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Monitoring orangutan reintroduction: Results of activity budgets, diets, vertical use and associations during the first year post-release in Kehje Sewen Forest, East Kalimantan, Indonesia

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Abstract. *Basalamah F, Utami-Atmoko SSU, Perwitasari-Farajallah D, Qayim I, Sihite J, Van Noordwijk M, Willems E, Van Schaik CP. 2018. Monitoring orangutan reintroduction: Results of activity budgets, diets, vertical use and associations during the first year post-release in Kehje Sewen Forest, East Kalimantan, Indonesia. Biodiversitas 19: 689-700. Pongo pygmaeus morio,* a subspecies of orangutan founded east Kalimantan is steadily declining and classified as endangered. A reintroduction program was recently established. We monitored the reintroduced individuals during their first year post-release at Kehje Sewen Forest in East Kalimantan to document the adjustment to their new habitat. Here, we present a report on the activity patterns, food choice, travel height, nest-building abilities and associations of six individuals ranging between eight and thirteen years old. Our results show that all individuals survived their first year. They spent most of their time feeding and had a largely frugivorous diet, similar to wild orangutans. However, although they were able to build nests, they reused or rebuilt old nests more often than expected. They also spent 16% of their total activity time on the ground, more than expected. This information will contribute to attempts to evaluate factors affecting the adjustment process, and thus optimizing future reintroduction procedures.

Keywords: Adjustment, daily activity, *Pongo pygmaeus morio*, reintroduction

INTRODUCTION

Wild orangutans live in female-philopatric societies (Arora et al. 2012), in which infants grow up and learn many of the vital ecological skills through social learning (i.e., under the influence of conspecifics, ranging from simply following models around to copying actions or outcomes) from their mothers, maternal relatives and associating males (Jaeggi et al. 2008, 2010). Immature may also learn from associates when they range independently after weaning. These suggest that an immature individual strongly relies on the presence of a tolerant and knowledgeable set of adults or older immature to acquire the full set of its survival skills. The development of these skills takes years, and is only completed around age 10 (Russon 2006; Schuppli et al., in prep.). Components are, in order of reaching adult values: locomotion skill, nest-building skills, diet selection, foraging techniques, ranging skills, and social skills (van Noordwijk et al. 2009).

Animals previously held in captivity (so-called rehabilitants) released into natural habitats (reintroduction) may thus need time to acquire these skills (Russon 2006). Many of these learned skills are geographically universal, and may therefore be acquired by maturing individuals even in the absence of models, but some foraging techniques (van Schaik et al. 2003) and elements of diet selection (Bastian et al. 2010) are site-specific. If these are cognitively difficult and thus may take time to become established, it is possible that populations of reintroduced individuals require time to accumulate the culturally based adaptations, very much like human populations would, or in the worst case even fail to establish themselves. Indeed, Russon (2002) showed that released ex-captives gradually expand their diet, but may remain stuck at lower diet breadth than their wild counterparts because they persistently work on existing techniques rather than try out new ones, and add fewer of the non-obvious fallback foods that are invisible and must be extracted (various kinds of pith, termites; see also Russon et al. 2009). However, Russon (2003) could also show that the presence of local experts that can serve as models makes a big difference.

Reintroduction of rehabilitant orangutans is the official government policy in Indonesia. Given the prominent role of learning there is some doubt that released rehabilitants or translocated wild individuals (moved directly from one habitat into a different one) will be successful. Unfortunately, there is surprisingly little information on the fate of released animals (Russon 2009) although the situation has recently been improving (see Riedler et al. 2010). This is understandable with rehabilitants since they

either remain dependent on humans, preferring to be fed rather than explore the forest on their own, or disappear, possibly because they roam widely in search of suitable habitat in which to settle down, or get lost. Until recently, fitting orangutans with radio-collars was impossible. Now that reasonably reliable internal radio transmitters have become available (Burk 2012), monitoring of reintroduced animals has become possible, although locating them in dense tropical forest in rugged terrain without roads or trails remains challenging.

Our aim, therefore, was to study the behavior of rehabilitant orangutans after their release into a novel natural habitat to assess their success at finding adequate food and their acquisition of general forest skills, such as nest building (Riedler et al. 2010). We examined changes over time since release in the presence of the animals in the study area and their behavior to identify trends in adjustment to their release forest, looked for individual variation in this process, and examined values of the various parameters such as activity budget, diet, nesting behavior, association relative to those of wild Borneo populations.

MATERIALS AND METHODS

Study site

The six ex-rehabilitant orangutans were released into the Ecosystem Restoration Concession (ERC) managed by PT. RHOI (Restorasi Habitat Orangutan Indonesia) - BOSF (Borneo Orangutan Survival Foundation). The area is known as Kehje Sewen. It is located in the East Kutai and Kutai Kartanegara Regencies (°6'36" South - 1°40'48" South; 116°1'12" East - 116°28'12" East), East Kalimantan (Figure 1). Kehje Sewen comprises an area of 86,890 ha, and is almost entirely covered in virgin primary forest (Landsat 7 ETM+ Path/Row 117/59 coverage on 3 October 2008). It has a steep topography (55% has slopes of 15-25%) and 82.5% is under 900 m asl. The release site (15.693 ha) is on the west of the Telen-Soh river. According to interpretation on the map, the area was previously evaluated as offering suitable orangutan habitat (19.377 ha), with 5500 ha effectively search for and follow orangutans. Vegetation assessment was based on 20 m wide plots along transect lines (2 transect 1000 m and 2 transect 1500 m), comprising a total of 5 km (BOSF 2010). These surveys identified 395 tree species in Kehje Sewen, of which 159 were food taxa known to be consumed by wild orangutans elsewhere (Russon et al. 2009): 104 tree species, 22 palm genera (including rattans), 20 shrub species and 13 epiphyte species. It had virtually no wild orangutans based on nest sighted (0.014 ind/km^2: BOSF 2010). It is also within the taxon's historic range. It therefore fulfills all the IUCN reintroduction guidelines for suitable reintroduction areas (Beck et al. 2007).

During this study, PT. RHOI-BOSF released six individuals, as subject study, namely Cassey, Mail, Lessan, Hamzah, Berlian and Abbie. They are the subject of this study.

