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Nest Building Ability and Nest Characteristic of Pre-release Bornean Orangutan (*Pongo pygmaeus*) in Jerora Forest School, Sintang Orangutan Center, West Kalimantan

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Abstract: Rescue, rehabilitation, and release is one of the strategies for orangutan conservation. Jerora Forest School, Sintang Orangutan Center, West Kalimantan, is a place to rehabilitate orangutan. One of the criteria for orangutan to be ready for release is the ability to build nests. The objective of this study was to analyze the nest building ability and nest characteristic preferences of four pre-release female bornean orangutans (Jamilah, Penai, Joss, and Bondan) in Jerora Forest School. Data was collected in November 2024 to January 2025 using the focal animal sampling, ad libitum sampling, and continuous recording methods. Three out of four female pre-release bornean orangutans (Jamilah, Joss, and Bondan) are categorized as moderate on their ability to build nest, while Penai is less capable. Nest trees used by the juvenile orangutan are more diverse than the ones used by the adult orangutan. The characteristics of the nests used by the research subjects were relatively similar across each age group. Nest trees used by the juvenile orangutans are more diverse than the ones used by the adult orangutans. Based on the nest building observation, Jamilah, Joss, and Bondan are ready to be released, while Penai is not ready to be released yet.

Keywords: Forest school; Orangutan nest; *Pongo pygmaeus*; Rehabilitation; Species-tree

Introduction

Orangutans (*Pongo* spp.) are the only great apes in Asia that live only on the islands of Sumatra and Kalimantan (Kuhlwilm et al., 2016). There are two endemic orangutans in Sumatra Island, the sumatran orangutan (*Pongo abelii*) and the Tapanuli orangutan (*Pongo tapanuliensis*). Meanwhile, bornean orangutans (*Pongo pygmaeus*) are distributed on Kalimantan Island, which is divided into three subspecies, namely *Pongo pygmaeus pygmaeus* in the western part of Kalimantan Island, *Pongo pygmaeus wurmbii* in the central and southern parts of Kalimantan Island, and *Pongo pygmaeus morio* in the eastern part of Kalimantan Island (Fleagle & Seiffert, 2016; Nater et al., 2017). Bornean orangutans (*Pongo pygmaeus* Linnaeus, 1760) are protected both locally and globally (Ancrenaz et al., 2016; Permen LHK No. P.106/2018; UNEP-WCMC, 2020).

The main causes of orangutan population decline are identified as habitat loss and degradation (Voigt et al., 2018; Pandong et al., 2019; Meijaard et al., 2023); and human-orangutan conflict (Abram et al., 2015; Santika et al., 2017; Sherman et al., 2022). Habitat protection and community engagement can slow the decreasing population of orangutans (Santika et al., 2022). In addition, improvements in human-orangutan conflict mitigation followed by rescue and release are needed to

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reduce orangutan killing and illegal ownership (Sherman et al., 2020).

One of the nongovernmental organizations (NGO) that focuses on orangutan rescue, rehabilitation, and release in West Kalimantan is Sintang Orangutan Center (SOC). This NGO collaborates with Betung Kerihun National Park as a release site for the rehabilitated orangutans.

Among great apes, orangutans build nests arboreally for sleeping at night and sometimes during the day (Prasetyo et al., 2008). Normal adult great apes living in natural environments tend to be skilled nest builders (Anderson et al., 2019). Being able to build a nest is one of the things learned in forest school to survive after release (Bani et al., 2018). Nest building ability is one of the criteria for readiness for release (Rosen & Byers, 2002; Beck et al., 2007).

Rehabilitated orangutans can build new nests, but also sometimes sleep on a tangle of lianas that they shape into a nest (Basalamah et al., 2018). Although primarily arboreal, male orangutans are more active on the ground than females (Ashbury et al., 2015; Loken et al., 2015; Supriatna, 2022). However, Sjahfirdi et al. (2023) found cases of female orangutans in forest schools sleeping on the forest floor several times during observation because they were suspected to be attracted to male orangutans who also slept on the forest floor. Another finding in the forest school observed by Fauzi et al. (2020) involved juvenile orangutans (2-5 years old) making simpler sleeping nests than adolescent or adult orangutans. These indicate that there is a variation in nest building behavior among orangutans from different backgrounds.

