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Exploring Conservation Management in an Oil-palm Concession

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Abstract: Tropical oil-palm plantations are considered a major threat to threatened wildlife, including the Critically Endangered Bornean Orangutan *Pongo pygmaeus*. We review the management intervention of one oil-palm company in Indonesian Borneo that developed a plantation in an area with a wild orangutan population. Through setting aside and effectively protecting natural forest areas, the company now protects a population of ca. 150 orangutans. Further and improved management is needed to increase the likelihood that this population can survive in the long term. This specifically requires retaining connectivity to other orangutan habitats around the plantation through landscape-level, multi-stakeholder planning and improved protection of remaining habitats. We conclude that through its oil-palm development the company has had a negative impact on the local orangutan population, although this needs to be weighed against the counterfactual of what would have happened to the forests had no oil-palm been developed. Lessons learned from this case study provide important insights into how orangutans and their habitats could be protected in the kind of multi-functional landscapes in which some 70% of all remaining orangutans occur.

Keywords: Borneo, Conservation, Deforestation, Oil-palm, Orangutan

1. Introduction

Many conservation scientists and practitioners consider the palm-oil industry a major threat to the conservation of tropical biodiversity [1-3]. From the 1960s onward, oil-palm (*Elaeis guinensis*) plantations have expanded rapidly, especially in Malaysia and Indonesia, and often at the expense of tropical rainforest [4, 5]. The industry is also expanding in tropical Africa and America with potentially large impacts on tropical forest species [6-8]. Oil-palm produces up to seven times more oil than other oil-producing crops [9], and there is a growing global demand for vegetable oil for both food and biofuel [10, 11]. Furthermore many farmers and governments in tropical regions consider the crop an important driver of economic development with high potential for local income generation [12, 13]. It is therefore unlikely that the expansion of the crop in the tropics will slow in the foreseeable future.

To reduce the impact of oil-palm expansion on biodiversity, many conservation practitioners and scientists have called on governments in producer countries to stop further development of the industry and on governments of consumer countries to reduce imports [9, 14-16]. Other approaches include the redirection of the industry away from forests and to focus its development on ecologically degraded areas [17, 18], or the development of more sustainable approaches to oil-palm management that would reduce

impacts on biodiversity [19-22]. Calls for such increased sustainability in the industry resulted in the launch in 2003 of the Roundtable on Sustainable Palm Oil (RSPO), but this initiative has so far not been able to significantly improve on-the-ground practices of planning and implementation [23, 24]. For example, the expansion of the oil-palm industry into forest areas on Borneo, South-East Asia, has increased despite a range of government commitments, including a moratorium on new oil-palm licenses in forest areas, and sustainability initiatives aiming for the opposite [4, 8]. It appears that so far none of the approaches—banning of oil-palm development, restricting it to degraded areas, or developing it in a more sustainable manner—have succeeded in significantly changing the way oil-palm development is implemented.

Recently there has been much focus on better landscape level planning to guide oil-palm development [25, 26]. An often employed tool in the planning stage of responsible oil-palm development is the identification of High Conservation Values (HCV), which the company subscribing to sustainability principles is supposed to maintain. It has been argued, however, that the criteria of this tool do not provide adequate protection for biodiversity when applied to agriculture, because the HCV forest areas that are set aside are often too small [27]. Individual oil-palm estates vary in size but are often around 20,000 ha. With even good companies rarely setting aside much more than 20% of their estate for conservation, remaining forest blocks generally range from a few hundred to a few thousand hectares in size. Such areas might be sufficient to retain viable populations of species with small ranges and high densities, but might be insufficient for low-density species with large ranges. Connecting individual forest blocks through ecological corridors could increase the effective area through which species can range, especially if connected to larger forest blocks outside the estate [28]. Such ecological corridors, however, tend to suffer from edge effects and are often ecologically degraded. This warrants the question whether individual oil-palm companies can realistically contribute to biodiversity conservation within their own plantations.

