

# Wildlife diversity of Malagufuk Forest for sustainable ecotourism and community-based forest management in Southwest Papua, Indonesia

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Manuscript received: 15 February 2025. Revision accepted: 8 May 2025.

**Abstract.** Turot A, Boer CD, Matius P, Marwa J, Rujehan, Rustam, Suba RB, Suhardiman A, Kristiningrum R, Ruslim Y. 2025. *Wildlife diversity of Malagufuk Forest for sustainable ecotourism and community-based forest management in Southwest Papua, Indonesia. Biodiversitas 26: 2320-2331.* Malagufuk Forest in West Papua, Indonesia, is a biodiversity hotspot supporting various endemic and endangered wildlife species. However, threats such as deforestation and habitat fragmentation endanger ecological integrity. This study aims to assess faunal diversity, analyze habitat relationships, and explore sustainable management strategies integrating conservation and ecotourism. Field surveys were conducted using direct observations, camera traps, mist nets, and structured community interviews. Species diversity was analyzed to determine richness and distribution, and qualitative assessments of habitat preferences were performed. The study also examined the socio-economic impact of ecotourism on local communities and its role in conservation efforts. Results revealed a high diversity of avian, mammalian, amphibian, and reptilian species, including five species of birds of paradise (Paradisaeidae) and other key fauna such as cassowaries (*Casuarius unappendiculatus*) and cuscus (*Spilococus maculatus*). Bird diversity was closely linked to forest cover, with denser vegetation supporting higher species richness. Similarly, the diversity of mammals and herpetofauna was influenced by habitat structure and minimal human disturbance. Community engagement in ecotourism has contributed positively to conservation awareness and provided alternative livelihood opportunities. Next, to ensure long-term sustainability, conservation strategies should include habitat zoning, controlled ecotourism, and community-based monitoring. Strengthening local participation through education and capacity-building initiatives is crucial for preserving the biodiversity of Malagufuk Forest. Future research should focus on long-term ecological monitoring and the expansion of conservation-driven tourism models. This study highlights the potential of ecotourism as a viable approach to sustainable forest management while promoting biodiversity conservation and local economic development.

**Keywords:** Biodiversity conservation, ecotourism, local community, Malagufuk Forest, wildlife diversity

## INTRODUCTION

Malagufuk Forest, located in Southwest Papua, Indonesia, is a significant repository of biodiversity. The unique ecological characteristics of Malagufuk Forest provide habitats for numerous endemic and endangered animal species, including five species of birds of paradise, contributing substantially to global biodiversity (Pattiwael and Turot 2020; Turot et al. 2024). However, Malagufuk faces threats from deforestation, habitat fragmentation, and unsustainable resource exploitation, which jeopardize its ecological integrity and the survival of its resident species. In response to these threats, the local community has implemented ecotourism initiatives to support both conservation and its own economic well-being (Rahman 2023).

Assessing faunal diversity and habitat relationships is crucial for effective conservation planning and sustainable management (Nugraha et al. 2021; Bha et al. 2023). Such assessments provide insights into species' richness,

distribution, and ecological requirements, informing targeted conservation strategies. Additionally, the ecotourism potential of biodiverse areas, such as Malagufuk Forest, can offer economic incentives for conservation by supporting livelihoods. When managed sustainably, ecotourism has proven to aid both conservation and community development (Sapary et al. 2017).

Recent studies have emphasized the integration of biodiversity conservation and ecotourism as a dual approach to ecological preservation and socio-economic growth. Ecotourism supports conservation funding while providing economic benefits to local communities and preserving their cultural heritage (Suyadnya et al. 2025). However, the success of ecotourism initiatives largely depends on comprehensive planning, effective management strategies, and active community participation (Stronza et al. 2019). In Papua, where communities rely heavily on forest resources, striking a balance between conservation and local needs is crucial.

Malagufuk Forest, covering approximately 3,500 hectares, exemplifies Papua's rich biodiversity. It supports iconic species such as birds of paradise (Paradisaeidae), cassowaries (*Casuarius* spp.), and various endemic mammals and reptiles. These species have ecological significance and serve as potential attractions for ecotourism. However, Malagufuk faces challenges, including illegal logging, habitat fragmentation, and limited local awareness about biodiversity conservation. These threats highlight the need for strategies that integrate conservation with sustainable livelihoods, particularly through ecotourism.

The insufficient data on the diversity of faunal species, habitat preferences, and ecological dynamics in Malagufuk Forest pose a challenge to conservation efforts and sustainable use. Pillay et al. 2022 confirmed that tropical forests, such as Malagufuk Forest, are home to more than half of the world's vertebrate species. The lack of detailed data on the distribution and ecology of these species can hinder effective conservation efforts. Without this information, it is challenging to identify critical habitats, assess the conservation status of species, or develop ecotourism initiatives that are both ecologically sustainable and economically viable. However, limited research has been conducted on integrating biodiversity conservation and ecotourism in Papua's unique ecological context (Ardiansyah et al. 2023). This study aims to fill this gap by providing a comprehensive analysis of the faunal diversity in Malagufuk Forest and identifying actionable strategies to enhance conservation outcomes through sustainable ecotourism.

