikas	Sexually active female
Butir (offspring of Galdikas)	Infant male (~3 years)
Perongos	Sexually active female
Keo (offspring of Perongos)	Juvenile male (~6 years)
New Mother	Sexually active female

Baloo (offspring of New Mother)	Infant male (4-5 years)
Tanah	Sexually active female
Malu (offspring of Tanah)	Infant male
Unknown	Young, but no mother; age and sex not determined
Hantu	Flanged male

Table 2: The number of follows from each month lasting three or more hours, and the individuals followed that month.

Month	Number of Follows >3 hours	Individuals Followed (>3 hour follow)
September	0	NA
October	5	Hantu, Perongos
November	4	Galdikas
December	0	NA
January	12	Keo, Baloo, Hantu, Galdikas, New Mother, Lari
February	16	Galdikas, Perongos, Minnie, Butir
March	0	NA

3.3 End time, start time, and length of active period

Table 3 demonstrates the mean start and end times of the four age/sex classes. There is no significant difference in mean start time between any of the age/sex classes (Kruskal-Wallis test: x2=1.6796, df=2, p=0.4319), or in the mean end time between any of the age/sex classes (Kruskal-Wallis test: x2=3.0607, df=2, p=0.2165).

Table 4 demonstrates the mean length of the active period between age/sex classes. There is no significant difference in the length of active period between the age/sex classes (Kruskal-Wallis test: x2=0.0845, df=1, p=0.7713).

Table 3: Mean start and end times, expressed as the mean of all individuals, as well as the mean of each age/sex class.

Age/Sex Class	Mean Start Time	Mean End Time
Overall	6:33	17:30
Flanged Males	6:58	17:21
Sexually Active Females	6:34	17:35
Non-sexually Active Females	6:14	16:30

Table 4: Mean length of active period, expressed as the mean of all individuals, as well as the mean of each age/sex class represented.

Age/Sex Class	Mean Length of Active Period (minutes)
Overall	677
Flanged Males	678
Sexually Active Females	677
Non-Sexually Active Females	NA

3.4 Activity budgets

Figure 1 demonstrates the average activity budget of all of the individuals in the four age/sex class categories, as well as the average activity budget comparing age/sex class. The overall average percentage of behaviors observed was 52.7% feeding, 24.2% resting, 16.4% resting, and 6.7% other. The difference in average percentage of feeding behavior between each age/sex class (flanged male = 41.03%, sexually active female = 53.67%, and non-sexually active female = 77.50%) was not significant (Kruskal-Wallis test: x2=4.3344, df=2, p=0.1145, NS). The difference in the average percentage of resting behavior between each age/sex class (flanged male (46.73%), sexually active female (21.04%), and non-sexually active female (6.86%)) was not significant (Kruskal-Wallis test: x2=5.5927, df=2, p=0.06103, NS). The difference in the average percentage of traveling behaviors between each age/sex class (flanged male = 9.63%, sexually active female = 17.74%, and non-sexually active female = 11.8%) was not significant (Kruskal-Wallis test: x2=5.6645, df=2, p=0.05888, NS). The average percentage of other behaviors between each age/sex class (flanged male = 2.60%, sexually active female = 7.56%, and non-sexually active female = 3.92%) was also not significant (x2=1.9315, df=2, p=0.3807, NS). Despite variation, there were no significant differences in the average percentage of behaviors observed between the age/sex categories.

