REPORT
IMPLEMENTATION ACTIVITY

Biodiversity Inventory in Mbeliling Protected Forest Area, West Manggarai Regency

2024

ACTIVITY IMPLEMENTATION REPORT

PROJECT *INVESTING IN THE KOMODO DRAGON AND OTHER GLOBALLY THREATENED SPECIES IN FLORES*

BIODIVERSITY INVENTORY IN MBELILING PROTECTED FOREST AREA, WEST MANGGARAI DISTRICT

RATIFICATION SHEET OF ACTIVITY

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BIODIVERSITY INVENTORY IN MBELILING PROTECTED FOREST AREA, WEST MANGGARAI DISTRICT

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ABSTRACT

East Nusa Tenggara is part of the Lesser Sunda Islands which has its own distinctive features and characteristics in biodiversity. There are approximately 22 endemic species in East Nusa Tenggara that are threatened with extinction. Mbeliling Forest is one of the remaining areas amidst the increasing development and tourism activities in Labuan Bajo, West Manggarai Regency. Regular updating of biodiversity data can be the basis for policy making and other conservation actions. Inventory activities were carried out by installing fog net and harp traps for the mammal class, using the *point-transect* method for the bird class, using the *visual encounter survey* method for the reptile and amphibian class, and the plot method for plant species. This activity resulted in eight species out of a total of 46 individuals in the mammal class, 36 species out of a total of 107 individuals in the bird class, 10 species out of a total of 20 individuals in the reptile and amphibian class, and 65 plant species found in the Mbeliling Protected Forest area. The biodiversity index value (H') for mammal, bird, and herpetofauna classes is 1.8, 3.3, and 2.0, respectively. While the value of the species richness index (Dmg) for mammal, bird, and herpetofauna classes is 1.8, 7.5, and 3.0, respectively. In addition, the species evenness index (E) for mammals, birds, and herpetofauna classes was 0.78, 0.73, and 0.75, respectively. Furthermore, the value of the species dominance index (C) for mammal, bird, and herpetofauna classes was 0.19, 0.05, and 0.18, respectively. This study also produced a plant importance index with the highest INP value at the tree level in various land cover types, namely the *F. griffithii* species in forest areas, the *T. grandis* species in savanna / open land areas, and *the Wanot* species in shrub areas. Protection of the Mbeliling Protected Forest Area is needed with a variety of partnership schemes and *stakeholders* because it is a habitat for endemic, protected and endangered species.

INTRODUCTION

The author thanks God Almighty for giving strength, perseverance, and abundant blessings so that the Report on the Implementation of Biodiversity Inventory Activities in the Mbeliling Protected Forest Area, West Mangarai Regency can be completed. The author would also like to thank various parties who have jointly supported the implementation of the activity. This report contains a description of biodiversity in the Mbeliling Protected Forest Area of West Manggarai Regency including classes of mammals, birds, reptiles, amphibians, and plants. This report is expected to be one of the bases for policy making and further conservation actions in the Mbeliling Protected Forest Area.

Thus this report was prepared, the author also feels that the report on the implementation of this activity is far from perfect. Therefore, any input in the form of suggestions and constructive criticism is highly appreciated. Hopefully this report can be useful for the author and readers.

Kupang, December 2024

Compilation Team

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CHAPTER I INTRODUCTION

a. Background

The Wallacea Bioregion including Sulawesi, Maluku and Nusa Tenggara has high biodiversity and has different characteristics from the Oriental and Australasian regions because this region is dominated by a dry (*semi-arid*) climate (Fick & Hijmans, 2017; Struebig et al., 2022; Zepner et al., 2021). As part of the Wallacea bioregion, the Lesser Sunda Islands have their own distinctive features and characteristics in biodiversity (Yuni & Yuda, 2020). IUCN (2024) noted that there are at least 19 species of mammals, 25 species of birds, 64 species of reptiles, and 19 species of amphibians that have limited distribution in the Lesser Sunda Islands. Furthermore, for the types of flora, IUCN notes that there are at least 493 species that spread in the Lesser Sunda Islands region (IUCN, 2024). There are at least 96 species of flora and fauna in the Lesser Sunda Islands categorized as threatened and 92 species categorized as data deficient (IUCN, 2024). In terms of population trends, there are 123 species that have a declining population trend and 451 species are unknown (IUCN, 2024).

East Nusa Tenggara, which is part of the Lesser Sunda Islands, has endemic biodiversity categorized as threatened by the IUCN, including *Cacatua sulphurea*, *Cacatua citrinocristata*, *Nisaetus floris*, *Eclectus cornelia*, *Aceros everetti*, *Treron psittaceus*, *Ptilinopus dohertyi*, *Otus alfredi*, *Treron floris*, *Symposiachrus sacerdotum*, *Corvus florensis*, *Loriculus flosculus*, *Gracula venerate*, *Varanus komodoensis*, *Varanus auffenbergi*, *Malayopython timoriensis*, *Chelodina mccordi*, *Oreophryne rookmaakeri*, *Komodomys rintjanus*, *Rusa timorensis*, *Suncus mertensi*, and *Kerivoula flora* (Hidayat & Pramatana, 2022; IUCN, 2024). The need for research and species monitoring as a form of conservation action is critical in this region (IUCN, 2024). Development activities, hunting, climate change, and other human disturbances are threats that can have an impact on reducing the quality and quantity of species habitat in this area (IUCN, 2024).

Mbeliling Forest Area is one of the remaining forest areas amidst the increasing development and tourism activities in Labuan Bajo, West Manggarai Regency. This forest area is directly adjacent to the city of Labuan Bajo, which has been designated as a Super Priority Tourism Destination Area (DPSP). The massive increase in human activities and development will potentially have an impact on biodiversity in this area (Habibullah et al., 2016; Van der Duim & Caalders, 2002). Hamzati & Aunurohim (2013) recorded 75 bird species from 37 families spread across four habitat types in the western mbeliling forest, namely savanna, mangrove forest, rainforest, and mixed plantation. Adinugroho et al. (2021) also reported that in their research in the Mbeliling landscape, at least five birds endemic to Flores were recorded, namely *Monarcha sacerdotum*, *Otus alfredi*, *Loriculus flosculus*, *Corvus florensis*, and *Trichoglossus weberi*. In addition, the critically endangered species *Cacatua sulphurea* was also recorded in the Mbeliling landscape area.

(Adinugroho et al., 2021). For flora species, Mulu et al. (2020) reported that there are 158 species from 64 families that are utilized for various needs of forest communities in Mbeliling District. Other fauna species such as mammals, reptiles, and amphibians have not been specifically recorded in publications in the Mbeliling forest area.

Based on some of the descriptions above, it is very important to conduct a comprehensive study of biodiversity in the Mbeliling Forest Area. Updating complete biodiversity data can be the basis for policy making and other conservation actions. These results can also increase the awareness of the surrounding community on the economic valuation of the forest area so that it is well preserved.

b. Problem Formulation

- What are the wildlife species including mammal, bird, reptile, and amphibian classes and plant species found in the Mbeliling Protected Forest Area?
- What is the biodiversity index value of each wildlife class and the importance index value for plant species in the Mbeliling Protected Forest Area?

c. Objective

To determine the types, populations, and biodiversity indices of wildlife including classes of mammals, birds, reptiles, and amphibians as well as the important value index for plant species in the Mbeliling Protected Forest Area.

d. Benefits

Enriching data and information and providing a basis for other activities or research related to conservation activities outside conservation areas. This study also provides practical benefits for various parties, including benefits for the Natural Resources Conservation Center of East Nusa Tenggara Province (BBKSDA NTT), which is the basis of information in the formulation or ecological recommendations for the protection of areas outside conservation areas / Essential Ecosystem Areas (KEE). In addition, this study provides practical benefits for local governments, namely as information, input, advice, and recommendations in the preparation of regional management plans or regional biodiversity conservation. This study will also provide benefits to the community by providing economic benefits and increasing knowledge related to conservation through community involvement in research activities.

e. Scope

The scope of the biodiversity inventory study in Mbeliling Protection Forest includes several classes of wildlife, namely mammals, birds, reptiles, and amphibians. In addition, this study also collected data on plant species. Data collection on the mammal class was limited to

use of methods specific to the orders *Chiroptera* and *Rodentia*. This study is also limited by several aspects including resources including time, cost, and energy as well as some physical and climatic conditions at the study site.

CHAPTER II FRAMEWORK THEORY

a. Theoretical foundation

The Mbeliling Protected Forest area is located on Flores Island, East Nusa Tenggara and is included in the Lesser Sunda Islands region and the Wallacea bioregion which is considered to have unique biodiversity and is different from the Oriental and Australasian bioregions. There are several biodiversity endemics of East Nusa Tenggara listed as threatened by the IUCN, including *Cacatua sulphurea*, *Cacatua citrinocristata*, *Nisaetus floris*, *Eclectus cornelia*, *Aceros everetti*, *Treron psittaceus*, *Ptilinopus dohertyi*, *Otus alfredi*, *Treron floris*, *Symposiachrus sacerdotum*, *Corvus florensis*, *Loriculus flosculus*, *Gracula venerate*, *Varanus komodoensis*, *Varanus auffenbergi*, *Malayopython timoriensis*, *Chelodina mccordi*, *Oreophryne rookmaakeri*, *Komodomys rintjanus*, *Rusa timorensis*, *Suncus mertensi*, and *Kerivoula flora*. The landscape of Mbeliling Protected Forest Area is one of the forest areas and preservation areas that still remain from the high development and tourism activities in West Manggarai Regency. Mbeliling Protected Forest Area is one of the last habitats for endemic species within the scope of Flores Island and the scope of the Lesser Sunda Islands region.

b. Hypothesis

There are endemic species from both Flores Island and the Lesser Sunda Islands recorded in the Mbeliling Protected Forest Area.

CHAPTER III METHOD

a. Basis Implementation

This activity is carried out on the basis of a self-management contract Number: PK.09/K.5.TU/PEG.3/11/2024 concerning Biodiversity Inventory Activities in the Mbeliling Protected Forest Preservation Area and Monitoring of Prey Animals and Komodo Habitat in the Nanga Bere Preservation Area.

b. Time Implementation

This activity was carried out in the Mbeliling Protected Forest Area, West Manggarai Regency on November 29 - December 6, 2024.

c. Team Implementation

The implementation team consisted of the research team, BBKSDA NTT field staff, UPT KPH Manggarai and West Manggarai field staff, and Burung Indonesia field staff in the Mbeliling area (Table 1).

