

Of Pongo, palms and perceptions: a multidisciplinary assessment of Bornean orang-utans *Pongo pygmaeus* in an oil palm context

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Abstract The oil palm industry is blamed for the demise of iconic species such as the orang-utan *Pongo pygmaeus* in Borneo but production of, and demand for, this commodity continue to expand. Therefore, a better understanding of how the orang-utan is adapting to human-transformed environments is crucial for conserving the species. Results from a combination of repeated ground transects, aerial presence/absence surveys, and interviews of workers in mature plantations of the lower Kinabatangan River floodplain (eastern Sabah) provide an overall picture of the current status of orang-utans in an established agro-industrial oil palm landscape. Our results show that orang-utans disperse into mature plantations, use oil palm trees for nesting, and feed on mature fruits. Most oil palm workers report orang-utans of all age–sex classes within the estates but fail to report any negative effect of the animals on productivity of mature palms ≥ 5 years. Our surveys also show that orang-utan presence in the mature oil palm landscape is correlated with proximity to natural forest patches. These results suggest that forest patches, even when small, fragmented and degraded, are required to sustain the species in human-transformed landscapes. Homogenous oil palm plantations are incompatible with viable populations of orang-utans. The cessation of further forest conversion to agriculture and the enforcement of better management practices are needed to reduce the threat of oil palm development to orang-utan survival.

Keywords Aerial nest surveys, best management practices, Borneo, nest decay rate, oil palm plantation, orang-utan, *Pongo pygmaeus*

Introduction

Development of oil palm plantations is a major driver in the destruction of wildlife habitat (Gilbert, 2012; Wich et al., 2012), and orang-utans (*Pongo* spp.) are a focal point of conflict between economic development and environmental conservation (Meijaard et al., 2011a). However, the economic benefit generated by this industry stimulates significant public and political support locally, and industrial expansion is likely to continue (Miettinen et al., 2012). Under current standard practice, industrial-scale agriculture has limited compatibility with conservation of tropical wildlife (Koh & Wilcove, 2008). Although some large protected species have been recorded in oil palm landscapes, such as tigers *Panthera tigris* in Sumatra (Maddox et al., 2007) and elephants *Elephas maximus* in Borneo and Sumatra (Brown & Jacobson, 2005; Estes et al., 2012), it is unlikely that these animals could survive in a pure oil palm landscape in the long term. It is therefore necessary to investigate whether and how the survival prospects of wide-ranging protected and threatened species could be enhanced in these landscapes (Meijaard et al., 2012).

Since 1998 the HUTAN–Kinabatangan Orang-utan Conservation Programme has studied the orang-utan population in the Kinabatangan River floodplain region of eastern Sabah, Malaysian Borneo (Ancrenaz et al., 2004a,b). Given the indirect evidence of orang-utan presence within oil palm plantations (nests, reports from local people), HUTAN and the Sabah Wildlife Department decided to conduct a general assessment of the situation in the oil palm landscape of the Kinabatangan. The majority of the plantations had been established for >5 years and were therefore considered mature.

The main objectives of this work were to determine (1) if orang-utan presence in mature plantations was localized or occurred throughout the entire lower Kinabatangan area; (2) if, when and how far the animals penetrated mature oil palm plantations; (3) if the animals used the palms for

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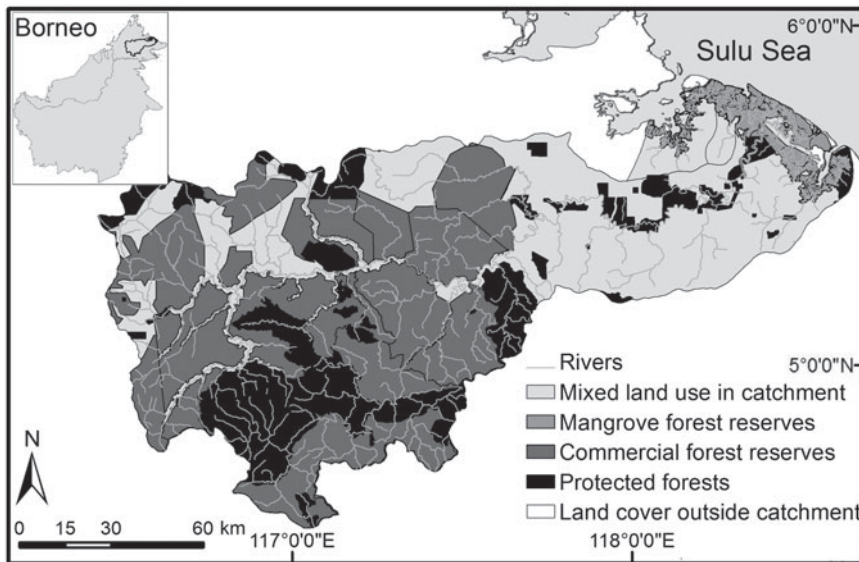