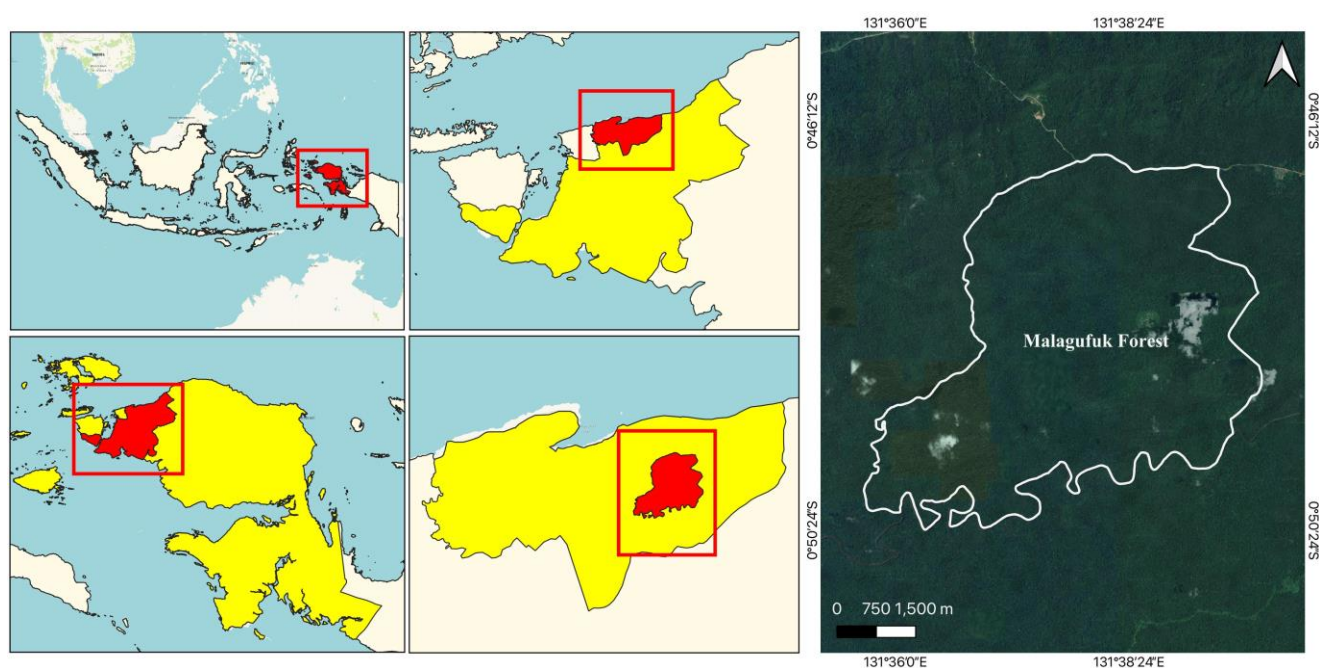
Specifically, we aim to assess the diversity of fauna in Malagufuk Forest, analyze their habitat relationships, and propose management strategies that support the forest's ecotourism potential. By conducting comprehensive field surveys and habitat assessments, we aim to fill existing

knowledge gaps and establish a foundation for sustainable management practices. This research represents the first comprehensive assessment of faunal diversity and habitat relationships in Malagufuk Forest. Unlike previous studies that have focused on specific taxa or broader regions, this study will provide an integrated analysis of multiple faunal groups within the forest. Additionally, by linking biodiversity assessments with ecotourism potential, this research offers a novel approach to conservation planning that aligns ecological objectives with socio-economic benefits. Given the escalating threats to tropical forests globally, there is an urgent need to develop sustainable management strategies that balance conservation with economic development. This study will provide critical data to inform strategies for preserving the unique biodiversity of Malagufuk Forest while promoting ecotourism as a sustainable livelihood option for local communities. The findings will be valuable for conservation practitioners, policymakers, and ecotourism developers aiming to implement evidence-based approaches to forest management. The new insight gained from this research will contribute significantly to our understanding of faunal diversity and habitat relationships in Malagufuk Forest, providing a basis for sustainable management that leverages the forest's ecotourism potential for conservation and community development.

## MATERIALS AND METHODS

### Study area

This study was conducted in the Malagufuk natural forest area, located in Malagufuk Village, Makbon Sub-district, Sorong District, Southwest Papua Province, Indonesia (Figure 1).



**Figure 1.** Location of Malagufuk Forest, Makbon Sub-district, Sorong District, West Papua, Indonesia

The geographic coordinates of the study site range from 131°34'0" to 131°40'0" E and 0°46'0" to 0°50'2" S. Malagufuk Forest is known for its rich biodiversity. It serves as a vital habitat for various species of birds, mammals, amphibians, and reptiles. The forest is primarily composed of dense tropical rainforests with a complex ecosystem that supports a high level of species endemism. Malagufuk Forest is an integral part of local conservation efforts and community-based forest management initiatives. The area is characterized by high humidity, frequent rainfall, and a relatively stable temperature, which influence the distribution and behavior of wildlife. The study site is accessible through forest trails, and certain observation points were strategically selected based on preliminary surveys and community knowledge (Turot et al. 2024).

### Data collection

Data collection was carried out over a specified period using the following methods, adapted from established biodiversity assessment approaches (Gurung et al. 2022):

#### Bird survey

The bird survey was conducted using a combination of direct and indirect observation methods. Direct observations were made using Nikon Coolpix P950 and P1000 cameras, as well as binoculars (10×40) for identifying arboreal bird species. Mist nets (6 meters long and 2.5 meters high) were installed at five locations for 3-4 days to capture understory bird species. Indirect observations involved recording bird calls, feather remains, and camera-trap footage. Community interviews and references from online databases were also used to supplement species identification. Species identification was based on *Birds in the Papua Region* (Schrader et al. 2020; Lahallo et al. 2022). Observations were conducted during peak bird activity hours (06:00-10:00 and 16:00-18:00) to maximize detection rates (Kristiningrum et al. 2020; Zwerts et al. 2021).

#### Mammal survey

Mammals were identified through both direct and indirect methods. Direct encounters were documented using cameras and field notes, while indirect methods included tracking footprints, feces, and tree markings. Camera traps (Bushnell Trophy Cam HD) were deployed in ten locations (Morgan et al. 2016; Rustam 2017; Zwerts et al. 2021), baited with instant cat food and shrimp paste to attract mammals. The observation points were selected purposively based on existing mammalian trails and local community information. The use of infrared-triggered cameras allowed continuous monitoring, particularly for nocturnal species. Identification was based on standard mammal field guidebooks, and conservation status was cross-referenced with the IUCN Red List and CITES Appendices.