Table 1. Details of the implementation team for biodiversity inventory activities in the Mbeliling Protected Forest Area

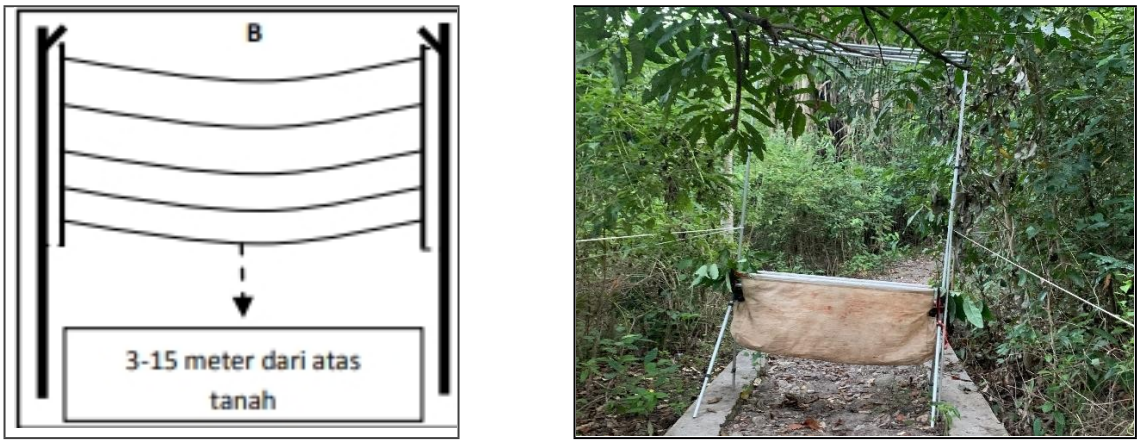
No.	Name / NIP	Position
1.	Fadlan Pramatana, S.Hut, M.Si / 19941112 201903 1 010	Teaching Staff at Nusa Cendana University
2.	Oki Hidayat, S.Hut, M.Bio.Sc / **2019 1 010** 19861027 200912 1 005	Researcher at the National Research and Innovation Agency (BRIN)
3.	Rischaardts Chornelis Manafe, S.Hut	Alumni of Undana Forestry Study Program
4.	Prudensia Wea, S.Hut	Alumni of Undana Forestry Study Program
5.	Maria Elisabet Lusitania Ngalu, S.Hut	Alumni of Undana Forestry Study Program
6.	Christo Eduardus Tae	Student of Undana Forestry Study Program
7.	Ofir Chaliama Dagadjara	Student of Undana Forestry Study Program
8.	Beatrix Luisa Wisang, SP / 19731006 200112 2 002	Junior Expert PEH in the KSDA Region II Division
9.	Andreas Avelinus Dos / 19680803 200212 1 001	Implementing PEH at Labuan Bajo Resort
10.	Erna Bte **Tar/** 19880929 202421 2 038	Manggala Agni Beginner at Ranamese Resort
11.	Antonius Junaidi T. Kleden / 19900604 202421 1 020	Beginner Manggala Agni at Labuan Bajo Resort
12.	Hasanuddin, S.Hut / 19800414 199903 1 003	Rehabilitation and Conservation Analyst at UPT KPH Manggarai and West Manggarai Districts
13.	Tiburtius Hani	Flores Program Manager NGO Burung Indonesia

d. Mammal Data Collection

Methods

Data were collected by setting traps using *mist-net* and harp *trap* (Appel et al., 2021; Mancini et al., 2022; Tanshi & Kingston, 2021). The data collected in this survey is the diversity of bat species or order *Chiroptera*. Data collection was carried out in different habitat types, namely, primary dryland forest, secondary dryland forest, shrubs, savanna / open land, and mixed agricultural land. In each habitat type, observation points were determined that would be used as a place to install mist nets and harp traps. The installation of fog nets and harp traps was carried out at (15.00-17.00 WITA), then periodically checked every 30 minutes at 18.00-20.00 WITA, then checked again at 22.00 WITA before being checked again.

at 22:00 WITA before releasing the traps the next day at 05:30 WITA. Fog nets and harp traps were set in locations with potential bat flight paths, such as on trails or in areas with potential fruiting plant species. Fog nets were installed on trees or branches at a height of 3-15 meters from the ground (Figure 1) (Prasetyo et al., 2011).



(a) (b)

Illustration of Trap Installation, a) Fog nets; b) Harp traps

Trapped bats were then released from the trap and morphometric measurements were taken including *head-to-body length* (HBL), tail (*tail-to-ventral* TV), arm (*forearm* FA), calf (*tibia* length TB), ear (ear *length* E), *hind foot* (HF), *metacarpal* bone (MCL), and *phalanges* bone length (P) (Figure 2) and (Table 2) (Hedrick & Dumont, 2018; Panyutina et al., 2015; Schmieder et al., 2015), 2015; Schmieder et al., 2015). Furthermore, the bats will be counted and identified by matching the guidebook (Suyanto, 2001) and matching the Indonesian mammal distribution book (Maryanto et al., 2019).

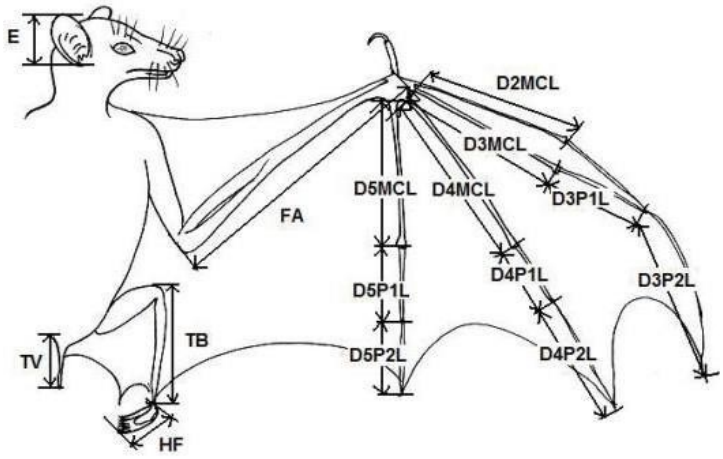


Figure 2. Bat Morphometric Parts

Table 2. Details of Morphometric Sections in Bat Measurements

Measurement Character	**Abbreviation**
Head and body length	HBL
Tail to Ventral Length	TV
Upper arm length (*Forearm*)	FA
Length of tibia	TB
Ear height	E
Hind foot length	HF
Length of second metacarpal digit	D2MCL
Length of third metacarpal digit	D3MCL
First phalange digit length	D3P1L
Second phalange digit length	D3P2L
Fourth metacarpal digit length	D4MCL
Length of the first digit of the fourth phalange	D4P1L
Second phalange length	D4P2L
Fifth metacarpal digit length	D5MCL
Length of first digit of fifth phalange	D5P1L
Second phalange length	D5P2L

The next mammal survey was for species in the Order *Rodentia*. Surveys were conducted with 20-30 *traps* in each land cover (Bismark, 2011). Traps are placed in areas that are potential movement paths for rodentia such as fallen logs, areas with abundant fruiting plants, cave crevices, holes in trees, former holes in the ground, former garbage, rocky corner areas, and the like (Bismark, 2011). The traps will be baited and set starting at 3:00 p.m. and re-diluted at 8:00 p.m. and the next day at 5:30 a.m. (Bovendorp et al., 2017; Cavia et al., 2012). This trap allows animals to remain alive (*life trap*), and when animals are trapped, all parts of the rodentia will be documented for further identification.

Birds

Bird species data collection can be done with a combination of transects and *point counts* (*Point-transect*) according to field conditions. When it is possible to use transects, the observer will walk along the path, observe the species, and count the number of individuals.

birds observed (Bismark, 2011; Pascoe et al., 2019; Taulman, 2013). Observers may also pause (10-20 minutes) to observe, identify, and count in detail when in areas with abundant bird numbers or in areas with wide views. When field conditions are steep and it is not possible to walk along the transect line, observers identify areas that allow the widest view to observe species and count individual birds.

Herpetofauna

Data collection of herpetofauna species can be done by *Visual Encounter Survey* (VES). Observers will walk within a certain time period (18:30-21:30 WITA) by following transect lines, rivers, around ponds, puddles, or other potential areas (Bismark, 2011; Boynton et al., 2021; Erawan et al., 2021). Observers will identify, document, and count the number of individuals of each type of herpetofauna encountered (Barnes, 2017; Karthik et al., 2018). Data collection is also carried out using *Glue* traps, which are boards treated with glue, and placed in areas that are possible pathways or *basking* places (Deuss & Jourdan, 2022; Glor et al., 2000). A total of 20-30 traps will be placed at each land cover.

Plants

Data collection on plant species is carried out using the plot method. Observers will make a 20x20 m plot as the first plot and 100 m apart to re-create the same size plot as the next plot (Figure 3) (Cinda et al., 2019; Hamidun & Baderan, 2014). There will be 10 plots for each land cover, representing a 1-km area.

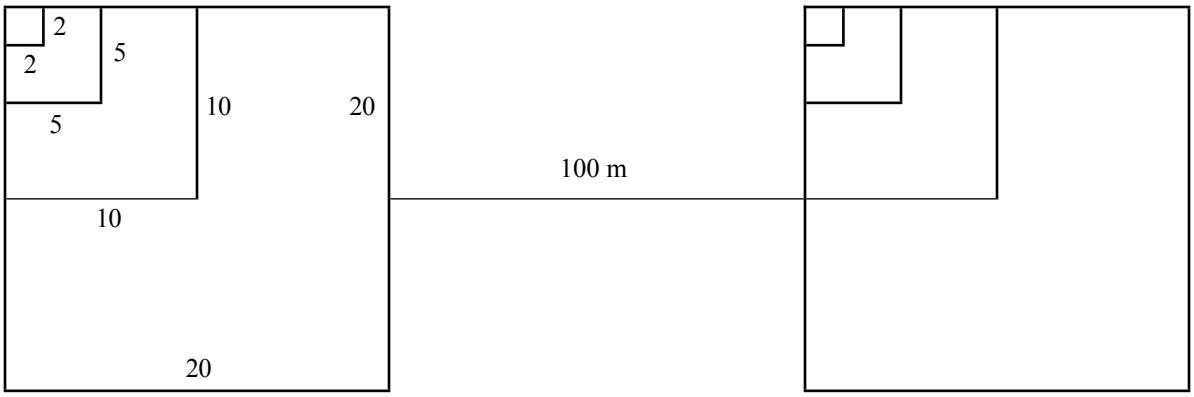


Figure 3: Illustration of the Plant Survey Plotted Pathway

Observers will observe seedling and understory species in 2x2 m plots, sapling species in 5x5 m plots, pole species in 10x10 m plots, and tree species in 20x20 m plots and then record the species and the number of individuals found (Rosminah et al., 2024).

and the number of individuals found (Rosminah et al., 2024). In this survey, observers need to be accompanied by local people who understand plant species to facilitate survey activities.

e. Data Analysis Technique

The results of recording fauna species found at the research site can produce some quantitative index information, including species diversity index, evenness index, richness index, dominance index, and community similarity index. These various indices are widely used by researchers to assess a habitat, compare between habitats, the relationship between a habitat and wildlife, and others (Alfareza et al., 2023; Hardina et al., 2020; Nababan et al., 2021).

Shannon-Wiener Species Diversity Index (H') (Magurran, 1988)

$$H' = -\sum_{i=1}^{n} \left(\frac{ni}{N} \ln \frac{ni}{N}\right)$$

Description:

H' : Species diversity index N : Total of all individuals

ni : Number of individuals of the i-th species

Classification of Species Diversity Index (Ludwig & Reynolds, 1988):

a. A value of H'> 3 indicates high species diversity.

b. A value of 1≤ H'≤ 3 indicates medium species diversity

c. H'< 1 indicates low species diversity

Species Evenness Index (E) (Pielou, 1966)

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

Description:

E : Evenness index

S : Number of species

H' : Species diversity index

Classification of the Species Evenness Index (Ludwig & Reynolds, 1988):

a. A value of 0< E≤ 0.4 indicates low species evenness.

b. A value of 0.4< E≤ 0.6 indicates medium species evenness

c. A value of E> 0.6 indicates high species evenness

The determination of the evenness index value serves to determine the evenness of each bird species in the community encountered. If the evenness index value is close to 1, then the distribution of individuals between species is even or the community is in a stable condition.