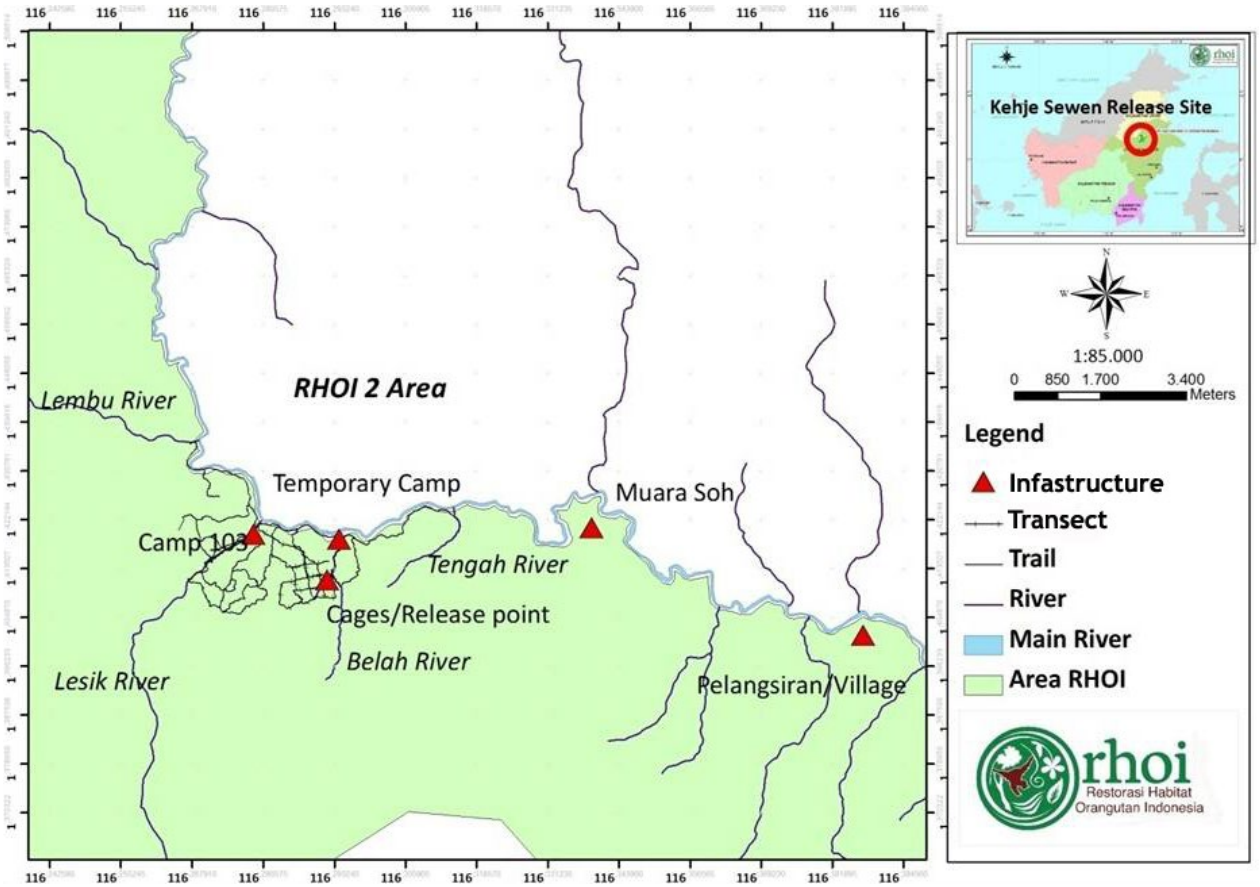


Figure 1. Location of study area in Kehje Sewen forest, East Kalimantan, Indonesia

Study subjects

We studied six individuals, the first to be released into the area. Subjects had been under rehabilitation at the BOS Foundation Rehabilitation Center at Samboja Lestari for varied amounts of time. They were between eight to thirteen years old (Table 1). All of them had been confiscated after having spent time in captivity, so in most cases their backgrounds are largely unknown, except for Hamzah, who came straight from forest that was being converted into plantations. One of them, Cassey, had a physical handicap; she had an injured hand she could not use for climbing (http://orangutanforest.wordpress.com). On their arrival, their age was estimated using dental eruption patterns (SOCP-FZS unpublished, 2014). Because permanent teeth erupt later in wild animals (Zihlman et al. 2004), we know these ages are underestimates, although it is unknown by how much. The ex-rehabilitant orangutans in Kehje Sewen were released in three groups. Cassey, Mail and Lessan were released first, then Berlian and Hamzah (transport by helicopter with a 2-week interval between the first to second release), and finally Abbie (four days later separately as a result of weather-induced constraints on helicopter trips).

Before being released, the subjects had stayed at the Rehabilitation Center of Samboja Lestari, near Balikpapan, East Kalimantan, for a variable amount of time. The Samboja Lestari rehabilitation center uses the following steps (see Table 2): (i) If individuals were still infants when confiscated (in this study, Mail), they were first placed in a nursery. (ii) If they were more than 3 years old and independent (Lessan, Cassey, Berlian, Hamzah and Abbie), they would be placed into an individual quarantine cage) for up to 2 months. (iii) Subsequently, they were moved to forest school level 1 (Mail), which involves taking orangutans into the forest and engage them in forest both subsistence and social activities. There, they would be fed forest food once daily and provided with solid food twice a day, but still slept in cages. (iv) If individuals were older than 5 years and were competent in building and using tree nests, they were moved to forest school level 2 (here: Lessan and Berlian), where they were expected to feed on natural food, and build nests, but were still provided with solid food and milk once per day. (v) Individuals that were difficult to handle (Cassey, Hamzah, and Abbie) were transferred to a half-way housing or an island in a river, where they were not handled but still received food. Mail joined them to island straight from forest school level 1. (vi) Finally, all individuals judged ready for release were transferred to forest school level 3, in preparation for release in Kehje Sewen Forest, a 53 ha forest area in which they could roam freely for 4 months and get used to forest life while still being provisioned.

The animals were released in April 2012. No supplementary feeding was provided at the release site, except for one individual during the few days in the first weeks (Cassey; see Table 2).