#### Amphibian and reptile survey

Herpetofauna surveys were conducted primarily at night for approximately three hours using the Visual

Encounter Survey (VES) method. Swamps, riverbanks, and puddles near bird- and mammal-observation sites were targeted for amphibian and reptile sightings. Unidentified species were temporarily captured for further identification using reference books such as *A Field Guide to the Frogs of Mimika Region* (Richards 2015), *A Field Guide to the Reptiles of Southeast Asia* (Das 2011), and *A Guide to the Snakes of Papua New Guinea* (O'Shea 1996). Field notes included data on species distribution, habitat type, and environmental conditions.

The target location for the wildlife survey was determined using a map from Google Maps and the Avenza Maps application. It is worth noting that Google Maps does not reflect the most recent land closure conditions, as it utilizes publicly available satellite or aerial images, some of which are several years old (Figure 2).

#### Community interviews

Structured interviews were conducted with local community members to gather traditional ecological knowledge about faunal diversity, habitat preferences, and changes in species distribution. This approach leverages participatory methods to integrate local knowledge into ecological research (Rustam 2017; Burgos-Ayala et al. 2020). Prior to conducting the interviews, we obtained consent from the local community and communicated the purpose of the research to the respondents. The respondents we used in this study consisted of 14 household heads with 7.14% women and 92.86% men. Most of the education is senior high school with the majority age in the range of 26-65 years and the majority of occupations are farmers.

#### Data analysis

The data collected were analyzed using both qualitative and quantitative approaches. Species richness was determined by counting the number of distinct species observed in each taxonomic group (birds, mammals, amphibians, and reptiles). Species evenness was evaluated to determine the uniformity of species distribution. Data from direct observations and camera traps were correlated with habitat parameters to identify key environmental factors influencing the presence of species (Magurran 2004; Withaningsih et al. 2020; Zakaria et al. 2022).



**Figure 2.** Location of the wildlife survey target sites and the placement of the cameras in Malagufuk Forest, West Papua, Indonesia using the Avenza maps application

Interviews with local communities were analyzed to assess traditional ecological knowledge, hunting pressures, and conservation attitudes (Cebrián-Piqueras et al. 2020; Haq et al. 2023; Zewdu et al. 2024). The findings were used to recommend sustainable forest management strategies that align with the goals of ecotourism development. Potential threats, including deforestation, illegal hunting, and land conversion, were documented. Species classified as Vulnerable (VU) under the IUCN Red List were given special attention in conservation planning. The findings were used to propose management strategies focusing on habitat zoning, community-based ecotourism, and conservation education to promote biodiversity protection and sustainable livelihoods (Sakti et al. 2024).

## RESULTS AND DISCUSSION

### Generale overview of Malagufuk Village

Malagufuk, in Makbon Sub-district, Sorong District, Southwest Papua, is a small village with significant ecological value. Established in 2002 and formally integrated into Suwatolo Village in 2017, it consists of 14 households and 67 residents. The Pacific Ocean, Klayili Village, Suatut Village, and Malaumkarta Village border Malagufuk. While under Suwatolo Village's jurisdiction, it has its own governance structure to manage local affairs and conservation efforts. The village prioritizes education through elementary school (*SD Negeri 30*) in Sorong District but lacks adequate healthcare facilities, relying on Malaumkarta's health center. Farming is the primary source of livelihood, with ecotourism, mainly birdwatching, providing an additional income source. Conservation agreements prohibit deforestation and hunting.

Predominantly Protestant, the community's Sion Malagufuk Church plays a key role in social policies. Tourism is growing, with government-backed infrastructure, such as homestays and Indonesia's longest wooden bridge (3,305 meters), enhancing accessibility. Malagufuk Village exemplifies sustainable conservation and ecotourism. Despite limited infrastructure, strong communal values, and strategic development efforts, it positions itself as a model for ecotourism in Papua.

### Bird species diversity in Malagufuk Forest

Papua's rich biodiversity encompasses a wide range of ecosystem types, from coastal areas and lowlands to lower and highland mountain regions (Barri et al. 2019). These diverse ecosystems provide an ideal habitat for various fauna species, including both endemic and exotic wildlife. The region is home to a unique array of mammals, reptiles, and avifauna (Pattiselanno et al. 2019).

During the study, 32 species of birds from 15 families were identified (Table 1). These included important species that have become iconic Papuans, such as the Cendrawasih bird of paradise and the cassowary (*Casuarius unappendiculatus*). Some of the identified species are protected and have a high conservation status, according to the IUCN (Iyai et al. 2020; Pattiwael and Turot 2020). These findings confirm the forest's status as a critical

biodiversity hotspot. Additionally, they align with Papua being recognized as one of the world's five major centers of avian species diversity.

The avifauna in Papua consists of over 700 species, categorized into four groups: 578 species that breed in terrestrial and freshwater habitats, 40 seabird species, 56 migratory species from the Northern Hemisphere, and 34 species that wander (Iyai et al. 2020). The presence of such high avian species richness aligns with studies indicating that lowland tropical forests support a high proportion of regional avian biodiversity (International 2022). Similarly, the seven mammal species identified, including the dusky pademelon (*Thylogale brunii*) and spotted cuscus (*Spilogale maculatus*), reflect the faunal uniqueness of Papua, which is home to endemic marsupial species and rodents (Report 2017). Lense et al. (2024) also conducted a study and identified a total of nine mammal species, 52 bird species from 25 families, 39 reptile and amphibian species, as well as 58 butterfly species belonging to the Papilionoidea superfamily. Several key flora and fauna species in the Sorong District of Papua require special attention due to their vulnerable status, necessitating conservation interventions to ensure their continued survival in the wild and prevent their decline.