Previous studies on nesting abilities or behaviors in orangutans have been conducted, including on orangutans in rehabilitation (Fauzi et al., 2020a; Sjahfirdi et al., 2023), post-release orangutans (Bani et al., 2018; Nayasilana et al., 2020), and wild orangutans (Ancrenaz et al., 2004; Prasetyo et al., 2012; Niningsih et al., 2021). Meanwhile, the characteristics of orangutan nests have been extensively studied, particularly in wild orangutans (Ancrenaz et al., 2004; Rayadin & Saitoh, 2009; Prasetyo et al., 2012; Cheyne et al., 2013; Riyadi & Said, 2015; Nasution et al., 2018; Allo et al., 2020; Kuswanda et al., 2020; Andini et al., 2021; Niningsih et al., 2021; Rizal et al., 2023; Simbolon et al., 2023), but there are only two studies on the characteristics of orangutan nests in forest schools (Fauzi et al., 2020a; Sjahfirdi et al., 2023) and one study on the characteristics of post-release orangutan nests (Nayasilana et al., 2020).

The objective of this study was to analyze the nest building ability and nest characteristic preferences of four pre-release female bornean orangutans (*Pongo pygmaeus*) at the Jerora Forest School, Sintang Orangutan Center (SOC), West Kalimantan.

Method

The data was completely collected in November 2024-January 2025 in Jerora Forest School, Sintang Orangutan Center, West Kalimantan. Observations were conducted from 16:00 until the research subject no longer moves in its nesting sites. Secondary data in the form of information from other observers or animal keepers regarding the nesting behavior of the research subjects was also used. The study was conducted in forest school 1 occupied by adult orangutans, and forest school 2 occupied by juvenile orangutans (Fig 1).

The study subjects were four pre-release female Bornean orangutan: Jamilah, Penai, Joss and Bondan (Fig 2). The profiles and descriptions of the research subjects are attached to Table 1. Jamilah and Penai are released into forest school #1 every other week, while Joss and Bondan are released together into forest school #2 with one other individual.

Figure 1. Layout of Jerora Forest School

Figure 2. Research subjects (a) Jamilah, (b) Penai, (c) Joss, (d) Bondan

Table 1. Profile of the research subjects

No	Name	Sex	Age	Age Group−Condition
1	Jamilah	Female	24	Adult−Pregnant
2	Penai	Female	21	Adult−Non pregnant
3	Joss	Female	6	Juvenile
4	Bondan	Female	7	Juvenile

Data was collected using focal animal sampling method and continuous recording to observe one predetermined individual over a period of time and recording all of its behaviors (Altmann, 1974; Martin & Bateson, 2007). Parameters recorded for nest building ability data from each individual included: start and end time of nest building; duration of nest building; and nest use (new, old, renovated). For nests that were not newly built, nests were also classified based on decay as seen on Johnson et al. (2005). Meanwhile, parameters recorded for nest characteristics data included: nest height and tree height; diameter at breast height (DBH) of the tree; tree species and leaves used to build the nest; and position of the nest in the tree (Fig 3). Data collected are only night nest that is used immediately to sleep.

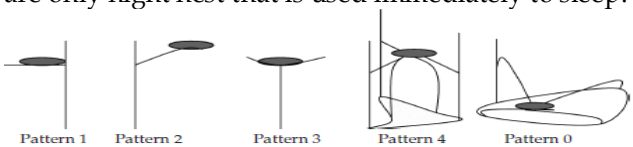

Figure 3. Nest position in the tree (Prasetyo et al., 2008)

Data on nest building ability and nest characteristics were calculated to obtain data in the form of percentages and graphs. Nest building ability was also evaluated using a Likert scale (Table 2).

