

Inventory and Diversity Analysis of Anurans in the Mulawarman University Forest Area with Special Purpose (KHDTK), Samarinda, East Kalimantan

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ABSTRACT

Anurans are amphibians that serve as important bioindicators of environmental quality, making biodiversity inventories essential for supporting conservation efforts. Information on the species composition, community structure, and conservation status of anurans in the Mulawarman University Forest Area with Special Purpose (KHDTK) remains limited. This study aimed to inventory anuran species, analyze their community structure, and evaluate the conservation status of the recorded species. Field surveys were conducted from April to June 2026 using transect sampling combined with the Visual Encounter Survey (VES) method. Data were analyzed using species composition, the Shannon–Wiener diversity index (H'), Pielou's evenness index (E), Simpson's dominance index (C), and conservation status based on the IUCN Red List, CITES, and the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No. P.106/MENLHK/SETJEN/KUM.1/12/2018. A total of 17 anuran species belonging to five families were recorded, comprising 248 individuals. Rhacophoridae exhibited the highest species richness, whereas Bufonidae was the most abundant family, dominated by *Ingerophrynus divergens*. The Shannon–Wiener diversity index ($H' = 2.203$) indicated moderate diversity, the evenness index ($E = 0.778$) indicated a relatively even distribution of individuals among species, and the Simpson dominance index ($C = 0.160$) indicated low species dominance. All recorded species were classified as Least Concern (LC) by the IUCN and were not listed under CITES or the protected species list of Indonesia. These findings indicate that the Mulawarman University Forest Area with Special Purpose continues to provide suitable habitat for anuran communities and offers valuable baseline information for biodiversity management and conservation in the area.

Keywords: Anurans, biodiversity, conservation, inventory, KHDTK

INTRODUCTION

Anurans play an important role in maintaining the ecological balance of tropical forest ecosystems. They function as predators of various insect species, occupy an intermediate position in food webs, and serve as bioindicators of environmental quality due to their high sensitivity to changes in microhabitat conditions, including temperature, humidity, and water quality. Consequently, environmental changes are often reflected in shifts in the composition, abundance, and distribution of anuran communities (Dewi *et al.*, 2024; Sari *et al.*, 2022). Despite their ecological importance, amphibian populations continue to decline worldwide. Approximately 40% of amphibian species are currently threatened with extinction as a result of habitat degradation, making their conservation a priority in tropical ecosystem management (Kurniawan *et al.*, 2022).

Indonesia is recognized as one of the world's megadiverse countries, harboring more than 450 anuran species distributed across a wide range of ecosystems. Kalimantan Island is considered one of the major centers of anuran diversity in Southeast Asia because of its extensive tropical rainforests and high level of endemism (Rifanjani *et al.*, 2023). However, increasing anthropogenic pressures, including deforestation, habitat fragmentation, infrastructure development, and land-use change, have reduced habitat quality and may negatively affect anuran diversity, abundance, and distribution (Agustini *et al.*, 2023). These conditions highlight the importance of conducting inventories and community structure analyses as baseline information for ecological monitoring and biodiversity conservation planning.

The Mulawarman University Forest Area with Special Purpose (KHDTK) is designated for education, research, and conservation activities. The area represents a lowland tropical rainforest in East Kalimantan and encompasses diverse habitat types, including forested areas, understory vegetation, leaf litter, and habitats associated with freshwater bodies, all of which potentially support a wide variety of anuran species. In addition to functioning as a natural laboratory, the high intensity of academic and research activities within the area makes information on anuran communities essential for evaluating ecological conditions and supporting conservation-based forest management (Mapa *et al.*, 2022; Mulawarman, 2025).

Previous studies have demonstrated that anuran diversity and community structure are strongly influenced by habitat characteristics, environmental disturbance, and the availability of suitable microhabitats for feeding, sheltering, and reproduction (Maulana *et al.*, 2023; Sari *et al.*, 2022). However, most of these studies have been conducted in formally protected areas, such as national parks and nature reserves. Information regarding species composition, distribution across sampling transects, community structure, and conservation status of anurans in the Mulawarman University Forest Area with Special Purpose (KHDTK), Samarinda, remains limited. This lack of baseline information restricts the evaluation of anuran communities within an educational forest that experiences ongoing human activities and habitat dynamics. Therefore, this study was conducted to address this knowledge gap and to provide scientific data that can support future research and the sustainable management of the study area.