Table 1 shows that all 15 families of birds in the Malagufuk Forest area have an IUCN status; of the 32 species identified, 30 are included in the LC category and 2 in the VU category. Most bird species in Papua are still considered wild, giving them a high level of exotic appeal (Iyai et al. 2020). The extent of forested land cover is the main factor affecting the presence and richness of bird species. Forests are major providers of food, shelter, and reproductive resources for bird species across various trophic levels and feeding classes (Kaban et al. 2017; Collina et al. 2021; Lee et al. 2023). Observations of bird species diversity have shown that it is higher in dense forest cover dominated by tall trees and characterized by a high diversity of plant species (Karuniyanti et al. 2018; Garg et al. 2020). Consistent with this, disturbed areas such as those close to logging roads or community gardens/fields, or those containing felled weeds, will have a very significant effect on the diversity of bird species because birds are sensitive to changes in forest cover and microclimate change (Karuniyanti et al. 2018; Santosa et al. 2018; Arzeta et al. 2021; Ramlah et al. 2021; Shahabuddin et al. 2021). The forested land in the Malagufuk Forest area and its surroundings is a crucial source of germplasm for birds, offering a suitable microclimate for breeding. Images of some of the bird species identified in Malagufuk Forest are shown in Figure 3.

### Mammalian species diversity in Malagufuk Forest

This study identified 7 mammal species from six families and four orders in Malagufuk Forest using a combination of direct and indirect detection methods (Table 2). These included pigs, ground kangaroos, rats, cuscus, and bats. Table 2 shows that 5 of the 7 identified mammals, *Cynopterus brachyotis*, *Nyctimene vizzaccia*, *Rattus leocopus* (rat), *Spilogale maculatus*, and *Sus scrofa*, are of low-risk conservation status (Least Concern).

Pattiselanno and Krockenberger (2021) also reported their presence in the Biak conservation area of Papua, further confirming the existence of the cuscus in the Papua region.

In contrast, two of the identified mammal species are classified as vulnerable (VU) according to the IUCN Red List, namely *Rusa timorensis* and *T. brunii*. Aside from the rat, the two species of bats, and the pigs, the other species

found are protected mammals, as per the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.106/Menlhk/Setjen/Kum.1/12/2018. By law, these species cannot be hunted in Malagufuk Forest. Images of some of the mammal species found in Malagufuk Forest are presented in Figure 4.

**Table 1.** List of bird species identified in Malagufuk Forest, West Papua, Indonesia

Species	Family	Indonesian name	Conservation state			Method
			IUCN	CITES	RI	
<i>Aepyodius arfakianus</i>	Megapodiidae	Maleo gunung	LC		DL	SG
<i>Ailuroedus buccoides</i>	Ptilonorhynchidae	Burung-kucing kuping-putih	LC		DL	SG
<i>Alisterus amboinensis</i>	Psittacidae	Nuri-raja ambon	LC	II	DL	SG
<i>Alisterus chloropterus</i>	Psittacidae	Nuri-raja sayap-kuning	LC	II	DL	SG
<i>Arses telescopthalmus</i>	Monarchidae	Kehicap biku-biku	LC		TD	SG
<i>Cacatua galerita</i>	Cacatuidae	Kakatua koki	LC		DL	SG
<i>Casuarus unappendiculatus</i>	Casuariidae	Kasuari gelambir-tunggal	LC		DL	SG
<i>Cicinnurus magnificus</i>	Paradisaeidae	Cendrawasih belah-rotan	LC	II	DL	VC
<i>Cicinnurus regius</i>	Paradisaeidae	Cendrawasih raja	LC	II	DL	VC
<i>Ducula pinon</i>	Columbidae	Pergam pinon	LC		TD	SG
<i>Eclectus oratus</i>	Psittaculidae	Nuri bayan maluku	LC	II	DL	SG
<i>Goura cristata</i>	Columbidae	Mambruk ubiaat	VU	II	DL	CT
<i>Lophorina superba</i>	Paradisaeidae	Cendrawasih-kerah barat	LC	II	DL	VC
<i>Lorius lory</i>	Psittacidae	Kasturi kepala-hitam	LC	II	DL	SG
<i>Microptilotis montanus</i>	Meliphagidae	Meliphaga rimba	LC		TD	SG
<i>Mino dumontii</i>	Sturnidae	Mino muka-kuning	LC		TD	SG
<i>Otidiphaps nobilis</i>	Columbidae	Delimukan dewata	LC		TD	SG
<i>Paradisaea minor</i>	Paradisaeidae	Cendrawasih kecil	LC	II	DL	SG
<i>Poecilodyras brachyura</i>	Petroicidae	Robin dagu-hitam	LC		TD	SG
<i>Probosciger aterrimus</i>	Cacatuidae	Kakatua raja	LC	I	DL	SG
<i>Psittrichas fulgidus</i>	Psittacidae	Nuri kabare	VU	II	DL	SG
<i>Ptilinopus iozonus</i>	Columbidae	Walik perut-jingga	LC		TD	SG
<i>Megaloprepia magnifica</i>	Columbidae	Walik wompu	LC		TD	SG
<i>Ptilinopus nainus</i>	Columbidae	Walik kerdil	LC		TD	SG
<i>Lophorina magnifica</i>	Paradisaeidae	Toowa cemerlang	LC	II	TD	SG
<i>Rhipidura rufiventris</i>	Rhipiduridae	Kipasan dada-lurik	LC		TD	SG MN
<i>Rhyticeros plicatus</i>	Bucerotidae	Julang papua	LC	II	DL	SG
<i>Sericulus aureus</i>	Ptilonorhynchidae	Namdur topeng	LC		DL	SG
<i>Talegalla cuvieri</i>	Megapodiidae	Maleo kamur	LC		TD	SG
<i>Tanyiptera galatea</i>	Alcedinidae	Cekakak-pita biasa	LC		TD	SG
<i>Todiramphus macleayi</i>	Alcedinidae	Cekakak rimba	LC		TD	MN
<i>Trichoglossus haematodus</i>	Psittacidae	Perkici pelangi	LC	II	DL	SG