Species Richness Index (Dmg) (Margalef, 1973)

$$Dmg = \frac{S - 1}{ln(N)}$$

Description:

Dmg : Species richness index

S : Number of species

ln : Natural logarithm

N : Total number of individuals

Species Richness Index Criteria:

Dmg < 2.5 : Low species richness

Dmg > 2.5 ≤ 4.0 : Medium species richness

Dmg > 4.0 : High species richness

Simpson's Index of Dominance (C) (Simpson, 1949)

$$C = \sum \left(\frac{ni}{N}\right)^2$$

Description:

C : Simpson's dominance index

ni : Number of individuals of the i-th species

N : Total number of all individuals

The classification of the dominance index is as follows:

C≤ 0.5 : Low dominance (no dominant) C > 0.5 : High dominance (there is a dominant one)

Bray-Curtis Community Similarity Index (Bray & Curtis, 1957; Krebs, 1989)

$$B = \frac{\sum |X_{ij} - X_{ik}|}{\sum (X_{ij} + X_{ik})}$$

Description:

B : Bray-Curtis dissimilarity measure

Xij, Xik : Number of individuals in the Ith species of each sample

For plant species, data from vegetation analysis is used to generate data on density, dominance, frequency, and the Index of Important Value (INP) of vegetation. This data can be used as potential supporting vegetation for the life of florescent kancilan in nature. Data from vegetation analysis is calculated using the following formulas (Indriyanto, 2012):

$$\text{Density (K)} = \frac{\text{Number of Individuals of a Type}}{\text{Total Area of Sample Plots}}$$

$$\text{Relative Density (KR)} = \frac{\text{Density of a Species} \times 100\%}{\text{Density of All Species}}$$

$$\text{Dominance (D)} = \frac{\text{Base Field Area Total}}{\text{Area of Sample Plots}}$$

$$\text{Relative Dominance (DR)} = \frac{\text{Dominance of a Species} \times 100\%}{\text{Dominance of All Species}}$$

$$\text{Frequency (F)} = \frac{\text{Number of Plots Found of a Species}}{\text{Total Number of Plots}}$$

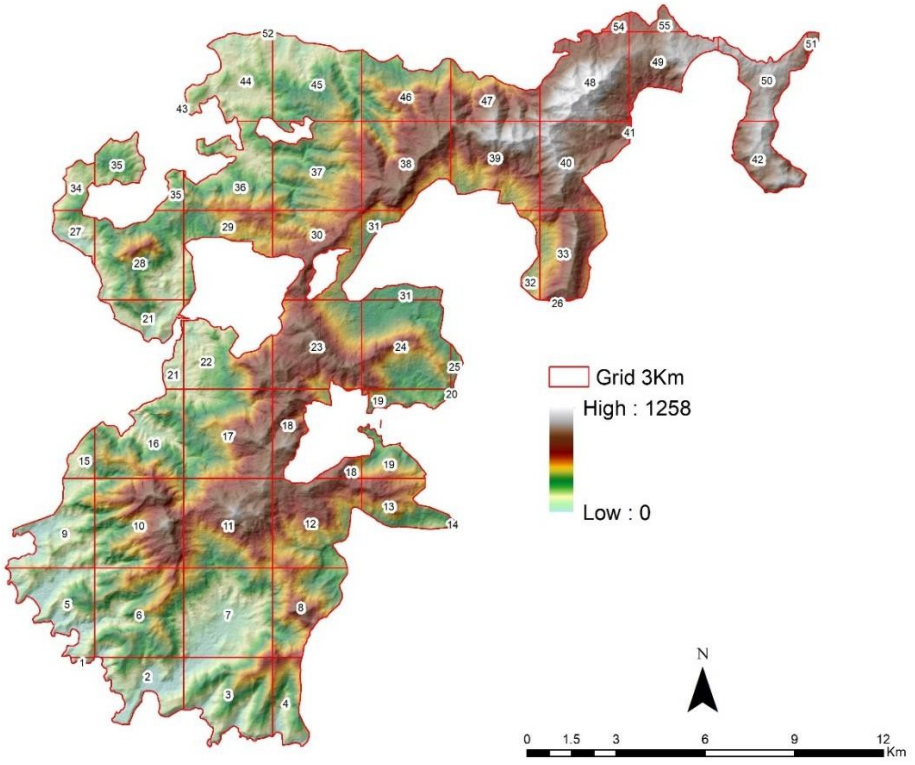
$$\text{Relative Frequency (FR)} = \frac{\text{Frequency of a Species} \times 100\%}{\text{Frequency of All Species}}$$

$$\text{Important Value Index (INP)} = KR + DR + FR$$

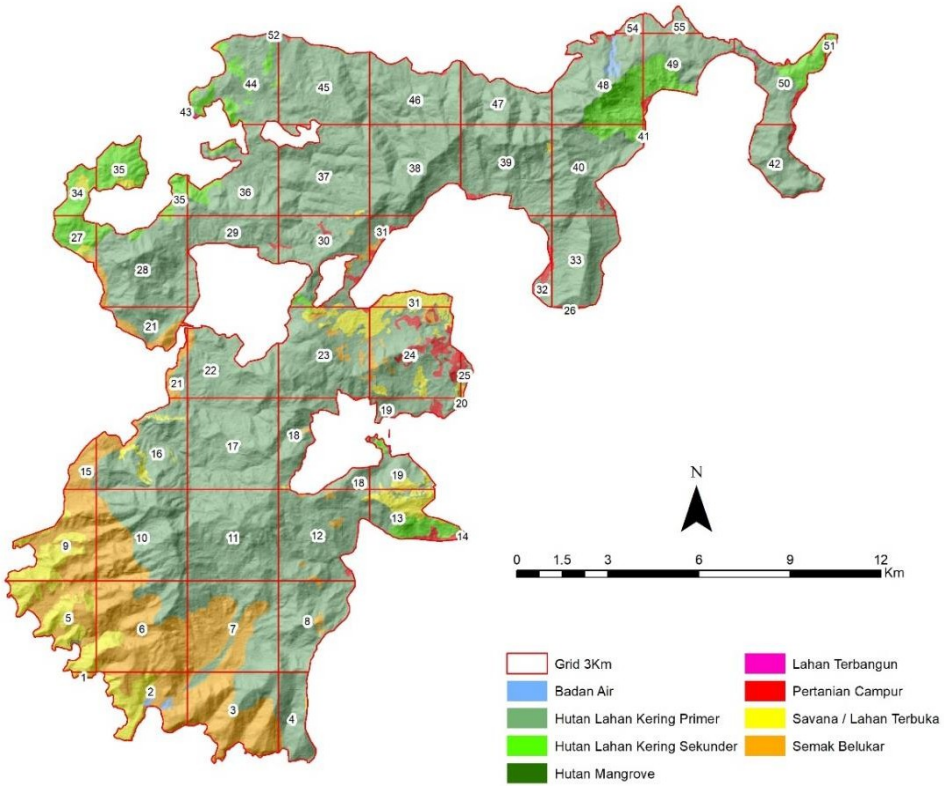
CHAPTER IV DISCUSSION

a. General Description of Location and Object Activities

Mbeliling Forest Area is one of the remaining forest areas amidst the increasing development and tourism activities in Labuan Bajo, West Manggarai Regency. This forest area is directly adjacent to the city of Labuan Bajo, which has been designated as a Super Priority Tourism Destination Area (DPSP). The massive increase in human activity and development will potentially have an impact on biodiversity in this area. The Mbeliling Protected Forest area is one of the last habitats for endemic species within the scope of Flores Island and the scope of the Lesser Sunda Islands region. Based on the National *Digital Elevation Model* (DEMNAS) data, the Mbeliling Forest Area is in the elevation value range of 0 - 1,258 meters above sea level. When referring to land cover data from the Ministry of Environment and Forestry (KLHK) in 2022, the Mbeliling Forest Area is divided into 8 land cover classes, namely water bodies, primary dryland forest, secondary dryland forest, mangrove forest, open land, savanna / open land, shrubs, and mixed agricultural land (Figure 4).



(a)



(b)

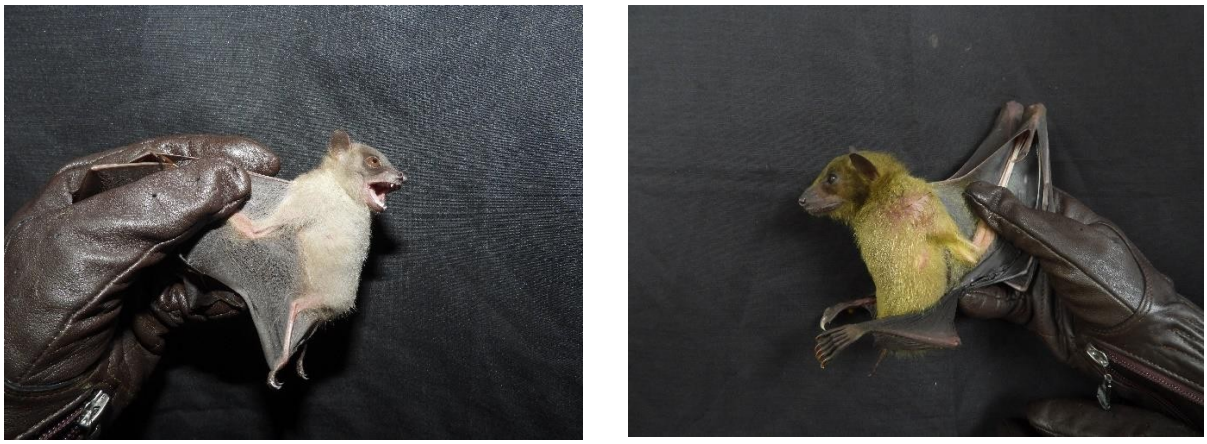
Figure 4. Mbeliling Forest Area, a) Elevation distribution; b) Land cover distribution

An overview of biodiversity in the western Mbeliling forest landscape recorded 75 bird species from 37 families. The biodiversity assessment in the Mbeliling landscape also recorded the discovery of Fores Island endemic species, namely *Monarcha sacerdotum*, *Otus alfredi*, *Loriculus flosculus*, *Corvus florensis*, and *Trichoglossus weberi*. The critically endangered species *Cacatua sulphurea* was also recorded in the forest landscape area. Other wildlife species such as mammals, reptiles and amphibians have not been specifically recorded in publications in the mbeliling forest area. For plant species, 158 species from 64 families were recorded, which are utilized for various needs of the community around the forest in Mbeliling Sub-district.

b. Description of Activity

Results Mammal Species List

The results of mammal biodiversity inventory activities in the Mbeliling Protected Forest Area, especially the *Chiroptera* Order, recorded eight species from two families at all observation locations. Two species were found in Grid 48, six species in grid 50, two species in grid 55, and four species in grid 27. Two species of bats were recorded that have a limited distribution only in the Lesser Sunda Islands, namely Codot Nusatenggara (*Cynopterus nusatenggara*) and Kubu Nusatenggara (*Dobsonia peronii*) (Figure 5). In addition, one species was also recorded that is believed to be a new record in the Lesser Sunda Islands, namely the Krawar Codot species (*Cynopterus brachyotis*) which has a distribution in Kalimantan, Sumatra, Java and Bali (Figure 6). The bat species observed during the inventory activities at the four locations are more fully detailed in Table 3.