Fig. 1 Forests and non-forest habitats in the Kinabatangan River catchment in eastern Sabah, Malaysian Borneo.

nesting, food or travelling; (4) the decay rate of orang-utan sleeping platforms (nests) in oil palm trees; (5) if the animals caused any form of damage to mature palms; and (6) if plantation workers were aware of orang-utans entering oil palm estates. To fulfil objectives 1 and 2 we used aerial surveys to determine orang-utan presence through detection of their nests in the canopy, following established methods (Ancrenaz et al., 2005). Objectives 1, 2, 3 and 4 were also investigated by regular ground monitoring of an oil palm estate bordered by natural forest. We conducted an interview survey of oil palm workers to better understand orang-utan use of oil palm plantations (objectives 5 and 6), as this approach can produce reliable information about presence/absence and people's tolerance of wildlife (Meijaard et al., 2011b).

Study area

We conducted this research in the lower Kinabatangan River floodplain catchment area (16,800 km²) in eastern Sabah (Fig. 1). Significant changes have occurred since the onset of commercial logging in the early 1960s (McMorrow & Talip, 2001) and only c. 750 km² (4% of the total watershed) of fragmented and degraded forests remain in the lower parts of Kinabatangan. Approximately two-thirds of these lowland forests are protected, comprising the Lower Kinabatangan Wildlife Sanctuary and several Class I Virgin Jungle Forest Reserves. The major land-use matrix outside these forest fragments is composed of extensive oil palm plantations, processing mills, roads, human settlements, small food-crop farms, orchards and patches of degraded forest under private or state ownership.

Methods

A team of four experienced HUTAN staff conducted two aerial surveys in June 2008 and September 2012 in a small helicopter (Bell 206) flying at low speed (c. 60 knots) and low altitude (<100 m above the canopy), following Ancrenaz et al. (2005). We aimed to record the location of small isolated patches of non-protected forest within the oil palm estates and to detect if orang-utan nests were present in these patches. For every forest patch identified during the flights we recorded the following information: (1) location (with a global positioning system); (2) approximate size in four classes: very small (<5 trees), small (>5 trees and < 1 ha), medium (>1 ha but <10 ha), large (>10 ha); (3) stage of degradation of the forest (based on a combination of visual information about canopy closeness, presence of large emergent trees, presence of invasive climbers, and signs of human activity, following Ancrenaz et al., 2005); (4) number of orang-utan nests visible (six classes: none; single, 1 nest; very few, 1–5 nests; few, 5–10 nests; medium, 10–20 nests; many, >20 nests). Because of the small size of the forest patches it was impossible to derive abundance estimates from aerial surveys, and therefore we only assigned presence/absence.

Following several reports of orang-utan sightings in an oil palm estate established in the early 2000s close to the village of Sukau-PPMS (95 houses and c. 600 people) we established five line-transects (300–800 m, total length 2,850 m) within this estate. Inter-transect distance was c. 500 m (Fig. 2). During February 2011–October 2012 the same team surveyed the five transects for sign of oil palm use by orang-utans. Surveys were carried out every 10 days during February–August 2011 (n = 24 visits) and then twice per month (n = 22 visits, with no visits conducted in