Here we assess what one particular oil-palm company in Indonesian west Borneo has done for biodiversity and whether this can be considered a positive contribution to biodiversity conservation. We study the impact of oil-palm development in the company's area on the local population of Bornean orangutans (*Pongo pygmaeus*). The Bornean orangutan is now listed by the IUCN as Critically Endangered [29], having declined by an estimated 29% between 2004 and 2014 [30]. Orangutans are a low density species with relatively large ranging requirements, and because of their very slow reproduction, highly vulnerable at the population level to unnatural mortality (e.g., conflict killing or hunting) [31]. Large areas of oil-palm have been developed in the orangutan's distribution range [32, 33], and the industry is generally considered a major factor in the species' decline [34]. If an oil-palm company can maintain a viable population of orangutans within its concession area, or in the broader landscape context around the plantation, it would demonstrate the potential role that the industry could play in biodiversity conservation, and what is required from individual estates to effectively play that role. Our study thus contributes to the broader discussion on the sustainability of the oil-palm industry, and what such sustainability concepts mean in terms of longer term conservation objectives.

2. Methods

2.1. Description of Company

PT Kayung Agro Lestari (hereafter referred to as KAL), is a limited liability company established under the laws of the Republic of Indonesia and part of the PT Austindo Nusantara Jaya (ANJ) Agri, a diversified agribusiness group, and a member of the RSPO (see http://www.rspo.org/members/150/PT-Austindo-Nusantara-Jaya-Agri). Its KAL oil-palm license area of 17,998 ha lies in the Ketapang District, West Kalimantan Province, Indonesia, and is part of a heterogeneous landscape comprising fragmented remnant natural forest with the ca. 54,000 ha Sungai Putri peat swamp to the south and the ca. 90,000 ha Gunung Palung National Park to the north (Figure 1). The KAL license area was part of a large logging concession (PT Marsela Wana Sekawan) between 1990 and 2000, and the primary land cover prior to oil-palm development was logged-over natural forest (about 8,000 ha) and the remainder degraded land including frequently burned grasslands on sandy soils [35]. Land clearing in the concession area started in 2010 and in September 2016, 12,061 ha had been planted with oil-palm. The areas not planted with oil-palm and not used for infrastructure, mills, offices, and houses have been set aside in a number of protected forests, riverine protection forests (50 m on either side of rivers), and other forest areas which were enclaved for agricultural or cultural reasons at the request of surrounding communities, and for a bauxite mining claim that overlaps the oil-palm license area.

KAL is in the process of applying for RSPO certification. This requires independent verification of the implementation of management that maintains the HCVs. One of the focal species for HCV management in KAL is the Bornean orangutan. Maintaining orangutans requires that the key threats of forest loss and degradation and killing are addressed [36], for example by setting aside protected forests areas in the estate as identified in the HCV assessment, implementing anti-poaching programs and reducing other threats such as illegal logging, fire and snaring.

2.2. Review of Conservation Measures

Two of the authors (GCS and EM) provided input to KAL in a series of field visits between May 2012 and October 2016, which resulted in recommended management practices that were subsequently implemented by the environmental manager (Nardiyono, NA) and his team at the estate. The recommendations included the protection and management of forest set asides, the development and implementation of an

ecological connectivity plan, prevention of illegal logging, prevention of hunting and snaring, fire prevention and fighting, development and implementation of standard operational procedures with regard to encounters of orangutans and other wildlife, training of plantation workers and staff, and crop damage control. We did not employ a formal impact analysis of the extent to which recommended management led to conservation impact, but the qualitative and quantitative data collected by the group are sufficient to draw preliminary conclusions.