Table 2. Likert scale categories for orangutan nest building skills

Point	Category	Percentage (%)	Description
1	Not capable	0−20	Orangutans do not sleep in nests
2	Less capable	21−40	Orangutan only replaces leaves on the old nest or sleeps on the old nest without any renovation
3	Moderate	41−60	Orangutan renovates some components of the old nest
4	Capable	61−80	Orangutans can build a nest by bending twigs or branches
5	Very capable	81−100	Orangutans can build a perfect nest by bending and braiding various sizes of twigs and branches

Source: modified from Martinez (2016) and Sjahfirdi et al. (2023)

Result and Discussion

Nest Building Ability

Three out of four research subjects are categorized as moderate on the nesting ability (Table 3). Despite being pregnant, Jamilah has the highest percentage of the nest building ability (55.56%) by consistently renovating nest during observation. This may be possible because Jamilah has the behavioral flexibility to balance her energy during pregnancy, as capuchin monkeys do (Webb et al., 2023). Penai with the lowest percentage (22.35%), is only observed once renovating another individual's nest, while Jamilah, Joss, and Bondan mostly renovate or reuse their own nest.

Table 3. Nest building ability of of four pre-release female bornean orangutans based on likert scale

Name	Percentage (%)	Category	Renovated/Reused Nest	
			Itself	Other Individual
Jamilah	55.56	Moderate	100	0
Penai	22.35	Less capable	0	100
Joss	44.44	Moderate	61.11	38.89
Bondan	50.59	Moderate	54.55	45.45

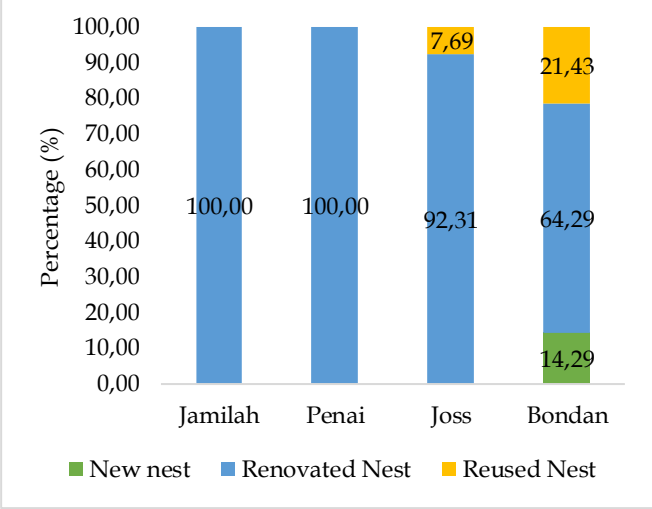

Figure 4. Preference of nest condition

Most of the research subjects are only able to renovate nests which belong to moderate category on nest building ability (Fig 4). This is in line with the statement by Kühl et al. (2008) that the reuse of old nests (both renovated and unrenovated) is a result of the availability of nesting sites or trees, especially in forest schools with a limited area of only 2 hectares. Only Bondan is observed making new nests that are used immediately to sleep. However, Bondan and Joss are observed reusing nests a few times without renovating or adding new leaves. Renovating or reusing old nests occur in both rehabilitated and reintroduced orangutans

(Riedler et al., 2010; Bani et al., 2018; Sjahfirdi et al., 2023) but rarely in wild orangutans (Prasetyo et al., 2008). However, outside of observation hours, Jamilah, Joss, and Bondan were observed building nests from scratch by SOC's behavior team.