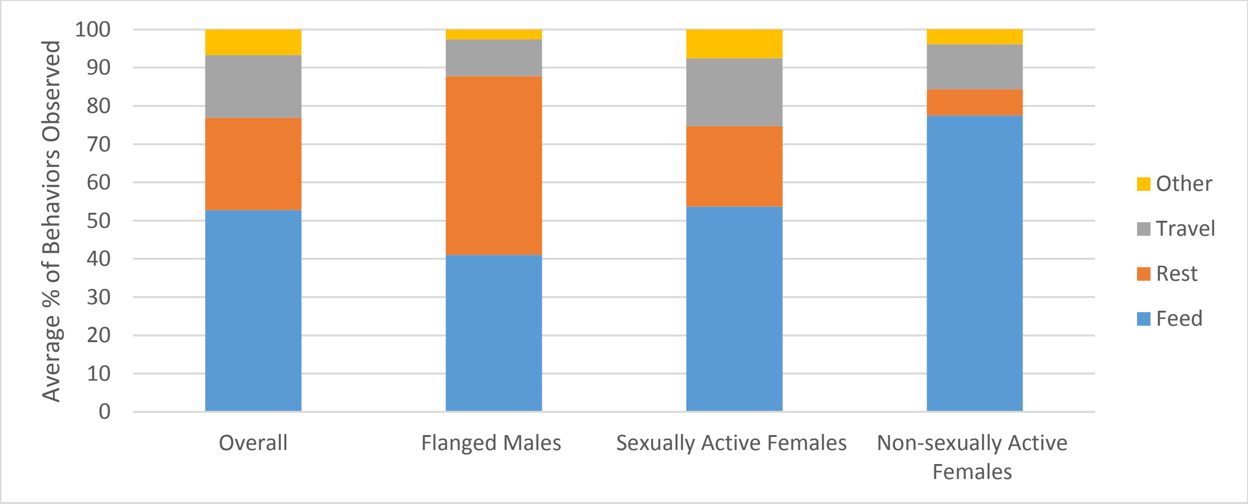

Figure 1: The average activity budget of orangutans residing in the vicinity of the Danau Girang Field Centre, and by age/sex class. Data expressed as the average percentage of behaviors observed for follows >3 hours.

3.5 Diet

There was no significant difference in the variations in percentage of each food category consumed from month to month. Figure 2 represents the six food categories, as well as the percentage of that food item consumed every month. In October, the flowers represented the highest percentage of the overall diet (37.8%), fruit was second highest (36.9%), then other/unknown (20.8%), leaves (3.02%), bark (1.51%), and no insects. In November, fruit represented the highest percentage of diet (91.5%), while other/unknown was second highest (4.64%), then leaves (3.4%), bark (0.299%), flowers (0.15%), and no insects. In January, fruit was again the highest percentage of diet (63.9%), other/unknown was second (21.8%), then leaves (10.26%), flowers (2.35%), bark (1.71%), and no insects. In February, fruit was the highest percentage of diet (46.9%), other/unknown was the second highest (24.8%), then leaves (10.4%), flowers (12.1%), insects (5.4%), and bark (0.311%).

Kruskal-Wallis tests for each food category resulted in a p-value >0.05, and therefore there was no significant variation in percentage of each food category consumed between each month.

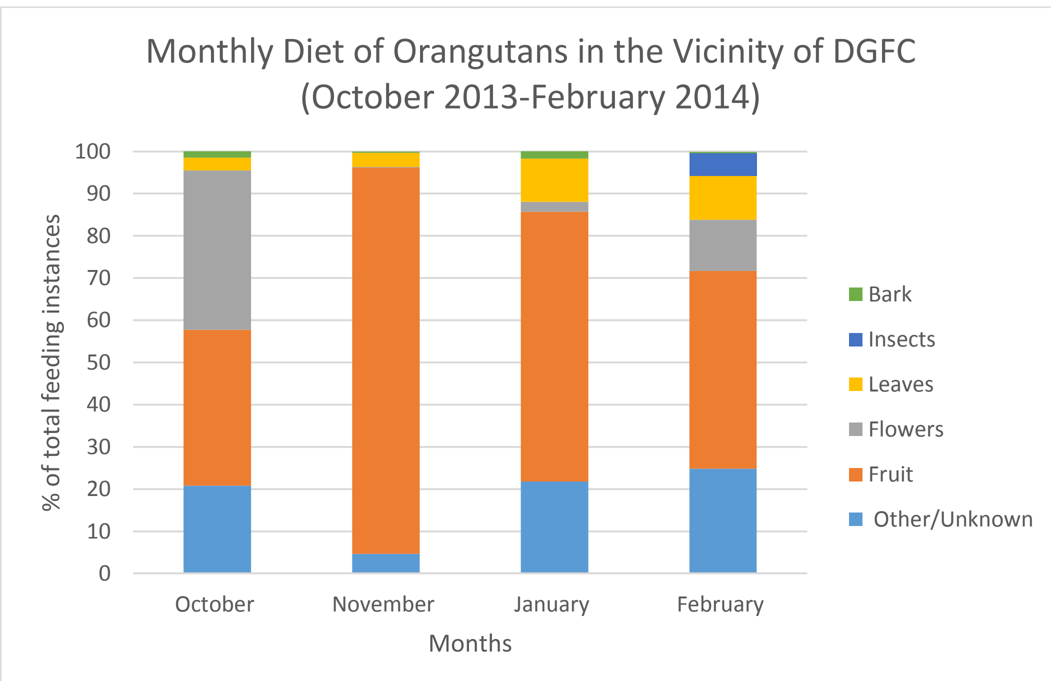

Figure 2: Monthly diet of the individuals from September 2013-March 2014. Data expressed as the percentage of total feeding instances in that month. Only months during which a follow (>3 hours) occurred are represented. Therefore, September, December, and March are not included.

