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Study on the Presence of the Rhinoceros Hornbill *(Buceros Rhinoceros)* and its Food Potential in the Pondok Buluh Forest Training Center

Rozalina[1*], Sarintan E. Damanik[1], Tri Adimas Sanjaya[1]

[1] Program Studi Kehutanan, Fakultas Pertanian, Universitas Simalungun Pematangsiantar, Indonesia

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Corresponding Author:
Rozalina
rozalina.lubis@gmail.com

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Abstract: This study aims to determine the presence of rhinoceros hornbills and their potential food trees in the Pondok Buluh Training Forest (KHDTK). Data collection on the presence of hornbill species was carried out using a concentrated point method determined by field observations. Observations were conducted at six observation locations along the rhinoceros hornbill's daily movement path. Observations were conducted at time intervals between 07.00-09.00 WIB (morning), 11.00-13.00 WIB (afternoon) and 15.00-17.00 WIB (evening), where these times are when rhinoceros hornbills are actively foraging and resting, so the opportunity for observation is greater. The data collected were encounter time, number of individuals, type of encounter (visual/audio) and encounter location. Data collection for potential food trees was carried out using the Species Area Curve Method with vegetation analysis. The parameters measured were species name (local and scientific), number of individuals, tree diameter at breast height and tree height. The vegetation analysis method used was the Species Area Curve Method. Based on the observation results, encounters with Rhinoceros Hornbills occurred at six observation points, namely at observation point 1 (coordinates N 02°46′45.3″ and E 098°59′55.3″), observation point 2 (coordinates N 02°46′40.1″ and E 099°00′02.3″), observation point 3 (coordinates N 02°46′80.2″ and E 098°59′93.6″), observation point 4 (coordinates N 02°46′07.7″ and E 098°59′06.6″), observation point 5 (coordinates N 02°46′24.768″ and E 098°58′00.426″) and observation point 6 (coordinates N 02°46′24.456″ and E 098°58′13.368″). The potential for food trees in the Pondok Buluh Training Forest KHDTK has a "good" regeneration rate so that it can support the survival of the rhinoceros hornbill.

Keywords: Buceros Rhinoceros; Food Potential; Rhinoceros hornbill

Introduction

Hornbill species in Indonesia are protected animals through Law No. 5 of 1990 concerning the Conservation of Biological Natural Resources and their Ecosystems and the Regulation of the Minister of Environment and Forestry P.106/MENLHK/SETJEN/KUM.1./12/2018 of 2018 concerning Protected Plant and Animal Species. Hornbills are a group of birds that have a high ecological function. These birds are a group of frugivorous birds that function as seed dispersal agents for various forest plants. The hornbill family *(Bucerotidae)* lives in tropical rainforests and requires primary forests as its natural habitat. Generally, hornbills live in the canopies of towering forest trees. Forest canopies are used as perches, foraging, and nesting places. Indonesia has 13 species of hornbills. These species are distributed across

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five major islands: Sumatra, Java, Kalimantan, Sulawesi, and Irian Jaya (Sukmantoro et al., 2007).

Hornbills are an easily recognizable group of birds. Generally, hornbills are characterized by their large size, with a total length ranging from 381 to 1600 mm. They have very large, sturdy yet lightweight beaks, called hornbills, which are red or yellow, curved, and some resemble horns. Their plumage is brown, black, white, or black and white. The skin and feathers around the throat are light in color, with strong wings, a long tail, short legs, large toes, and syndactyly (Mackinnon & Rahardjaningtrah, 2010).

One of the 13 hornbill species in Indonesia is the rhinoceros hornbill. The rhinoceros hornbill (Buceros rhinoceros) is one of the largest hornbill species in Asia. The rhinoceros hornbill spends its time in the upper forest canopy, eating primarily fruit, insects, small reptiles, rodents, and small birds. This animal has a unique behavior: the female nests in a tree hole, which is then covered with mud. During her stay, the male feeds her (Widjojo, 2011)

According to the IUCN Red List, the rhinoceros hornbill is an endangered species. Its rarity is due to high rates of poaching, illegal wildlife trade, and forest degradation. The primary reason hornbills are sought after is their uniqueness, and many collectors are willing to collect them illegally. CITES also classifies this bird as Appendix I (the species is threatened by all forms of trade).

