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

Article · May 2025

DOI: 10.13057/biodiv/d260529

CITATIONS
0

READ
1

9 authors, including:

Yosep Ruslim
Mulawarman University
107 PUBLICATIONS **421** CITATIONS

SEE PROFILE

Rustam Rustam
Mulawarman University
58 PUBLICATIONS **1,428** CITATIONS

SEE PROFILE

BIODIVERSITAS
Volume 26, Number 5, May 2025
Pages: 2320-2331

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d260529

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

AMATUS TUROT[1,2,3], CHANDRADEWANA BOER[4], PAULUS MATIUS[4], JONNI MARWA[5], RUJEHAN[4], RUSTAM[4], RACHMAT BUDIWIJAYA SUBA[4], ALI SUHARDIMAN[4], ROCHADI KRISTININGRUM[4,♥], YOSEP RUSLIM[4,♥♥]

[1]Doctoral Student, Faculty of Forestry and Tropical Environment, Universitas Mulawarman. Jl. Penajam, Kampus Gunung Kelua, Samarinda 75123, East Kalimantan, Indonesia
[2]Faculty of Agricultural and Environmental Sciences, Universitas Victory. Jl. Basuki Rahmat KM 11.5, Klasaman, Sorong 98416, West Papua, Indonesia
[3]Social Department of Sorong District. Jl. Sorong-Klamono KM 24, Sorong 98416, West Papua, Indonesia
[4]Faculty of Forestry and Tropical Environment, Universitas Mulawarman. Jl. Penajam, Kampus Gunung Kelua, Samarinda 75123, East Kalimantan, Indonesia. Tel.: +62-541-735089, Fax.: +62-541-735379, ♥email: rkristiningrum@fahutan.unmul.ac.id; ♥♥email: yruslim@gmail.com; yruslim@fahutan.unmul.ac.id
[5]Faculty of Forestry, Universitas Papua. Jl. Gunung Salju, Amban, Manokwari 98314, West Papua, Indonesia

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 (*Spilocuscus 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).

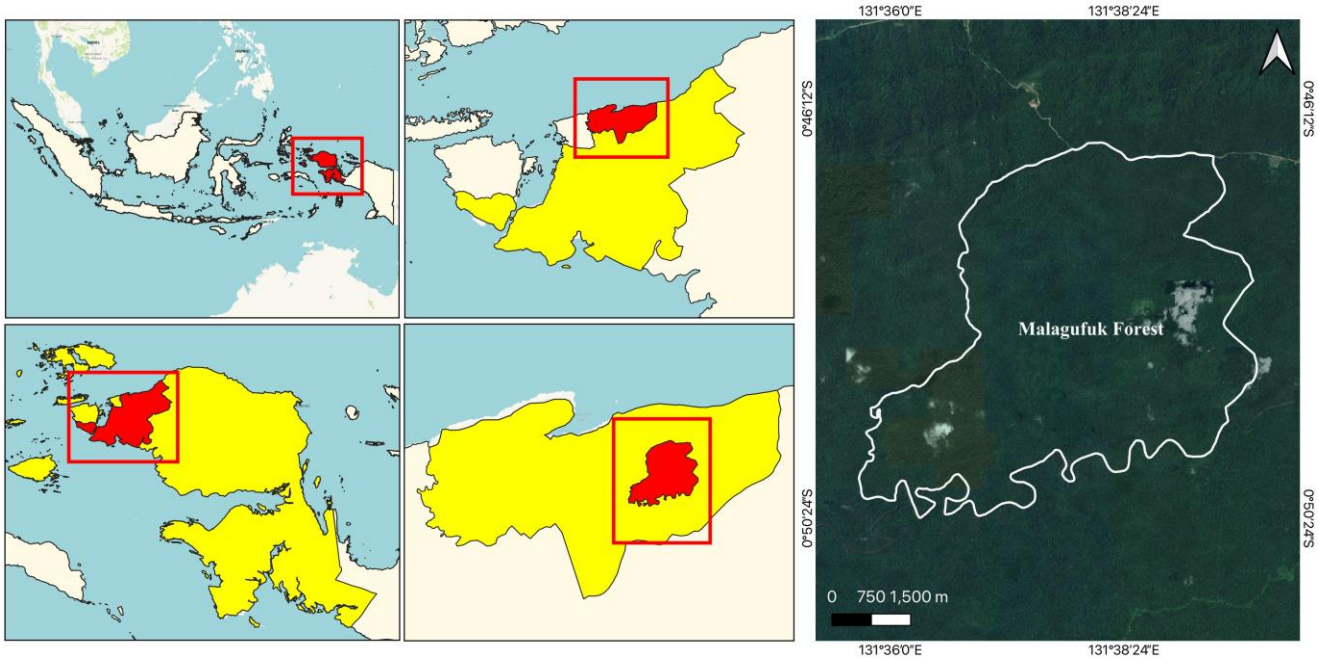

Figure 1. Location of Malagufuk Forest, Makbon Sub-district, Sorong District, West Papua, Indonesia

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).