This study aimed to inventory anuran species in the Mulawarman University Forest Area with Special Purpose (KHDTK), Samarinda, analyze their diversity and community structure using diversity, evenness, and dominance indices, and evaluate the conservation status of each recorded species based on the IUCN Red List, CITES, and the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia. The findings are expected to provide baseline information on anuran communities in KHDTK that can be used to support area management, future ecological studies, and biodiversity conservation initiatives

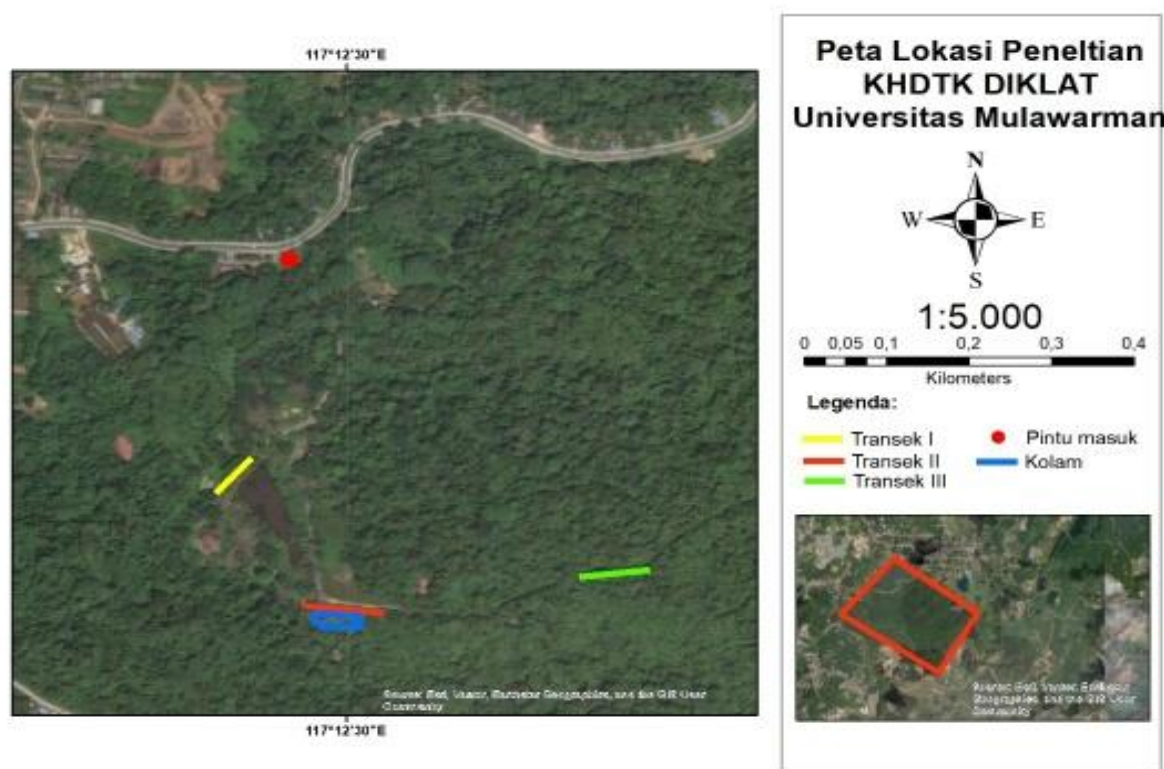
MATERIALS AND METHODS

Materials

The equipment used in this study included a Global Positioning System (GPS), headlamp, smartphone, field data recording board, data sheets, stationery, gloves, and rubber boots. Species identification was carried out using *A Field Guide to the Frogs of Borneo* (Inger & Stuebing, 2005) and *The Amphibians of Java and Bali* (Iskandar, 1998).

Study Area and Data Collection

This study was conducted from April to June 2026 in the Mulawarman University Forest Area with Special Purpose (KHDTK), Samarinda, East Kalimantan, Indonesia (Figure 1). Field surveys were performed using transect sampling combined with the Visual Encounter Survey (VES) method. Transects were established purposively based on habitat characteristics and the availability of suitable microhabitats for anurans, including the presence of water bodies, high humidity, dense vegetation cover, and leaf litter.