2.3. Determining Orangutan Distribution and Numbers

Surveys to determine the distribution and abundance of orangutans in the forested areas of KAL were undertaken during a period of 10 days in December 2015 by an expert survey team with many years' experience (Table 1). These surveys were divided between two separate regions of the concession: (a) southern forest block, an area of peat forest entirely designated as HCV and contiguous with the Sungai Tolak forest outside the concession to the south, which in turn connects to the large Sungai Putri forest; and (b) north-western forest block, an area of peat forest, part of which is designated as HCV, contiguous with the community forest of Kuala Satong. The latter area is separated from Gunung Palung National Park by a road and adjacent development (Figure 1). In addition to these surveys, nest transect surveys following the same methodology were undertaken between 10 and 20 October 2012 in the north-western block alone. We add these survey data to understand local population trends.

Table 1. *Survey Transects as indicated in Figure 1, their date of survey, length and number of orangutan nests encountered.*

Transect Number	Date	Transect Length (m)	Number of Nests
South			
T1	03/12/2015	1100	39
T2	04/12/2015	1000	17
T3	04/12/2015	820	37
T4	05/12/2015	1060	55
T5	06/12/2015	1080	44
T6	07/12/2015	860	61
T11	07/12/2015	1000	33
T8	08/12/2015	1100	40
T7	08/12/2015	1000	18
T9	09/12/2015	1100	63
North-west			
T15	10/12/2015	1100	79
T14	10/12/2015	1100	40
T13	12/12/2015	1100	30
T12	12/12/2015	440	16
TOTAL		13860	572

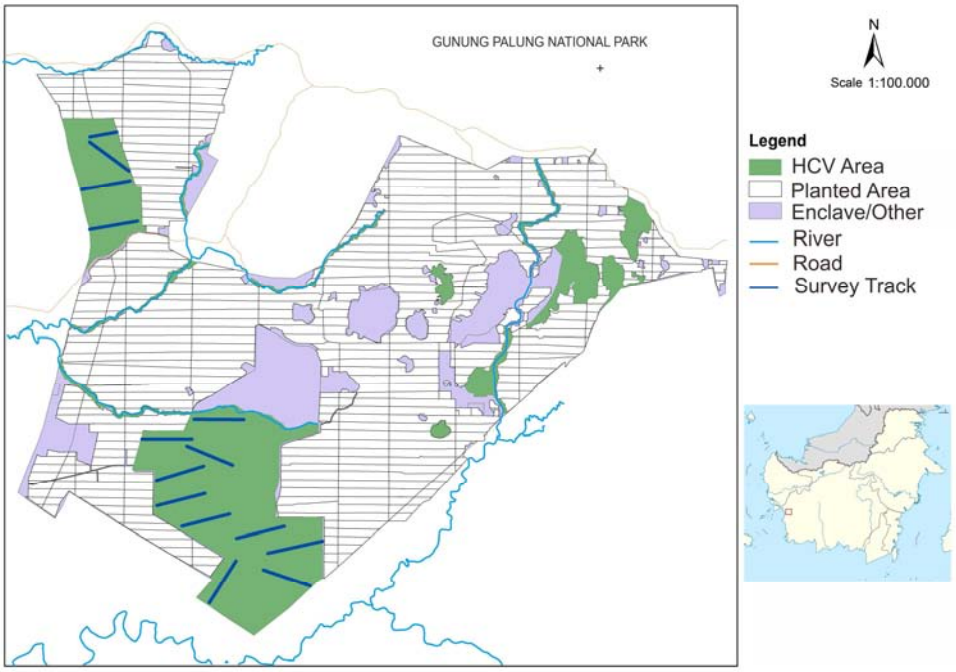

Figure 1. *Survey Locations in both High Conservation Value forest blocks in KAL: 4 in north—western region and 10 in the southern region.*

Orangutans were surveyed using standardised nest survey methods involving counts of nests along straight line transects [37, 38]. The field team slowly walked straight line transects searching for orangutan nests. These are large, round, flat platforms of leaves and branches which orangutans build each night, and sometimes during the day, for sleeping or resting. Each nest was photographed, mapped and the perpendicular nest-to-transect distance measured.