Notes: IUCN: International Union for the Conservation of Nature and Natural Resources; CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora. Roman numerals indicate specific CITES appendices; RI: Protection Status based on the Regulation of the Minister of Environment and Forestry; Republic of Indonesia Number P.106/MENLHK/SETJEN/KUM.1/12/2018; VU: Vulnerable (Vulnerable); LC: Least Concern (Low Risk); SG: Sighted (direct observation); MN: Mist Net; CT: Camera Trap; VC: Voice. Indonesian species name by Burung Indonesia (<https://burung.org>); scientific name by IUCN (<https://www.iucnredlist.org/species/>) and Burung Indonesia (<https://burung.org>)

**Table 2.** Species of mammals identified in Malagufuk Forest, West Papua, Indonesia

Species	Family	Indonesian name	Conservation state			Method
			IUCN	CITES	RI	
<i>Cynopterus brachyotis</i>	Pteropodidae	Kelelawar-buah berhidung-endek	LC			SG
<i>Nyctimene vizcaccia</i>	Pteropodidae	Kelelawar umboi-hidung	LC			TR
<i>Rattus leucopus</i>	Muridae	tikus	LC			CT
<i>Rusa timorensis</i>	Cervidae	Rusa timor	VU		DL	FV
<i>Spiloglossus maculatus</i>	Phalangeridae	Kuskus tutul	LC	II	DL	SG
<i>Sus scrofa</i>	Suidae	Babi hutan	LC			CT, FP
<i>Thylogale brunii</i>	Macropodidae	Pelandu aru	VU	II	DL	CT, SG

Notes: IUCN: International Union for Conservation of Nature and Natural Resources; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora; DL: Protected under the Minister of Environment and Forestry of the Republic of Indonesia Number P.106 Year 2018; SG: Sighted; CT: Camera Trap; FP: Footprint; TR: Trapped. Scientific name by IUCN (<https://www.iucnredlist.org/species/>)



**Figure 3.** Species of birds in the Malagufuk Forest Area, West Papua, Indonesia: A. *Casuarius unappendiculatus*; B. Dollar Bird; C. *Goura cristata*; D. *Cacatua galerita*; E. *Alisterus chloropterus*; F. *Microptilotis montanus*; G. *Paradisaea minor*; H. *Arses telescopthalmus*; I. *Rhyticeros plicatus*



**Figure 4.** Species of mammals found in Malagufuk Forest, West Papua, Indonesia. A. *Nyctimene vizcaccia*; B. *Thylogale brunii*; C. *Spilocuscus maculatus*; D. *Sus scrofa*

Several threats to biodiversity were identified in Malagufuk Forest, including habitat degradation from logging, agricultural encroachment, and hunting. The sensitivity of species such as birds of paradise to these disturbances underscores the urgency of conservation efforts. In a similar context, Ausprey et al. (2023) found that the vulnerability of Andean bird species to disturbances in agricultural environments can be mitigated by preserving forest patches and regenerating vegetation. The opening up of forest areas in the tropics has been shown not only to increase the risk of forest loss but also, in the absence of effective regulatory measures, to facilitate access to activities such as harvesting and hunting. For instance, roads have been observed to increase overall hunting pressure and encourage commercially driven activities, such as the shift from subsistence to market-oriented livelihoods and associated activities (Pattiselanno and Krockenberger 2021).

The importance of intact habitats for biodiversity is further corroborated by studies in similar ecosystems, such as the Amazon Basin, where intact forests provide critical ecological functions for endemic species (Watson et al. 2018). The breakdown of forest habitats caused by human activities, such as deforestation, farming, and infrastructure expansion, results in species populations becoming isolated, genetic diversity declining, and ecological processes being disrupted. Consequently, endemic wildlife in the Democratic Republic of the Congo, including primates, birds, and large mammals, is increasingly at risk of population decline and possible extinction. The vocalizations of primates and birds are considered a distinctive feature of this forest, often described as more melodious than those of many primates in Borneo, according to local observers and ecotourism reports. Furthermore, habitat fragmentation intensifies other environmental threats, such as climate change and the spread of invasive species, further hindering efforts to conserve biodiversity in the region (Gomez and Patel 2020; Carter and Singh 2023; Jenny 2024).

### **Amphibian and reptile species diversity in Malagufuk Forest**

Based on surveys and direct observation methods, we detected nine species of amphibians and reptiles in Malagufuk Forest (Table 3). These included frogs, snakes, monitor lizards, and reptiles, with all identified species having a low conservation risk (LC) status. Neither species nor conservation status can identify the species of *Dendrelaphis calligaster* and *Eutropis multifasciata*. There were identification difficulties, so not all reptile species could be identified, as some species of reptiles exhibit variations in color or body patterns that resemble those of other species. Additionally, environmental factors such as adverse weather conditions, challenging terrain, or time constraints during surveys can cause some individuals to be observed briefly without adequate documentation for identification purposes. Some species are so similar in morphology to other species that their identification requires genetic analysis or examination of microscopic characters, which cannot be observed directly in the field.

Images of several species of amphibians and reptiles found in Malagufuk Forest are shown in Figure 5. For species that have not yet been named, such as *Eutropis* sp. and *Dendrelaphis* sp., it is essential to recognize that there are still opportunities to discover new species and initiate further research, considering that many species and their ecology in West Papua are not yet fully understood. Species like *L. lubisi* and *M. ikaheka* demonstrate the ecological value of Malagufuk Forest as a habitat for herpetofauna. Forest degradation is predicted to have a detrimental effect on amphibian and reptile species diversity, as more degraded forest habitats have relatively lower amphibian abundance and species richness. However, the marginal effect of habitat degradation on reptiles is minimal when comparing degraded forests to intact forests (Crane et al. 2018).