Sampling methods

To assess their readjustment to forest life, we followed the animals that could be located using focal animal sampling and compared the results with wild populations (see grey bar on result figure). Individuals were followed for 12 months post-release using focal animal sampling (Altmann 1974). Upon finding an animal, they were followed all day, with average eleven hours per follow. During the first three months, individuals were followed whenever encountered. After that, they were not followed for more than 6 days per month, to reduce human impact. However, not all individuals could be followed each month. Over 3218 hours of total daily active time were collected from April 2012 to April 2013 (with between 0-14 follow days per month).

Table 1. Observation times of study subjects

Name of individuals	Sex	Age (released)	Length in rehab center (months)	History	Observation times (hours: minutes)	Total days followed
Cassey	F	9	59	C	890:49	88
Mail	M	8	70	C	371:40	46
Lessan	F	9	65	C	746:00	78
Hamzah	M	9	60	R	345:52	38
Berlian	F	10	66	C	793:15	86
Abbie	F	13	74	C	70:59	8
Total					3218:35	344

Note: C: confiscation; R: rescued

Table 2. History of rehabilitation stages

Name of individuals	Released date	Age (years)		Rehabilitation Stages					
		Intake	Released	Quarantine	FS1	FS2	HWH	Island	FS3
Cassey	24 Apr 12	3-4	9	√				√	√
Mail	24 Apr 12	2-3	8	√	√		√	√	√
Lessan	24 Apr 12	3-4	9	√		√	√	√	√
Hamzah	06 May12	4-5	9	√				√	√
Berlian	06 May12	4-5	10	√		√	√	√	√
Abbie	12 May12	7-8	13	√			√	√	√

Data were recorded using a standardized set of methods (http://www.aim.uzh.ch/de/research/orangutannetwork.html), which includes instantaneous scans every 2 minutes of activity, food item, and height. Activities included feeding (F), moving (M), resting (R) and others (Oths) (incl. nesting, socializing, playing). Whenever feeding occurred, we recorded the food item consumed: fruit, leafy material (included stem and pith), cambium/bark, invertebrates (ants, termites, and bees), flowers and others (human/trash food, water, soil). We collect the sample and take a photo to be identified by a local assistant that is expert about the plant or sending the photo to someone who is expert on this major.

Height was scored as follows: 0 m (on the ground with at least one foot); <5 meters: when was between 0 and 5 m high; and >5 meters. Social behavior and other remarkable events were recorded continuously. Nest building was a special focus. We recorded whether individuals built new nests from scratch, rebuilt existing nests, or simply used existing nests without modifications.

Data analysis

For each day, activity, diet, and height classes were expressed as % of total time. This was done as follows. The active period was defined as the time between leaving the morning nest and lying flat on the evening nest. If the total active period was less than 12 hours, the remaining time was considered as spent resting (because the animal was on its nest) and the percentages were calculated over the full 12-hour period. If the total active period was more than 12 hours, actual percentages were used. Partial days were included if at least 6 hours of focal follow time was available (following Harrison et al. 2009), and uncorrected percentages were used.

To examine trends with time, we lumped together observations into six consecutive 2-month periods, by calculating mean percentages over each individual's observation days in that period (Harrison et al. 2009). However, some animals showed dramatic changes within this first 2-month block, so we broke the first period into 2 phases: the first 2 weeks since release (shock-phase) and the rest (adjustment-phase). To be included in a given 2-month period, the individual had to have been followed for at least 20 hours in this period. We used rank correlations with time-period to assess the presence of continuous trends in an individual's activities, diet composition, or use of the ground. Statistical significance for these tests was set at $P<0.05$.

To test for individual differences, we preselected individuals whose values were systematically (at least 4 of 6 time periods) above or below those of others for a given variable. We then used non-parametric statistical tests (Mann-Whitney U, Kruskal Wallis and Friedman test) (from 2 month to 9-10 month phase), using a conservative level of significance ($P < 0.01$) because of our pre-selection criterion (Siegel and Castellan 1988). We resorted to this technique because, although our sample size was small, it was important to identify individual outliers.

To estimate the degree of adjustment to the local habitat, we used data from comparable wild populations living the same general region (central, eastern and northern Borneo). We chose this because *P. p. morio* is not monophyletic and the use of subspecies affiliation was therefore not warranted (Arora et al. 2011), but eastern Borneo differs in terms of climate and soil from western Borneo or Sumatra (Krützen et al. 2011). Because the reintroduced individuals were on average between 9 to 12 years old, we preferably compared our results with those of wild juveniles and adolescents, where possible. Orangutans in Mentoko and Danum Valley live in dryland forests, similar to Kehje Sewen, but data on adolescents were absent or scarce, respectively (Morrogh-Bernard et al. 2009; Kanamori et al. 2010). We therefore also included the swamp forests of Kinabatangan and Tuanan (Morrogh-Bernard et al. 2009; van Noordwijk et al., unpubl) into the comparison. The ranges expected based on the relevant wild population (grey bar) are indicated in the graphs as colored background bands.

These assessments with wild populations were semi-qualitative; simply counting the number of individuals that was outside the expected range. For the latter, we mostly had to use annual averages although this is not optimal for seasonal activities, such as diet composition. However, because no reliable phenology data was available, it was impossible to compare periods of identical food abundance.

In the graphs, results are presented as mean ± standard deviation where possible. Data analysis was conducted using SPSS 11.5 and R software for Windows.

RESULTS AND DISCUSSION

Presence in the area

Presence in the study site during the first year post-release is provided in Table 3. During the first period, all individuals were recorded as present. Some newly released orangutans may roam widely in search of food, making it difficult to find animals or to relocate them after they were lost during focal follows. This means it is difficult to distinguish between animals being present but going unrecorded and animals not present in the study area. This is unfortunate, because presence can also be used to estimate survival.

Of the four females, three remained in the area while Abbie, who was the oldest individual at intake and release, was the exception. From the second half of the first month onwards, she was not directly observed until the beginning

Table 3. Presence of individuals in the study site

Ind	Period (months)					
	0.5-2	3-4	5-6	7-8	9-10	11-12
Cassey	X	X	X	X	X	X
Mail	X	X				X
Lessan	X	X	X	X	X	
Hamzah	X			X	X	
Berlian	X	X	X	X	X	X
Abbie	X	X				

of month three when we encountered her on the opposite side of the River Soh (Figure 2), ±1500 m from the release point. This river is so wide that the canopies on both sides do not touch, and thus not easily crossed by orangutans. In the beginning of February 2015, Lessan, Cassey, Hamzah and Berlian still ranged around camp Lesik.