Gambar 3. 1 Peta Lokasi Penelitian

Three transects were established as sampling units, each measuring 100 m in length with an observation width of 5 m on each side of the transect. The transects were designed to encompass a variety of microhabitats, including moist soil, leaf litter, understory vegetation, and shallow water bodies. Surveys were conducted by systematically walking along each transect, and all anuran individuals encountered within the observation boundaries were recorded.

Field observations were conducted at night between 19:00 and 21:00 Central Indonesian Time (WITA) on 30 sampling occasions, with a total survey effort of approximately 60 hours. For each individual encountered, the species, number of individuals, location, habitat type, and microhabitat were recorded. Species identification was based on external morphological characteristics using *A Field Guide to the Frogs of Borneo* (Inger & Stuebing, 2005) and *The Amphibians of Java and Bali* (Iskandar, 1998).

Data Analysis

The collected data were analyzed descriptively to determine species composition, distribution among transects, habitat and microhabitat utilization, and the community structure of anurans. Community structure was evaluated using the following ecological indices:

1. Shannon–Wiener diversity index (H')

$$H' = - \sum_{i=1}^S P_i \ln p_i$$

Where:

H' = Shannon–Wiener diversity index

P_i = Proportion of individuals of the i th species relative to the total number of individuals

S = Total number of species recorded

2. Evenness Index (E)

$$E = \frac{H'}{\ln S}$$

Where:

E' = Evenness Index

H' = Shannon–Wiener diversity index

S = Total number of species recorded

3. Simpson's dominance index (C)

$$C = \sum_{i=1}^s (P_i)^2$$

Where:

C = Simpson's dominance index

P_i = Proportion of individuals of the *i*th species relative to the total number of individuals

The conservation status of each recorded species was determined based on the IUCN Red List of Threatened Species, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No.P.106/MENLHK/SETJEN/KUM.1/12/2018.

RESULTS AND DISCUSSION

Species Composition of Anurans

Anuran surveys were conducted along three sampling transects representing different habitat characteristics within the Mulawarman University Forest Area with Special Purpose (KHDTK). Transect I was located near the nursery area and lakeshore, characterized by relatively moist soil, thick leaf litter, and dense vegetation cover. Transect II was situated around a pond and an open area dominated by grasses with lower canopy cover. In contrast, Transect III consisted of densely vegetated forest with high humidity and a small stream flowing through the area, providing a greater variety of microhabitats. These differences in habitat characteristics were likely to influence the species composition and distribution of anurans recorded during the study.

Table 3. 1 Description of sampling transects in the Mulawarman University Forest Area with Special Purpose (KHDTK).

No	Sampling Transect	Description
1	Transect I	Located near the nursery area and lakeshore within the Mulawarman University Forest Area with Special Purpose (KHDTK). This transect was characterized by relatively moist soil, a thick layer of leaf litter, and dense understory vegetation, shrubs, and trees with relatively closed canopy cover. The presence of nearby water bodies maintained high environmental humidity and provided diverse microhabitats, including leaf litter, moist soil, and lakeshore habitats.
2	Transect II	Located around a pond and an open area dominated by grasses. Compared with the other transects, this area had lower canopy cover, resulting in a more open environmental condition. Nevertheless, several sections remained moist due to the presence of nearby water bodies and scattered shrubs along the sampling route.

3	Transect III	Located within a forested area characterized by dense vegetation and relatively high humidity. A small stream crossed the transect and was surrounded by understory vegetation, shrubs, and trees with relatively closed canopy cover. The forest floor was dominated by leaf litter and moist soil, creating a wide variety of microhabitats throughout the sampling area.
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A total of 17 anuran species belonging to five families—Bufonidae, Dicroglossidae, Ranidae, Rhacophoridae, and Microhylidae—were recorded during the survey, comprising 248 individuals (Table 3.2.)

Tabel 3. 2 Species composition and abundance of anurans recorded in the Mulawarman University Forest Area with Special Purpose (KHDTK).