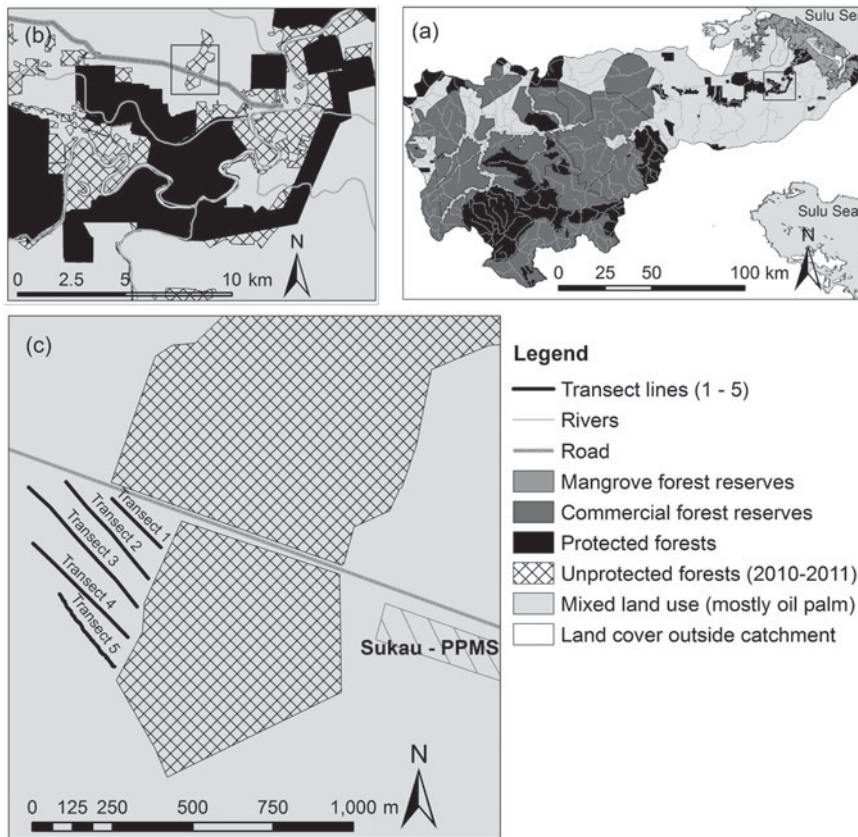


FIG. 2 Five line transects located in an oil palm estate close to the village of Sukau-PPMS (c). The rectangle on (a) shows the location of (b) and the rectangle on (b) shows the location of (c).

December 2011 or January 2012 because of widespread flooding). For each survey, three lines of palms were assessed on each side of the transect baseline (c. 1,700 palms). Sign left by orang-utans included nests, broken or bent leaves, and partially eaten fruits. As it was not possible to determine if damage was caused by one orang-utan or more, or in one or more forays, damage results are descriptive rather than quantifiable. Fifteen isolated non-palm trees (mostly *Anthocephalus chinensis*) that were standing near the transects and within the oil palm estate were also monitored.

Orang-utan nests in palm trees were monitored following Ancrenaz et al. (2004a) to determine their decay rate. A nest was included in our results only if we witnessed its construction ($n = 2$) or detected a strong smell of urine or faeces under the nest ($n = 10$), indicating that it was not more than 1 or 2 nights old (Ancrenaz et al., 2004a).

We conducted a separate experiment to assess the effect of nest-building and leaf destruction on fruit productivity by selecting three oil palm trees with a minimum of five leaves recently damaged by orang-utans for nesting or feeding. As a control we included the five nearest palms without any orang-utan damage ($n = 15$). Once per month we counted the number of fruit bunches still hanging from the palms and those that had already been harvested (indicated by the number of cut stems visible on the palm). We then compared the results for damaged

and non-damaged plants, using a *t*-test in SPSS v. 14.0 (SPSS, Chicago, USA).

During September–November 2011 and June–July 2012 we conducted interview surveys to collect information about the use of oil palm plantations by orang-utans and to document the general perception of orang-utans among oil palm workers in the lower Kinabatangan, following similar protocols and recommendations to Meijaard et al. (2011b). The questionnaire was specifically targeted at workers who spend most of their time within the oil palm landscape itself. A letter of consent issued by the Director of the Sabah Wildlife Department was presented to all estate managers, and an introductory text was read to all survey participants, explaining the objectives of the interviews. The identity of respondents was not recorded, to ensure anonymity and to reduce the likelihood of biased results. The questionnaire comprised a mix of 48 open-ended and closed (single answer) questions in Malay. Eleven questions established the basic demographics of the respondents (age, sex, type of work, country of origin, and how long they had lived in the area). Respondents' reliability was then assessed by presenting photographs of eight animals known to be found in the local landscape. People who correctly identified orang-utans and did not misidentify monkeys as orang-utans were considered reliable. Only these interviews were used in the analysis; all others were discarded. We asked 23 questions about orang-utan sightings (location, time,

number and description of individuals, activities) and 11 questions on general perceptions of orang-utans. We interviewed 560 plantation field workers from 12 commercial oil palm estates (mean 2,500 ha planted), three smallholders and one village bordering a protected forest.