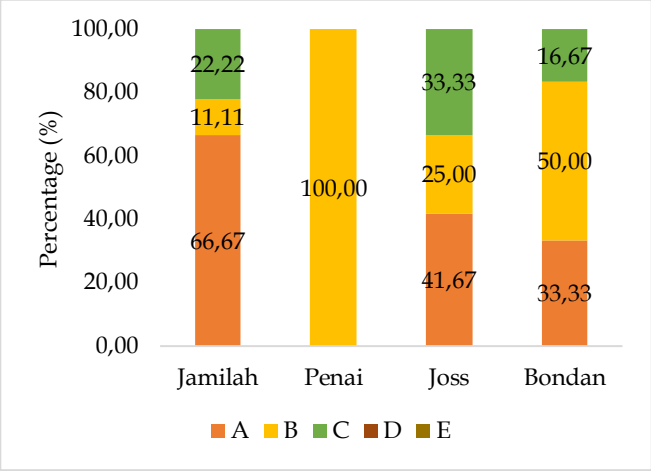

Figure 5. Decay class in renovation nest

As nest renovation occurs very frequently, a nest decay analysis was conducted as seen on Fig 5. Jamilah and Joss mostly renovated or reused nests that are still new or fresh with leaves that are still green (decay class A), while Penai and Bondan mostly renovated or reused nests that are relatively new with leaves starting to dry out decay class B). Jamilah, Joss, and Bondan are also observed a few times to renovate or reuse nests that have dried but still have shape (decay class C). The research subjects were never observed renovating or reusing nest with decay class D and E because the forest enclosure is a limited area constantly being used for orangutan to learn.

All the research subjects mainly select trees as a place to build nests (Fig 6). The only exception is Penai because Penai also used a 3.30 meter high feeding platform, and a 1.80 meter high tunnel connected to the cage as a place to sleep. However, Penai always used several leaves as a base while sleeping on the feeding platform or the tunnel.

Orangutans at Jerora Forest School are also conditioned to sleep with several leaves as a base while sleeping inside the holding cage. This may enable orangutans to show leaf-carrying behavior as seen on other rehabilitation sites (Russon et al., 2007). However, all the research subjects were never observed using this leaf-carrying technique to build nest. They just collected leaves near the nest sites.