4. Discussion

Overall, the data collected did not have any statistical significance when it came to variations in age/sex classes, possibly due to the small amount of data available. It is important to note the trends demonstrated by the data, as this may indicate some important differences that with further investigation and a longer period of data collection, could turn out as significant.

A compilation of data from study sites in both Borneo and Sumatra serves as a broader context for the data collected in this pilot study (Wich et al, 2009). In respect to mean start and end times, three sites studying *P. p. morio* were compared: Danum Valley, with mean start and stop times of 06:31 and 17:41 respectively (Wich et al, 2009), Ulu Segama, with mean start and stop times of 06:30 and 17:46 respectively (Wich et al, 2009) and Kinabatangan, with mean start and times of 07:45 and 18:08 (Wich et al, 2009). Data collected for this pilot study at DGFC is more similar to Danum Valley and Ulu Segama, with a mean start time of 06:33, rather than to the field site that is also in the Kinabatangan. The mean end time of DGFC orangutans is 17:30, which is earlier than the other field sites. This could be because end time for this study was defined as when building the evening nest began, and therefore the actual length of nesting time could have ended much later. Data for the mean start time and the mean end time were also corrected relative to sunrise and sunset time, which this study did not do. Further data collection at this site should record time of sunrise and sunset relative to start time and end time of the active period, as well as the time of the end of next building when possible.

In respect to the mean length of the active period, Danum Valley and Ulu Segama both had a 676 minute mean length of active period, while Kinabatangan had a shorter mean length of active period at 630 minutes. DGFC had a mean active period length of 677 minutes, which is again more similar to Danum Valley and Ulu Segama rather than its Kinabatangan counterpart. Again, a more robust data set would allow for a more accurate comparison, but it would be interesting to further explore the distinctions between DGFC and its fellow field site in the Kinabatangan to see why they differ, if these differences are significant.

Four sites were compared in describing the average activity budget of *P. p. morio* (Morrogh-Bernard et al. 2009): Mentoko, Kinabatangan, Gunung Palung, and Ulu Segama, which are all mixed dipterocarp forests, similar to DGFC's forest. For all four sites represented in the book, rest behaviors were demonstrated with the highest percentage of the activity budget, while feeding was the second, travel was the third, and other was the least observed. At DGFC, feeding was observed with the highest frequency, followed by resting, traveling and other. Reasons for this difference could be because feeding was easier to see than resting behavior during observations, and therefore when an individual was resting, this behavior could have been recorded as out of view ("OV") rather than rest.

It is difficult to know whether the individuals were fully habituated, and therefore more "natural" behaviors remain unknown for the group observed at DGFC, and the activity budget could be skewed due to this reason. Only a long-term study can give an idea of what is considered natural for the individuals in the vicinity of DGFC, especially since behaviors may fluctuate throughout the year, and these data only give a glimpse of a few months. Time otherwise normally spent resting could have been interfered with kiss squeaking and agonistic behaviors from the focal towards the observer. Therefore, this pilot study lays the groundwork for further investigation of this group.

In terms of diet, Ulu Segama is used to highlight *P. p. morio* diet by month (Morrogh-Bernard et al. 2009). Although twelve months are represented for the Ulu Segama site, we will just compare the four months represented at DGFC. In October at Ulu Segama, fruit was consumed with the highest frequency, while leaves were consumed with the lowest frequency. No other food items were recorded during that month. In November, fruit was consumed with the highest frequency, leaves with the second, and bark with the lowest frequency, and no other food items were recorded for that month. In January, fruit was consumed with the highest frequency, leaves with the second, and bark with the lowest frequency, with no other food items recorded. In February, bark was consumed with the highest frequency, leaves the second highest, fruit the third highest, and invertebrates with the lowest frequency, with no other food items recorded. Flowers were never recorded as a food item at Ulu Segama, while flowers were the highest food item consumed in October at DGFC, and observed being eaten in every other month but November. Bark was consumed with a much higher frequency at Ulu Segama compared to DGFC, with bark observed at most as 1.71% of the total feeding instances at DGFC in a month, and either the 4^{th}, 5^{th}, or 6^{th} highest frequency of food item consumed out of six items. Limitations to this data do exist, as there were limited follows per month. Therefore, in order to gain a better idea of fluctuations in feeding frequencies and items, more data must be collected.

