Bioedukasi
Jurnal Biologi dan Pembelajarannya
Vol. 23 No 1, February page 68-75
e-ISSN: 2580-0094; p-ISSN:1693-3931
DOI: 10.19184/bioedu.v23i1.53707
bioedukasi.unej.ac.id/index.php/BIOED/index

Vegetation Analysis of Sumatran Orangutan (*Pongo abelii*) Habitat in Mamas Resort Area, Gunung Leuser National Park, Southeast Aceh

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Article Info
Article history:
Accepted 23 December, 2025
Revised 25 February, 2025
Accepted 25 February, 2025

Keywords: (AZ)
Food trees
Primary forest
Secondary forest
Sumatran orangutan
Vegetation

ABSTRACT
Most fauna species are highly dependent on forest quality, one of which is orangutans. Orangutans have a habitat preference that is evenly distributed or in groups. Therefore, the management of orangutan populations and their habitats must consider the habitat preferences of orangutan populations. The purpose of this study was to determine the habitat quality (vegetation types) of orangutan populations through vegetation richness in both habitat types, namely primary and secondary forests. The method used is plotted (20x20) line method. This study was conducted for 2 weeks (8-21 August 2023). Each habitat type consists of 4 transects, 40 plots in primary forests and 18 plots in secondary forests. The highest Importance Value Index (IVI) in primary forests is *Litsea diversifolia* from the Lauraceae Family, while in secondary forests, the hignest IVI is *Macaranga gigantea* from Euphorbiaceae family. The availability of sumatran orangutan food tree species, as many as 60 species in Primary forest and 45 species in secondary forest. The diversity index shows that primary forests have higher diversity than secondary forests. The species diversity index, dominance index, and evenness index in primary and secondary forests are categorized as high.

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1. INTRODUCTION

The diversity of flora and fauna is a significant variation in the life of living things on Earth, because biodiversity is the most important element of the planet. Without us realizing it, the planet has entered the sixth mass extinction. Although the loss of species is a normal part of nature, human activities have accelerated the process. Research (Lambertini, 2020) claims that there has been a 68% decline in the number of fish, amphibians, reptiles, mammals, and birds. For Southeast Asia, which has grown into a center for wildlife trade, and illegal forestry worldwide, this is very concerning. The law protects a number of species native to the region, including orangutans, elephants, pangolins, rhinos, and tigers.

Most fauna species are highly dependent on forests, one of which is the Sumatran orangutan (*Pongo abelii*), the survival of orangutans is highly dependent on good forest conditions, and as fruit-eating primates (*frugivorus*), orangutans need fruits as their main food source, (Utami Atmoko and Rifqi, 2012) . Experts say that the current orangutan population is limited, namely only in Sumatra and Kalimantan (Prasetyo et al., 2019) . Land clearing is a very serious threat, which from year to year becomes a serious threat to the lives of orangutans. Large-scale logging on these two islands has resulted in widespread forest fragmentation, and is a serious threat to the survival of orangutans and other wildlife (Dalimunthe, et al ., 2020) . The decline in the sustainability of forest habitats has a major impact on wildlife populations, one of which is orangutans and other primates, which breed in the area. Other factors that affect the orangutan population include poaching and conversion of forest land, namely into oil palm plantations (Prasetyo et al., 2019) . These factors are external threats that have a direct impact on the survival of orangutans and other wildlife.

The combined impacts of habitat loss, habitat degradation, and illegal logging and poaching have caused the orangutan population in Indonesia to decline drastically, so that orangutans that were previously categorized as " *endangered "* have become "critically *endangered " on the International Union for Conservation of Nature*

(IUCN) Red List of Endangered Species , so that conservation efforts are urgently needed, both for forest areas and orangutan habitats (Ancrenaz 2016; Alikodra et al., 2017) .

Implementation of special measures, to reduce and avoid negative impacts on forest areas, as habitats where orangutans live, needs to be implemented. Orangutan conservation efforts can be carried out through the management of remaining habitats, both outside and inside the area. One of the orangutan habitats is in the Gunung Leuser National Park (GLNP) area. GLNP is a conservation area for its flora and fauna, which is determined by the government regarding the protection, education, and preservation of the flora and fauna contained therein (BBTNGL, 2021) . Therefore, knowledge of habitat (forest vegetation), and fluctuations in fruit plants with the presence of new orangutan nests is absolutely necessary.