The two males explored the area more thoroughly, ranging as far as the protected forest over 5 km to the north of the release point. During the third week, one male, Mail, returned to our temporary camp, where observers stayed and cooked. Because Mail was interested in human activity he was returned to the acclimatization enclosure for the night. His transponder was damaged in the second month; the veterinary team retrieved Mail and replaced the broken transponder, upon which he was placed inside the acclimatization enclosure during the recovery process for a period of 2 weeks. Three months after being released again, Mail crossed the Lesik River, probably using a water pipe, and at the end of the month was reported along the Lembu River by local people, some 4 km from the release point (Figure 2). Although we could not find him there, Mail showed up around our main camp almost a year after his first release. In the beginning of July 2014, his signal was picked up more than 20 km north from the release point, but we were unable to find him.

The other male, Hamzah, was difficult to track because he did not respond well to being tracked by humans. As a result, no detailed follow data could be recorded after the end of the second month. He was seen again around our main camp seven months after release. During 2013, Hamzah was seen near the release point again, in association with Lessan and Agus (the latter a newly released orangutan).

Activity budgets

Based on a year's observations at the research site, in general the six orangutans spent 53.5% of time feeding, 29.7% resting and 14.4% travelling (Figure 3). The individuals at Kehje Sewen showed strongly significant variation in their activities (Chi-Square-test feeding: Cassey (N=88), Mail (N=36), Lessan (N=78), Hamzah (N=38), Berlian (N=86), Abbie (N=8), df=5, χ^2=65.75, P<0.001; traveling: χ^2=35.51, P=<0.001; resting: χ^2= 39.83, P<0.001).

We also tested for changes over time post-release. However, because all individuals showed a strong discontinuity during the first 2 week and the last 2-month period, which was almost certainly due to a majorreduction in food availability, we restricted the analysis to the first 10 months. We found significant variaton only in the time allocated to travel (Friedman tests:feeding: χ^2_4= 6.67, P = 0.15; resting: χ^2_4= 6.93, P = 0.14; travel: χ^2_4= 9.87, P = 0.04; and others: χ^2_4= 6.93, P = 0.14).Thus, as also shown in Figure 3, over the course of the observation period animals gradually spent less time travelling.

Generally, the activity patterns of all observed rehabilitant orangutans showed a similar pattern but differed from those seen among wild immature Bornean orangutans. Feeding time accounted for the largest part of the released orangutans' activity budget and often exceeded that of the wild populations. Resting and traveling time were correspondingly reduced.

Two individuals, Mail and Abbie spent slightly more time resting than feeding in the first two-week period (Figure 3). Mail's high resting time can be attributed to the fact that he came to our camp and waited to be fed. Abbie spent much time on her nest and did not engage in any meaningful activity.

Hamzah, the wild orangutan, was the only orangutan whose activity budget (except travel) was largely in the range of wild population. Hamzah was remarkably fast and agile, and unhabituated. He once travelled very far from acclimatization area into a protected forest upstream the River Soh, which is located around 5 km from the acclimatization area. All of this suggested he already possessed more forest experience than the others.

Cassey, a 9-year-old female, although suffering from a disability to her right hand, was able to climb and move through the trees with apparent ease, albeit at a slower rate than the others. Cassey initially moved less and remained close to the release point, often sitting on the ground.

Comparison of the males and females in Kehje Sewen showed a significant difference in feed and travel (MWU-test feeding: Nfemale=240, Nmale=94, Z=-2.04, P =0.042; traveling: Z=-2,94, P =0.003). There is a trend for non-sexually active females to spend more time feeding, whereas males spent more time traveling. In addition, females were more selective in choosing food so that their mealtime was longer than males.

Diet composition

The released orangutans in Kehje Sewen clearly spent more time feeding on fruit (pulp, skin, seed, endocarp, exocarp) than on leaves (mature leaves, leaf shoots, stems, pith), bark (the cambium layer) or invertebrates (including larvae, ants, termites) and others (soil, water, grass, human food etc.) during the study period (Figure 4). In addition, the time spent feeding on bark was higher for two individuals, Abbie and Mail, who travelled on a larger area and explored the area, and also consumed a lot of *Ficus* sp. bark and leaves. There is some variation in time spent feeding leaves. The animals tried to eat every species of potential interest to them, such as the leaves of *Spatholobus* sp., the stems of Zingiberaceae, and the young shoots and pith of rattans and bamboos.

The percentage of feeding time varied significantly between individuals (Figure 4) for fruits (Cassey (N=71), Mail (N=36), Lessan (N=78), Hamzah (N=38), Berlian (N=86), Abbie (N=8), df=5, χ^2=61.483) leaves (χ^2=81.836), bark (χ^2=21.468), invertebrates (χ^2=13.678), and other foods (χ^2=26.163), but not for flowers (χ^2=8.031). Compared to wild orangutans, they spent less time eating flowers and were in the lower range of time spent feeding on invertebrates (Figure 4).The animals released in Kehje Sewen were somewhat more frugivorous than their wild counterparts, and systematically spent less time on flowers and probably invertebrates. These items may require more forest experience for effective harvesting.