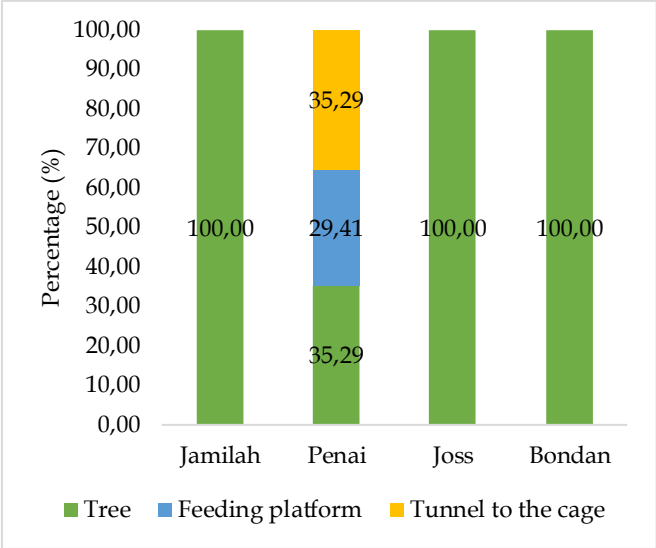

Figure 6. Nesting site preference

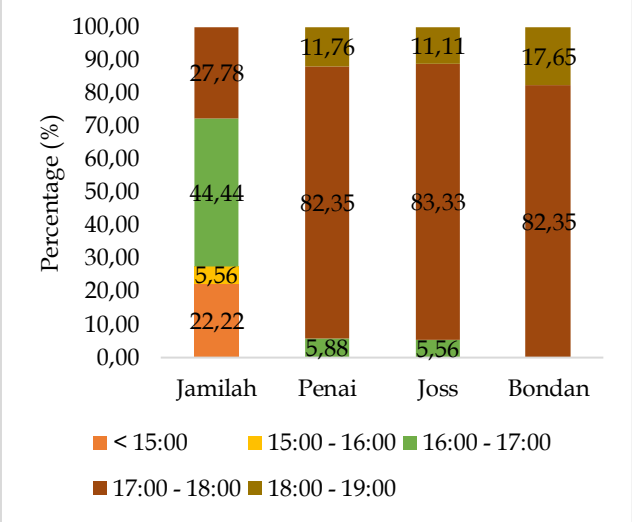

Figure 7. Nest building start time

All the research subjects mostly start building nests at around 17:00–18:00 (Fig 7) as seen on wild orangutan in East Kalimantan (Niningsih et al., 2021). Meanwhile, Jamilah frequently built nest early at 16:00–17:00. In fact, Jamilah was observed a few times built a nest even before 15:00 and missed evening meal given at 16:00. This may be attributed to Jamilah's reproductive status (pregnancy) affecting her energy expenditure, causing her to sleep earlier (Knott et al., 2009). Nayasilana et al. (2020) also described that reintroduced orangutan normally slept between 15:00–17:00.

Nest building typically takes 1–5 minutes for Jamilah, Joss, and Bondan, as shown in Figure 8. Penai often (94.12%) only takes less than 1 minute to build a nest because Penai is often observed sleeping on tree branches, feeding platforms, and tunnels using several leaves as a base. Penai was observed renovating the nest once with a duration of 1-5 minutes, similar to other

research subjects. The duration of nest building < 1 minute in Joss and Bondan occurred when they only used existing nests without renovating them or when they slept on tree branches. These findings are not significantly different from previous studies by Fauzi et al. (2020), which reported that orangutans aged 2–5 years in forest schools built nests in 5.00–6.44 minutes, and Nayasilana et al. (2020), who found that reintroduced orangutans typically required 5.1 minutes to build a nest. The four research subjects may have taken less time because they were only renovating existing nests, rather than building new ones from scratch. However, Jamilah was observed several times spending more than 5 minutes building a nest, which may have been due to her need for a more comfortable nest during pregnancy as stated by Nayasilana et al. (2020) that the time required to build a complete nest can be influenced by the adaptation process, comfort, and nest shape.

Three research subjects with moderate ability in building nests observed a few times building two nests before they went to sleep (Fig 9). Jamilah usually built a nest twice when she built nest early at around 16:00 and needed to come down from the tree to retrieve the food provided by the animal keeper. While Joss and Bondan are observed using each other's first nest when they built nest twice. Once, Bondan used Joss's first nest after Joss abandoned it and the other times Joss intimidated Bondan to move from her nest, so Bondan built another nest from scratch.