Despite limitations, this study demonstrates that DGFC serves as a good field site to further the study of the behavior of *P. p. morio* in a secondary dipterocarp forest, and can add to the existing data on the Bornean orangutan. The limitations only highlight the potential and need for further research to be carried out. The pilot study demonstrates the need for multiple observers present to collect more behaviors at one time, and also assist in tracking individuals. A lot of time was spent looking for individuals, which limited the amount of time spent collecting data. A year round study with multiple observers would allow a richer database, and better comparisons to other field sites.

5. Acknowledgments

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6. References

Ancrenaz, M., Ambu, L., Sunjoto, I., Ahmad, E., Manokaran, K., Meijaard, E., Lackman,I. (2010). Recent surveys in the forests of Ulu Segama Malua, Sabah, Malaysia, show that orang-utans (*P. p. morio*) can be maintained in slightly logged forests. PLOS ONE, 10.1371/journal.pone.0011510

Ancrenaz, M., Marshall, A., Goossens, B., van Schaik, C., Sugardjito, J., Gumal, M. & Wich, S. (2008) Pongo pygmaeus. The IUCN Red List of Threatened Species. Version 2014.2. www.iucnredlist.org.

"Anthropological Institute & Museum." *UZH*. N.p., 05 Sept. 2012. http://www.aim.uzh.ch/Research/orangutannetwork/FieldGuidelines.html.

Bruford, M.W., Ancrenaz, M., Chikhi, L., Lackman-Ancrenaz, I., Andau, M., Ambu, L., Goossens, B. (2010). Projecting genetic diversity and population viability for the fragmented orang-utan population in the Kinabatangan floodplain, Sabah, Malaysia. Endangered Species Research 12:249-261.

Chapman, A.C. and Peres, C.A. (2001). Primate Conservation in the New Millennium: The Role of Scientists. Evolutionary Anthropology 10:16-33.

Gaveau DLA, Sloan S, Molidena E, Yaen H, Sheil D. (2014) Four Decades of Forest Persistence, Clearance and Logging on Borneo. PLoS ONE 9(7): e101654. doi:10.1371/journal.pone.0101654

Goossens, B., Jalil, C.F., Ancrenaz, M., Lackman-Ancrenaz, I., Mohamed, M., Andau, P., and Bruford, M.W. (2005). Patterns of genetic diversity and migration in increasingly fragmented and declining orang-utan (*Pongo pygmaeus*) populations from Sabah, Malaysia. Molecular Ecology, 14: 441-456.

Hardus M. E., Lameira A., Singleton I., Knott C. D., Morrogh-Bernard H., Ancrenaz M., Utami-Atmoko S. S., Wich S. A. (2009) A description of the orangutan's vocal and sound repertoire, with a focus on geographic variation. In Orangutans (eds Wich S., Utami S., Setia T., Van Schaik C.), pp. 49–64. Oxford, UK: Oxford University Press.

Harrison, M. E., Vogel, E. R., Morrogh-Bernard, H. C., & van Noordwijk, M. A. (2009).Methods for calculating activity budgets compared: A case study using orangutans. American Journal of Primatology, 71, 353–358.

Meijaard E, Buchori D, Hadiprakarsa Y, Utami-Atmoko SS, Nurcahyo A, et al. (2011) Quantifying Killing of Orangutans and Human-Orangutan Conflict in Kalimantan, Indonesia. PLoS ONE 6(11): e27491. doi:10.1371/journal.pone.0027491

Meijaard E, Buchori D, Hadiprakarsa Y, Utami-Atmoko SS, Nurcahyo A, et al. (2012) Correction: Quantifying Killing of Orangutans and Human-Orangutan Conflict in Kalimantan, Indonesia. PLoS ONE 7(3): 10.1371. DOI: 10.1371

Morrogh-Bernard, H.C., Husson, S.J., Knott, C.D., Wich, S.A., van Schaik, C.P., van Noordwijk, M.A., Lackman-Ancrenaz, I., Marshall, A.J., Kanamori, T., Kuze, N., bin Sakong, R. (2009) Orangutan activity budgets and diet. In Orangutans (eds Wich S., Utami S., Setia T., Van Schaik C.), pp. 119-133. Oxford, UK: Oxford University Press.