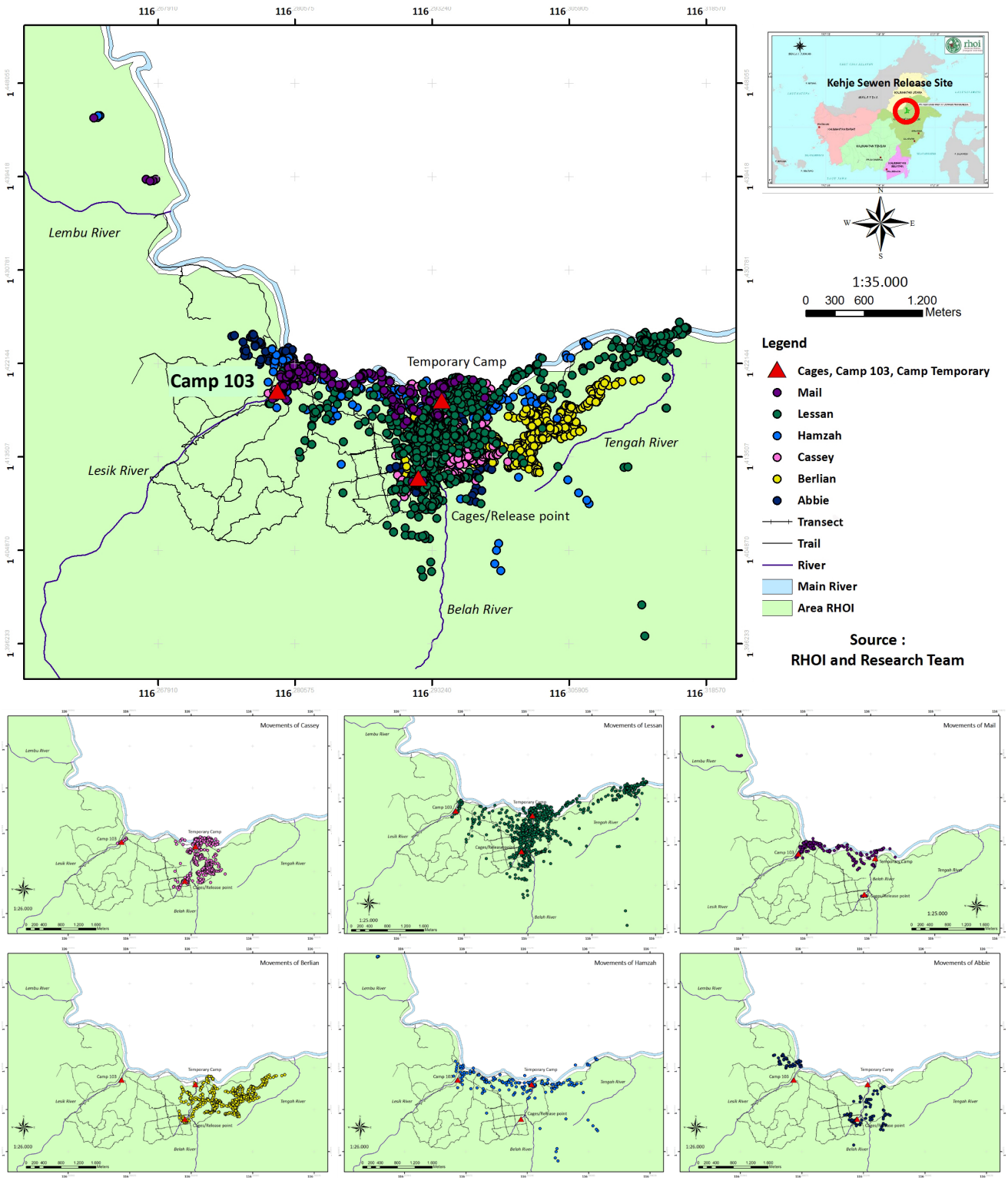


Figure 2. Ranging of ex-rehabilitant orangutans in study site. A. All, B. Cassey, C. Lessan, D. Mail, E. Berlian, F. Hamzah, G. Abbie

Analysis to examine trends over time since release showed that the proportion of fruit, flowers, leaves and bark significantly changed over the observation period (Friedman tests: fruits: χ^2_4= 10.93, P= 0.03; flowers: χ^2_4= 10.51, P = 0.03; leaves: χ^2_4= 10.93, P = 0.03 and bark: χ^2_4= 11.47, P = 0.02). The proportion of fruit increased, whereas that for flowers and leaves decreased and bark and invertebrates and others items did not reveal a clear pattern over time.

During the first two weeks, some individuals (Cassey, Mail, and to some extent Lessan) took food from the technicians, scavenged leftovers from campsites, or retrieved food remains from under the acclimatization cages occupied by Berlian and Hamzah, who were released two weeks later. After this period, there was virtually no consumption of human food. However, Cassey continued to occasionally search for food on the forest floor, taking the fruits that fallen to the ground while other individuals fed up in the canopy, and generally taking food from the forest floor. She may have had more trouble climbing due to her injured hand.

During the 344 follow days, we collected and identified 256 samples of orangutan's food plants. We identified food plants from 49 families, estimated to contain at least 200 species of tree (*Artocarpus* sp., *Melastoma* sp., *Microcos* sp., *Ptenandra* sp., *Macaranga* sp., *Aglaia* sp., *Diospyros* sp., *Baccaurea* sp., *Shorea* sp., *Mangifera* sp., *Xanthophylum* sp. etc), 20 species of Zingiberaceae, 13 species of liana, and 23 species of Palmae.

Use of the canopy

Ex-rehabilitants in Kehje Sewen spent over time 50% on >5 m, even though some individuals spent much time on the ground (Figure 5). They sometimes came down from the trees to travel terrestrially, drink from the river or to get food.

Kehje Sewen animals spent somewhat more time on the ground than the wild population with good data on ground use (Tuanan), but this was quite variable. There were significant differences in height among the individuals: Cassey and Mail spent more time on the ground than the others, although not significant (Cassey (N=88), Mail (N=35), Lessan (N=75), Hamzah (N=37), Berlian (N=84), Abbie (N=7), df=5, Chi-Square=49.539, P=0.000; 0.5-5meter: Chi-Square=48.938 P=0.000; >5 m: Chi-Square=61.903, P=0.000). There was no clear sex difference in the use of tree strata (on the ground: Nfemale=225, Nmale=91, z=-0.20, P=0.843; 0.5-5 m: z=-1.57, P=0.177; >5 m: z=-1.84, P=0.067).

Nest building

All individuals were able to make a new nest, but also sometimes slept on liana tangles that they shaped like a nest. Cassey, during the first 2 weeks used old nests for 50% of nights, and Berlian refurbished existing nests on 75% of nights during the 9-10-months period (Table 4). In comparison with wild populations at other sites (in Tuanan, for instance, individuals rebuilt 10.8- 13% of nests, and reused 0.1 -12.5 %), the percentage of nest building by rehabilitants was lower (Prasetyo et al. 2009).