Forest vegetation is a study, to determine the composition and structure of the forest, the diversity of vegetation types, and their distribution are useful variables for assessing habitat quality (Farhan et al., 2019) . Good orangutan habitat is usually a mosaic of small forest gaps, with various types of woody plants, there are also types of fruit trees (Alikodra et al., 2017) . The presence of fruit plants, accompanied by new nests, is an effective step, to identify the presence of orangutans, by building new nests, in the area, because orangutans build new nests every day, for their resting places, orangutans make new nests when they find woody plants that produce fruit. A suitable habitat for orangutans is in a place where there are trees and vines that can produce 30-50 percent of fruit (March et al., 2016) .

Research in the Mamas Resort area, Darul Makmur Village forest area, Darul Hasanah District, Gunung Leuser National Park (GLNP), there are two different types of habitats, namely primary forest and secondary forest, so it is very important to know the type of vegetation, in an area of Sumatran orangutan habitat type that lives there. According to reports from people living on the border of the park, in fact orangutans in the forest often come to community plantations, at Mamas Resort in Gunung Leuser National Park. So far, data on vegetation conditions and prevalence of orangutan food tree species, in primary and secondary forest areas, at Mamas Resort Gunung Leuser National Park, are still unknown. Based on this background, the objectives of this study are to 1) Determine the composition of vegetation, 2) Determine the proportion of orangutan food tree species, 3) Diversity index , dominance index, and equity index in Primary Forest and Secondary Forest, and 5) Species similarity index (SI). The benefit of this research is as a basis for new information on the quality of the habitat in this area (Mamas Resort) for the development of management efforts in GNLP, in order to support the life of the Sumatran orangutan.

2. RESEARCH METHODS

This research was conducted in the Mamas Resort area in Darul Makmur Village, Gunung Leuser National Park (GLNP), Darul Hasanah District, Southeast Aceh, Aceh Province. Geographically located at 3°37'83.3" N and 97°43'23.411" E. The research was conducted for almost 2 (two) week, namely 8-21 August 2023.

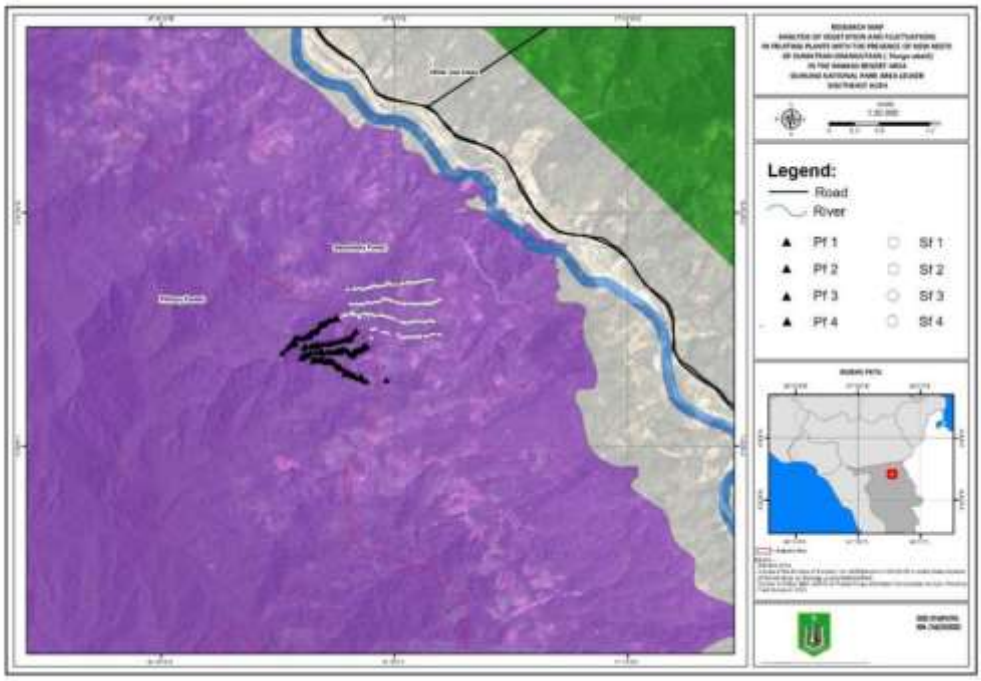

Figure 1. Map of research locations and transect distribution.