Nater A, Arora N, Greminger MP, van Schaik CP, Singleton I, Wich SA, Fredriksson G, Perwitasari-Farajallah D, Pamungkas J, Krutzen M. Marked population structure and recent migration in the critically endangered Sumatran orangutan (Pongo abelii). J Hered 2013;104:2-13.

R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.URL http://www.R-project.org/.

Wich, A.S., Atmoko, S.S.U., Setia, T.M., van Schaik, C.P. (2009). Orangutans: Geographic Variation in Behavioral Ecology and Conservation. Oxford University Press Inc., New York.

Wich, S.A., Gaveau, D., Abram, N., Ancrenaz, M., Baccini, A., Brend, S., Curran, L., Delgado, R.A., Erman, A., Fredriksson, G.M., Goossens, B., Husson, S.J., Lackman, I., Marshall, A.J., Naomi, A., Molidena, E., Nardiyono, Ratnasari, D., Santana, A.H., Sapari, I., van Schaik, C.P., Sihite, J., Spehar, S., Santoso, E. Suyoko, A., Tiju, A., Usher, G., Atmoko, S.S.U., Willems, E.P., Meijaard, E. (2012). Understanding the impacts of land-use policies on a threatened species: is there a future for the Bornean orang-utan? PLOS ONE, 7:11, e49142.

Wich, S.A., Meijaard, E., Marshall, A.M., Husson, S., Ancrenaz, M., Lacy, R.C., van Schaik, C.P., Sugardjito, J., Simonrangkir, T., Traylor-Holzer, K., Doughty, M., Sufrianta, J., Dennis, R., Gumai, M., Knott, C.D., Singleton, I. (2008). Distribution and conservation status of the orang-utan (Pongo spp.) on Borneo and Sumatra: How Many Remain? Fauna and Flora International, Oryx, 42(3) 329-339.

7. Appendix

7.1. Identification Sheet for the DGFC Pilot Study

Kawan (K GPS): female; Non-sexually active female between 9-12 yrs (found in September)

Important features: Large bulge at the top of her head, dark face, does not kiss squeak.

Galdikas (G GPS) and **Butir (B GPS)** : Sexually active female and infant male (around 3yrs) (found in early October)

Important Features: Galdikas has a long, oval face and a short forehead. Her eyes are close together and appear "sunken". Butir is small and clings to mother occasionally, but can climb well on his own/often not supported by the mother. He has light rings around his eyes, which may change with age. He has a high forehead, and bald mainly on the middle of his head, with more hair on the sides of his head (again, may change with age).

Butir

Galdikas:


Perongos (P GPS) and Keo (Ke on GPS): Adult female and juvenile male (between 5 and 6)(found in early October)

Perongos:

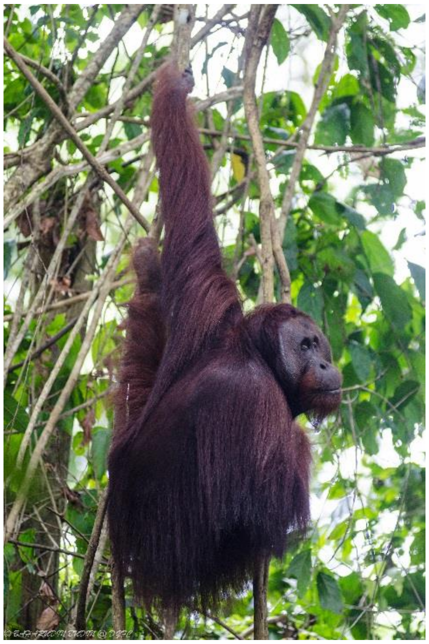
Important features: High forehead, mainly bald in the middle with long hair on both sides that frames her face. Her cheeks are prominent, and she does not have a strong browridge. She has a large bulge on her butt, as pictured.


Keo:

Important features: Oval face, light eyes (may change with age), no prominent brow ridge. Often ranging with Perongos, but builds his own nest and can feed as far as 30m from her.