The diversity and composition of amphibian and reptile species vary based on the degree of human disturbance: Habitats with minimal disturbance exhibit the highest species richness, while heavily disturbed areas, as anticipated, support the lowest diversity. Although many amphibian and reptile species can survive in habitats with low levels of disturbance, forest-dependent species are at risk of disappearing when undisturbed forests are altered (Hocking and Babbitt 2014; Gillespie et al. 2015; Frost 2018; Kusriani et al. 2020). Amphibians play a crucial role in ecosystems (Pradhan et al. 2018), serving as primary predators of insects and as a food source for birds, mammals, and other predators (Cortéz-Gómez et al. 2015). Additionally, they are widely recognized as one of the most effective indicators of environmental health (Flores et al. 2023). Frogs, like amphibians, are among the most threatened taxa globally, making many species highly vulnerable to extinction (Desforges et al. 2022). Their limited mobility and relatively small home ranges further increase their susceptibility to habitat alterations (Flores et al. 2023).

### **Management strategies and potential for wildlife utilization in Malagufuk Forest**

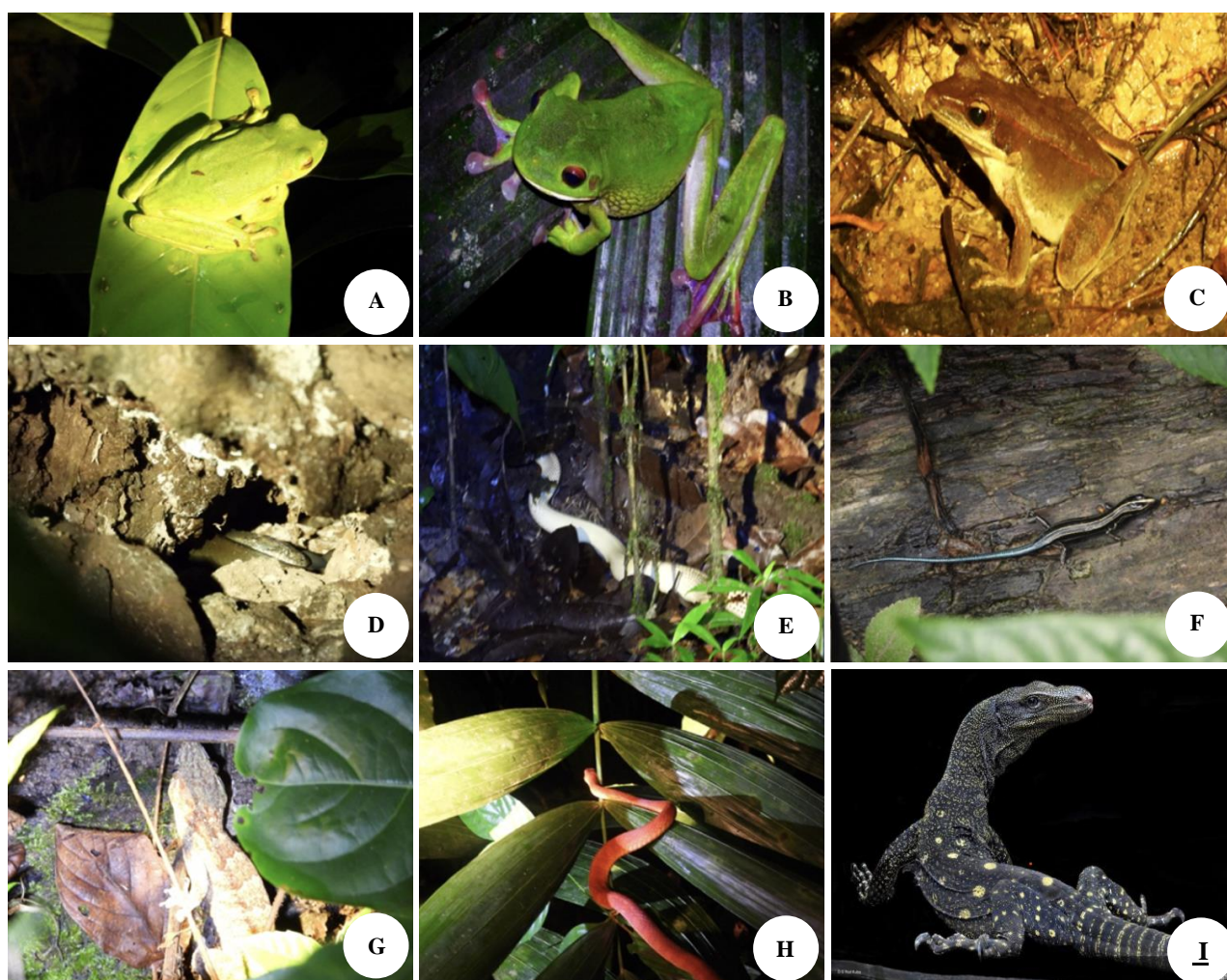
Malagufuk Forest is a 3,500-hectare wildlife habitat spread across multiple islands. It requires appropriate management methods and strategies, as, in addition to its very high biodiversity, the forest is home to small or rare distributions of some fauna and many endemic species (Figure 6).

This high diversity of species, combined with the low population sizes of each species, presents challenges for wildlife management (Rustam et al. 2016; Leslie and Rahayu 2023). Another challenge is the area's low accessibility to management stakeholders, which also limits their ability to secure the area. Additionally, community activities both within and outside the Malagufuk Forest area cannot be effectively monitored, let alone controlled. This is especially true during the dry season, when activities such as creating fields by burning, hunting animals, and collecting agarwood are prevalent. One potential strategy to counter such activity would be to conduct as much conservation activity as possible in Malagufuk, as well as to establish the widest possible conservation area.