(a) (b)

Bat species with limited distribution in the Lesser Sunda Islands, a) *C. nusatenggara*;
b) *D. peronii*

(a) (b)

New record in the Lesser Sunda Islands of the species *C. brachyotis*, a) side view; b) front view

Table 3. List of bat species in Mbeliling Protected Forest Area

No.	Family	Indonesian name	Scientific Name	a	b	c	d	∑
1.	Pteropodidae	Nusatenggara codot	*Cynopterus nusatenggara*	-	2	2	1	**5**
2.		Codot Barong	*Cynopterus sphinx*	1	9	-	1	**11**
3.		Krawar Codot	*Cynopterus brachyotis*	-	3	-	-	**3**
4.		Kubu Nusatenggara	*Dobsonia peronii*	2	-	-	1	**3**
5.		Common Nyap	*Rousettus amplexicaudatus*	-	12	-	-	**12**
6.		Small Banana Cecadu	*Macroglossus minimus*	-	6	3	-	**9**
7.	Hipposideridae	Great Barong	*Hipposideros diadema*	-	2	-	-	**2**
8.		Double-colored Barong	*Hipposideros bicolor*	-	-	-	1	**1**
Total				**3**	**34**	**5**	**4**	**46**

Notes: a= Grid 48; b= Grid 50; c= Grid 55; d= Grid 27

The Nusatenggara Codot (*C. nusatenggara*) has a distinctive distinguishing feature on the edge of the ear that is black in color when compared to all other species in the Genus *Cynopterus* (Suyanto, 2001). This species has a *forearm* size range of 55 - 65 mm (Suyanto, 2001). *C. nusatenggara* is one of the endemic species in the Lesser Sunda Islands spread from Bali Island, Nusa Tenggara, Wetar Island Maluku, and Timor Leste (Maryanto et al., 2019; Ruedas et al., 2019). Five individuals of this species were found in the three grids of study sites. According to IUCN (2024), this species is very common within its range and has a stable population trend.

Another species with a limited distribution in the Lesser Sunda Islands is Kubu Nusatenggara (*D. peronii*). The only *Dobsonia* genus distributed in the Lesser Sunda Islands is the *peronii* species with observable characteristics being ivory yellow claws (Hutson et al., 2019; Maryanto et al., 2019; Suyanto, 2001). The size of this species is quite large with the size range of the forearm of the wing

(*Forearm*) ranges from 108.5 - 127 mm (Suyanto, 2001). This species was found as many as three individuals in the two grid study sites. According to IUCN (2024), this species is very common in its range and has a stable population trend.

There is an interesting note on the bat species found because a species was identified that is believed based on morphology and morphometrics to be the Krawar Codot (*C. brachyotis*) with distribution areas in Kalimantan, Sumatra, Java, and Bali (Maryanto et al., 2019) (Table 4).

Table 4. Morphometric size comparison of *C. brachyotis*

Characteristics	**(Kitchener, 1991; Suyanto, 2001)**	**Individual I**	**Individual II**	**Individual III**
Forearm Wing	54.7 - 66.7	57.6	59.1	56.1
Calf	18.7 - 26.3	19.1	21.1	18.3
Ears	15.0 - 17.0	13.6	13.1	14.1
Back Leg	13.5 - 15.5	11.6	12.8	11.4

According to Suyanto (2001), *C. brachyotis* is characterized by white ear edges and has no protrusion on the center of the chewing tooth surface. The morphometric size of the *forearm* of this species is in the range of 54.7 - 66.7 mm (Suyanto, 2001). The three individuals found had wing forearm sizes of 57.6 mm, 59.1 mm, and 56.1 mm. The closest species, *C. sphinx*, when viewed based on the size of the wing forearm, is in the range of 58 - 76 mm and the ear size is in the range of 18 - 20 mm (Suyanto, 2001). Based on morphological characteristics and morphometric measurements compared to its closest species, this record is believed to have the potential to be a new record of the discovery of this species in the Lesser Sunda Islands region, especially on Flores Island. This species was found as many as three individuals in one grid of study sites. This species is well-adapted because in Southeast Asia, it can be found in disturbed habitats and residential areas (Csorba et al., 2019). In terms of population trends, IUCN (2024) reported that the global trend of this species is unknown.

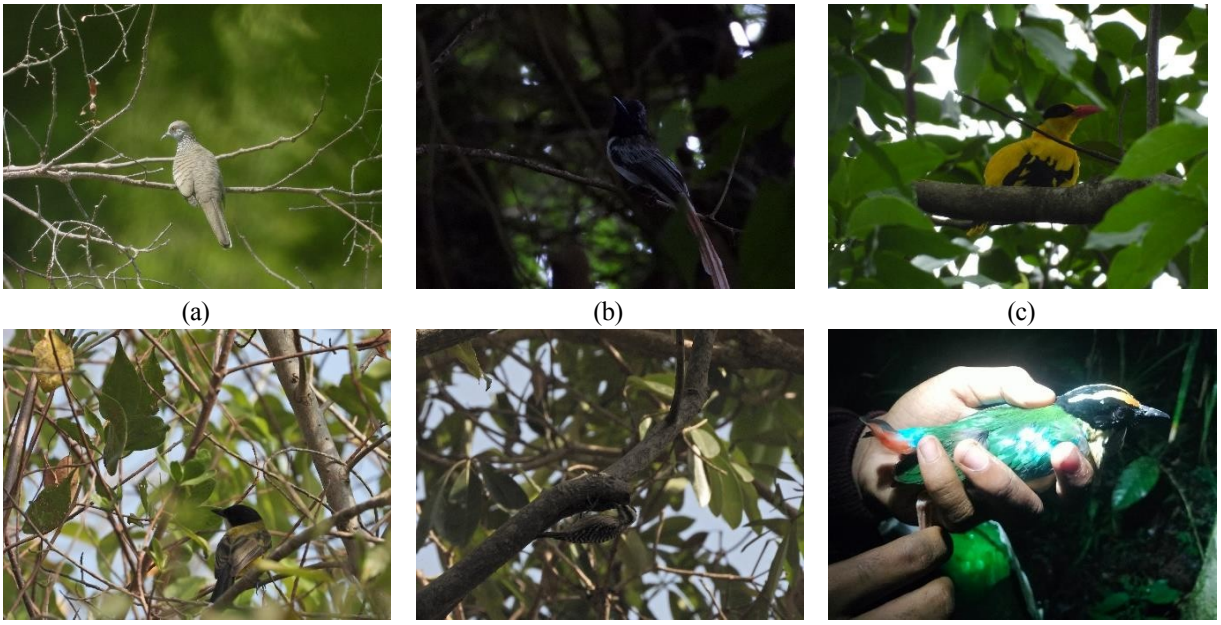
Bird Species List

The results of bird species biodiversity inventory activities in the Mbeliling Protected Forest Area recorded 36 species from 23 families at all observation locations. 11 species were found in Grid 48, seven species in Grid 50, 13 species in Grid 55, six species in Grid 47, six species in Grid 42, 15 species in Grid 27, and nine species in Grid 34. Four endemic bird species were recorded that only have a limited distribution on Flores Island, namely the Flores Crow (*Corvus florensis*), Flores Srigunting (*Dicrurus bimaensis*), and Flores Kehicap (*Symposiachrus sacerdotum*) (Figure 7). In addition, two sub-species of birds that are restricted to Flores Island were also found, namely

white-throated Cekak (*Caridonax fulgidus gracilirostris*) and crested Opior (*Heleia dohertyi subcristata*) (Figure 7). At the level of the Lesser Sunda Islands bioregion, 14 species were recorded that have a distribution in this bioregion, namely Perkutut loreng (*Geopelia maugeus*), Chili forehead-black (*Dicaeum igniferum*), Seriwang nusa-tenggara (*Terpsiphone floris*), Burung-madu matari (*Cinnyris solaris*), Tesia timur (*Tesia everetti*), Opior wallacea (*Heleia wallacei*), sub-species of Burung-madu kelapa (*Anthreptes malacensis convergens*), sub-species Black-backed shrimp (*Oriolus chinensis broderpi*), sub-species Southeastern kancilan (*Pachycephala calliope fulvotincta*), sub-species Caladi tilik (*Picoides moluccensis grandis*), sub-species Paok wallacea (*Pitta elegans concinna*), sub-species Kareo padi (*Amaurornis phoenicurus leucomelana*), sub-species Red-cheeked parrot (*Geoffroyus geoffroyi floresianus*), and sub-species Kipasan Flores (*Rhipidura diluta diluta*) (Figure 8). Bird species observed during the inventory are shown in Table 5.

(a) (b) (c)

Figure 7. Bird species with limited distribution on Flores Island, a) *D. bimaensis*; b) *C. fulgidus gracilirostris* (G. V. De Araujo); c) *H. dohertyi subcristata*. *C. florensis* and *S. sacerdotum* were only observed but not documented.



(a) (b) (c)

(d) (e) (f)


(g)


(h)


(i)


(j)


(k)


(l)

Bird species with limited distribution in the Lesser Sunda Islands, a) *G. maugeus*; b) *T. floris*; c) *O. chinensis broderpi*; d) *P. calliope fulvotincta*; e) *P. moluccensis grandis*; f) *P. elegans concinna*; g) *A. phoenicurus leucomelana*; h) *G. geoffroyi floresianus*; i) *R. diluta diluta*; j) *D. igniferum* (G. V. De Araujo); k) *C. solaris* (G. V. De Araujo); l) *H. wallacei* (G. V. De Araujo). *T. everetti*, , and *A. malacensis convergens* were only observed but not documented.

Table 5. List of bird species in Mbeliling Protected Forest Area

No.	Family	Species	a	b	c	d	e	f	g	∑
1.	Accipitridae	*Circaetus gallicus*	-	-	-	-	-	-	1	**1**
2.		*Haliastur indus*	-	-	-	-	-	-	1	**1**
3.		*Aquila fasciata*	-	-	-	-	-	-	1	**1**
4.	Alcedinidae	*Caridonax fulgidus gracilirostris*	1	-	1	1	1	-	-	**4**
5.		*Todiramphus chloris*	1	1	-	-	-	1	3	**6**
6.	Cuculidae	*Centropus bengalensis sarasinorum*	1	-	-	-	-	-	2	**3**
7.		*Cacomantis sepulcralis*	1	-	-	-	-	-	-	**1**
8.	Columbidae	*Ducula aenea polia*	-	-	1	1	-	-	1	**3**
9.		*Chalcophaps indica*	1	1	-	-	4	-	-	**6**
10.		*Geopelia maugeus*	-	-	-	-	-	1	2	**3**
11.	Corvidae	*Corvus florensis*	-	1	1	1	1	-	-	**4**
12.	Dicaeidae	*Dicaeum igniferum*	1	-	-	-	-	-	-	**1**
13.	Dicruridae	*Dicrurus bimaensis*	-	1	-	1	-	2	1	**5**
14.	Megapodiidae	*Megapodius reinwardt*	-	-	-	-	1	-	-	**1**
No	**Family**	**Species**	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**∑**