The survey team walked 14 transects (10 in the southern block and 4 in north-western-block), a total of 13.86 km, between the two surveys, encountering 572 orangutan nests (Figure 1), along with sightings of two young adult orangutans, one male and one female.

We estimated nest density by dividing the number of nests

counted by the survey area, using the DISTANCE software program to estimate the strip width. Nest density (DN) is converted to orangutan density (DOU) using the following formula [37, 38]:

$$DOU = DN / (p \times r \times t) \times \alpha$$

where

p = 0.89, the proportion of nest-builders in the population (1)

r = 1.16, the average number of new nests built per day per orangutan (2)

t = 365, the habitat-specific number of days that nests remain visible in the environment (3)

α = 1.49, a conversion factor to calibrate survey results using single-walk transect surveys (4)

3. Results

3.1. Key Conservation Measures

As an RSPO member, PT Austindo Nusantara Jaya Agri, the company that owns KAL, is committed to the Principles and Criteria of the RSPO [39]. In 2013, KAL commissioned an HCV assessment, which was conducted by the Bogor Agriculture Institute. The result of this assessment identified 3,884 ha (21%) of the KAL concession as a High Conservation Value area, requiring management that retains these values. One of the important species identified during the assessment was the orangutan, which occurred in several of the recommended forest set asides in the concession, and also in neighbouring forest areas. A first priority for KAL was therefore to ensure that the forest in the HCV set asides was protected and remaining orangutan populations as safe as possible. For this, KAL developed a memorandum of understanding with International Animal Rescue Indonesia (IAR), who subsequently assisted in the development of management guidelines and standard operational procedures, and provided training to concession staff for implementing these guidelines and procedures.

The main threats to orangutans in KAL were illegal logging and fires. As witnessed on return visits to the concession between 2012 and 2016, KAL effectively managed to halt illegal logging in their concession. During a field visit in 2013, three of us (EM, GCS, and NA), counted 54 illegal logging trails and 11 active illegal logging camps along a 3 km road through the southern HCV area [40]. During two subsequent visits in 2015, no signs of logging were either seen or heard in any of the HCV areas in KAL. KAL used a non-confrontational approach to reduce illegal logging, which involved near-daily visits, sometimes involving local police and conservation authorities, to as many illegal logging camps as possible, reminding workers that the forest belonged to the concession and that removing timber was not permitted. Also, all timber trucks and their timber loads leaving the concession were recorded by the concession and data were shared with the conservation authorities and local police. One by one, all illegal loggers halted their operations in the concession until none were left. KAL allocated a 10-person team for regular patrolling to ensure no illegal loggers returned and also to check forests for potential poaching or snaring activities.

Fires are another major threat to both the conservation set asides and the planted oil-palm areas. Nearly every year during the dry season, fires escaping from adjacent scrub lands and small-holder farming areas, cause damage to the planted oil-palm and sometimes the HCV set asides. For example, during the extremely dry conditions of the 2015 El Niño, KAL lost 200–300 ha of planted oil-palm, while one fire severely damaged several hundred ha of conservation forest. The company spent ca. US$ 350,000 on fire-fighting during this event, involving 450 local villagers and company staff, and now keep a permanent staff of 33 people who work as fire rangers. Fires remain a danger in the concession though, and one fire in forest set asides, especially in highly flammable peat areas, can easily set back several years of forest protection.

The use of snares is widespread in Kalimantan's forests, and snares were regularly found in and around the KAL concession. Such snares can be a danger to orangutans too, as was shown in the community forest adjacent to the north-western forest block, where an orangutan was caught in a snare in 2012, resulting in its rescue but also amputation of its hand. HCV forest areas are regularly checked for snares. KAL staff regularly patrol the conservation areas and between January 2013 and August 2016 they found 7 snares inside these forests.