Results

The 2008 aerial surveys revealed the presence of >100 orang-utan nests in the mangrove area located between the sea and newly established plantations further inland (Fig. 3), even though mangroves are generally not considered to be orang-utan habitat (Rijksen & Meijaard, 1999). Some of these nests were located in nipah palms *Nypa fruticans* and others were observed in taller trees (*Rhizophora* sp., *Bruguiera* sp., *Intsia palembanica*). Further towards the interior, away from the mangrove area, we recorded 32 small forest patches that contained orang-utan nests (1–30; >120 nests in total). These patches ranged in size from a single tree to c. 100 ha, and each patch was completely surrounded by oil palm plantations. During the flight we observed that most of these forest patches were located on ground unsuitable for agriculture (limestone, steep slopes, quarries, swamps). All were degraded, without a closed tree canopy, and invaded by pioneer trees, climbers and creepers. We repeated the aerial survey in 2012. Nests were still detected in most mangroves, except in the north-western part of the mangrove forest reserves that had recently been converted

to oil palm monoculture (Fig. 3). Of the 32 non-mangrove forest patches identified in 2008, only 15 patches were still standing in 2012. Fourteen patches had been converted to oil palm plantations and three patches were in the process of being converted. We identified c. 60 nests in 11 of the remaining forest patches (75% of all forest patches identified during our flight).

The 1,700 palms and 15 non-palm trees included in the regular ground monitoring were checked during 46 surveys throughout the study period. To prevent elephants from entering the estate, one plantation owner had cleared an area along the fence line and created a deep dry trench, 2–5 m wide, separating the estate from the forest in late July 2012. No orang-utan sign was detected during August–November 2012 in this plantation and only data collected before July 2012 were included in the final analysis ($n = 42$ point checks).

A total of 36 orang-utan nests were recorded in palm trees (representing 0.05% of the total number of palms monitored during the 42 surveys) and four nests in non-palm trees (c. 0.6%). Orang-utans use the central part of the palm to build their nests, creating a platform of broken leaves to support the inner part of the nest, and bending leaves at the periphery. Bent leaves unfold after a few days or weeks, depending on weather conditions (wind, rain), with no obvious coloration changes. Broken leaves begin to dry after a few weeks and can remain visible for several months in some cases (Plate 1). The mean decay rate was $97.1 \pm \text{SD } 52.1$ days ($n = 12$ nests), with one outlier lasting up to 242 days.

FIG. 3 Locations of orang-utan *Pongo pygmaeus* nests in non-protected forest patches, identified during a 2012 aerial survey of the lower Kinabatangan catchment.



PLATE 1 Orang-utan nest in a mature palm tree.

After removing the outlier the mean decay time was $83.9 \pm \text{SD } 26.0$ days ($n = 11$). The majority of nests were located close to a forest edge or to a patch of trees (mean distance $62 \pm \text{SD } 41$ m), the furthest distance being only 150 m. Leaves broken or damaged by orang-utans as a result of travelling or feeding activities were recorded in 41 palms (0.057% of our total sample size). This type of damage was recorded up to 400 m away from the edge of a patch of trees. Appearance of new nests and damage to palms were highly correlated (Pearson's $r = 0.835$, $P < 0.001$). Most leaf damage and establishment of new nests occurred in the first months of the year but a t -test comparing the number of events in February–June to July–November did not indicate any significant temporal differences ($t = 1.52$, $\text{df} = 10.27$, $P = 0.159$). A t -test comparing the mean number of fruit bunches produced by damaged trees ($n = 42$, mean = $6.6 \pm \text{SE } 0.38$, 95% CI 5.82–7.37) and non-damaged trees ($n = 210$, mean = $7.33 \pm \text{SE } 0.245$, 95% CI 6.84–7.83) did not show a statistically significant difference between the two samples ($F = 0.562$, $t = 0.311$, $P = 0.757$).