No	Famili	Spesies	Number of Individuals
1	Bufonidae	<i>Ansonia leptopus</i>	1
		<i>Duttaphrynus melanostictus</i>	7
		<i>Ingerophrynus divergens</i>	78
2	Dicroglossidae	<i>Fejervarya limnocharis</i>	14
		<i>Limnonectes kuhlii</i>	12
		<i>Limnonectes malesianus</i>	1
		<i>Limnonectes paramacrodon</i>	29
3	Ranidae	<i>Chalcorana raniceps</i>	3
		<i>Hylarana baramica</i>	14
		<i>Hylarana chalconota</i>	15
		<i>Hylarana erythraea</i>	9
4	Rhacophoridae	<i>Kurixalus chaseni</i>	12
		<i>Nyctixalus pictus</i>	2
		<i>Polypedates macrotis</i>	43
		<i>Polypedates ottilophus</i>	5
		<i>Rhacophorus pardalis</i>	2
5	Microhylidae	<i>Microhyla berdmorei</i>	1
Total		17 spesies	248

Rhacophoridae exhibited the highest species richness, comprising five species, followed by Dicroglossidae and Ranidae with four species each, Bufonidae with three species, and Microhylidae represented by a single species. The high species richness of Rhacophoridae suggests that the study area continues to provide suitable habitat for arboreal anurans. This finding is consistent with Marisa *et al.* (2024), who reported that members of the family Rhacophoridae are commonly associated with tropical forest habitats characterized by complex vegetation structure and high humidity.

Although represented by only three species, Bufonidae accounted for the highest number of individuals (86 individuals). This pattern was primarily attributed to the dominance of *Ingerophrynus divergens*, which accounted for 78 individuals, representing approximately 31.5% of all recorded individuals. These findings indicate that *I. divergens* is well adapted to the environmental conditions of the study area. Similar observations were reported by Muchlis *et al.* (2025), who found that several members of the family Bufonidae exhibit broad ecological tolerance, enabling them to persist across a wide range of habitat types, including areas experiencing moderate disturbance.

The family composition observed in this study indicates that the Mulawarman University Forest Area with Special Purpose supports a variety of habitat types suitable for terrestrial, semi-aquatic, and arboreal anurans. Variations in vegetation structure, environmental humidity, and the presence of freshwater habitats likely contributed to the observed community composition. This finding agrees with Rifanjani *et al.* (2024), who emphasized that habitat heterogeneity plays an important role in increasing anuran species richness within tropical forest ecosystems.

Distribution of Anuran Species Among Sampling Transects

The distribution of anuran species varied among the three sampling transects (Table 3). Transect III supported the highest number of individuals, with 129 individuals, followed by Transect I with 82 individuals, whereas Transect II had the lowest abundance, with only 37 individuals. Differences in vegetation structure, environmental humidity, and the availability of aquatic and terrestrial microhabitats likely contributed to the observed variation in species distribution.

Table 3. 3 Distribution and abundance of anuran species among sampling transects in the Mulawarman University Forest Area with Special Purpose (KHDTK), Samarinda, East Kalimantan.

No	Species	Transect I	Transect II	Transect III	Total
1	<i>Ansonia leptopus</i>	1	0	0	1
2	<i>Duttaphrynus melanostictus</i>	4	0	3	7
3	<i>Ingerophrynus divergens</i>	37	15	26	78
4	<i>Fejervarya limnocharis</i>	3	5	6	14
5	<i>Limnonectes kuhlii</i>	1	3	8	12
6	<i>Limnonectes malesianus</i>	0	1	0	1
7	<i>Limnonectes paramacrodon</i>	13	4	12	29
8	<i>Chalcorana raniceps</i>	1	0	2	3
9	<i>Hylarana baramica</i>	10	1	3	14
10	<i>Hylarana chalconota</i>	5	5	5	15
11	<i>Hylarana erythraea</i>	6	3	0	9
12	<i>Kurixalus chaseni</i>	0	0	12	12
13	<i>Nyctixalus pictus</i>	0	0	2	2
14	<i>Polypedates macrotis</i>	0	0	43	43
15	<i>Polypedates ottilophus</i>	0	0	5	5
16	<i>Rhacophorus pardalis</i>	0	0	2	2
17	<i>Microhyla berdmorei</i>	1	0	0	1
TOTAL		82	37	129	248

The high abundance recorded in Transect III was likely associated with its dense forest vegetation, relatively closed canopy, consistently moist environmental conditions, and the presence of a small stream. These habitat characteristics provide favorable conditions for foraging, shelter, and reproduction, thereby supporting a greater diversity and abundance of anurans. All five species of the family Rhacophoridae were exclusively recorded in this transect, indicating a strong association between arboreal frogs and forest habitats with complex vegetation structure and high humidity. Similar findings were reported by Marisa *et al.* (2024), who noted that members of Rhacophoridae are commonly associated with well-preserved forest habitats containing abundant vegetation and suitable arboreal substrates.