Hantu (H GPS): Flanged adult male (found late September)

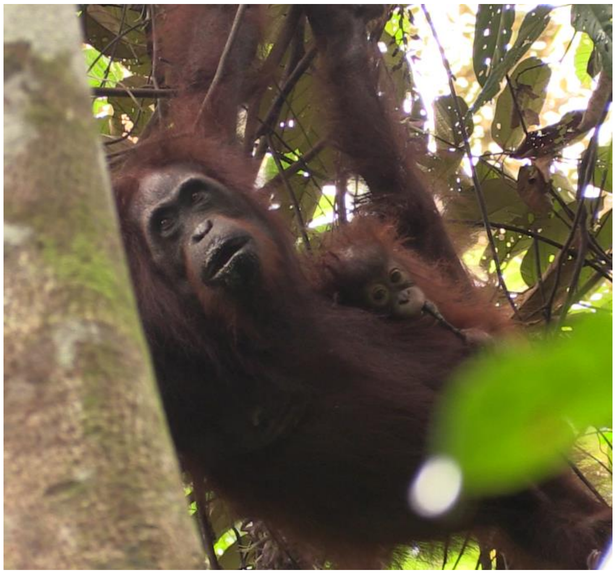
Important features: Flanged cheeks, large, the only adult male found in the area.



Minnie (Sexually active female) with Carlos (C GPS for both) (Infant, female) and Kekasih (KS GPS) (non-sexually active female) Found 11/20/14

Minnie and Carlos (Infant):

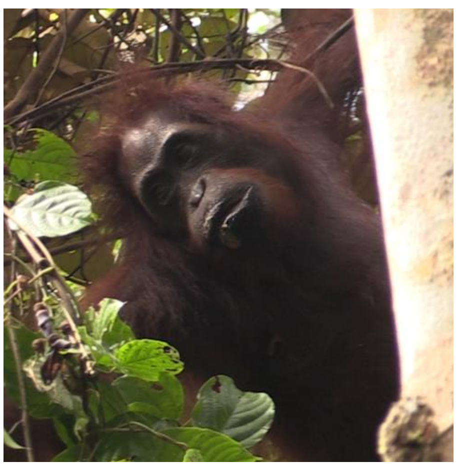
Important features: Minnie has a very strong brow ridge, almost like mouse ears. She has a short forehead, with a lot of hair at the top of her head. She also has a dark face, but light eyelids. Carlos is small and often clings to the mother. She is rarely seen climbing on her own.



Carlos (Infant, female)

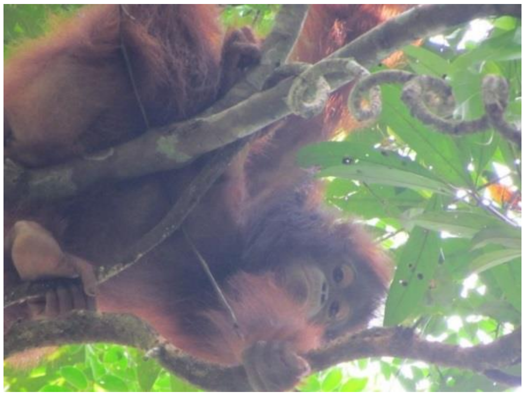
Minnie

Mother of Carlos (unknown if Kekasih and Mother/infant pair related; ranging together occasionally):



Kekasih (non-sexually active female):

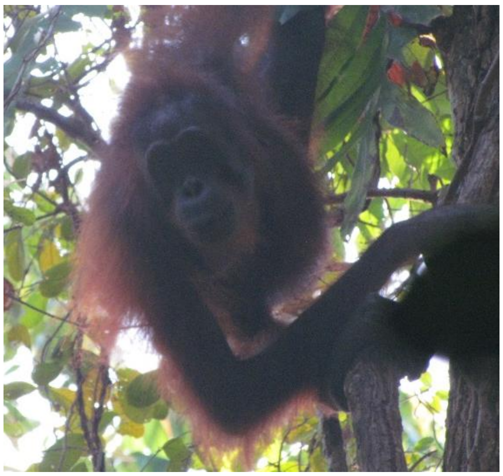
Important features: Light eyes (may change with age), a lot of hair, light orange fur and light mouth. Does not kiss squeak towards observers. Occasionally seen ranging with Carlos and Minnie. Carlos, Minnie, and Kekasih have been seen feeding in the same tree, and Carlos climbed onto Kekasih and was tolerated. Relationship between the three unknown, but possible that Kekasih is Minnie's offspring.

