ABUNDANCE, FEEDING AND BEHAVIOURAL ECOLOGY OF ORANGUTANS *(PONGO PYGMAEUS MORIO)* IN THE FRAGMENTED FORESTS OF THE KINABATANGAN FLOODPLAIN

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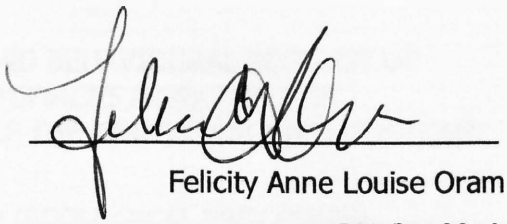
DECLARATION

I hereby declare this dissertation is based on my original work, except for quotations, equations, summaries and references, each of which I have fully acknowledged.



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Felicity Oram
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ABSTRACT

This study characterized core life history determinants, feeding ecology, local abundance variation and population trends of orangutans, *Pongo pygmaeus morio,* in the degraded floodplain of the Lower Kinabatangan River. This is the first long-term comprehensive analysis of wild orangutan survival in a landscape that has been highly disturbed from commercial timber extraction, and greatly fragmented by extensive nearby land conversion. The study also proposed key aspects necessary for orangutan conservation in this region. A novel measure of habituation was established based on feeding-to-resting ratios to build a dataset representative of all age-sex classes, including both more resident animals and transient visitors to the study site. Floristically, the Kinabatangan now has higher baseline fruit abundance with lower synchronous peaks and less extreme seasonality, in sharp contrast to intact primary forest at Danum Valley. Over 50% less cambium feeding activity was observed compared to Danum Valley. Therefore, orangutans in this degraded forest experience less fruit shortfall and less reliance on fall-back foods. This is indicative that sufficient habitat heterogeneity and plant diversity has been retained in this degraded floodplain region to support this large-bodied primate. Also, no correlation between feeding time on fall-back foods (leaves, cambium) and increased daytime rest was found, signifying additional rest for digestive processing of fibrous foods was not required. Mean travel time was significantly shorter than Danum Valley, although mean daily travel distance was not different. This suggests orangutans make use of the extensive vine profusion in this degraded habitat to move laterally with greater efficiency and speed than conspecifics in primary forests. A positive correlation between general forest productivity (shoot production) and unripe fruit production with orangutan abundance and a negative correlation with ripe fruit and orangutan abundance was found. Since studies have shown larger patch size (fruit per unit area) is a key predictor of orangutan movement, more transient individuals (males) likely move away at peak ripeness when resident orangutans and other more selective frugivores begin to also deplete the resource. Overall, localised population trends were stable from 2005-2016 but short-term variation, characteristic of primary floodplains, was still observed. Mean daily travel distances varied in adult male polymorphs (flanged, unflanged) and in females by reproductive status and offspring age, suggesting a possible social constraint to movement that could confound conservation efforts. Therefore, ongoing monitoring is necessary to assure continued access across human transformed landscapes is maintained. Also, further study is warranted of the role female hierarchy and adult male polymorphs play in territorial defence, resource guarding and reproduction that could potentially limit long-term viability in this now highly fragmented mixed-use landscape. These findings also highlight the importance of scientifically rigorous behavioural study if we are to have the proper tools to manage orangutans in an anthropogenic environment.

ABSTRAK

KELIMPAHAN, PEMAKANAN DAN EKOLOGI KELAKUAN ORANGUTAN (PONGO PYGMAEUS MORIO) DI HUTAN TERFRAGMENTASI DI DATARAN BANJIR KINABATANGAN