Transect I contained the second-highest number of individuals and was characterized by moist soil, thick leaf litter, and the presence of a lakeshore. These environmental conditions favored several terrestrial and semi-aquatic species, particularly *Ingerophrynus divergens* and *Limnonectes paramacrodon*, which were among the most frequently encountered species in this transect. The availability of leaf litter, moist substrates, and nearby water bodies likely provided suitable foraging sites and refuge for these species. Previous studies have similarly demonstrated that leaf litter and moist forest floors constitute important microhabitats for many terrestrial anurans (Rifanjani *et al.*, 2024).

In contrast, Transect II recorded the lowest abundance of anurans. This transect was dominated by open grassland with lower canopy cover, resulting in higher exposure to sunlight and reduced environmental humidity compared with the other transects. Such conditions may limit the occurrence of moisture-dependent amphibians, particularly species that require stable and shaded microhabitats. Nevertheless, several relatively adaptable species, including *Hylarana chalconota*, *Fejervarya limnocharis*, and *Ingerophrynus divergens*, were still recorded in this transect, suggesting broader ecological tolerance than that of other species. Similar

observations were reported by Ritonga *et al.* (2025), who found that habitat structure and vegetation cover strongly influence the distribution and encounter frequency of anuran species.

Overall, the distribution pattern observed in this study indicates that habitat heterogeneity plays an important role in shaping anuran communities within the Mulawarman University Forest Area with Special Purpose (KHDTK). Variations in canopy cover, environmental humidity, water availability, and vegetation complexity appear to influence both species composition and abundance among sampling transects.

Community Structure of Anurans

The community structure of anurans in the Mulawarman University Forest Area with Special Purpose (KHDTK) was evaluated using the Shannon–Wiener diversity index (H'), Pielou's evenness index (E), and Simpson's dominance index (C). The calculated index values for each sampling transect and for the overall study area are presented in Table 3.4.

Table 3. 4 Community structure indices of anurans recorded in the Mulawarman University Forest Area with Special Purpose (KHDTK), Samarinda, East Kalimantan.

No	Parameter	Transek			Overall
		I	II	III	
1	Jumlah Spesies	11	8	13	17
2	Jumlah Individu	82	37	129	248
3	Indeks Keanekaragaman (H')	1,753	1,75	2,067	2,203
4	Indeks Kemerataan (E)	0,731	0,842	0,806	0,778
5	Indeks Dominansi (C)	0,257	0,227	0,18	0,160

The overall Shannon–Wiener diversity index was 2.203, indicating a moderate level of species diversity within the study area. Among the three sampling transects, Transect III exhibited the highest diversity index ($H' = 2.067$), followed by Transect I ($H' = 1.753$) and Transect II ($H' = 1.750$). The relatively higher diversity observed in Transect III was likely associated with its dense vegetation, high environmental humidity, and the presence of a small stream, which together provided a wider range of suitable habitats and ecological niches for anuran species. According to Odum (1993), habitat heterogeneity generally promotes higher species diversity by increasing the availability of resources and microhabitats.

The overall evenness index ($E = 0.778$) indicates that individuals were relatively evenly distributed among species. Transect II exhibited the highest evenness value ($E = 0.842$), suggesting that individuals were more uniformly distributed despite its relatively low abundance. In contrast, Transect I showed the lowest evenness ($E = 0.731$), reflecting the numerical dominance of several species, particularly *Ingerophrynus divergens*. According to Magurran (2004), high evenness values indicate that species contribute relatively equally to the community, whereas lower values suggest that a few species account for a greater proportion of the total abundance.