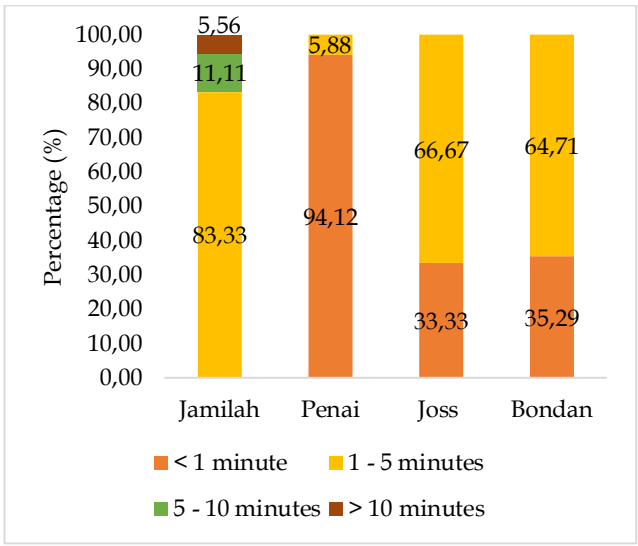

Figure 8. Duration of nest building activity

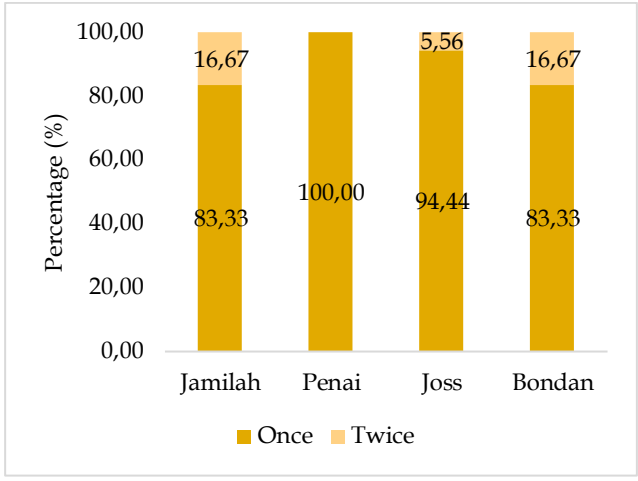

Figure 9. Frequency of nest building activity

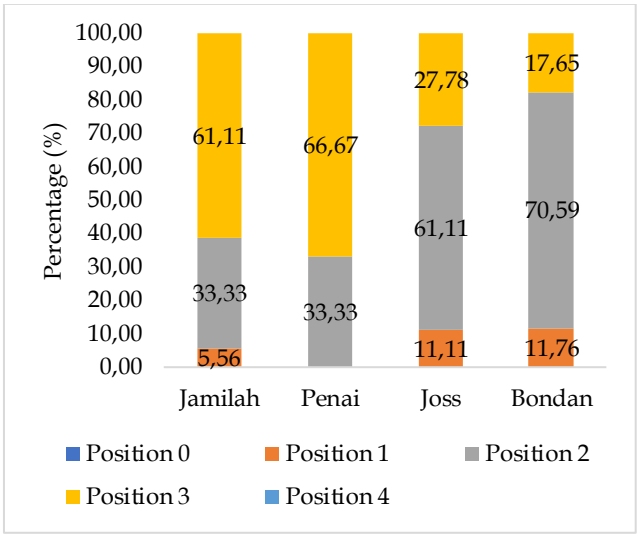

Figure 10. Nest position preference

Nest characteristic

The most frequently used nest position (Fig 10) by the adult orangutans (Jamilah and Penai) was position 3, typically built at the top of *Palaquium* sp (Menyatu). or within the tree forks of *Lithocarpus* sp. (Bambang), followed by position 2, located on the horizontal side branches of *Dialium indum* (Keranji) and *Syzygium* sp. (Ubah). Whereas the juvenile orangutans (Joss and Bondan) showed a preference for position 2, primarily on horizontal side branches, and position 3 in tree forks, utilizing a greater variety of tree species (Table 4). These findings are consistent with Sjahfirdi et al. (2023), who reported similar nesting preferences (positions 2 and 3) as the most favored among orangutans in another forest school.

Juvenile orangutans used more various tree species to build nests than the adult orangutans as seen on Table 4. This may be caused by the larger body size in adult orangutans, so they are more selective on choosing a nest tree or just reused nest that fit their body as seen on

Sjahfirdi et al. (2023). The research subjects often used the same tree species to build nests, especially the juvenile orangutan. Furthermore, they also used the same tree individual to build nest alternately. Tree species belonging to the *Dipterocarpaceae*, *Myrtaceae*, and *Fagaceae* families are commonly utilized for nest building, as reported in studies by Hakim et al. (2019), Fauzi et al. (2020), Andini et al. (2021), Firmansyah et al. (2023), and Sjahfirdi et al. (2023).