The Mamas Resort forest area consisted with primary forest, and partially (small part) used by the local community. People in the past (>20 years ago) gardened and turn the forest became secondary forests by planting fruit trees such as durian, langsat, areca nut, jengkol, coffee and petai. However, there were also those who planted young plants such as corn, chili, sweet potatoes and other.

a. Data collection technique

The method used in this study is the Plotted Line method The data collection technique was carried out using 8 transects in two types of habitats, each four transects established in primary and secondary forests with in total an observation area of 40 ha. Each transect was divided into 10 small plots measuring 20x20 m with an interval of 100 m (Utami Atmoko and Rifqi, 2012) . The parameters taken are tree species, total tree height, tree canopy and dbh; (> 30 cm) (Kuchler et al., 1976) .

3. Data anliysis

Important value index (IVI) analysis is used to determine the dominance of a species over other species in a stand, namely Density (D), Frequency (F) and Dominance (C) in the form of an important value index (IVI), Species Diversity Index (H'), Dominance Index (D), Uniformity Index (E) and Species Similarity Index (SI).

a. Diversity Index

To find species diversity, the author used the Shannon-Wiener index with the following formula (Mueller et al., 1976)

$$\mathbf{H' = -\sum (pi) \ln (pi) \rightarrow \text{where: } pi = \frac{ni}{N}}$$

ni = Number of individuals of a species
N = Number of individuals of all species
Ln = Natural log

The assessment categories for species diversity are as follows:

H'< 1: Indicates a low level of species diversity
1>H'>3: Indicates a moderate level of racial diversity
H' > 3: Indicates a high level of species diversity

b. Dominance index

The dominance index is calculated using the Index (Simpson, 1949; in Dianthani, 2003) (C) with the formula:

$$\mathbf{C = \sum pi = n/N}$$

Information:

C = Dominance index
ni = Number of individual species
N = Number of individuals of all species

The index value ranges from 0-1 with the following categories:
0 < C < 0.5 = Low dominance
0.5 < C ≤ 0.75 = Moderate Dominance
0.75 < C ≤ 1.0 = High dominance.

c. Evenness index

Evenness index with the formula (Magguran, 1988 in Kusmana and Susanti, 2015)

$$\boldsymbol{E = \frac{H'}{Ln(S)}}$$

Information:

E = Evenness index
H′ = Diversity index
S = Number of types

The index value ranges from 0-1 with the following categories:

E < 0.3 low evenness index
E = 0.3 – 0.6 moderate evenness index
E > 0.6 high evenness index (Kusmana and Susanti, 2015)

d. Similarity Index (SI)

The Similarity Index (SI) was calculated using the Sorensen Similarity Index (Kuchler et al., 1976), with the formula:

$$\mathbf{SI = (2c/A+B) \times 100\%}$$

Where:

A = Total number of types at location A
B = Total number of types at location B
C = Number of the same species at locations A and B

The similarity index value is SI <50% = low similarity; SI>50% = high similarity.

e. Important Value Index (IVI)

The collected data is then calculated using the Important Value Index (IVI). This value is calculated using a formula.

a) Density

- Absolute Density (AD)
  $AD = \frac{Number\ of\ individual\ plants\ in\ a\ plot}{Plot\ area}$
- Relative Density (RD)
  $RD = \frac{density\ of\ a\ type}{density\ of\ all\ types}$x100%

b) Frequency

- Absolute Frequency (AF)
  $AF = \frac{Number\ of\ plots\ where\ the\ species\ was\ found}{Total\ number\ of\ plots\ observed}$
- Relative Frequency (RF)
  $RF = \frac{Frequency\ of\ a\ species}{absolute\ frequency\ sum\ of\ all\ types}$x100%

c) Domination

- Domination (D)
  $D: \frac{The\ basic\ surface\ area\ of\ a\ type}{Plot\ area}$
- Relative Dominance (DR)
  $DR = \frac{Dominance\ of\ a\ species}{Total\ dominance\ of\ all\ species}$x100%

Area of the Basic Plane = πr2 or 1/4πd2 or 0.25*PI( )*(d2)
Measurement of the diameter of the liana plant was carried out on the stem which was 25 cm above the roots.
Determining the Importance Index
INP = RD + RF + DR.