To accommodate orangutan movement both within the concession and between the concession and surrounding forest, KAL is implementing measures to connect all the HCV areas in their concession through a network of riverine forest set asides, forest corridors, and mechanical means such as rope bridges crossing roads. This work is in progress and the impacts on population dynamics and survival remain untested.

Orangutans can cause significant damage to young palms [8, 32]. KAL implemented several strategies to mitigate these impacts, especially focusing on recently planted areas. This included the digging of drainage ditches between forest set asides and newly planted areas. The assumption was that orangutans are reluctant to cross these ditches, being generally afraid of deep water. Field observations indicated that these ditches provide only partial protection to newly planted palms because often the ditches become passable when fallen trees provide a bridge. In addition, KAL therefore frequently survey newly planted areas to spot orangutans and other species that damage young palms (e.g., porcupines and pigs). When orangutans are spotted among the palms, the field staff use non-projectile firing noise makers [41] to drive orangutans back into the forest. Hand-held firecracker cannons were locally manufactured from bamboo and tin and used calcium carbide to produce a loud noise. These cannons were only fired if orangutans were found crop-raiding within the concession.

Finally, KAL implements a reforestation and forest enrichment program to improve the habitat quality in the forest set asides. This involved planting fast-growing and hardy native tree species, such as *Ficus microcarpa, Dillenia excelsa, Durio* spp., *Arthocarpus champeden,* and *Nephellium lappacium*.

3.2. Orangutan Population Estimates

The 572 nests found during the transect surveys (407 in southern HCV; 165 in north-western HCV) were classified according to age classes: A (new, <1 week) 37 (6%); B (recent, <3 months) 38 (7%), C (older) 121 (21%), D (advanced degradation) 188 (33%), E (no leaves remaining) 188 (33%). The total area of remaining swamp forest in the two HCV areas was ca. 3,000 ha, of which 2,400 ha is in the southern region, and 600 ha in the north-west forest block.

We used the following inputs in the DISTANCE analysis. We truncated the statistical outliers (furthest 5% data), and selected between multiple models based on their lowest AIC value. We selected a uniform + cosine adjustment for modelling densities in the southern region, and a hazard rate + cosine adjustment for the north-western block. Estimated strip width was 16.48 m (S) and 12.38 m (NW). Based on this we found an overall orangutan density of 5.49 (± 1.12) individuals/km^2, with a density of 4.50 (± 0.61) individuals/km^2 in the southern block and 6.99 (± 1.89) individuals/km^2 in the north-western block. Based on these density estimates and the size of the forest areas, we estimated a total orangutan population size for the two HCV areas in KAL of 150 individuals (± 25), with 108 individuals (± 14) in the 2,400 ha southern block and at least 42 individuals (± 11) in the 600 ha north-western block.

4. Discussion

4.1. Current Orangutan Abundance in KAL

The overall orangutan density of 5.49 (±1.12) individuals/km^2 is exceptionally high, higher than may be expected to occur naturally in this region [37]. One note of caution regarding this estimate is that we used a standard decay rate for peat swamp forests (365 days). 2015, however, was an exceptionally dry year and one of Indonesia's worst fire years in recent history [42, 43]. Microbial and other biological activity that drives nest decay slows down under such dry conditions generally resulting in longer decay rates [44]. We could thus have underestimated decay rates, and because these are directly proportional to density estimates [45], we could overestimate these densities, possibly by 10% based on longest known decay rates from Gunung Palung National Park, just to the north [46]. Even when this is corrected, a density of around 5 individuals/km^2 would be much higher than average for such habitat conditions [37].