15.	Meliphagidae	*Philemon buceroides*	-	1	1	2	1	3	-	**8**
16.	Meropidae	*Merops philippinus*	-	-	-	-	-	10	-	**10**
17.	Monarchidae	*Hypothymis azurea*	-	-	1	-	-	2	-	**3**
18.		*Symposiachrus sacerdotum*	1	-	-	-	-	3	-	**4**
19.		*Terpsiphone floris*	-	-	1	-	-	-	-	**1**
20.	Muscicapidae	*Saxicola caprata fruticola*	-	-	-	-	-	1	-	**1**
21.		*Ficedula dumetoria*	-	-	1	-	-	1	-	**2**
22.	Nectariniidae	*Cinnyris solaris*	-	-	2	-	-	-	-	**2**
23.		*Cinnyris ornatus ornatus*	-	-	-	-	-	-	1	**1**
24.		*Anthreptes malacensis convergens*	-	-	-	-	-	1	-	**1**
25.	Oriolidae	*Oriolus chinensis broderpi*	1	-	-	-	-	1	-	**2**
26.	Pachycephalidae	*Pachycephala calliope fulvotincta*	1	-	-	-	-	-	-	**1**
27.	Picidae	*Picoides moluccensis grandis*	-	-	1	-	-	1	-	**2**
28.	Pittidae	*Pitta elegans concinna*	1	1	-	-	-	-	-	**2**
29.	Psittacidae	*Geoffroyus geoffroyi floresianus*	1	1	1	2	8	-	-	**13**
30.	Phasianidae	*Gallus varius*	-	-	-	-	-	1	1	**2**
31.	Rallidae	*Amaurornis phoenicurus leucomelana*	-	-	-	-	-	3	-	**3**
32.		*Rallina fasciata*	-	-	-	-	-	2	-	**2**
33.	Rhipiduridae	*Rhipidura diluta diluta*	-	-	2	-	-	-	-	**2**
34.	Cettidae	*Tesia everetti*	1	-	-	-	-	-	-	**1**
35.	Zosteropidae	*Heleia dohertyi subcristata*	-	-	2	-	-	-	-	**2**
36.		*Heleia wallacei*	-	-	2	-	-	-	-	**2**
Total			**12**	**7**	**17**	**8**	**16**	**33**	**14**	**107**

Notes: a = Grid 48; b= Grid 50; c= Grid 55; d= Grid 47; e= Grid 42; f= Grid 27; g= Grid 34

Flores Crow (*C. florensis*) is an endemic species whose distribution is limited to the island of Flores (BirdLife International, 2024b; Eaton et al., 2016). Four individuals of this species were observed in the four study grids. This species is quite rare due to its small population and limited distribution (Eaton et al., 2021). Species density is reported to be low, requiring more effort in surveys to encounter this species (BirdLife International, 2024b). According to BirdLife International (2024), this species has a declining population trend and its distribution is restricted to lowland areas in the western part of the island of Flores.

Another endemic species found is the Flores Srigunting (*D. bimaensis*). This species is one of the subspecies of the Wallacean Srigunting (*D. densus*), which has a distribution in the Lesser Sunda Islands (BirdLife International, 2024c; Eaton et al., 2016). Five individuals of this species were observed in the four grids of the study site. This species is highly dependent on forest land cover habitat, making it highly

vulnerable to land degradation and deforestation (BirdLife International, 2024c). BirdLife International (2024b) further predicts that there has been a linear decline in population numbers with the loss of forest land cover. This is confirmed by IUCN (2024), which reports that population trends for this species are likely to decline.

The next endemic species is the Flores Kehicap (*S. sacerdotum*), which has a very limited distribution in the western part of Flores Island (BirdLife International, 2017). Four individuals of this species were observed in the two study grids. The density of this species was estimated to reach only 0.8 individuals per hectare in suitable habitat areas (BirdLife International, 2017). Another study reported that the species was found in three forest blocks, namely Mbeliling, Sano Nggoang, and Nggorang - Bowosie forest blocks) with a predicted population of 1855 - 6659 individuals with a density of 8.52 - 23.98 individuals per $Km^{(2)}$ (BirdLife International, 2017). The species is reported to inhabit primary forest habitats and is adaptable to slightly degraded habitats (Reeve & Rabenak, 2016). In terms of population trends, this species is likely to have a declining trend with an estimated number of adults remaining at 2500 - 10000 individuals (BirdLife International, 2017).

Another Flores Island endemic species observed was the white-tailed Cekak (*C. fulgidus gracilirostris*). This species is one of the sub-species of the white-tailed Cekakak (*C. fulgidus*), which is distributed in Lombok and Sumbawa (*C. fulgidus fulgidus*) and in the Flores region (*C. fulgidus gracilirostris*) (BirdLife International, 2024a; Eaton et al., 2016). This species was observed as many as four individuals in four grids of study sites with land cover of primary dryland forest. This species can be found in forest areas, shrubs, plantations, forest edges, and even in degraded areas in locations with elevation values up to 1700 masl (Eaton et al., 2016). BirdLife International (2024a) reports that this species is common in its range and dependent on forest land cover. When referring to its population, this species is reported to have a declining population trend (BirdLife International, 2024a). This is thought to be linear with the loss of land cover in forested areas (BirdLife International, 2024a).

The most recently observed endemic species of Flores Island is the Crested Opior (*H. dohertyi subcristata*). This species is one of the subspecies of the Crested Opior (*H. dohertyi*), which is distributed in Sumbawa and Satonda (*H. dohertyi dohertyi*) and in the Flores region (*H. dohertyi subcristata*) (BirdLife International, 2018; Eaton et al., 2016). Two individuals of this species were observed in one grid of study sites. The species is reported to be common in moist primary forest areas from 300 - 1400 masl (BirdLife International, 2018; Coates & Bishop, 2000; Eaton et al., 2016). In terms of population, the species is thought to have a declining population trend due to habitat destruction and fragmentation (BirdLife International, 2018).

List of Herpetofauna Species

The results of the inventory of herpetofauna biodiversity in the Mbeliling Protected Forest Area recorded 10 species from eight families in all observation locations. Three species were found in Grid 48, six species in grid 50, three species in grid 55, one species in grid 47, three species in grid 42, and four species in grid 27. One reptile species and one endemic amphibian species that only has a limited distribution on Flores Island, namely the *Flores Banded Skink* (*Sphenomorphus striolatus*) (Figure 9). One reptile and three amphibian species were also recorded that have a limited distribution in the Lesser Sunda Islands bioregion, namely *Darmandville Bow-fingered Gecko* (*Cyrtodactylus darmandvillei*), Bangkong kadarsan (*Limnonectes kadarsani*), Floresian Frog (*Papurana florensis*), and Flores Oriental Frog (*Occidozyga floresiana*) (Figure 10). The herpetofauna species observed during the inventory are shown in Table 6.

Herpetofauna species endemic to Flores Island (*S. striolatus*)

(a)

(b)

(c)

(d)

Herpetofauna species with limited distribution in the Lesser Sunda Islands, a) *C. darmandvillei*; b) *L. kadarsani*; c) *P. florensis*; d) *O. floresiana*

List of herpetofauna species in Mbeliling Protected Forest Area

No.	Family	Species	a	b	c	d	e	f	∑
1.	Scincidae	*Sphenomorphus striolatus*	2	1	-	-	-	-	**3**
2.	Viperidae	*Trimeresurus insularis*	1	-	1	-	-	-	**2**
3.	Pseudaspididae	*Psammodynastes pulverulentus*	-	-	-	1	-	-	**1**
4.	Varanidae	*Varanus salvator*	-	-	-	-	-	1	**1**
5.	Gekkonidae	*Cyrtodactylus darmandvillei*	-	1	-	-	-	1	**2**
6.		*Hemidactylus frenatus*	-	-	-	-	-	1	**1**
7.	Dicroglossidae	*Limnonectes kadarsani*	-	2	2	-	2	1	**7**
8.		*Occidozyga floresiana*	-	-	-	-	1	-	**1**
9.	Ranidae	*Papurana florensis*	-	1	-	-	-	-	**1**
10.	Microhylidae	*Kaloula baleata*	-	1	-	-	-	-	**1**
Total			**3**	**6**	**3**	**1**	**3**	**4**	**20**

Notes: a = Grid 48; b= Grid 50; c= Grid 55; d= Grid 47, e= Grid 42; f= Grid 27

The Flores Banded Skink (*S. striolatus*) is an endemic species whose distribution is limited to the island of Flores (Shea et al., 2021). Other references report that this species is very restricted with early records in Reo and western Flores (Uetz et al., 2024). Three individuals of this species were observed in the two study site grids. This species is reported to occur in areas with elevation values up to 1200 masl in lowland forest to upland forest habitats (Shea et al., 2021). In terms of population, this species is reported to be common within its range and no threats to the population have been identified, resulting in a stable population trend (Shea et al., 2021).

Another species of herpetofauna with a limited distribution is the *Flores Oriental Frog* (*O. floresiana*). This species was originally believed to be endemic to Flores Island, but new records report that it was also found in the Mount Rinjani region of West Nusa Tenggara at an altitude of 1000 masl (IUCN SSC Amphibian Specialist Group, 2019). However, this species was first encountered and recorded restricted to western Flores (Frost & Darrel R, 2024). This species was observed as one individual in one grid of study sites. This species is uncommon and rare due to a decline in the extent and quality of forest habitat, and is reported to have a declining population trend (IUCN SSC Amphibian Specialist Group, 2019).

List of Plant Species

The results of plant species biodiversity inventory activities in the Mbeliling Protected Forest Area recorded 65 plant species with details of 48 species from 31 families can be identified and as many as 17 plant species are only identified at the local name level. Vegetation analysis was conducted on three types of land cover, namely forest land cover, shrubs, and savanna / open land. A total of 54 plant species were found in forest land cover, 15 plant species were found in shrub land cover, and 7 plant species in savanna/open land cover. Plant species observed during inventory activities are more fully displayed in Table 7.

Table 7. List of plant species in Mbeliling Protected Forest Area

No.	Local Name	Family	Scientific Name	a	b	c
1.	Fig	Moraceae	*Ficus variegata*	√		
2.	Jackfruit	Moraceae	*Artocarpus heterophyllus*	√		
3.	Aseng	Rutaceae	*Acronychia trifoliolata*	√	√	
4.	Cirek	Clusiaceae	*Septogarcinia sumbawaensis*	√		
5.	Brown	Malvaceae	*Theobroma cacao*	√		
No.	**Local Name**	**Family**	**Scientific Name**	**a**	**b**	**c**
6.	Kukung	Malvaceae	*Schoutenia ovata*		√	√
7.	Ndamer	Malvaceae	*Pterospermum diversifolium*	√	√	
8.	Sompe	Malvaceae	*Microcos tomentosa*	√	√	√
9.	Wajur	Malvaceae	*Pterospermum javanicum*	√	√	
10.	Daleng	Fabaceae	*Piliostigma malabaricum*	√		
11.	Class	Fabaceae	*Desmodium pulchellum*		√	
12.	Reket	Fabaceae	*Albizia odoratissima*		√	
13.	Dempol	Lauraceae	*Litsea sp.*	√		