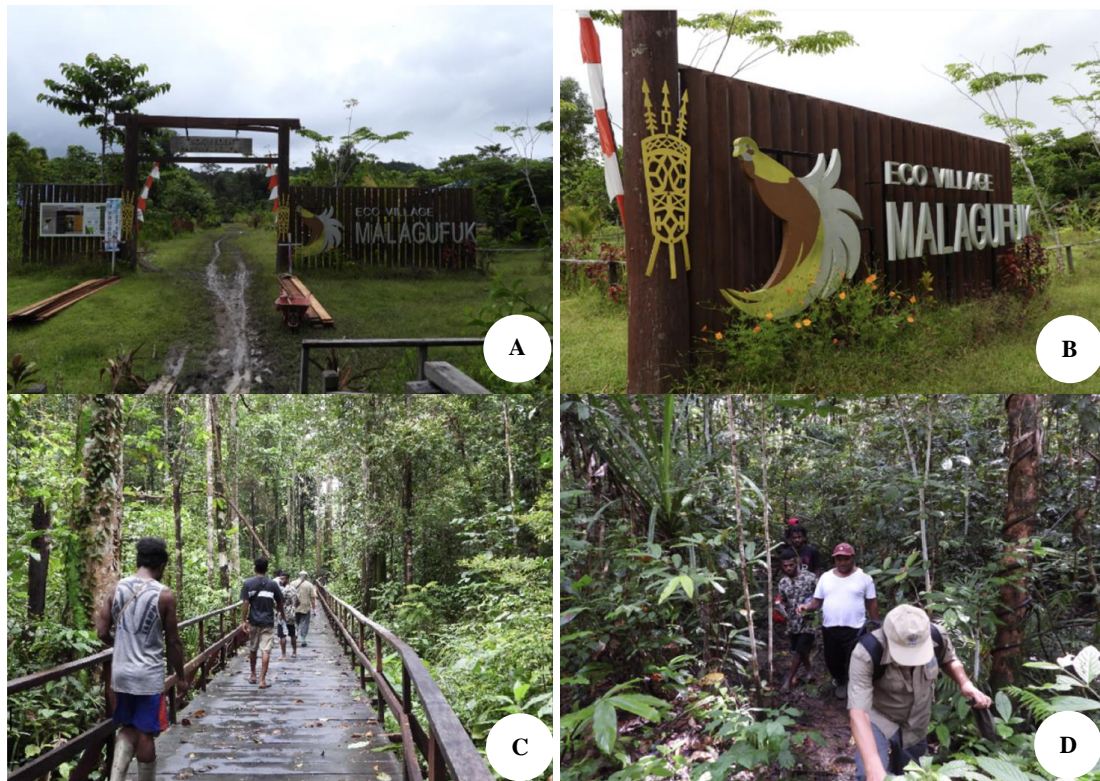
**Table 3.** Species of amphibians and reptiles (Herpetofauna) in Malagufuk Forest, West Papua, Indonesia

Species	Family	Vernacular name	Conservation state			Method
			IUCN	CITES	RI	
<b>Amphibians</b>						
<i>Hylarana daemeli</i>	Ranidae	Katak sejati	LC			SG
<i>Litoria infrafrenata</i>	Hylidae	Katak-pohon berbibir- putih	LC			SG
<i>Litoria lubisi</i>	Hylidae	Katak-pohon hijau	LC			SG
<b>Reptiles</b>						
<i>Dendrelaphis</i> sp.	Colubridae		N/A			SG
<i>Eutropis</i> sp.	Scincidae		N/A			SG
<i>Gehyra mutilata</i>	Gekkonidae	Tokek	LC	N/A	N/A	SG
<i>Leiopython albertisii</i>	Pythonidae	Ular sanca bibir- putih	LC			SG
<i>Micropechis ikaheka</i>	Elapidae	Ular putih	LC	N/A	N/A	SG
<i>Varanus salvadorii</i>	Varanidae	Biawak	LC			SG

Notes: IUCN: International Union for Conservation of Nature and Natural Resources; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora; DL: Protected under the Minister of Environment and Forestry of the Republic of Indonesia Number106 Year 2018; SG: Sighted; CT: Camera Trap; FP: Footprint; TR: Trapped



**Figure 5.** Species of Amphibians and Reptiles in the Malagufuk Forest Area, West Papua, Indonesia. A. *Litoria infrafrenata*; B. *Litoria lubisi*; C. *Hylarana daemeli*; D. *Leiopython albertisii*; E. *Micropechis ikaheka*; F. *Eutropis multifasciata*; G. *Gehyra mutilata*; H. *Dendrelaphis calligaster*; I. *Varanus salvadorii* (Photographs *V. salvadorii* by Rod Kuba)



**Figure 6.** Condition of Malagufuk Forest, West Papua, Indonesia. A. Entrance; B. Signboards; C. Road tracks; D. Forest condition

The use of forests for natural recreation offers valuable lessons in utilizing forest environmental services, including the sustainable use of forest resources for timber and wildlife conservation, as well as for consumptive and commercial purposes. Indeed, ecotourism has long been recognized as a tourism development model that contributes to nature conservation, supports businesses, and strengthens local communities (Suyadnya et al. 2025)

In general, the Malagufuk Forest area is composed of two natural forest groups: the Malagufuk Forest group and the Klanjii Forest group, within which several community settlements with various tribes and clans are located. Malagufuk Forest is a customary forest whose function serves several of the community's villages. With their agreement, the forest has been developed for the preservation of rare species of birds of paradise, as well as many other species that have yet to be discovered. One approach is to develop village potential by leveraging the strengths of indigenous communities (Garg et al. 2020; Suyadnya 2021). However, Nugraha et al. (2021) note that land-use change, and habitat destruction impact the species composition, underscoring the importance of understanding the relationship between fauna and habitat for effective conservation strategies.

This is somewhat contradictory, as the community also needs to improve its welfare through the forest's existence. The arrival of tourists has so far provided considerable evidence that forests and nature can be utilized as a means of education, research, and tourism. For this reason, planning has been carried out in stages, utilizing an area

design that creates physical boundaries as a preventive measure against the entry of unexpected activities from outside the area. Some criteria and strategies that can be conveyed gradually and appropriately to manage the Malagufuk Forest area are described in Table 4.