3. RESULTS AND DISCUSSION

Based on the results of research that has been conducted on two types of habitat in secondary forests and primary forests, the vegetation parameters of the plants analyzed are as follows:

a. Vegetation Composition of Plants in Primary Forests

The results of field observations for vegetation composition in the Primary Forest location were obtained from 4 transects consisting of 40 plots with a total of 675 trees analyzed, a total of 98 tree species, and 60 of them are orangutan food trees species from 34 families in the primary forest habitat. The results of the vegetation analysis in the primary forest are *Litsea diversifolia* from the Lauraceae family has the highest INP at all growth levels. The following are the ten highest INP results in the primary forest presented in table 1.

Table 1. Importance value index in primary forest (*orangutan food tree species).

No	Scientific Name	Local Name	Family	RD (%)	FR (%)	DR (%)	IVI
1	*Litsea diversifolia Blume.**	Shortening	Lauraceae flowers	17,481	6.197	1.121	24,799
2	*Oriental Trema (L.) Bl.*	Knotty	Marijuana	0.444	0.214	10,614	11,272
3	*Durio oxleyanus Griff.**	Forest Durian	Malvaceae flowers	0.593	0.855	8,994	10,442
4	*Ficus Drupacea Thunb. **	Horse Rib	Moraceae family	0.148	0.214	10,031	10,393
5	*Syzygium acuminatissimum (Blume) DC.**	Forest guava	Myrtaceae flowers	5.333	4,701	0.191	10,226
6	*Lithocarpus hystrix (Korth.) Rehder.**	Horn sound	Family Fagaceae	3.259	3,846	1,374	8,479

No	Scientific Name	Local Name	Family	RD (%)	FR (%)	DR (%)	IVI
7	*Parashorea lucida.**	Entap	Dipterocarp	1,778	1,923	4.665	8,366
8	*Shorea Sp.**	Semantuk	Dipterocarp	0.444	0.641	6,580	7,665
9	*Dysoxylum densiflorum (Blume) Miq.**	Rhino set	Meliaceae	1.185	1,496	3.855	6,536
10	*Sterculia cordata Flower.*	Big Sepang	Malvaceae flowers	0.593	0.641	5.010	6.244

Table 1 shows the results of vegetation analysis found in the primary forest of the research location, the highest (IVI) is found in the *Litsea diversifolia tree* (pepening) of 24.799% from the Lauraceae family . However, the smallest IVI is found in the *Eurycoma longifolia tree* (tongkat ali) of 0.427 % from the Simaroubaceae family. There are 8 species of the highest percentage as food for sumatran orangutans (*Pongo abelii*).

b. Vegetation Composition of Plants in Secondary Forests

Field observations, for the composition of vegetation in secondary forest locations were obtained from 40 plots, but only 18 plots were dominated by trees, with a total of 298 trees with 79 species, 45 species of which are orangutan food trees from 35 families. The results of vegetation analysis showed that *Macaranga gigantea* from the Euphorbiaceae family had the highest (IVI) at all growth levels. The following are the ten highest (IVI) results in secondary forests presented in table 2.

Table 2. Importance value index in secondary forests (*orangutan food tree species)

No	Scientific Name	Local Name	Family	RD (%)	FR (%)	DR (%)	IVI
1	*Macaranga gigantea (rchb.f. & zoll.) Müll.arg.*	Elephant Lamp	Euphorbiaceae flowers	10,738	5.263	0.517	16,518
2	*Balakata baccata (approx.) Be.**	Selupik	Euphorbiaceae flowers	8,054	4.094	0.511	12,658
3	*Mallotus paniculatus (lam.) Müll.arg.*	Wind Turning Lamp	Euphorbiaceae flowers	7,047	4.678	0.731	12,456
4	*Styrax benzoin dry.**	Incense	Styracaceae flowers	5.705	4.678	1,327	11,710
5	*Hevea brasiliensis muell. Arg.*	Rubber	Euphorbiaceae flowers	5.705	4.094	1,012	10,811
6	*Litsea diversifolia blume.**	Shortening	Lauraceae flowers	1,342	1,754	6.145	9.242
7	*Ficus variegata blue flowers**	Gala Gala Rahu	Moraceae family	3.356	4.094	0.603	8,052
8	*Alangium rotundifolium (hassk.) Bloemb.*	Sugarcane Paper	Euphorbiaceae flowers	3.356	3,509	1,024	7,888
9	*Aryteria littoralis.*	Kamok	Sampindaceae family	2.013	1,754	3.484	7.252
10	*Knema latifolia warb.**	Small Forest Nutmeg	Myristicaceae flowers	0.336 years	0.585 years	5,967	6,888