14.	Ndingar	Lauraceae	*Cinnamomum burmanni*	√		
15.	Loi	Apocynaceae	*Alstonia spectabilis*	√		
16.	Niti	Apocynaceae	*Wrightia pubescens*		√	
17.	Pasa	Apocynaceae	*Tabernaemontana macrocarpa*	√	√	
18.	Teak	Lamiaceae	*Tectona grandis*		√	√
19.	Jerjowang	Sapindaceae	*Allophylus cobbe*	√		
20.	Lait	Symplocaceae	*Symplocos cochinchinensis*	√		
21.	Rare	Rhamnaceae	*Ziziphus mauritiana*			√
22.	Paci	Rhamnaceae	*Ziziphus timoriensis*		√	
23.	Lente	Euphorbiaceae	*Homalanthus populneus*	√		
24.	Puser	Euphorbiaceae	*Mallotus philippinensis*	√	√	
25.	Raccoon	Euphorbiaceae	*Macaranga tanarius*	√		
26.	Lanteng	Urticaceae	*Dendrocnide microstigma*	√		
27.	Enau	Arecaceae	*Arenga pinnata*	√		
28.	Pinggong	Arecaceae	*Pinanga coronata*	√		
29.	Wene	Arecaceae	*Areca catechu*	√		
30.	Lokom Puar	Myrtaceae	*Syzygium lineatum*	√		
31.	Longkorpo	Meliaceae	*Aglaia silvestris*	√		
32.	Mahogany	Meliaceae	*Swietenia mahagoni*	√		
33.	Neem	Meliaceae	*Azadirachta indica*		√	√
34.	Mbaceng	Oleaceae	*Fraxinus griffithii*	√		
35.	Munting	Lythraceae	*Lagerstroemia flos-reginae*	√		
36.	Ndeer	Myricaceae	*Myrica javanica*	√		
37.	Ngancar	Lecythidaceae	*Planchonia valida*	√		
38.	Ngantol	Phyllanthaceae	*Glochidion perakense*	√		
39.	Nito	Elaeocarpaceae	*Elaeocarpus sphaericus*	√		
40.	Pante	Rubiaceae	*Neonauclea sp.*	√		
41.	Pao	Anacardiaceae	*Mangifera indica*	√		
No.	**Local Name**	**Family**	**Scientific Name**	**a**	**b**	**c**
42.	Sela	Dipterocarpaceae	*Shorea robusta*	√		
43.	Sema	Rosaceae	*Prunus wallaceana*	√		
44.	Siang	Viburnaceae	*Viburnum sambucinum*	√		
45.	Telo Acu	Pittosporaceae	*Pittosporum moluccanum*	√		
46.	Teu	Stemonuraceae	*Gomphandra mappioides*	√		
47.	Tilutuna	Podocarpaceae	*Podocarpus blumei*	√		
48.	Tompok	Costaceae	*Costus speciosus*	√		
49.	Bambo			√		

50.	Lalas	√		
51.	Lingar	√		
52.	Lokeng	√		
53.	Making	√		
54.	Mbararat			√
55.	Mbinar	√		
56.	Mbodong	√		
57.	Mbune			√
58.	Nakeng	√		
59.	Nggurus	√		
60.	Nungang		√	
61.	Parik	√		
62.	Rati	√		
63.	Roja	√		
64.	Welas	√		
65.	Wanot		√	
Total		**54**	**15**	**7**

Description: a= Forest Land Cover; b= Shrub Land Cover; c= Savanna/Open Land Cover

Vegetation analysis data were collected in the Mbeliling protected forest area as many as 39 plots with details of 24 plots on forest land cover, eight plots on shrub land cover, and seven plots on savanna/open land cover. The data from this vegetation analysis was then analyzed to obtain an important value index (INP) at each level of vegetation and land cover. Vegetation types that have the highest INP values at each level and land cover are more fully presented in Table 8.

Table 8. Highest INP values in each land cover and vegetation level

Land Cover	Vegetation Level	Local Name	Scientific Name	INP (%)
Forest	Shrub	Pasa	*Tabernaemontana macrocarpa*	27.53
	Stake	Cirek	*Septogarcinia sumbawaensis*	13.72
	Pole	Cirek	*Septogarcinia sumbawaensis*	34.60
	Tree	Mbaceng	*Fraxinus griffithii*	37.67
Shrubs	Seedling	Sompe	*Microcos tomentosa*	58.33
	Stake	Sompe	*Microcos tomentosa*	54.56
	Pole	Kukung	*Schoutenia ovata*	88.02
	Tree	Wanot		106.72
Savanna /	Stake	Rare	*Ziziphus mauritiana*	67.61
Open Land	Pole	Teak	*Tectona grandis*	175.76
	Tree	Teak	*Tectona grandis*	234.85

The T. macrocarpa plant species has a very wide distribution with sizable populations and is reportedly not under significant threat, so it has a stable population trend (Botanic Gardens Conservation International (BGCI) & IUCN SSC Global Tree Specialist Group, 2018). These plants are also utilized by local communities as construction materials and used in traditional rituals (Mulu et al., 2020).

Other plant species with the highest INP at the pole and tree level in the forest land cover area are *S. sumbawaensis* and *F. griffithii*. *S. sumbawaensis* was first described by Kostermans (1962) from the Lesser Sunda Islands region. This species is distributed in several countries, namely Brunei, East Timor, Indonesia, and Malaysia (Steenis, 1979). This species can be found in tropical forest habitat at an altitude range of 500 - 700 meters above sea level (Medellín-Zabala & Marinho, 2015). This species was also reported by Mulu et al. (2020) used by local communities around the Mbeliling forest as raw material for construction. *F. griffithii* grows with a tree habitus type and can be found in dryland forests, forest edges, and river banks with a height of up to 20 m (Oldfield, 2018). This species is widely utilized by local communities in the Manggarai region as a medicinal plant with uses to treat malaria and dysentery (Iswandono, 2018). This species was also reported to have the highest INP value in locations with an altitude of 1800 masl (Iswandono, 2016). This species is distributed in several countries including Indonesia in Java and the Lesser Sunda Islands (WFO, 2024a).

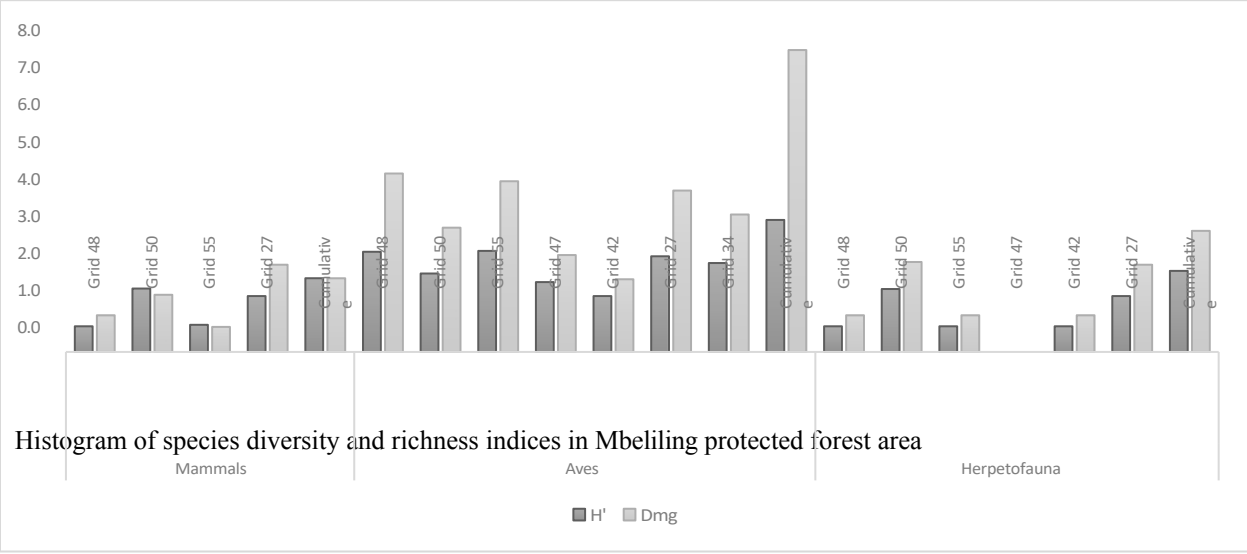
Furthermore, the plants with the highest INP at the pole and tree levels in the shrub land cover area were *S. ovata* and *Wanot* species. *S. ovata* can be found in areas of mixed season forest and *evergreen* dryland forest at an altitude range of 100 - 200 meters above sea level (de Kok, 2024; WFO, 2024b). The species is distributed in several countries such as Thailand, Laos, Cambodia, Vietnam, Australia, and Indonesia in Java, Lesser Sunda Islands, Maluku, and Papua (WFO, 2024b).

It has also been reported that its wood can be utilized as raw material for construction (WFO, 2024b).

Vegetation analysis was also conducted on areas with savanna/open land cover. Some locations in this area were converted by the community by planting teak (*T. grandis*). This is in line with the results of the highest INP at the pole and tree level in this area, namely the *T. grandis* species. Mulu et al. (2020) reported that the *T. grandis* species is used by local communities around the Mbeliling forest area as a coloring material. This species is distributed in many countries including Indonesia in the Lesser Sunda Islands bioregion (WFO, 2024c). This species can grow in seasonal forest areas, dryland forests, and moist forests with an altitude range of 100 - 700 meters above sea level (Gua et al., 2022). Despite its wide distribution and ability to adapt to various habitat conditions, this species is categorized as endangered with declining populations due to illegal logging activities, as it is one of the most expensive timber species (Gua et al., 2022).

Species Diversity and Richness Index (H' and Dmg)

Based on the results of the biodiversity inventory in the Mbeliling Protected Forest Area, the values of the diversity index and species richness vary for mammals, birds, and herpetofauna. The biodiversity index of mammals and herpetofauna is at a moderate level ($1 \leq H' \leq 3$) with an H' value for mammals of 1.8 and herpetofauna of 2.0. As for the bird species biodiversity index, it is at a high level of diversity ($H' > 3$) with a value of 3.3. When referring to the results of the margalef richness index analysis, the mammal class has a low species richness index value ($Dmg < 2.5$) with a value of 1.8, the aves class has a high richness index ($Dmg > 4$) with a value of 7.5, and the reptile and amphibian class has a medium richness index ($2.5 \leq Dmg < 4$) with a value of 3.0 (Figure 11).



Histogram of species diversity and richness indices in Mbeliling protected forest area

The biodiversity index in the mammal class has the highest value at grid location 50 with a value of H' 1.6, while in the aves class the highest value is at grid locations 48 and 55 with a value of H' 2.5, and in the herpetofauna species the highest value is at grid location 50 with a value of H' 1.6. When referring to the margalef species richness index, the mammal class has the highest value on grid 27 with a Dmg value of 2.2, while the aves class has the highest value at grid location 48 with a Dmg value of 4.4, and the herpetofauna species has the highest value at grid locations 50 and 27 with a Dmg value of 2.2. Grid locations 48, 50, and 55 are areas with primary and secondary dryland forest land cover types, while grid location 27 is an area with a mixed land cover type of secondary dryland forest and shrubs (Figure 12).

(a) (b)

(c) (d)

Grid condition of Mbeliling protected forest area, a) Grid 48; b) Grid 50; c) Grid 55; d) Grid 27

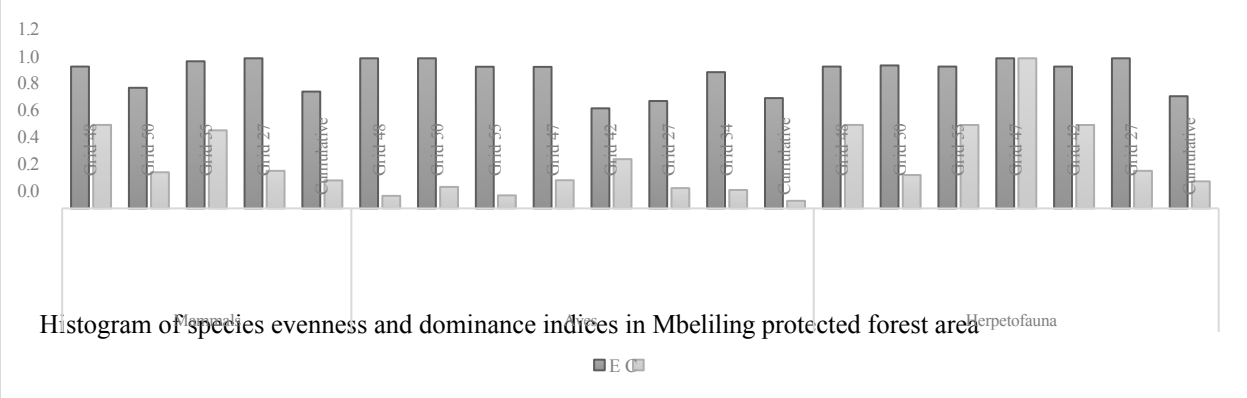
Grid 48 is dominated by pole and tree vegetation with steep road conditions and several large rocks. There are several water sources on this grid that may be utilized by a variety of wildlife. This water source is also found in grid 50 with mixed vegetation from shrubs to dense vegetation. As for grid 55, the vegetation type is still in the form of primary dryland forest land cover with moist and wet soil conditions. Furthermore, for location

grid 27 has a vegetation type of secondary dryland forest, shrubs, and there are several open areas. This grid location is also dominated by pole and tree vegetation levels with sloping to steep land conditions and flowing water sources.