To successfully carry out the planning in the three stages above in five-year intervals, it will be necessary to continue to convince local communities that the area's existence is indeed very important and beneficial for the preservation of the cenderawasih as well as many other species, and for the lives of the people living around and in the area. The socio-economic development of the community needs to be monitored, and it can be directed by considering local conditions, such as providing education related to the preservation of nature and its diverse components, including flora and fauna. Infrastructure development is part of Indonesia's national agenda, which is not in line with sustainable development in Papua. To ensure equitable and environmentally responsible road expansion, government agencies must improve coordination and promote green infrastructure that integrates sustainable resource use with indigenous knowledge. Such initiatives could also support broader biodiversity conservation efforts (Fatem et al. 2020; Pattiselanno and Krockenberger 2021). Wieckard et al. (2020) and Samal and Dash (2023) have demonstrated that forest management by local communities can maintain and increase species diversity through a deep understanding of habitat relationships.

**Table 4.** Malagufuk Forest area management strategy, West Papua, Indonesia

Criterion	Stages or strategies
Criteria for stages and design of the first 5-year area	<p>There are no physical boundaries of the area in the field, except for imaginary boundaries on the map for management and allocation purposes</p> <p>Utilizing wooden roads/bridges that have been built as a means of transportation assistance to enter the area for more than 3 km</p> <p>Building rest huts every 1 km to rest and shelter in case of heavy rain</p> <p>Building and continuing the construction of roads/bridges to reach the cenderawasih observation zone</p> <p>Planning and building several homestays for the benefit of tourists and others</p>
Criteria for stages and design of the second 5-year area	<p>There are still no physical boundaries of the area in the field, but the map may be expanded (&gt;1,000 ha) or narrowed for some purpose (&lt;3,500 ha)</p> <p>Determining and conducting an inventory of areas to create core areas/zones that cannot be disturbed, extensive or intensive use zones, camping grounds, and so on</p> <p>Building agreements with the surrounding community and within the region to maintain commitments to regional development and increase several activities to add value to sustainability and as additional income for the community in the long term</p> <p>Setting the price of entrance tickets based on visitors' distance from the location (method of travel)</p> <p>Addressing the need for guidance by providing education to visitors through conversations, sharing knowledge about forest ecology or avifauna, as well as regional history, and other topics</p>
Criteria for stages and design of the third 5-year area	<p>Gradually replacing wooden roads/bridges with more permanent types of infrastructure (paving blocks or others)</p> <p>Creating some means of information needed by visitors in places where few people can be found to answer questions</p> <p>Limiting the number of visitors per entry. Registration for entry can be conducted online</p> <p>Providing counseling to the community on various matters related to the conservation and preservation of species, both flora and fauna</p> <p>Planning the creation of physical boundaries in the field, taking many factors into consideration</p> <p>Determining whether it is necessary to build a buffer zone between the area and the surrounding villages and other areas</p>

The integration of ecological, economic, and social dimensions in forest management remains a significant challenge for stakeholders who support community-based forestry and recognize the rights of indigenous peoples (Barri et al. 2019; Ungirwalu et al. 2021). In addition to education, the construction and development of health facilities are also necessary to meet the community's needs in the Malagufuk area, thereby achieving comprehensive and equitable welfare. It is also vital to establish core conservation zones, buffer zones, and areas for sustainable use in the area (Wiraputra 2023). Community-based ecotourism that involves local communities in biodiversity monitoring and ecotourism activities can improve both conservation outcomes and livelihoods, as demonstrated in Uganda's Bwindi Impenetrable Forest (Stone and Nyaupane 2018; Wang et al. 2024). The Karangasem local government of Bali Province, Indonesia, promotes community-based tourism for the Tenganan people, positioning them as both subjects and owners of cultural attractions. This model aims to enhance economic independence, cultural dignity, and political sovereignty. However, it has not significantly impacted the villagers, who remain indifferent to the shift. Despite this community-centered approach to tourism, the Tenganan community has not witnessed significant changes in tourism (Suyadnya et al. 2025).

Training and incentive programs will enhance locals' awareness of ecotourism and increase their understanding of the national relevance of wildlife conservation. Former poachers are now employed as guides or conservationists,

increasing their knowledge of wildlife and its habitats (Samal and Dash 2023). The local community in Malagufuk is preserving its forests from deforestation and habitat fragmentation through birdwatching ecotourism, which contributes to the conservation of endemic and endangered animal species (Samperante 2024) and provides economic benefits (Jaya et al. 2024).

This study highlights the ecological significance of Malagufuk Forest as a biodiversity hotspot and the potential of ecotourism based on conservation. Malagufuk Forest is a pristine forest area characterized by land cover conditions and biodiversity of plant and wildlife species typical of a Papuan lowland forest. This study identified a high diversity of plant and wildlife species, some of which are important, protected, and of high conservation status. The biodiversity of Malagufuk Forest is a distinctive trait of Papua's tropical forests, which are characterized by a rich array of bird species. The distinctive, lively sound of birds at the top of the forest canopy. The absence of large primate orders contributes to the uniqueness of Papua's bird-rich forests. The conservation of the bird species in Southwest Papua is of paramount importance, as it is essential to ensure their continued survival and flourishing.

#### ACKNOWLEDGEMENTS

Our gratitude goes to the late Raharjo Ari Swasono, Arie Prasetya, and Kalami, as well as the entire community of Malagufuk Village, who have greatly assisted the

authors during the research. We would like to express our gratitude to the anonymous reviewers for their constructive feedback to improve the manuscript and also wishes to express his deep appreciation to Ariyanto for his assistance in preparing the maps of the research sites. In addition, gratitude is extended to all parties who have contributed their support and efforts, thereby facilitating the successful execution of this research.

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