Table 2 shows the results of the analysis of 10 vegetation with the highest IVI in the Euphorbiaceae family, namely *Macaranga gigantea* (elephant tree) with an IVI of 16.518%, while *Knema latifolia* (wild nutmeg) with an IVI of 6.888%. Overall, *Castanopsis inermis* with an IVI of 1.227% from the Fagaceae family ranks the lowest. There are 5 species of the highest proportion as food for sumatran orangutans.

c. Proportion of orangutan food tree species in primary and secondary forests

The results of the analysis of the availability of orangutan food trees at the two research locations can be seen in Figure 2.

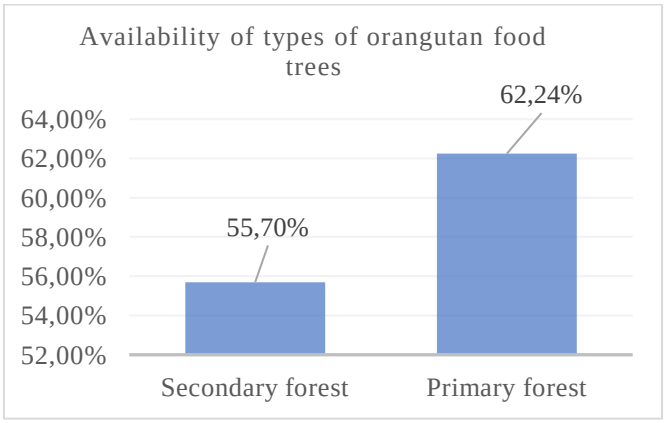

Figure 2. Proportion of availability of orangutan food tree species in both habitats.

The results above show that he proportion of trees species that are also food trees for orangutans is highert in the primary forest habitat, namely 62.24%.

d. Species diversity index , dominance index, and equivalence index in Primary Forest

The observation location in the primary forest is a forest that has never been disturbed by humans, so it is important to know the quality and stability of the primary forest reference ecosystem in Mamas Resort, GLNP. The index values are presented in table 3.

Table 3. Species diversity index , dominance index, and evenness index

Index		Tree
Diversity Index (Shanon-Wiener)	H '	4.014
Evenness Index	E	0.876
Dominant Index (Simpson)	C	0.958

Shannon-Wiener species diversity index value in the primary forest ecosystem of the Mamas Resort GLNP is classified as high at all growth rates (table 3).

e. Species diversity index , dominance index, and equity index in secondary forests

To determine the quality and stability of the ecosystem in secondary forests, it is necessary to know the diversity index H', species diversity (H'), dominance index (C) and evenness index (E). The index values are presented in table 4.

Table 4. Species diversity index, dominance index, and evenness index

Index		Tree
Diversity Index (Shanon-Wiener)	H'	3,778
Evenness Index	E	0.824
Dominant Index (Simpson)	C	0.962

The results of table 4. based on the *Shannon-Wiener index* (H') show 3.778% which means it is classified as high**.**

f. Species similarity index (SI) in Secondary and Primary Forests

Results of species similarity (SI) and species diversity (H') in secondary forests and primary forests. Table 5 Comparison of species similarity (SI) and species diversity in secondary forests and primary forests.

Table 5. Species similarity index (SI).

He	Information	Secondary Forest	Primary Forest
1	Research areas	Area 4000 km²	Area 4000 km²
2	Number of Trees	298	675
3	Density (Ind/Ha)	413,889	421,875
4	Average species diversity index (H')	3,778	4.014
5	IS type similarity	**58.75%**	

Based on the table above, the species similarity index in both types of primary forest and secondary forest habitats is categorized as high, because the species similarity level is more than 50%. High Level of Similarity of Species, Means Primary Forests and Secondary Forests Have the Same Environmental Conditions, Such as Climate, Soil, and Topography.