The general picture of the location of the above grids holds the highest index value of diversity and species richness. Primary forest habitats with diverse vegetation and dominating vegetation levels at the pole and tree levels can be utilized by wildlife as a source of food, shelter, and protection (Gibson et al., 2011; Liu et al., 2024; Nasir et al., 2021; Trimble & Van Aarde, 2014). Wildlife tend to choose habitat types that can fulfill all their needs (Morrison et al., 2012; Tellería, 2016). The Mbeliling protected forest area, with a land cover dominated by primary forest, holds high biodiversity potential considering that the entire area has not been recorded in this study.

Index of Evenness and Dominance (E and C)

Based on the results of the biodiversity inventory in the Mbeliling Protected Forest Area, the species evenness index value in each class of wildlife is high or the community at each location is considered stable (E> 0.6). The evenness index for the mammal class has a value of 0.78, the aves class has a value of 0.73, and the herpetofauna species has a value of 0.75. The value of the evenness index ranges from 0 - 1 with the criteria that if the value is close to 0 then the evenness of the species is low and there is a dominant species (stressed community), whereas if the index value is close to 1 then the evenness of the species is high and it can be interpreted that there is no dominant species (stable community). When referring to the results of the Simpson dominance index analysis, the mammal class has a dominance index value of 0.19, the aves class has a value of 0.05, and the herpetofauna species has a value of 0.18. The overall result of the simpson dominance index cumulatively has a value of C≤ 0.5 or low dominance. This result is linear with the species evenness index which describes a stable community or no dominating species (Figure 13).

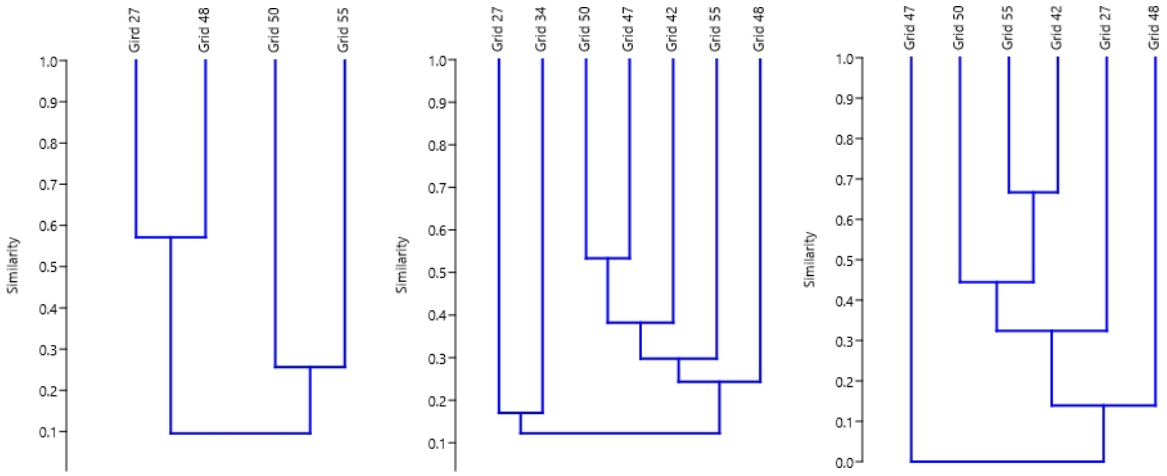


Histogram of species evenness and dominance indices in Mbeliling protected forest area

All wildlife classes in all grids of the study site obtained a high evenness index value (E > 0.6). This result illustrates that in each grid and cumulatively the entire study site is at a high level of species evenness or describes a stable community. When referring to the dominance index of each grid of the study site, there are several grids in the wildlife class that have high dominance index values including the mammal class on grid 48 with a dominance index value of 0.556 and grid 55 with a value of 0.52. Furthermore, the herpetofauna class on grid 48 with an index value of 0.556, grid 55 with a value of 0.556, grid 47 with a value of 1, and grid 42 with a value of 0.556. This is because there are only one or two types of species that produce a high dominance index. A high evenness index value also illustrates that in a community it is considered that there is no competition in finding needs, such as food, water, shelter, and breeding grounds (Akatov et al., 2018; Ludwig & Reynolds, 1988). Thus, this illustrates that the habitat in the Mbeliling protected forest area is still able to provide resources for various types of wildlife.

Community Similarity Index

Assessment of community similarity at the observation site using the Bray-Curtis index. Assessment using this index is widely done by researchers to assess community similarity with classical clustering and presented in the form of dendrograms (Hardina et al., 2019; Ruppert et al., 2017; Tamnge et al., 2016; Wiryono & Nurliana, 2022). The following are the results of the Bray-Curtis similarity index dendrogram of each wildlife class (Figure 14).

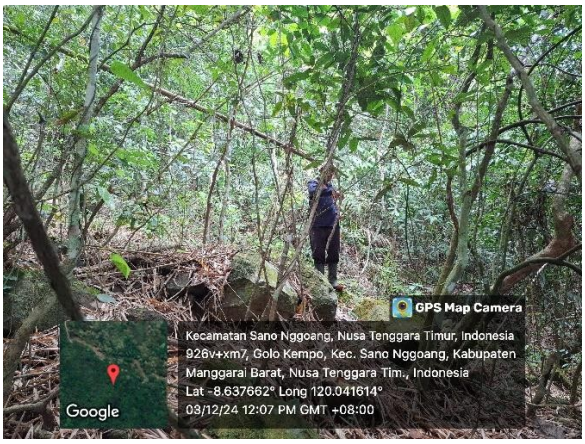


(a) (b) (c)

Figure 14. Histogram of Bray-Curtis community similarity, a) Mammal class; b) Aves class; c) Reptiles and amphibians class.

The dendrogram of the Bray-Curtis index analysis results formed three community clusters in the mammal class, six clusters in the avian class, and five clusters in the reptile and amphibian class. Grid locations 42, 47, 48, 50 and 55 are locations with forest land cover.

55 are locations with primary and secondary dryland forest land cover, while grid 27 is a location with mixed land cover consisting of secondary dryland forest, shrubs, and open areas. Furthermore, for grid 34, this location also has mixed land cover conditions consisting of secondary dryland forest and open areas (Figure 15).



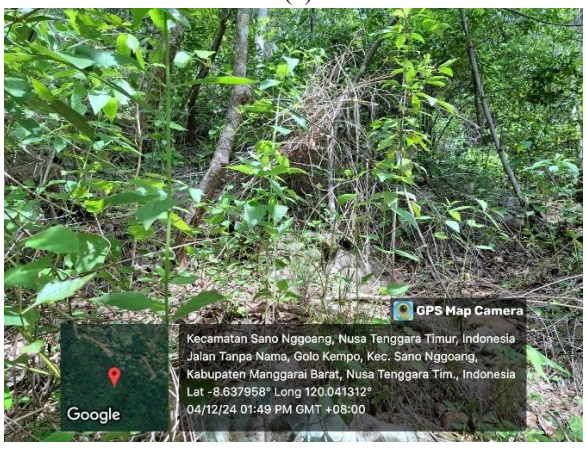
(a)

(b)

(c)

(d)

(e)



(f)

(g)

Grid location condition of Mbeliling protected forest area, a) Grid 42; b) Grid 47; c) Grid 48; d) Grid 50; e) Grid 55; f) Grid 27; g) Grid 34

The community similarity index in the mammal class resulted in grid location 48 with grid location 27 having the highest index value. Grid 48 and 27 both have dominant forested areas, so the results show that in the mammal class these two grids are close in community similarity. Two species of mammals were found in grid 48, namely *C. sphinx* and *D. peronii*, while grid 27 also found *C. sphinx*, *D. peronii*, and additional species of *C. nusatenggara*. The finding of this species similarity makes the two grids have a high community similarity index value. *C. sphinx* is a species that can be found in a variety of habitat types including primary and secondary forests, to urban landscapes and rural areas (Bates et al., 2019). Another species, *D. peronii*, can be found in forested areas or seen roosting in caves and rock crevices (Hutson et al., 2019). Another species is *C. nusatenggara*, this species can be found in secondary forest areas to areas with disturbed habitat up to 100 meters above sea level (Ruedas et al., 2019).

The dendrogram results in the aves class illustrate that grid 47 and grid 50 locations have the highest index of forming one cluster of community similarity. The community similarity index in the aves class shows that habitat locations with primary and secondary forest land cover form several community clusters (Grid 47, 50, 42, 55, and 48) and habitat locations with mixed land cover (Grid 27 and 34) form one community cluster. Thus, these results clearly illustrate that areas with primary and secondary forest land cover have the same community similarity, and different communities with mixed land cover.

Furthermore, the community similarity index in the reptile and amphibian class resulted in the location of grid 55 with grid 42 having the highest index value. Grid 55 and 42 both have primary dryland forest land cover, so the results show that in the reptile and amphibian classes these two grids are close in community similarity. The reptile and amphibian species found in grid 55 are two

T. insularis and *L. kadarsani*, while grid 42 also found *L. kadarsani* and an additional species of *O. floresiana*. The finding of this species similarity makes the two grids have a high community similarity index value. *L. kadarsani* is a species that can be found in various habitat types including primary forest areas, secondary forests, streams, wetlands, and rural areas with predictions of being able to survive in disturbed habitats (IUCN SSC Amphibian Specialist Group, 2018). Another species, *O. floresiana*, can be found in forested areas, areas with wetlands, and streams within forests (IUCN SSC Amphibian Specialist Group, 2019).

Conservation Status

A biodiversity inventory study in the Mbeliling protected forest area recorded two species of *endangered* wildlife, namely one species of bird *S. sacerdotum* categorized as *Endangered* (EN) and one species of amphibian *O. floresiana* categorized as *Vulnerable* (VU). The study also recorded two species categorized as *Near Threatened* (NT) and 50 species categorized as *Least Concern* (LC) based on the threat status on the *International Union for Conservation of Nature and Natural Resources Red List of Threatened Species (IUCN*, 2024). Based on the status of wildlife trade under the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES), there are four wildlife species in the Appendix II category, namely *C. gallicus*, *H. indus*, *A. fasciata*, and *G. geoffroyi* (UNEP-WCMC (Comps.), 2024). The Appendix II category is a group of species that are not threatened with extinction, but have the potential to become extinct if traded without regulation (UNEP-WCMC (Comps.), 2024). This biodiversity inventory study also recorded nine wildlife species that are protected under the Minister of Environment and Forestry Regulation No. 106/2018 on Protected Plant and Animal Species, namely *C. gallicus*, *H. indus*, *A. fasciata*, *C. fulgidus*, *C. florensis*, *S. sacerdotum*, *P. Elegans*, *G. Geoffroyi*, and *H. wallacei* (Figure 16). The conservation status of wildlife is further detailed in Table 9.