Association and social interactions

Based on the result, in the first 2 weeks, Mail and Lessan traveled together to explore the new habitat, and often ate food in the same tree. In the second month, Lessan instead followed Berlian, and ate bark (*Ficus* sp.), pulp (*Mangifera* sp.) together, but Berlian chased Lessan, who subsequently spent time alone. Lessan, Berlian and Mail had been together in forest school 2 (FS2), where they were long-term close companions. Berlian also chased Cassey, especially in or near food patches. As a result, they spent only limited time in close association (< 10 m), usually meaning they were in the same food patch. However, all those six rehabilitants spent much more time in less close association (< 50 m) (Figure 6) than is common in wild populations (van Noordwijk et al. 2009), even for adolescents.

There was a clear sex difference in association pattern. Male-male association was rare, whereas female-female and male-female association was most common, similar to the patterns found in wild populations (Noordwijk et al. 2009).

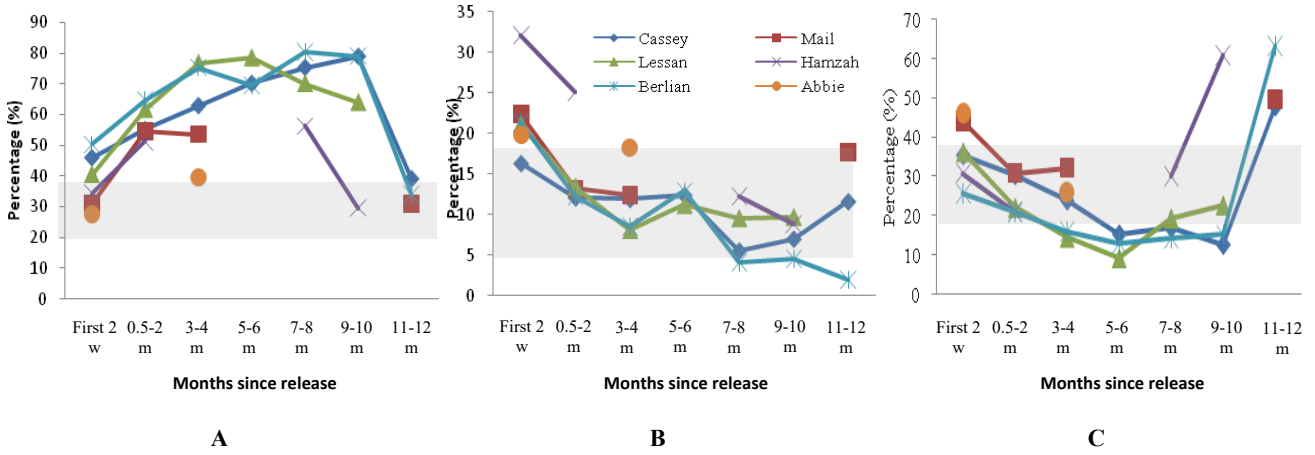


Figure 3. Daily activities budgets for ex-rehabilitant orangutans in Kehje Sewen during the 7 post-release periods considered in this study. Note: A. Feed, B. Travel. C. Rest

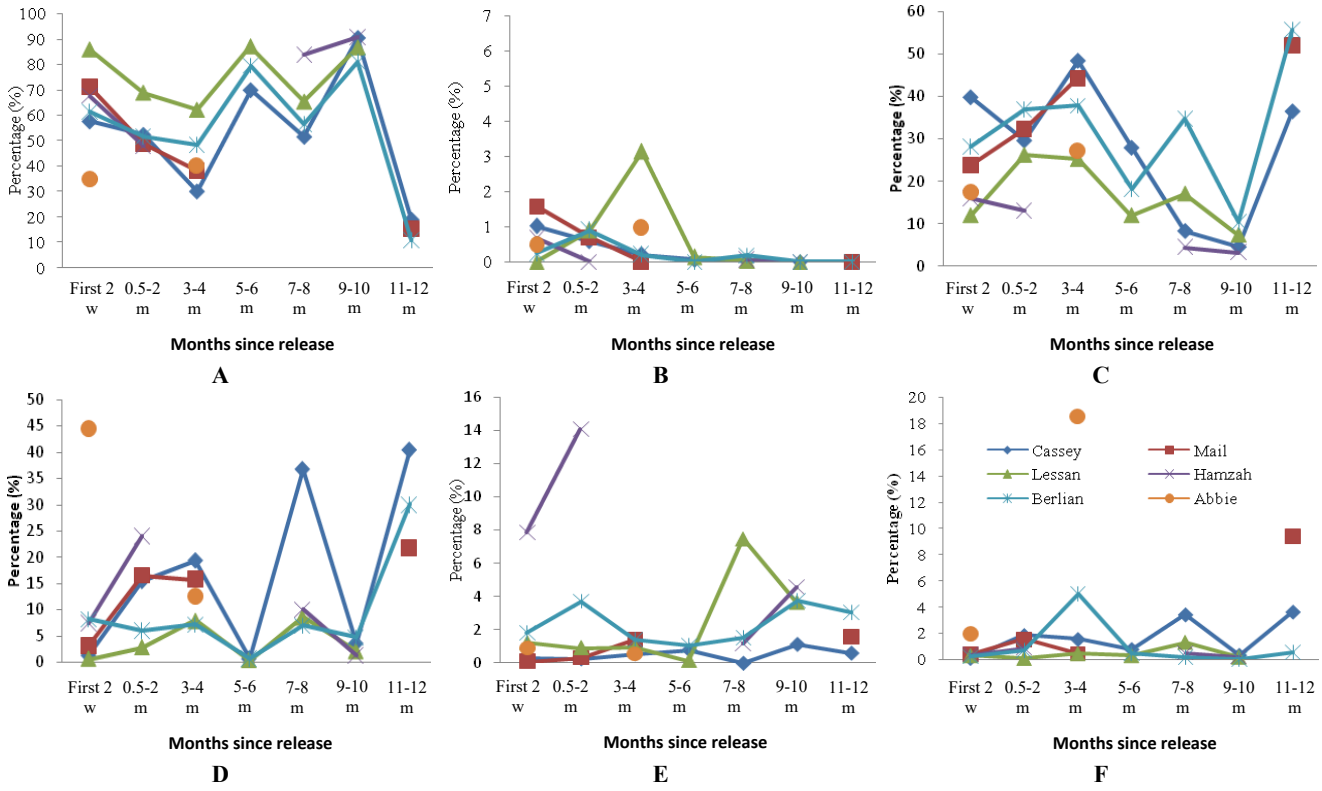


Figure 4. Individual diets and changes over the 12 months since release, with grey band as range of wild population. A. Fruits, B. Flower, C. Leaves (incl. pith, stem), D. Bark, E. Invertebrates, F. others