Currently, the distribution of rhinoceros hornbills in Sumatra is concentrated only in forested areas, particularly in natural forests that are still in relatively good condition. One area identified as rhinoceros hornbill habitat in North Sumatra is the Pondok Buluh Training Forest (KHDTK), which serves as a crucial habitat for rhinoceros hornbills. The Pondok Buluh Training Forest (KHDTK) boasts a largely pristine ecosystem consisting of forest and river ecosystems. Various species of flora and fauna thrive within this forest area, one of which is the rhinoceros hornbill, the object of this study, which is also found in the Pondok Buluh Training Forest (KHDTK). This study aims to determine the existence and potential of rhinoceros hornbill food in the KHDTK Pondok Buluh Training Forest.

Method

Location and Time

This activity was conducted at the Pondok Buluh Forest Training Center (KHDTK) in Simalungun Regency, North Sumatra. Field data collection took place from January to February 2021. Data collection took place at six observation points.

Data Collection

Primary Data

Primary data is data obtained directly through field observations and is directly related to the research. The primary data collected included data on rhinoceros hornbills and their potential food trees.

Bird Observation

The rhinoceros hornbill presence study used the concentration point count method.

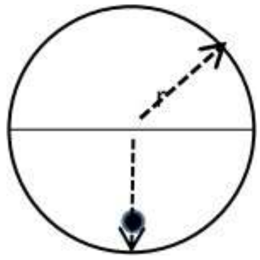

Figure 1. Design of the concentration point count method.

Data collection on the presence of hornbill species was conducted using a concentrated point method, determined through field observations and information from the community regarding locations where rhinoceros hornbills are frequently found. The concentrated point method involves direct observation/contact with groups of rhinoceros hornbills observed during their vocalization, feeding, and resting activities (Rinaldi, 1992). Observations were conducted at six observation locations along the rhinoceros hornbill's daily movement routes. Observations were conducted between 7:00 and 9:00 a.m. in the morning, 11:00 a.m. and 1:00 p.m. in the afternoon, and 3:00 p.m. and 5:00 p.m. in the evening, as these are the times when rhinoceros hornbills are actively foraging and resting, thus increasing the chance of observation. Data collected included encounter time, number of individuals, type of encounter (visual/audio), and encounter location.

Vegetation Observation

Data collection for potential forage trees was conducted using vegetation analysis using the gridded strip method at the Pondok Buluh Forestry Training Center (KHDTK). Strips were created by intersecting contour lines. Observation plots were created along each strip: 2 x 2 m plots were used to analyze seedling and understory vegetation. 5 x 5 m plots were used to analyze sapling vegetation, 10 x 10 m plots to analyze pole vegetation, and 20 x 20 m plots to analyze tree vegetation. Parameters measured directly in the field were species names (local and scientific), number of individuals, and tree diameter at breast height and tree height. The vegetation analysis method used was the Species Area Curve Method, with work stopping when the increase in plot area did not result in a significant increase in the number of species. This minimum area was determined based on the assumption that increasing plot area would not result in an increase in the number of species by more than 5-10% (Cain & Castro, 1959; Roberts & Oosting, 1958).

$$K = \frac{N}{A} \quad (1)$$

Description:
K: Species density
N: Number of individuals of one species
A: Total area of the plot

$$KR = \frac{KS}{KA} x100\% \quad (2)$$

Description:
KR: Relative Density
KS: Density within one species
KA: Density of all species

$$f = \frac{Np}{Nt} \quad (3)$$

Description:
f : Species Frequency
Np : Number of Plots Where a Species is Found
Nt : Total Number of Plots

$$fR = \frac{fs}{ft} x100\% \quad (4)$$

Description:
fR : Species Frequency
fs : Frequency of a species
ft : Frequency of all species

$$D = \frac{As}{At} \quad (5)$$

Description:
D: Dominance
As: Basal Area of a Species
At: Total Area of Sample Plot

$$DR = \frac{Ds}{Dt} x100\% \quad (6)$$

Description:
D: Relative dominance
Ds: Dominance of a species
Dt: Dominance of all species

Secondary Data

Secondary data is data obtained indirectly or supporting data obtained through literature studies and other sources. The secondary data collected includes the general conditions of the research location, supporting literature on the rhinoceros hornbill, habitat, and diversity.