Kajian ini memerihalkan teras penentu sejarah kehidupan, ekologi pemakanan, variasi kelimpahan tempatan dan trend populasi orangutan, Pongo pygmaeus morio, yang tinggal di dataran banjir terdegradasi di bahagian hilir Sungai Kinabatangan. Kajian ini merupakan kajian analisis komprehensif jangkamasa panjang yang pertama mengenai kemandirian orangutan liar di landskap habitat yang teruk terganggu akibat daripada ekstrasi balak, dan sangat terfragmentasi oleh perubahan guna-tanah yang meluas di kawasan yang berhampiran. Kajian ini juga mencadangkan aspek penting yang diperlukan untuk pemuliharaan orangutan di rantau ini. Satu kaedah baharu untuk mengukur habituasi telah ditubuhkan berdasarkan kepada nisbah makan-dan-berehat untuk membina wakil bagi set data semua peringkat pengkelasan umur serta jantina, termasuk kedua-dua haiwan yang lebih bermastautin dan pelawat sementara ke tapak kajian. Dari segi foristik, Kinabatangan kini mempunyai kelimpahan asas buah yang lebih tinggi dengan puncak sinkroni yang lebih rendah dan kurang kemusiman yang ketara, iaitu sangat berbeza berbanding dengan hutan primer di Lembah Danum. Lebih daripada 50% pengurangan dalam aktiviti pemakanan kambium telah diperhatikan berbanding dengan di Lembah Danum. Oleh itu, orangutan di hutan terdegradasi kurang menghadapi masalah kekurangan buah dan kurang bergantung kepada makanan sampingan. Ini bermakna keheterogenen habitat dan kepelbagaian tumbuhan telah dikekalkan di habitat yang tergredasi. Selain itu, tiada korelasi antara masa pemakanan untuk makanan sampingan (daun, kambium) dan peningkatan masa berehat pada waktu siang, dan ini menunjukkan bahawa tiada masa berehat tambahan diperlukan untuk proses pencernaan makanan berserat. Purata masa untuk aktiviti bergerak adalah jauh lebih singkat berbanding di Lembah Danum, walaupun purata jarak perjalanan harian adalah tidak berbeza. Ini mencadangkan bahawa orangutan memanfaatkan tumbuhan menjalar yang banyak terdapat di habitat terdegradasi untuk bergerak secara lateral dengan lebih cekap dan pantas berbanding dengan orangutan di habitat primer. Terdapat korelasi positif antara produktiviti hutan secara am (penghasilan pucuk) dan penghasilan buah-buahan belum matang, dengan kelimpahan orangutan. Kajian terdahulu menunjukkan bahawa saiz patch adalah peramal penting terhadap pergerakan orangutan, maka terdapat kemungkinan bahawa lebih banyak individu transien (jantan) yang berpindah keluar semasa kemuncak kematangan buah apabila orangutan residen dan haiwan frugivor selektif yang lain mula mengurangkan sumber makanan berkenaan. Secara keseluruhan, trend populasi tempatan adalah stabil daripada 2005-2016 tetapi variasi kelimpahan jangkamasa pendek, iaitu merupakan ciri-ciri dataran banjir primer masih dapat diperhatikan. Purata jarak perjalanan harian yang bervariasi antara individu jantan dewasa polimorf (yang mempunyai pad pipi dan tanpa pad pipi) dan antara betina dewasa, mengikut status pembiakan and usia anak, mencadangkan terdapat kemungkinan wujudnya kekangan sosial dalam pergerakan yang mungkin boleh menghalang usaha-usaha pemuliharaan. Oleh itu, pemantauan yang berterusan sangat diperlukan untuk memastikan akses di seluruh landskap yang terubah oleh manusia dapat dikekalkan. Selain itu, kajian mengenai peranan hierarki individu betina dan peranan polimorfisme yang berbeza di kalangan individu jantan yang berkaitan dengan pertahanan wilayah, pengawalan sumber dan pembiakan yang mungkin berpotensi mengehadkan kemandirian jangkamasa panjang juga adalah diperlukan. Dapatan kajian ini juga menekankan kepentingan kajian tingkah laku secara saintifik yang teliti sekiranya kita ingin mempunyai alat yang sesuai untuk mengurus orangutan di dalam persekitaran antropogenik.

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ASL/asl	–	Above sea level
CI	–	Confidence interval
CITES	–	Convention on International Trade in Endangered Species
D	–	Difficult to Determine or Out of Sight behaviour
DF	–	Dry forest
dFL	–	Dominant flanged males
D_{OU}	–	Orangutan density
F	–	Feeding behavior
F:R	–	Feeding to resting ratio
FBF	–	Fall-back foods
FLO	–	Flowers
FR	–	Total fruit (ripe fruit + unripe fruit)
ENSO	–	El Niño-Southern Oscillation
ESW	–	Effective strip width
Hab	–	Habituated
IUCN	–	International Union for Conservation of Nature
L	–	Leaves
kg	–	Kilograms
km	–	Kilometres
km^2	–	Square kilometres
KOCP	–	Kinabatangan Orangutan Conservation Programme
LKWS	–	Lower Kinabatangan Wildlife Sanctuary
m	–	Metres
ML	–	Mature leaves
MKST	–	Modified Kelker trip transect
mm	–	Milimetres
MNC	–	Marked nest count
NAF	–	Nulliparous adult females
N_N	–	Nest density
N	–	Nesting behavior
O	–	Other behavior
PAF	–	Parous adult female