We provide a more detailed analysis of each sub-population separately. The southern HCV area has an estimated density of 4.50 (±0.61) individuals/km^2 which extrapolates to an approximate population of between 90 and 125 individuals (estimated, 108 (± 14) individuals)) inside this part of the concession. Based on maps provided and satellite imagery from Google Earth, the Southern HCV block covers approximately 2,330 ha of which 2,200 ha remains forested. Combined with remnant forest inside the concession but outside the HCV block, including part of a planned bauxite mining area, there are approximately 2,400 ha of forest available for orangutans. This forms part of a larger forested area of approximately 4,200 ha which extends south outside the concession to Sungai Tolak (Figure 2). Assuming these densities are the same outside the concession, the entire forest block may support 189 (±25) individuals and is completely contiguous with the ca. 54,000 ha Sungai Putri forest where 2013 surveys by IAR and the Orangutan Tropical Peatland Project identified an orangutan density of 2.91 individuals/km^2, suggesting the possible presence of up to 1,500 orangutans.

We believe that several of the ca. 189 orangutans in Sungai Tolak have already made the journey south across the Tolak River to escape the overcrowding and thus the population may currently be lower than the above estimate. Nevertheless, the population density is high and whether it can be sustained at this level depends on efforts to protect and restore the remaining forest. Eleven orangutans have been translocated into this region. We advise that further translocations into an already overcrowded population are unlikely to be successful and options of translocating into larger areas of forest such as Sungai Putri or Gunung Palung may have more chance of success.

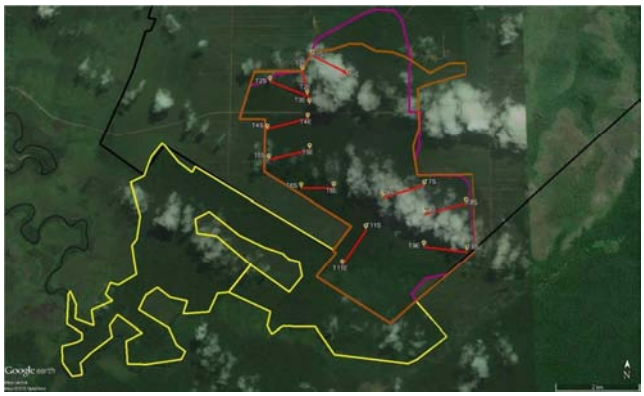

Figure 2. *Orangutan habitat in South KAL. The area with the brown border is designated HCV. The overlapping area bordered in purple is the actual forest cover in and around this HCV. The area bordered in yellow is contiguous forest cover outside the concession. The yellow and purple areas combined, measure 4,200 ha in area.*

The north-western HCV block has an estimated density of 6.99 (±1.89) individuals/km^2. This is an exceptionally high density and very likely a result of severe overcrowding, caused by habitat clearance for plantation development, clearance of forest outside the concession and forest fires. This much is indicated by comparing the 2015 surveys with surveys conducted by the company in October 2012, which initially estimated at density in the north-western HCV block of 4.36 individual/km^2 [47], which we reassessed at 2.46 individuals/km^2 after correcting strip-width estimates. At that

time, the north-western HCV block still extended outside the company boundaries into community forest, but fires and land clearing by communities in 2015 destroyed large areas of these community forests, as well as parts of the HCV itself. Based on maps provided and pre-fire satellite imagery from Google Earth, the north-western HCV block covers approximately 664 ha and at most 600 ha is still forested after the fires (Figure 3) a loss of 64 ha of forest. We estimate that this total forest block (in and outside the concession) was about 1,600 ha prior to recent land clearing and fires and that currently at least 57 (± 15) orangutans are compressed into the remaining 820 ha, including 42 (± 11) crowded into the 600 ha of forest inside the concession (see Figure 3).