Data Analysis

Data analysis for bird observations in this study used qualitative descriptive analysis. The researcher described, explained, and illustrated the data obtained in the field and systematically compiled it into scientific sentences. Meanwhile, data analysis for observations of potential food vegetation used the gridded path method (Importance Value Index). This Importance Value Index is used to determine the dominance of one species over another; in other words, the importance value describes the ecological position of a species within the community. The Importance Value Index is calculated based on the sum of Relative Density (KR), Relative Frequency (FR), and Relative Dominance (DR) values (Mueller-Dombois & Ellenberg, 1974; Supartono, 2010)).

Result and Discussion

The Presence of Rhinoceros Hornbills in the Pondok Buluh Forest Training Area

Based on observations, 38 encounters with Rhinoceros Hornbills were recorded at the six (6) observation points, consisting of visual and audio encounters, as shown in Table 1.

Kusrini et al. (2003) stated that rhinoceros hornbills are active from 6:00 AM to 11:00 AM WIB (Western Indonesian Time) and in the afternoon (3:00 PM to 6:00 PM WIB). This is based on observations conducted in the Pocut Meurah Intan Nature Reserve (Tahura). Rhinoceros hornbills actively forage in the morning (6:00 AM to 11:00 AM WIB). During the day (11:00 AM to 2:00 PM WIB), they begin to reduce their foraging activity. They are observed perching more in the tree canopy, preening their feathers. They become active again in the afternoon (3:00 PM to 6:00 PM WIB), but their foraging intensity decreases in the afternoon. In addition to foraging in the afternoon, rhinoceros hornbills are seen resting in the tree canopy, preparing to return to their resting place.

Threats

All hornbill species in Indonesia are listed as protected species. According to the IUCN Red List, of the 13 species of hornbills in the world, one is Critically Endangered (CR), three are Vulnerable (VU), four are Near Threatened (NT), and five are Least Concern (LC). The Helmeted Hornbill (Rhinoplax vigil) is a species that is one step closer to extinction, or Critically Endangered (CR). This status increased in just 3 years, from Near Threatened (NT) to Critically Endangered (CR) due to hunting and the loss of forests as habitat for the Helmeted Hornbill.

The presence of rhinoceros hornbills in the Pondok Buluh Training Forest (KHDTK) also faces several threats, both natural and non-natural. Natural threats stem from climate change, which causes changes in soil fertility in the Pondok Buluh Training Forest (KHDTK) (Madjid et al., 2025). This, in turn, inhibits the growth rate of potential food trees for rhinoceros hornbills and reduces their fruit production. Meanwhile, non-natural threats are the biggest problem facing rhinoceros hornbills in the Pondok Buluh Training Forest (KHDTK). This is because rhinoceros hornbills are unique and have high market value, leading to rampant hunting.

In addition to hunting, high levels of community activity around the Pondok Buluh Training Forest (KHDTK) also disrupt their habitat. Land clearing for agriculture, logging, and other illegal activities have reduced the rhinoceros hornbill's habitat. Therefore, sustainable conservation measures are needed to maintain the existence of the rhinoceros hornbill in the Pondok Buluh Forest Training Center (KHDTK).

Table 1. Frequency of Encounters with Hornbills

Observation Points	Coordinate location	Meet				Amount	
		Morning		Evening			
		Visual	Audio	Visual	Audio	Visual	Audio
Point 1	N 02°46′45,3″ & E 098°59′55,3″	2	3	-	2	2	5
Point 2	N 02°46′40,1″ & E 099°00′02,3″	-	1	-	2	-	3
Point 3	N 02°46'80.2" & E 098°59'93.6"	-	10	-	-	-	10
Point 4	N 02°46'05,7" & E 099°58'06.6"	2	10	-	-	2	10
Point 5	N02°46'24.456" & E098°58'13.368"	3	-	-	-	3	-
Point 6	N02°46'24.768" & E098°58'00.426"	-	3	-	-	-	3
Amount		7	27	-	4	7	31

Potential Hornbill Food Trees in the Pondok Buluh Forest Training Center (KHDTK)

The presence of hornbill food trees is crucial for their survival. This study used the Species-Area Curve to determine the number of sample plots. Five sample plots were selected, with a total area of 0.2 hectares, using the path method, creating sample plots along the observation path. The number of individuals in each vegetation phase and the percentage of potential tree families used by rhinoceros hornbills as food and nesting sites can be seen in the following table.