The overall Simpson's dominance index was 0.160, indicating low species dominance within the anuran community. Among the sampling transects, the highest dominance value was recorded in Transect I ($C = 0.257$), whereas the lowest occurred in Transect III ($C = 0.180$). The higher dominance observed in Transect I was primarily associated with the abundance of *Ingerophrynus divergens*, while the lower dominance in Transect III reflected a more balanced distribution of individuals among species. Odum (1993) stated that communities with low dominance values generally exhibit greater ecological stability because no single species overwhelmingly dominates the assemblage.

Overall, the diversity, evenness, and dominance indices indicate that the anuran community in the Mulawarman University Forest Area with Special Purpose (KHDTK) is relatively stable. The moderate diversity, relatively even distribution of individuals among species, and low dominance values suggest that the study area continues to provide suitable environmental conditions for supporting diverse anuran assemblages.

Conservation Status of Recorded Anuran Species

The conservation status of all recorded anuran species was assessed based on the IUCN Red List of Threatened Species, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No. P.106/MENLHK/SETJEN/KUM.1/12/2018. The conservation status of each species is presented in Table 3.5.

Tabel 3. 5 Status Konservasi Spesies Anura di KHDTK Universitas Mulawarman

No	Spesies	Conservation Status		
		IUCN	CITES	PP RI
1	<i>Ansonia leptopus</i>	LC	-	-
2	<i>Duttaphrynus melanostictus</i>	LC	-	-
3	<i>Ingerophrynus divergens</i>	LC	-	-
4	<i>Fejervarya limnocharis</i>	LC	-	-
5	<i>Limnonectes kuhlii</i>	LC	-	-
6	<i>Limnonectes malesianus</i>	LC	-	-
7	<i>Limnonectes paramacrodon</i>	LC	-	-
8	<i>Chalcorana raniceps</i>	LC	-	-
9	<i>Hylarana baramica</i>	LC	-	-
10	<i>Hylarana chalconota</i>	LC	-	-
11	<i>Hylarana erythraea</i>	LC	-	-
12	<i>Kurixalus chaseni</i>	LC	-	-
13	<i>Nyctixalus pictus</i>	LC	-	-
14	<i>Polypedates macrotis</i>	LC	-	-
15	<i>Polypedates otitophus</i>	LC	-	-
16	<i>Rhacophorus pardalis</i>	LC	-	-
17	<i>Microhyla berdmorei</i>	LC	-	-

All 17 recorded species were classified as Least Concern (LC) according to the IUCN Red List, indicating that they are currently considered to face a relatively low risk of extinction at the global level. In addition, none of the recorded species are listed under CITES, indicating that international trade is not currently regarded as a major threat requiring trade regulation for these species. Likewise, none are included in the list of protected species under the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No.P.106/MENLHK/SETJEN/KUM.1/12/2018.

Although all recorded species are currently categorized as Least Concern, this status should not be interpreted as an indication that conservation efforts are unnecessary. Population declines may occur as a result of habitat degradation, forest fragmentation, pollution, and climate change, particularly in tropical ecosystems where amphibians are highly sensitive to environmental disturbances. Consequently, maintaining habitat quality within the Mulawarman University Forest Area with Special Purpose (KHDTK) remains essential for sustaining anuran diversity and supporting long-term ecosystem stability.

The present findings provide updated baseline information on the conservation status of anurans in KHDTK and may serve as a scientific reference for biodiversity monitoring, ecological research, and conservation-oriented management of the area.

KESIMPULAN

A total of 17 anuran species belonging to five families were recorded in the Mulawarman University Forest Area with Special Purpose (KHDTK), Samarinda, with a total of 248 individuals. Rhacophoridae exhibited the highest species richness, whereas Bufonidae had the highest abundance, primarily due to the dominance of *Ingerophrynus divergens*. The overall Shannon–Wiener diversity index indicated moderate species diversity, while the evenness and dominance indices suggested a relatively stable community structure with a balanced

distribution of individuals among species. All recorded species were categorized as Least Concern (LC) according to the IUCN Red List and were not listed under CITES or the Indonesian protected species list. These findings demonstrate that the Mulawarman University Forest Area with Special Purpose (KHDTK) continues to provide suitable habitat for anuran communities and serves as an important area for biodiversity conservation, ecological research, and long-term environmental monitoring.

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