Based on the results of the study, the highest Importance Value Index (IVI) in primary forests is the type of orangutan food tree, namely Litsea diversifolia (pepening; 24.8%) from the Lauraceae family. There are 60 types of orangutan food trees in primary forests including Litsea diversifolia . Trees with high IVI values mean they have better adaptability, competitiveness, and reproductive ability, compared to other plants (Bara'a, 2023) . Sumatran orangutans eat Litsea diversifolia not only the fruit, but also the leaves. In general, the Lauraceae family is the largest branch of the Leurales order, with 50 genera and more than 2000 species, spread throughout tropical latitudes, to subtropics, especially in Southeast Asia and Tropical America (Kusparadini et al., 2018) . According to the Bappenas report (1993) and MacKinnon et al. (2000) there are 300-400 species, found in Gunung Leuser National Park (GLNP), dominated by the Dipterocarpaceae family (Shorea and Dryobalanops), Myristicaceae, Eurphobiaceae, Sapotaceae, Meliaceae, Moraceae and Oleaceae. In addition to Litsea diversifolia there are four other species that are included in the top five most abundant species, namely Durio oxleyanus, Syzygium acuminatissimum, Ficus Drupacea and Trema orientalis These five species are dominant species in primary forest habitats. The dominance index is used to see the dominance of plant species in a location (Utami & Putra, 2020).

The highest important value index type in secondary forests is Macaranga gigantea (Tampu Gajah; 16.52%). In this forest there are 45 species identified as orangutan food tree species. Macaranga gigantea from the Euphorbiaceae family is a pioneer species that grows rapidly in secondary tropical rainforests and is abundant in forests, after plantation activities (Amirta et al., 2017) , in the northern part of Kalimantan, it is stated that the dominance of pioneer species from the genus Macaranga SPP grows after forest clearing activities and forest fires. This species is also found on the Malay Peninsula and Kalimantan. Pioneer species are tree species that live in the early stages of succession, the vegetation succession process occurs in several stages and usually begins with growth, plants that are resistant to sunlight and can live without shade (Lawrance et al., 2014 in Ardi 2023).

According to Whitmore (in Nayasilana et al., 2015) , logged forests can be restored through secondary succession with 3 growth phases, namely the gap phase, the development phase, and the maturity phase. These three phases form a mosaic that affects dynamic changes in vegetation structure. Macaranga gigantea is an important indicator tree species in young secondary forests and old secondary forests. If this species is found dominant and grows well in a certain area, it indicates that the soil in the area is fertile enough for further plantation activities. However, the dominant tree species in secondary forests is Styrax benzoin dryand which is also one of the types of food trees and nesting places for orangutans.

The diversity index in both habitat types shows that the primary forest area has higher diversity compared to the secondary forest, with a level value of 4.014 while for the secondary forest it is 3.778. The results of the diversity index in both habitat types are classified as high because they have a value of > 3 (Utami & Putra, 2020) . The species similarity index (SI) between primary and secondary forests is 58.75%, which means that more than 50% have the same species. This can occur because of the proximity of the two habitat types (Nayasilana et al., 2015). This can be explained because in the last 20 years, the secondary forest area in the Mamas Resort GLNP, some of the open areas have been abandoned and not utilized by the local community, the secondary forest area will be returned to nature. According to (Dumbois & Ellenberg in Rio 2023) if tropical rainforests have been damaged naturally or intentionally (human intervention), then the secondary succession that occurs usually 15 to 20 years will form a young secondary forest, and after 50 years will form an old secondary forest that will gradually reach its climax. However, the proportion of orangutan food tree species in primary and secondary forests is still dominated by primary forest habitats of 62.24%, while in secondary forests it is only 55.70%.

4. CONCLUSION

The value of the species diversity index, dominance index, and evenness index in primary forests is higher than in secondary forests. However, the results of the diversity index in both habitat types are classified as high, this probably due to the proximity of the two habitat types and abandoned by human activity, which lead this secondary forest also used by sumatran orangutan as their habitat.

5. ACKNOWLEDGEMENT

We would like to thank Mamas Resort and Gunung Leuser National Park Office (BBTNGL/ GLNP) in Banda Aceh for their permission and support to conduct this research. We would like to thank Universitas Nasional (UNAS) for their support and cooperation, especially Dr. Fitriah Basalamah, Didik Prasetyo Ph.D, Astri Zulfa, M.Si and Silvia Hasan, M.Si. We would like to thank the Darul Makmur community and the Leuser Conservation Forum, for their support.

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