Table 2. Potential Trees at the Seedling Stage

Scientific Name	Local Name	KR %	FR %	INP %
Xylopia altissima Bl	Jangkang	12	9.52	21.93
Enterolobium cyclocarpum	Sengon Buto	7	14.29	20.86
Litsea brachystachys	Medang Batu	17	23.81	40.60
Tarrietia sp.	Dori	6	4.76	10.60
Dehaasia cuneata Blume	Medang Kuning	9	9.52	19.01
Litsea sp.	Medang	20	19.05	38.76
Artocarpus dadah	Porporan	6	4.76	10.60
Syzygium polyanthum	Salam	8	9.52	17.55
Cinnamomum porectum	Losa	15	4.76	20.09
Total		100	100	200

Table 3. Potential of Sapling-Level Feed Trees

Scientific Name	Local Name	KR %	FR %	INP %
Xylopia altissima Bl	Jangkang	7.14	8	15.14
Enterolobium cyclocarpum	Sengon Buto	1.79	12	13.79
Litsea brachystachys	Medang Batu	25.00	20	45.00
Tarrietia sp.	Dori	1.79	4	5.79
Dehaasia cuneata Blume	Medang Kuning	3.57	8	11.57
Litsea sp.	Medang	14.29	16	30.29
Artocarpus dadah	Porporan	32.14	4	36.14
Syzygium polyanthum	Salam	1.79	8	9.79
Cinnamomum porectum	Losa	3.57	4	7.57

Scientific Name	Local Name	KR %	FR %	INP %
Calotropis gigantea	Rube	1.79	4	5.79
Parkia speciosa	Petai	5.36	8	13.36
Archidendron pauciflorum	Jengkol	1.79	4	5.79
Total		100	100	200

Table 4. Potential of Pole-Level Feed Trees

Scientific Name	Local Name	KR %	FR %	DR %	INP %
Xylopia altissima Bl	Jangkang	1.56	6.5	4.1	12.07
Enterolobium cyclocarpum	Sengon Buto	7.81	9.7	6.3	23.82
Litsea brachystachys	Medang Batu	14.06	16.1	10.2	40.35
Tarrietia sp.	Dori	3.13	3.2	6.3	12.68
Dehaasia cuneata Blume	Medang Kuning	9.38	6.5	7.2	23.03
Litsea sp.	Medang	29.69	12.9	9.1	51.71
Artocarpus dadah	Porporan	3.13	3.2	9.1	15.47
Syzygium polyanthum	Salam	7.81	6.5	10.2	24.42
Cinnamomum porectum	Losa	3.13	3.2	2.8	9.16
Calotropis gigantea	Rube	1.56	3.2	9.1	13.90
Parkia speciosa	Petai	1.56	6.5	5.5	13.55
Archidendron pauciflorum	Jengkol	1.56	3.2	8.1	12.92
Litsea odorifera Val.	Medang Kertas	6.25	6.5	2.8	15.51
Beilschmiedia sp.	Balang Horas	3.13	3.2	2.8	9.16
Artocarpus elasticus	Torop	6.25	9.7	6.3	22.26
Total		100	100	100	300

Table 5. Potential of Tree-Level Feed Trees

Scientific Name	Local Name	KR %	FR %	DR %	INP %
Xylopia altissima Bl	Jangkang	3.79	5.6	11.05	20.4
Calotropis gigantea	Rube	0.76	2.8	0.76	4.3
Tabernaemontana macrocarpa Jack	Sakupal	12.12	11.1	27.69	50.9
Parkia speciosa	Petai	2.27	2.8	0.44	5.5
Enterolobium cyclocarpum	Sengon buto	2.27	5.6	0.44	8.3
Archidendron pauciflorum	Jengkol	0.76	2.8	0.39	3.9
Garcinia dioica	Medang Handis	0.76	2.8	0.33	3.9
Litsea brachystachys	Medang batu	17.42	8.3	7.67	33.4
Dehaasia cuneata Blume	Medang kuning	6.06	5.6	0.33	11.9
Litsea odorifera Val.	Medang Kertas	3.03	5.6	0.33	8.9
Litsea sp.	Medang	12.12	5.6	15.08	32.8
Cinnamomum porectum	Losa	1.52	2.8	0.60	4.9
Cinnamomum subavenium Miq.	Medang sabal	3.03	5.6	7.67	16.3
Beilschmiedia sp.	Balang Horas	1.52	2.8	0.13	4.4
Sandoricum koeljape	Sotul	0.76	2.8	0.12	3.7
Artocarpus elasticus	Torop	6.82	5.6	0.75	13.1
Artocarpus dadah	Porporan	17.42	13.9	24.85	56.2
Syzygium polyanthum	Salam	2.27	2.8	0.69	5.7
Tarrietia sp.	Dori	5.30	5.6	0.67	11.5
Total		100	100	100	300