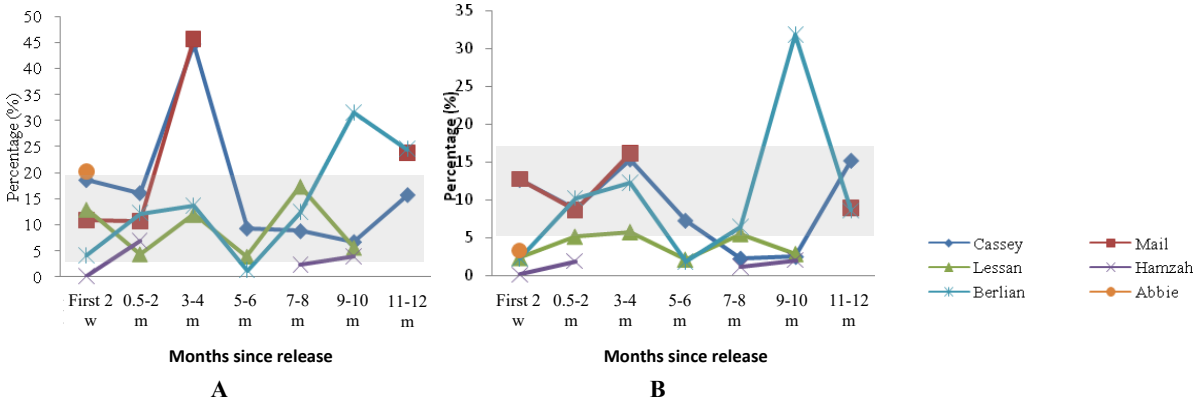


Figure 5. Proportion of time individuals spent at different heights over the 12 month since release. Note: A. On the ground, B. 0.5-5 meter

Discussion

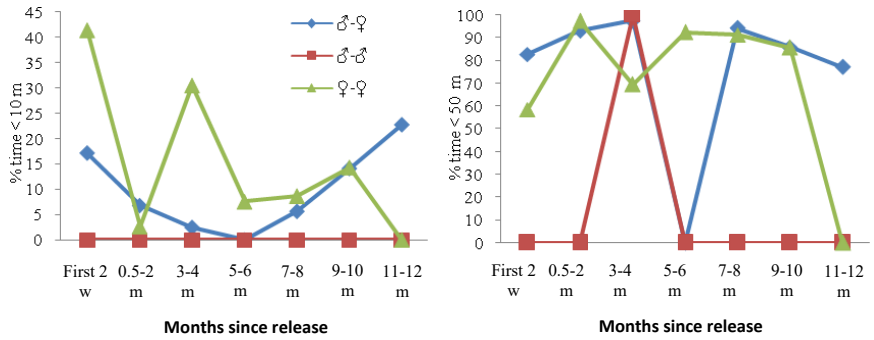
Post-release monitoring in adjusting to forest life is critical if we are to evaluate reintroduction success. In the past, post-release monitoring of reintroduction attempts was often weak and unsystematic, so evidence of reintroduction success rates has similarly been weak (Russon 2009). An additional contributing factor can be the difficulty of relocating rehabilitants once they have been released. However, it should be noted, that it is very difficult to fully assess the success of past reintroductions, because it was often impossible to relocate released orangutans, especially since some of them moved into remote areas without any road access.

We were able to relocate and follow five of the first six rehabilitants released because they had been implanted with radio telemetry. Released in April 2012, they were still known to be alive in February 2015, except for Abbie, who was last seen in January 2013, across the Soh river, the same area when we saw her in June 2012. All others, especially the males, travelled far, several km from the release point in both directions.

Table 4. Competence in nest building, as estimated by the percentages building new nests (N), refurbishing existing nests (R) or simply using old nests (U)

Individual period	First 2 week	0.5-2 months	3-4 months	5-6 months	7-8 months	9-10 months	11-12 months
Cassey	N: 29	N: 76	N: 33	N: 71	N: 75	N: 78	N: 67
	R:14	R:12	R:29	R: 12	R: 25	R: 11	R: 33
	U: 57	U:12	U:38	U: 18		U:11	
Mail	N	N,R,U	N,R,U	?	?	?	N
Lessan	N: 43	N: 44	N: 46	N:91	N: 54		
	R:29	R: 44	R:36	R: 9	R: 39		
	U:29	U:12	U:18		U: 7		
Hamzah	N,R	?	?	?	N,R	N,R	?
Berlian	N:25	N: 72	N: 67	N: 83	N: 74	N: 25	N: 100
	R:50	R:4	R: 11	R: 17	R: 21	R: 75	
	U: 25	U:24	U: 22		U: 5		
Abbie	N	?	?	?	?	?	?

Note: ?: individual wasn't found



A **B**

Figure 6. Months of release and percentage of time: A. <10 m, B. < 50 m

Activity budgets

During the first 2 weeks post-release (called the *shock period*), many spent most of their time resting and trying to obtain human food. After that, the animals changed their behavior, exploring their new habitat and trying to find familiar food. Hamzah was a clear exception. He appeared wild and immediately avoided humans, refusing to be tracked by observers. Abbie took the longest to become more active, perhaps because she was brought in overland rather than by helicopter, or because she was the oldest individual to be released (Russon, pers. comm.) and was rather oriented toward humans. When she was found again after 3 months, she directly came down to approach the observers and tried to make contact with them. Mail explored the area around the acclimatization enclosure together with Lessan, and would also try to approach the observers. Cassey, Lessan and Berlian spent more time feeding than in any other activity.

During the subsequent months, we compared the changes in activity budgets and diets in relation to values found among their wild counterparts. There was a sharp break in the trend in the last 2 months-block, in which they fed less and rested more and ate mainly leaves and tree bark. This is the same response as wild orangutans show during a severe fruit shortage (Morrogh-Bernard et al. 2009; Kanamori et al. 2010). This last period was therefore excluded when we exmined changes over time.