Table 4. Nest tree species used by the research subjects at Jerora Forest School

Species	Family	Ja	Pe	Jo	Bo
Dialium indum	*Fabaceae*	√			
Lithocarpus sp.	*Fagaceae*	√	√		
Syzygium sp1.	*Myrtaceae*	√			
Syzygium sp2.	*Myrtaceae*	√		√	
Palaquium sp1.	*Sapotaceae*	√	√	√	
Shorea sp1.	*Dipterocarpaceae*		√		
Vatica sp2.	*Dipterocarpaceae*				√
Shorea sp2.	*Dipterocarpaceae*			√	√
Dryobalanops beccarii	*Dipterocarpaceae*			√	√
Lithocarpus lucidus	*Fagaceae*			√	√
Shorea sp3.	*Dipterocarpaceae*			√	√
Tetractomia tetrandrum	*Rutaceae*			√	√
Vitex pinnata	*Lamiaceae*				√
Litsea sp.	*Lauraceae*				√
Vatica sp1.	*Dipterocarpaceae*			√	√
Artocarpus dadah	*Moraceae*				√
Total		5	3	8	10

Notes: Ja = Jamilah; Pe = Penai; Jo = Joss; Bo = Bondan

The diameter of trees used to build nests in adult orangutan research subjects ranged from 31.70 to 350.32 cm (mean = 107.52 cm; SD = ± 119.18). Meanwhile, in juvenile orangutan research subjects, it ranged from 22.50 to 134.00 cm (mean = 53.75 cm; SD = ± 39.68). The diameter of the nest tree in adult orangutans is larger than that in juvenile orangutans because adult orangutans are larger in size and therefore require a more stable tree (with a larger diameter) to accommodate a larger nest (Rayadin & Saitoh, 2009). In addition, adult orangutans in the research subject built nests at heights ranging from 6.50 m to 15.00 m (mean = 12.39 m; SD = ± 2.90) with tree heights varying from 11.00 m to 17.90 m (mean = 15.24 m; SD = ± 2.37). The juvenile orangutan research subjects built nests at heights of 6.00 m to 25.00 m (mean = 15.05 m; SD = ± 6.37) with tree heights ranging from 6.00 m to 36.00 m (mean = 19.23 m; SD = ± 11.01). The nest height was not significantly different from previous studies (Riyadi & Said, 2015; Sidiq et al., 2015; Kuswanda et al., 2020; Firmansyah et al., 2023). Orangutans are primarily arboreal animals with arboreal sleeping nests (Prasetyo et al., 2008; Supriatna, 2022). Additionally, the presence of terrestrial predators such as clouded leopards (*Neofelis diardi*) also contributes to orangutans building arboreal sleeping nests. The correlation between nest height and tree height in juvenile orangutans is more significant (rho = 0.72, p <0.01, n = 39) compared to adult orangutans (rho = 0.31, p <0.01, n = 27). This demonstrates that nest height is directly proportional to tree height. This also occurs because juvenile orangutans use a wider variety of nesting trees, and their relatively small body size allows them to build nests at even greater heights. This correlation aligns with Breuer et al. (2021), who stated that the fewer large trees there are, the lower the nests built by chimpanzees. The lower nests increase vulnerability to terrestrial predators.

Conclusion

Three out of four female pre-release bornean orangutans (Jamilah, Joss, and Bondan) are categorized as moderate on their ability to build nest, while Penai is less capable. Nest trees used by the juvenile orangutan are more diverse than the ones used by the adult orangutan. The characteristics of the nests used by the research subjects were relatively similar across each age group. Nest trees used by the juvenile orangutans are more diverse than the ones used by the adult orangutans. Based on the nest building observation, Jamilah, Joss, and Bondan are ready to be released, while Penai is not ready to be released yet.

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Author Contributions

Conceptualization, HI, LS, and TMS; methodology, HI, LS, and TMS; software, HI, LS, and TMS; validation, HI, LS, and TMS; formal analysis, HI, LS, and TMS; investigation, HI, LS, and TMS; resources, HI, LS, and TMS; data curation, HI, LS, and TMS; writing—original draft preparation, HI, LS, and TMS; writing—review and editing, HI, LS, and TMS; visualization, HI, LS, and TMS; supervision, LS, and TMS; project administration, HI, and LS; funding acquisition, HI, and LS. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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