Research data shows that 19 tree species are preferred food sources for hornbills in the Pondok Buluh Training Forest (KHDTK). The total number of individual food trees for rhinoceros hornbills in the Pondok Buluh Training Forest (KHDTK) at all observation points is 450, divided into eight plant families: Annonaceae, Apocinaceae, Fabaceae, Lauraceae, Meliaceae, Moraceae, Myristicaceae, and Sterculiaceae. The table above shows the number of individuals at each stage of the food tree: 137 at the seedling stage, 56 at the sapling stage, 64 at the pole stage, and 132 at the tree stage.

The presence of the Moracea family in the Pondok Buluh Training Forest (KHDTK) is closely linked to the presence of animals such as primates and birds, which utilize the fruit of the Moraceae family as a food source. Seeds from the digestive waste of these animals can help regenerate damaged forest in the Pondok Buluh Training Forest (KHDTK), and are supported by the somewhat undulating and hilly topography of the KHDTK.

Plant species from the Lauraceae family that have the potential to be used as food sources by hornbills include the Handis Hornbill (Garcinia dioica), the Stone Hornbill (Litsea brachystachys), the Yellow Hornbill (Dehaasia cuneata Blume), the Paper Hornbill (Litsea odorifera Val.), the Hornbill (Litsea sp.), the Losa Hornbill (Cinnamomum porectum), the Sabal Hornbill (Cinnamomum subavenium Miq.), and the Horas Hornbill (Beilschmiedia sp.).

Forage Tree Regeneration Status

Regeneration is the ability of a species to complete its life cycle and is a key process for the species' persistence within a community under varying environmental conditions (Laughlin, 2024). The regeneration status of tree stands can be determined by comparing the species richness and diversity between tree levels and their generations, namely saplings and seedlings. The seedling and sapling phases of the sapling phase are the most critical phases in the life cycle of an individual plant species because at this stage the mortality rate is high (Chang-Yang et al., 2021; Sloey et al., 2022). According to De Frutos et al. (2022); Toledo-Aceves et al. (2021), tree regeneration is considered and classified based on the number of seedlings and compared with the condition of the adult stage.

This stage is a selection period to determine which species are able to grow and survive, which ultimately influences the composition and diversity of the forest community (Setiawan, 2022). The presence of adequate seedlings indicates better species recruitment and germination in the forest. Conversely, the dominance of seedlings and saplings growing beneath mature trees also influences future community composition. The absence of seedlings and saplings of certain tree species in the forest is an indicator of poor regeneration (Harris et al., 2022). Common studies on tropical tree regeneration focus only on the seedling stage, which is typically more abundant than the mature stage (Gahlowt et al., 2025).

The regeneration status of an individual can be categorized as "good," "poor," "fair," "newly regenerated," and "none" (Khadka et al., 2024). Species with a "good" regeneration status also have a good number of seedlings, while those that do not regenerate are likely due to thick litter accumulation, which can reduce seed germination for most species in the forest. Forest stands characterized by a high number of adults or an absence or very low population of seedlings and seedlings are expected to face local extinction (Kremer et al., 2025).

Species with a regeneration status in the "poor" and "none" categories may have occurred due to disturbances in the forest, such as overgrazing, fuelwood collection, and the poor biotic potential of the tree species, which can affect seed germination or the successful conversion of seedlings to seedlings (Bogale et al., 2017). Newly regenerated species may occur because mature individuals are very poor and have been harvested by local residents, but seeds remain as a seed bank that germinates during favorable seasons (Absakine et al., 2024; de Paula et al., 2023). On the other hand, the regeneration of a species is influenced by various factors such as light, canopy density, soil moisture, nutrients and anthropogenic pressure (Sarkar & Devi, 2014).

Regeneration status was analyzed by calculating the proportion of regeneration (seedlings and saplings) to potential mature trees (poles and trees). Regeneration status parameters refer to several studies conducted by Bogale et al. (2017); Malik & Bhatt (2016); Rawat et al. (2018); Sarkar & Devi (2014).

To find out the level of regeneration of the rhinoceros hornbill's food trees in the Pondok Buluh Forest Training Center, you can see the potential food tree graph as shown in Figure 2.