Of 560 interviewees, 214 reported seeing an orang-utan at least once. Of these 214 respondents, 156 (27.8% of the general total) were considered reliable. Of the 156 reliable respondents, 141 (90.5%; mean age $31.4 \pm \text{SD } 10.3$ years)

reported having seen an orang-utan within the local oil palm plantation or its immediate surroundings. Ninety-two informants (65.2%) reported an orang-utan sighting within the previous 2 years and 103 (73%) reported a sighting within the previous 3 years, indicating that most of the sightings were relatively recent although most palm estates had been established for >25 years. Forty-two respondents (29.8%) reported seeing an orang-utan within homogenous oil palms. Seventeen people (40% of those that reported sightings within contiguous oil palm) reported sightings of animals in the oil palm trees, with the remainder reporting sightings of animals walking or running on the ground (two orang-utans were reported crossing the main paved road leading to Sukau). Sightings indicate that all sex–age classes are present within this landscape: 55 reliable reports of a single non-flanged individual of unknown sex, 12 of adult females with a clinging baby, three of an adult female with an accompanying juvenile, and 14 of a flanged male. The majority of workers (97 respondents; 68.8%) said that orang-utans caused no disturbance in mature palm trees except for breaking leaves, which was considered of little or no consequence to palm productivity, reinforcing the findings of our own experiment.

Discussion

Aerial and ground surveys show orang-utan nests in forest patches and isolated trees throughout the entire oil palm matrix of the lower Kinabatangan floodplain, as well as in oil and nipah palms. Although our regular ground monitoring suggests that orang-utans preferentially select non-oil palm trees for nesting within a plantation, oil palms are also used for this purpose. Orang-utan nests built in oil palms are similar in form and shape to those built in nipah palms in mangrove areas (MA, pers. obs.) or chimpanzee nests in native wild oil palm trees in Guinea Bissau (Sousa et al., 2011). The nest decay rate in oil palms is short compared to other tree species (Ancrenaz et al., 2004a). Orang-utans also use oil palm as a food source, consuming young shoots and ripe fruits picked from bunches on the ground or on the palm (we witnessed this behaviour directly on one occasion). Undigested oil palm fruits were also detected in several orang-utan faeces samples (KOCF, unpubl. data). Our results also indicate that the destruction of leaves by orang-utans in mature palms (i.e. >5 years old) has no effect on fruit productivity. In contrast, a high rate of damage caused by orang-utans to young palms <4 –5 years of age has been recorded in areas of new land conversion (Yuwono et al., 2007).

Circa 90% of orang-utan sign identified within oil palm plantation was found within 50 m of forest patches, suggesting orang-utan distribution within an oil palm estate depends on the presence of natural forests and non-palm trees. Although orang-utans can move from palm to palm

arboreally, they often walk on the ground to move through an oil palm plantation or to cross roads and open areas quickly when disturbed by people. Moving on the ground is quieter than moving through the palm fronds arboreally so this may be an adaptive response to avoid detection (authors, pers. obs.). But increased terrestrial locomotion in a human-made vegetation matrix may increase conflict with people, susceptibility to hunting and exposure to new diseases (Loken et al., 2013; Ancrenaz et al., 2014).

Our unexpected findings of use of oil palm areas by orang-utans are reinforced by the relatively high encounter rate between oil palm workers and orang-utans within this agro-industrial landscape. The percentage of reliable respondents who reported sightings in the oil palm plantation landscape (90.2%) is significantly higher than the percentage of local people who, during a general interview study, reported having seen wild orang-utans in the forests of Kalimantan (42%; Meijaard et al., 2011a,b). Orang-utans appear more resilient to habitat changes than was originally thought: apparently viable populations are found in commercial forests exploited using reduced-impact logging practices in Sabah (Ancrenaz et al., 2010); significant numbers of individuals are found in acacia plantations in East Kalimantan (Meijaard et al., 2010); and stable groups have been living in a mosaic of mixed agriculture and forest in Sumatra for >20 years (Campbell-Smith et al., 2011a,b).