Table 9. Conservation status of wildlife in Mbeliling protected forest area

No.	Family	Species	IUCN	CITES	P.106
Mammals					
1.	Pteropodidae	*Cynopterus nusatenggara*	LC	-	-
2.		*Cynopterus sphinx*	LC	-	-
3.		*Cynopterus brachyotis*	LC	-	-
4.		*Dobsonia peronii*	LC	-	-
5.		*Rousettus amplexicaudatus*	LC	-	-
No	**Family**	**Species**	**IUCN**	**CITES**	**P.106**
6.		*Macroglossus minimus*	LC	-	-
7.	Hipposideridae	*Hipposideros diadema*	LC	-	-
8.		*Hipposideros bicolor*	LC	-	-
Aves					
9.	Accipitridae	*Circaetus gallicus*	LC	II	√
10.		*Haliastur indus*	LC	II	√
11.		*Aquila fasciata*	LC	II	√

12.	Alcedinidae	*Caridonax fulgidus gracilirostris*	LC	-	√
13.		*Todiramphus chloris*	LC	-	-
14.	Cuculidae	*Centropus bengalensis sarasinorum*	LC	-	-
15.		*Cacomantis sepulcralis*	LC	-	-
16.	Columbidae	*Ducula aenea polia*	NT	-	-
17.		*Chalcophaps indica*	LC	-	-
18.		*Geopelia maugeus*	LC	-	-
19.	Corvidae	*Corvus florensis*	NT	-	√
20.	Dicaeidae	*Dicaeum igniferum*	LC	-	-
21.	Dicruridae	*Dicrurus bimaensis*	LC	-	-
22.	Megapodiidae	*Megapodius reinwardt*	LC	-	-
23.	Meliphagidae	*Philemon buceroides*	LC	-	-
24.	Meropidae	*Merops philippinus*	LC	-	-
25.	Monarchidae	*Hypothymis azurea*	LC	-	-
26.		*Symposiachrus sacerdotum*	EN	-	√
27.		*Terpsiphone floris*	LC	-	-
28.	Muscicapidae	*Saxicola caprata fruticola*	LC	-	-
29.		*Ficedula dumetoria*	LC	-	-
30.	Nectariniidae	*Cinnyris solaris*	LC	-	-
31.		*Cinnyris ornatus ornatus*	LC	-	-
32.		*Anthreptes malacensis convergens*	LC	-	-
33.	Oriolidae	*Oriolus chinensis broderpi*	LC	-	-
34.	Pachycephalidae	*Pachycephala calliope fulvotincta*	LC	-	-
35.	Picidae	*Picoides moluccensis grandis*	LC	-	-
36.	Pittidae	*Pitta elegans concinna*	LC	-	√
37.	Psittacidae	*Geoffroyus geoffroyi floresianus*	LC	II	√
38.	Phasianidae	*Gallus varius*	LC	-	-
39.	Rallidae	*Amaurornis phoenicurus leucomelana*	LC	-	-
40.		*Rallina fasciata*	LC	-	-

No	Family	Species	IUCN	CITES	P.106
41.	Rhipiduridae	*Rhipidura diluta diluta*	LC	-	-
42.	Cettidae	*Tesia everetti*	LC	-	-
43.	Zosteropidae	*Heleia dohertyi subcristata*	LC	-	-
44.		*Heleia wallacei*	LC	-	√
Reptiles					
45.	Scincidae	*Sphenomorphus striolatus*	LC	-	-
46.	Viperidae	*Trimeresurus insularis*	LC	-	-

47.	Pseudaspididae	*Psammodynastes pulverulentus*	LC	-	-
48.	Varanidae	*Varanus salvator*	LC	-	-
49.	Gekkonidae	*Cyrtodactylus darmandvillei*	LC	-	-
50.		*Hemidactylus frenatus*	LC	-	-
Amphibian					
51.	Dicroglossidae	*Limnonectes kadarsani*	LC	-	-
52.		*Occidozyga floresiana*	VU	-	-
53.	Ranidae	*Papurana florensis*	LC	-	-
54.	Microhylidae	*Kaloula baleata*	LC	-	-
Total			**2**	**4**	**9**

The Mbeliling protected forest area has important conservation value for animals. This is illustrated by the presence of endangered species, Appendix II species, and species protected by the Indonesian government. *S. sacerdotum* is one of the endangered species (EN) since 1994 due to its very narrow range and declining population due to habitat fragmentation, degradation, and loss (BirdLife International, 2017). The species inhabits primary and secondary forest habitats at elevations of 350 to 1000 meters above sea level with an estimated population of only 2500 - 10000 adult individuals (BirdLife International, 2017). BirdLife International (2017) further reported that the species faces the threat of loss of forested areas due to various activities, such as shifting cultivation, fires, and development on the island of Flores.

Another threatened species is *O. floresiana*. This species was categorized as *Data Deficient* (DD) in 2004, while in the next assessment in 2017 this species was categorized as *Vulnerable* (VU) due to very narrow encounter opportunities and range with an encounter rate of 5801 $Km^{(2)}$ (IUCN SSC Amphibian Specialist Group, 2019). This species was originally thought to be endemic to Flores island, but in 2017 there were records of this species in forest areas in West Nusa Tenggara (IUCN SSC Amphibian Specialist Group, 2019). The IUCN SSC Amphibian Specialist Group (2019) further reports that the species faces the threat of

habitat loss due to forest degradation in its range with other threats in the form of tourism infrastructure development and increasing human activities on Flores Island.

When referring to CITES trade status, there are several species from the *Psittacidae* and *Accipitridae* families that are classified as Appendix II (Figure 16). The *Psittacidae* family classified into the Appendix II category is *G. geoffroyi* (Nandika et al., 2021), while the *Accipitridae* family classified into the Appendix II category includes *C. gallicus* (Buij et al., 2016), *H. indus* (Iqbal, 2016; Nijman et al., 2022; Panter & White, 2020), and *A. fasciata* (Di Vittorio et al., 2018).

(a)

(b)

(c)

(d)

(e)

(f)

(g)

Species of the Aves class that are included in CITES and protected by the Indonesian government (P.106), a) *C. gallicus*; b) *H. indus*; c) *A. fasciata*; d) *G. geoffroyi*; e) *C. fulgidus**; f) *P. elegans**; g) *H.* wallacei*.

Notes: *= Only included in category P.106; species C. floresnsis and S. sacerdotum not documented

Globally, these species are categorized as potentially endangered species if trade is not controlled. The results of the inventory study noted that species included in the CITES category are also species protected by the Indonesian government (P.106 of 2018 concerning Protected Plant and Animal Species), namely *C. gallicus*, *H. indus*, *A. fasciata*, and *G. geoffroyi*. There are five species that are only protected by Indonesian government regulations but not under CITES protection, namely *C. fulgidus*, *P. elegans*, *H. wallacei*, *C. florensis*, and *S. sacerdotum*. The determination of protected species by the Indonesian government considers several factors and considerations from scientific authorities (National Research and Innovation Agency) and several conservation organizations that focus on species studies.

c. Testing Hypotheses

The results of the Biodiversity Inventory study in the Mbeliling Protected Forest Area recorded seven species endemic to Flores Island, 20 species endemic to the Lesser Sunda Islands region, and one species that has the potential to become a new record in the Lesser Sunda Islands region. The Mbeliling Protected Forest area is also home to two IUCN endangered species, four Appendix II species under CITES, and nine species protected under P.106 of 2018.

CHAPTER V CLOSING

a. Conclusion

Eight species from two families with a total of 46 individuals were recorded in the mammal class, 36 species from 23 families with a total of 107 individuals in the bird class, 10 species from eight families with a total of 20 individuals in the reptile and amphibian class, and 65 plant species with details of 48 species from 31 families identified and 17 plant species only identified at the local name level. The biodiversity index value (H') for mammal, bird, and herpetofauna classes is 1.8, 3.3, and 2.0, respectively. Meanwhile, the species richness index (Dmg) for mammals, birds, and herpetofauna classes were 1.8, 7.5, and 3.0, respectively. In addition, the species evenness index (E) for mammal, bird, and herpetofauna classes was 0.78, 0.73, and 0.75, respectively. Furthermore, the value of the species dominance index (C) for mammal, bird, and herpetofauna classes was 0.19, 0.05, and 0.18, respectively. This study also produced a plant importance index with the highest INP value at the tree level in various land cover types, namely the *F. griffithii* species in forest areas, the T. Grandis species in savanna / open land areas, and *the Wanot* species in shrub areas.

b. Suggestion

Protection of the Mbeliling Protected Forest is urgently needed through various partnership and *stakeholder* schemes. Mbeliling Protected Forest is one of the remaining forest areas amidst increasing development and various human activities on Flores Island. This area needs special attention considering that it is one of the last habitats for endemic and endangered species.

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APPENDIX

Appendix 1. Mammal (*Chiroptera*) Tally Sheet

Date :

Land Cover :

Location :

Coordinates (*Misnet & Harp*) :

Code	FA	TB	HF	E	HB	TV	D2MCL	D3MCL	D3P1L	D3P2L	D4MCL	D4P1L	D4P2L	D5MCL	D5P1L	D5P2L	Weight	Sex	Age	Type

Appendix 2. Mammal (*Rodentia*) Tally Sheet

Date :

Land Cover :

Location :

Coordinates (*Trap*) :

No	Type	P. Total Body	P. Tail	P. Ears	P. Legs	Hoofed / Clawed	P. Nails / Claws	Number of Nipples Front Milk	Number of Nipples Rear Milk	Top Color	Bottom Color	Coarse/Fine Hair	Quantity	Sex	Weight	Substrate*	Photo Code***

Description:

*) Trap substrate containing rodent species

***) Top view, bottom view, side view, face, forelegs, hindlimbs, tail, and claw photos only

Appendix 3. Bird Tally Sheet

Location :

Date :

Habitat Type :

Weather :

Coordinates (Start, End, and Point) :

GPS Always Switched on in Transect

Take Additional Coordinates for Specific Species (Endemic, Endangered, etc.)

No.	Time	Type	Scientific Name	Family	Encounters*	Total	Activity**	Remarks***

Notes:

*) Direct encounters (documented; seen/heard); indirect encounters (nests, secondary information, etc.)

**) Flying, perching, feeding, moving/moving, resting, vocalizing

***) Vegetation utilization (canopy, branches, forest floor, etc.)

Appendix 4. Tally Sheet Herpetofauna

Location :

Date :

Habitat Type :

Wet Bulb Temperature :

Dry Bulb Temperature :

Coordinates (Start and End of Transect) :

GPS Always Switched on in Transect

Take Additional Coordinates for Specific Species (Endemic, Endangered, etc.)

No.	Time	Type	Scientific Name	Family	Substrate*	Quantity	Distance from Water	Distance from Ground	Distance from Previous Individual	Photo Code**

Description:

*) Substrate on which the species was found (grass, puddle, twig, soil, etc.)

**) Photographs in nature when found, top view, side view, special photos of forelimbs and hindlimbs

Appendix 5. Plant Tally Sheet

Location :

Date :

Habitat Type :

Wet Bulb Temperature :

Dry Bulb Temperature :

Plot No. :

Plot Coordinates :

Plot	Local Name	Indonesian Name	Scientific Name	Circumference (cm)	Diameter (cm)	Total Height (m)	Branch Free Height (m)	X in plot	Y in plot	Side 1 Azimuth Angle	Distance Center to Header Side 1	Azimuth Angle of Side 2	Distance Center to Crown Side 2	Side 3 Azimuth Angle	Distance Center to Crown Side 3	Azimuth Angle of Side 4	Distance Center to Crown Side 4	Photo Code*

Description:
*) Photographs of the condition of each plot and photographs of each plant species