Figure 3. *Orangutan habitat in North-west KAL. The area with the brown border is designated HCV. The overlapping area bordered in purple (600 ha) is the actual forest cover in and around this HCV. The area bordered in yellow is contiguous forest cover outside the concession. The yellow and purple areas combined, measure 820 ha in area.*

4.2. Historical Context Impacts Orangutan Populations

The KAL concession area was formerly part of a much larger forest, presumably with a large resident population of orangutans distributed throughout [48, 49]. A large proportion of the original forest in these two regions has been unsustainably harvested for timber and subsequently cleared and converted to oil-palm and small-holder agriculture, forcing the displaced orangutans to crowd into remnant forests. This was the situation when KAL became active and land clearing within the plantation further compressed populations. Prior to the clearance of forest for the plantation, a 2011 preliminary HCV assessment of KAL mapped the area of remnant forest [35]. The southern region had approximately 7,300 ha of forest, including 5,000 ha within the concession, and the north-western region had approximately 2,700 ha of forest, including 1,470 ha within the concession. Land clearing in and outside the plantation thus equated to a loss of up to 4,900 ha of forest habitat in the southern region and 2,100 ha in the north-western region. Acknowledging the irreversible loss of 7,000 ha of forest and the orangutan population contained within is important. This original forest cover would have 'hypothetically' supported all 189 orangutans in the South (that currently occur in 4,200 ha) at a density of 2.6 individuals/km^2, and all 57 orangutans in the north-west (that currently occur in 820 ha) at a density of 2.1 individuals/km^2. These are 'expected' densities, likely close to the original carrying capacity of the forest, and thus indicate why overcrowding is now occurring. Orangutans are now living here at densities 2–3 times higher than this.

4.3. Managing Overcrowding

The remnant orangutan population in KAL may now be above carrying capacity, although carrying capacity conditions remain poorly understood [50]. If the carrying capacity is indeed exceeded, this will lead to orangutan deaths or emigration at times of food shortage, for example during prolonged dry seasons. Supplementary feeding, enrichment planting with orangutan food trees, and the prevention of conflict killings [8, 51] may reduce impacts, but these are large forests areas that are difficult to fully manage. A likely scenario is that population size will go down over time. Population reductions have been observed elsewhere following periods of overcrowding [32, 52]. In the Kinabatangan area in Sabah (Malaysian Borneo), for example, isolated forest reserves in an oil-palm matrix have seen their orangutan populations decline by some 50%, despite the absence of threats. It appears that especially young males leave forest areas and move through the oil-palm estates to look for females and food. It is unclear what happens to these animals [8, 32]. We expect similar out-migration to occur from overcrowded areas in KAL, and improved monitoring of orangutan dispersal in and outside forest areas in KAL is high on the research agenda.

4.4. Management Recommendations

We provide recommendations at two levels, the KAL plantation itself and the larger landscape in which the KAL concessions and its orangutans are located. Owing to the high density of orangutans found within the remaining peat-forests of KAL it is essential to prevent further loss of habitat in this region and expand the current HCV boundaries to include all remaining forested regions of the concession. KAL management has already taken significant steps to clearly delineate the boundaries of HCV forests and prevent illegal logging, but especially fires remain a threat to the survival of these forests. Maintaining a high water table in the peat forests in KAL is important to ensure that peats do not dry out and burn easily in dry season. Control of access to the forests and patrolling, especially during dry times, need to be improved to prevent further forest losses like those that occurred in 2015. Facilitating as much orangutan dispersal as possible allows animals to move through larger parts of the concession in search of food. This requires that the connectivity within the plantation is further improved by additional well-protected corridors and rope bridges to allow orangutans and other arboreal species to cross plantation roads.

To minimize conflicts between orangutans and people in the plantation and to minimize damage to oil-palm seedlings, KAL staff should adhere to the Standard Operating Procedures that have been developed. This requires that all

staff of KAL are trained and educated about orangutans, and the basic principles of 'what to do' and 'what not to do' when encountering an orangutan. This plan should also consider how to deal with nuisance, sick or malnourished orangutans, so that the welfare of the orangutan is ensured.