New Mother (NM GPS) with Baloo (Juvenile Male) (NJ GPS) (Found 01/06/14)

New Mother (sexually active female)

Important Features: Kiss squeaks a lot/not habituated. "Receding" hairline, dark face, short hair on head (unlike Perongos, who has long hair at the sides of her head).

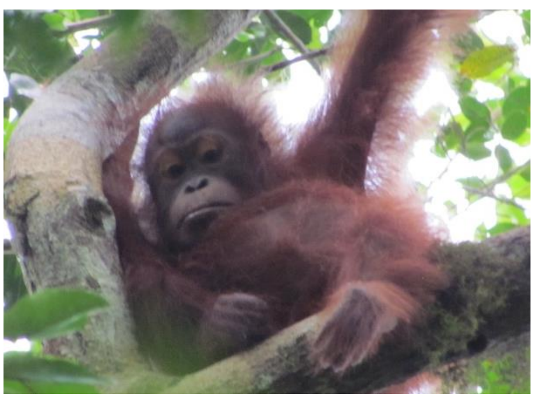
Baloo (Juvenile male)

Important Features: Dark, round head with light eyelids and a large, light mouth. Little hair on the top of the head. Kiss squeaks a lot/not habituated.

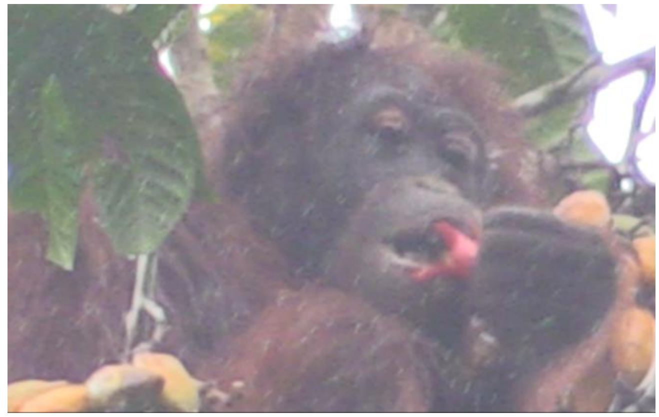
Unknown Juvenile/individual (first seen 03/13/14)

Description: This individual (sex unknown) was seen ranging with Baloo and New Mother on March 13th. He/she played with Baloo for about 2 hours, and was tolerated by New Mother as they played. This individual ranged with them for the rest of the day, within 30 meters, and nested near them. Not seen by observer March 14th. No mother seen by observer with this individual during the follow. Videos of play between Baloo and the unknown individual recorded.

Lari (JF GPS) (non-sexually active female) Found 01/26/14

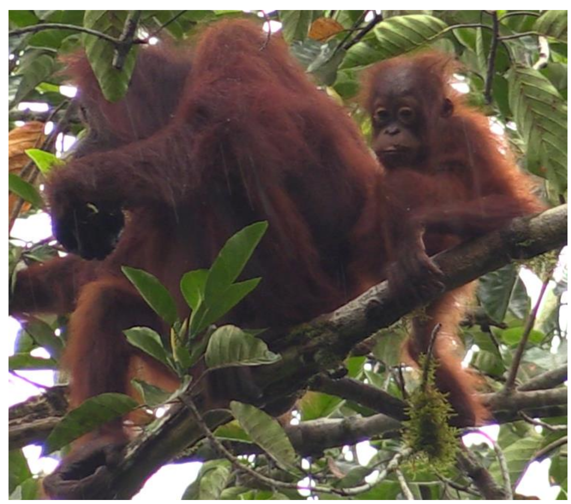
Important features: Light eyelids, strong browridge, short forehead with a lot of hair. Kiss squeaks occasionally.

Tanah (MI GPS) and Malu (infant male) found 02/09/14

Tanah and Malu

Important features: Mother has a dark face with a lot of hair on her head. She does not have a strong browridge. The infant is around Butir's size, but has a darker face and does not have prominent round circles around his eyes. His hair and hands/feet are darker than Butir's. Only followed for an afternoon, and then lost because they went on the ground and it began to rain.

Malu (infant male)

Tanah (sexually active female)