However, these results do not suggest that agro-industrial environments can sustain orang-utans. Long-term study is needed to monitor the changes in the number of orang-utan sightings with the age of the plantation or the time since forest clearance, and to document whether this landscape can accommodate orang-utans and provide safe passage for dispersal between forest fragments.

In the early 1960s the lower Kinabatangan floodplain was covered with forests and the overall orang-utan density was at least 0.5 per km² (Yoshihara, 1964). Based on this conservative estimate there were >4,000 orang-utans in the forests of the lower Kinabatangan (c. 8,000 km²) before their conversion to agriculture. Recent estimates indicate that there are c. 800 orang-utans remaining in the lower Kinabatangan (Ancrenaz, unpubl. data), and genetic analysis shows that this population has declined by >95% in the last 100 years (Goossens et al., 2006). These results show that converting forests occupied by orang-utans to oil palm plantations is a major threat to orang-utan survival; the majority of the resident orang-utans are either killed outright (Wich et al., 2012) or starve; neither young oil palm shoots nor mature oil palm provides a sufficient food source for such a large mammal. We can therefore assume that most orang-utans sighted in the plantations today belong to the original Kinabatangan meta-population, which is now fragmented as a result of forest conversion to agriculture. These animals may have lost their original home territory

when the forest was destroyed or they may be dispersing between fragmented forest patches in search of food or mating opportunities. Long-term monitoring of orang-utan presence and distribution is needed to ascertain if these animals are part of a declining remnant population or if they can be self-sustaining within the agro-industrial/degraded forest matrix. This study indicates that the presence of small natural patches is essential for orang-utan survival but further study is needed to establish how conservation of this nationally and internationally protected species can be assured within a mixed-use landscape.

There are already relevant recommendations for minimizing the negative effect of oil palm development on orang-utan survival (RSPO, 2007; Dennis et al., 2010). Our results emphasize the value of patches of forest within an oil palm landscape for orang-utan conservation, irrespective of their size and degree of degradation. This must be recognized and acknowledged by government planners and policymakers, the scientific community, the private sector and all land-users. Forest patches and corridors must be identified, marked and set aside before any new development takes place, with a view to maintaining ecosystem functionality and meta-populations of wildlife (Koh & Wilcove, 2008; McShea et al., 2009; SWD, 2012). These patches should not be converted but incorporated in land-use plans as ecological set-asides, and appropriately managed. Planting non-palm trees throughout an agro-industrial oil palm landscape will increase food opportunities for wildlife and create possible nesting sites for orang-utans. Trenches and strips of bare land seem to deter orang-utans from entering oil palm plantations and could physically separate plantations from forests inhabited by orang-utans, to mitigate conflicts when plantations are newly established. When palms become more mature these trenches could be bridged to allow orang-utans to move across the mature oil palm landscape. Orang-utan survival in highly modified landscapes is dependent on human tolerance towards them (Wich et al., 2012), and hunting will threaten the survival of these populations (Marshall et al., 2009). A zero-tolerance policy on the killing of orang-utans and other harmful acts needs to be strictly enforced at all management levels. Finally, thorough and regular monitoring of orang-utan presence and of the condition of forest patches needs to be implemented in all oil palm estates within the orang-utan range. All sightings of orang-utans and other protected wildlife should be reported by oil palm workers to their team leaders and a proper flow of information needs to be established between field operation management and wildlife authorities.

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Biographical sketches

For 15 years orang-utan conservation in Sabah has been led by the HUTAN–Kinabatangan Orang-utan Conservation Programme (KOCP), the Sabah Wildlife Department and other partners active in Kinabatangan and throughout the state. MARC ANCRENAZ and ISABELLE LACKMAN established HUTAN/KOCP in 1998 and have promoted orang-utan conservation at the landscape level throughout Sabah since then. FELICITY ORAM, EDDIE AHMAD and HAMISAH ELAHAN are part of the KOCP team that studies wild habituated orang-utans at the KOCP intensive study site and in surrounding oil palm estates. LAURENTIUS AMBU is the director of the Sabah Wildlife Department and oversees the Lower Kinabatangan Wildlife Sanctuary. HARJINDER KLER and NICOLA ABRAM are involved in the development of a strategic conservation plan for orang-utans in the agro-industrial landscape of the Kinabatangan. ERIK MEIJAARD has been working on orang-utan and general conservation issues in Borneo for many years.