In a broader geographic context, the orangutans in KAL form part of the regionally and nationally important Coastal West Kalimantan orangutan meta-population [48, 53]. Together with orangutans found outside the KAL concession, this is a significant and viable population of the Southern Bornean orangutan that is in need of better protection. Essential for that is the preparation of a habitat management plan that takes into account areas outside the concession and connectivity to other populations in the region. The local government, community stakeholders, and other plantation owners and forest managers need to agree on that plan, and on how it will be implemented. Specifically we recommend providing permanent protection to the contiguous forests of the PT Bumitama Gunajaya Agro plantations that neighbour KAL, and ensure that these are not cleared during plantation development. The Bumitama plantation is owned by Bumitama Agri Ltd, an RSPO member, and the group is thus expected to implement management in their plantations that is in line with the RSPO Principles and Criteria, including preventing the loss of high conservation value forests. Protecting these forests would ensure that the KAL population retains ecological connectivity to the Gunung Palung National Park to the north, potentially also connecting with the Gunung Tarak Protection Forests.

To the south, the Sungai Tolak and the large Sungai Putri swamp forest areas are crucial to the survival of some 1,500 orangutans. These areas remain allocated to timber production licenses but reportedly permits have been given out to clear-cut and drain large parts of these peat swamps areas. High levels of illegal logging and potential fires are further major threats. Considering the commitment from the Indonesian government to significantly improve the management of the country's peat lands, providing permanent protection management to Sungai Tolak and Sungai Putri forests should be pushed at both local and national government levels.

4.5. Potential Rescue Management

The current overcrowding is likely to result in dispersal of orangutans away from KAL, and could lead to orangutan starvation and conflict with people. We only recommend translocation of orangutans out of a naturally-occurring population as a very last resort, in this instance the removal of some individuals which would help alleviate pressures on the remainder and therefore should be considered. Orangutans will need to be captured safely, with no risk to their health, under the supervision of qualified veterinary personnel and with an emergency evacuation plan prepared in case of injury to the ape. Only healthy orangutans that do not show signs of serious malnutrition should be moved (malnourished individuals may be captured for treatment and feeding if desired). Only adult male orangutans are moved, preferably those who are still unflanged. By choosing these individuals we are mirroring the natural dispersal patterns of orangutans. Alternatively, older males (>30) who are no longer dominant, can be moved. No females should be translocated, as these form permanent home ranges and translocation is unlikely to be successful. The exception is those females who are living outside the forest and therefore do not have a forested home range. Finally, and for obvious reasons, no further translocations should be made into these overcrowded populations inside KAL.

5. Conclusion

Our study adds to the ongoing discourse about improving the environmental performance of the oil-palm industry. Our historical analysis shows that KAL has had a negative impact on the local orangutan population. This needs to be considered in the light of the unknown counterfactual of what would have happened to these forests without oil-palm development. We show that with good management significant numbers of orangutans can survive within oil-palm plantations, at least in the short term, and assuming that connectivity with the larger landscape is maintained. Our case study indicates several key components of good conservation management in palm-oil: 1. Commitment from company owners and senior management towards good environmental practices; 2. Leadership, competence and commitment at the concession level, ensuring that environmental practices are effectively implemented and are integrated with broader management of social and economic objectives; 3. Environmental planning at the earliest stages of project implementation rather than as an after-thought; 4. Transparency about environmental plans, their implementation, and their impact on ultimate biodiversity objectives.

We realize that despite the relatively high numbers of orangutans in the KAL area, it is yet unclear how these populations will change over time, depending on the extent of over-crowding and the intensity of food shortages. Case studies like that of KAL and other committed companies remain exceptions, and most palm-oil companies give little attention to protecting orangutans and their habitat. Nevertheless, it is important to highlight positive examples of improved management so that others in the industry can follow. With some 20-25% of the remaining orangutans living in areas allocated to industrial-scale oil-palm development [33], there is an urgent need to learn what the palm-oil industry can do to ensure they abide by Indonesian and Malaysian laws on protecting threatened wildlife.

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