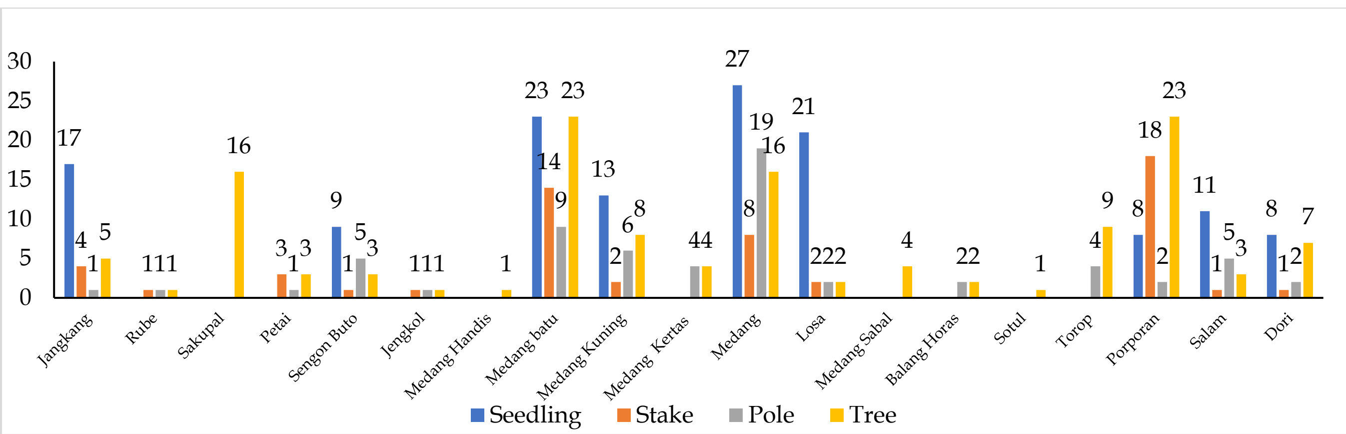

Figure 2. Graph of Potential Feed Trees

Based on the graph obtained from the observation of the potential of rhinoceros hornbill food trees in the KHDTK Pondok Buluh Training Forest, it can be seen that the vegetation at the seedling level is dominated by the Medang Batu (Litsea brachystachys) species with a total of 27 stems, at the sapling level it is dominated by the Medang Batu (Litsea brachystachys) species with a total of 14 stems, while at the pole level it is dominated by the Medang (Litsea sp.) species with a total of 19 stems and at the tree level it is dominated by the Medang Batu (Litsea brachystachys) and Porporan (Artocarpus dadah) species with a total of 23 stems. This shows that the regeneration of food trees has a "good" regeneration level so that it can support the survival of rhinoceros hornbills in the KHDTK Pondok Buluh Training Forest. The reciprocal relationship between consumers, namely hornbills, and plants as producers has a very close relationship so that if one of them experiences extinction, it will affect the sustainability of the ecosystem (Kurniawan et al., 2025; Lado et al., 2025). However, to maintain the sustainability of food trees, security patrols and conservation measures are needed, such as planting seedlings for the types of food trees for rhinoceros hornbills.

Conclusion

Based on field observations, 38 encounters with rhinoceros hornbills (Buceros rhinoceros) were recorded. Of these, 7 were visual encounters, meaning the individual birds were directly seen by observers, either perched in trees or flying above the forest canopy. The remaining 31 were audio encounters, where the rhinoceros hornbill's presence was detected through its distinctive sounds, such as loud wingbeats or echoing calls. The predominance of audio encounters indicates that this species primarily operates in the upper canopy, making it difficult to directly observe. Furthermore, an assessment of food tree availability in the Pondok Buluh KHDTK Training Forest area indicates that the regeneration rate of the trees serving as rhinoceros hornbill food sources is in the "good" category. This good regeneration is indicated by the presence of abundant and evenly distributed saplings, saplings, and young trees. These conditions are crucial because the rhinoceros hornbill relies on the fruits of certain trees, particularly those from the Moraceae, Lauraceae, and Myristicaceae families. The availability of these food tree species with healthy regeneration is a key factor in the rhinoceros hornbill's survival in the KHDTK area. An environment that provides a sufficient and sustainable food supply allows this species to maintain its activity patterns, including foraging, breeding, and maintaining its home range. Therefore, the Pondok Buluh area has good habitat potential for long-term rhinoceros hornbill conservation.

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Author Contributions

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