Overall, most individuals spent more time feeding and less time resting than their wild counterparts. In contrast, Russon (2009) had found that ex-rehabilitant in Tanjung Puting, Sungai Wain and Beratus did not spend more time feeding than wild populations, as did Riedler et al. (2010) in Bukit Tigapuluh on Sumatra. One possible explanation for this difference lies in the nature of release, and thus the amount of post-release provisioning, but details are too scanty to evaluate this idea. Alternatively, although all release sites have a forest school; the one in Samboja Lestari is more extensive, which may have prepared candidates more fully for release. Overall, then, these reintroduced individuals were more like wild orangutans than others that had been released, suggesting that the forest school experience led to a good preparation for life post-release.

Diet

Although direct comparisons are impossible, it appeared that the reintroduced individuals had a broad diet. They fed on at least 75 species of plants in the first three months after release, including various well-known fruits orangutans fed on. They were often seen eating insects such as termites in rotten wood. This was possible because Kehje Sewen forest was a primary forest with a high diversity of flora and fauna. The reintroduced orangutans also consumed a variety of fallback foods, in the form of leaves, cambium, and pith. Several types of green leaves were identified from both lianas (*Spatholobus* sp.) and trees, such as *Xanthophylum* sp. and *Ficus* sp. These are also targeted by as fallbacks by *P. p. morio* in Danum Valley (Kanamori et al. 2010).

In the absence of clear trends over time in diet, it is not certain that the changes in activity budgets reflect learning of more efficient techniques or the consumption of more nutritious foods over time. Overall, however, their diet choice appeared to be closer to that of natural populations than those of animals released elsewhere (e.g. Fredriksson 1995), perhaps because they had spent a long time in forest school before release. Continued monitoring of both diet choice and phenology will be needed to test this idea.

Ground use

Orangutans are the largest arboreal animals on the planet. Most of their lives are spent in trees where orangutans travel from branch to branch by climbing, clambering, and brachiating. Recent camera-trapping studies (Ancrenaz et al. 2014) suggest that orangutans in eastern Borneo spend more time on the ground than commonly thought, including in nearby Wehea forest (Loken et al. 2013). However, although all age-sex classes are known to come down to feed, only males travel extensively on the ground, and immatures only reluctantly follow their mother to feed (Ashbury et al., in press.). Wild adolescents thus are not expected to spend much time on the ground.

Although mostly arboreal, ex-rehabilitant in Kehje Sewen occasionally traveled on the ground to move between stands of trees. The males, Mail and Hamzah often traveled on the ground near the river around the camp (103) and sometimes sat on a rock, looking towards the RHOI 2 forest across the river. Mail even tried to cross the river while on the ground, using a stick to check the water level. Even so, the individuals showed evidence of knowing that the ground was a dangerous place, responding to sudden sounds by climbing up into the trees. We have observed multiple instances, where individuals suddenly climbed up into the trees or even went back into the nest after hearing some suspicious sounds like wild hogs and deers. However, Abbie would come down from up high to be near the observer on the ground, where she clearly felt comfortable. This observation obviously implies that such individuals should be followed as little as possible post-release, to wean them from using the ground.

Cassey spent most time on the ground, perhaps because other individuals chased her from food patches. Such displacements are common among orangutans (Utami et al. 1997), but in most cases do not lead to feeding on the forest floor. It might be argued that the presence of Zingiberaceae in the study area, especially near the released point may have attracted the individuals to come down to feed. Studies by Frederiksson (1995), Grundmann et al. (2001) and Kuncoro (2004) all show that ex-rehabilitants extensively use foods from the forest floor (e.g., terrestrial invertebrates, shoots of grasses [Graminae spp.] and rattans, and stems of gingers [Zingiberaceae spp.]). This could result from their identifying foods by trial and error for lack of expert guidance or their tendency to be more terrestrial than wild (Peters 1995; Kuncoro 2004; Grundmann 2006). However, wild adolescents largely ignore these foods (e.g. Snaith 1999; Kanamori et al. 2010), suggesting that they exploited them because they were on the ground in the first place, rather than were attracted to the ground because of the food. Overall, then, some of the released individuals did not have enough fear of being on the ground and spent more time feeding on terrestrial foods than their wild counterparts.

Nest building

All wild orangutans build night nests, usually building a new nest each night (Prasetyo et al. 2009). Infants learn to build nests by watching their mother and others in their neighborhood. The rehabilitants in Kehje Sewen were able to build nests (Table 3), almost certainly because they had learned to do so in forest school. However, the proportions of new nests were lower than in wild populations, perhaps because they were less motivated or lacked the energy to build fresh nests: across populations, reuse is most common where food is most scarce (Prasetyo et al. 2009). Further observations are needed to distinguish between these possible explanations.

Association and social interactions

As expected for non-adult individuals (Mitra Setia et al. 2009), the released orangutans in Kehje Sewen frequently engaged in associations, although the time wild immature spend in associations varies considerably among populations (van Noordwijk et al. 2009), and even within populations over time. This variability makes it hard to compare the total association time with wild adolescents.

These associations were almost certainly used to learn feeding skills. During the first months post-release, many associations involved co-feeding. Lessan, for instance, often followed Mail or Berlian around, and copied their feeding choices. Females were more likely to associate than males, but their tolerance nonetheless varied. Berlian was dominant to Cassey and Lessan. However, whereas Berlian generally tolerated Lessan in food trees, Cassey always stayed away, waiting for Berlian to leave the food tree. This selective tolerance may reflect pre-release friendships.

In conclusion, all the released rehabilitants studied survived their first year and adjusted to forest life. Although comparisons with existing wild populations are difficult, we suggest the main differences were that the reintroduced individuals spend more time feeding overall, spent more on fruit and less on flowers and insects than

expected (as seen in other reintroduced apes: Stoinski and Beck 2004), built fewer fresh nests and spent more time than expected for their age. Finally, the individual with an injured hand (Cassey) showed various deviations from expectation. Such individuals have trouble climbing and by spending more time on the ground may have lower survival prospects. These results are obviously preliminary. First, longer-term data on the same individuals are needed. Second, although at present, comparisons are still difficult, it is important in future work, to assess the effects of different strategies of pre-release preparation, so as to identify the factors affecting reintroduction success.

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