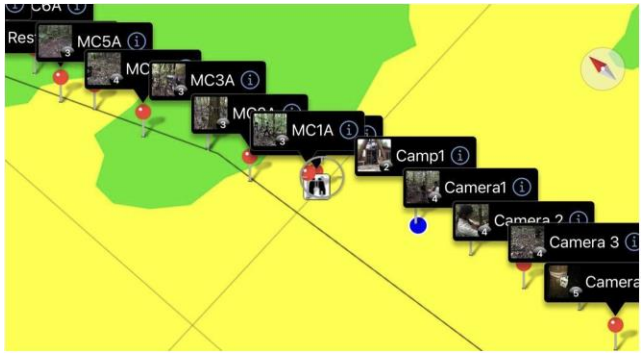

Figure 2. Location of the wildlife survey target sites and the placement of the cameras in Malagufuk Forest, West Papua, Indonesia using the Avenza maps application

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 (*Spilocuscus 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 vizcaccia*, *Rattus leocopus* (rat), *Spilocuscus 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	
Aepypodius arfakianus	Megapodiidae	Maleo gunung	LC		DL	SG
Ailuroedus buccoides	Ptilonorhynchidae	Burung-kucing kuping-putih	LC		DL	SG
Alisterus amboinensis	Psittacidae	Nuri-raja ambon	LC	II	DL	SG
Alisterus chloropterus	Psittacidae	Nuri-raja sayap-kuning	LC	II	DL	SG
Arses telescopthalmus	Monarchidae	Kehicap biku-biku	LC		TD	SG
Cacatua galerita	Cacatuidae	Kakatua koki	LC		DL	SG
Casuarius unappendiculatus	Casuariidae	Kasuari gelambir-tunggal	LC		DL	SG
Cicinnurus magnificus	Paradisaeidae	Cendrawasih belah-rotan	LC	II	DL	VC
Cicinnurus regius	Paradisaeidae	Cendrawasih raja	LC	II	DL	VC
Ducula pinon	Columbidae	Pergam pinon	LC		TD	SG
Eclectus roratus	Psittaculidae	Nuri bayan maluku	LC	II	DL	SG
Goura cristata	Columbidae	Mambruk ubiaat	VU	II	DL	CT
Lophorina superba	Paradisaeidae	Cendrawasih-kerah barat	LC	II	DL	VC
Lorius lory	Psittacidae	Kasturi kepala-hitam	LC	II	DL	SG
Microptilotis montanus	Meliphagidae	Meliphaga rimba	LC		TD	SG
Mino dumontii	Sturnidae	Mino muka-kuning	LC		TD	SG
Otidiphaps nobilis	Columbidae	Delimukan dewata	LC		TD	SG
Paradisaea minor	Paradisaeidae	Cendrawasih kecil	LC	II	DL	SG
Poecilodryas brachyura	Petroicidae	Robin dagu-hitam	LC		TD	SG
Probosciger aterrimus	Cacatuidae	Kakatua raja	LC	I	DL	SG
Psittrichas fulgidus	Psittacidae	Nuri kabare	VU	II	DL	SG
Ptilinopus iozonus	Columbidae	Walik perut-jingga	LC		TD	SG
Megaloprepia magnifica	Columbidae	Walik wompu	LC		TD	SG
Ptilinopus nainus	Columbidae	Walik kerdil	LC		TD	SG
Lophorina magnifica	Paradisaeidae	Toowa cemerlang	LC	II	TD	SG
Rhipidura rufiventris	Rhipiduridae	Kipasan dada-lurik	LC		TD	SG MN
Rhyticeros plicatus	Bucerotidae	Julang papua	LC	II	DL	SG
Sericulus aureus	Ptilonorhynchidae	Namdur topeng	LC		DL	SG
Talegalla cuvieri	Megapodiidae	Maleo kamur	LC		TD	SG
Tanysiptera galatea	Alcedinidae	Cekakak-pita biasa	LC		TD	SG
Todiramphus macleayii	Alcedinidae	Cekakak rimba	LC		TD	MN
Trichoglossus haematodus	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	
Cynopterus brachyotis	Pteropodidae	Kelelawar-buah berhidung-endek	LC			SG
Nyctimene vizcaccia	Pteropodidae	Kelelawar umboi-hidung	LC			TR
Rattus leocopus	Muridae	tikus	LC			CT
Rusa timorensis	Cervidae	Rusa timor	VU		DL	FV
Spilocuscus maculatus	Phalangeridae	Kuskus tutul	LC	II	DL	SG
Sus scrofa	Suidae	Babi hutan	LC			CT, FP
Thylogale brunii	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 telescophthalmus*; 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; Kusrini 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	
Amphibians						
Hylarana daemeli	Ranidae	Katak sejati	LC			SG
Litoria infrafrenata	Hylidae	Katak-pohon berbibir- putih	LC			SG
Litoria lubisi	Hylidae	Katak-pohon hijau	LC			SG
Reptiles						
Dendrelaphis sp.	Colubridae		N/A			SG
Eutropis sp.	Scincidae		N/A			SG
Gehyra mutilata	Gekkonidae	Tokek	LC	N/A	N/A	SG
Leiopython albertisii	Pythonidae	Ular sanca bibir- putih	LC			SG
Micropechis ikaheka	Elapidae	Ular putih	LC	N/A	N/A	SG
Varanus salvadorii	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

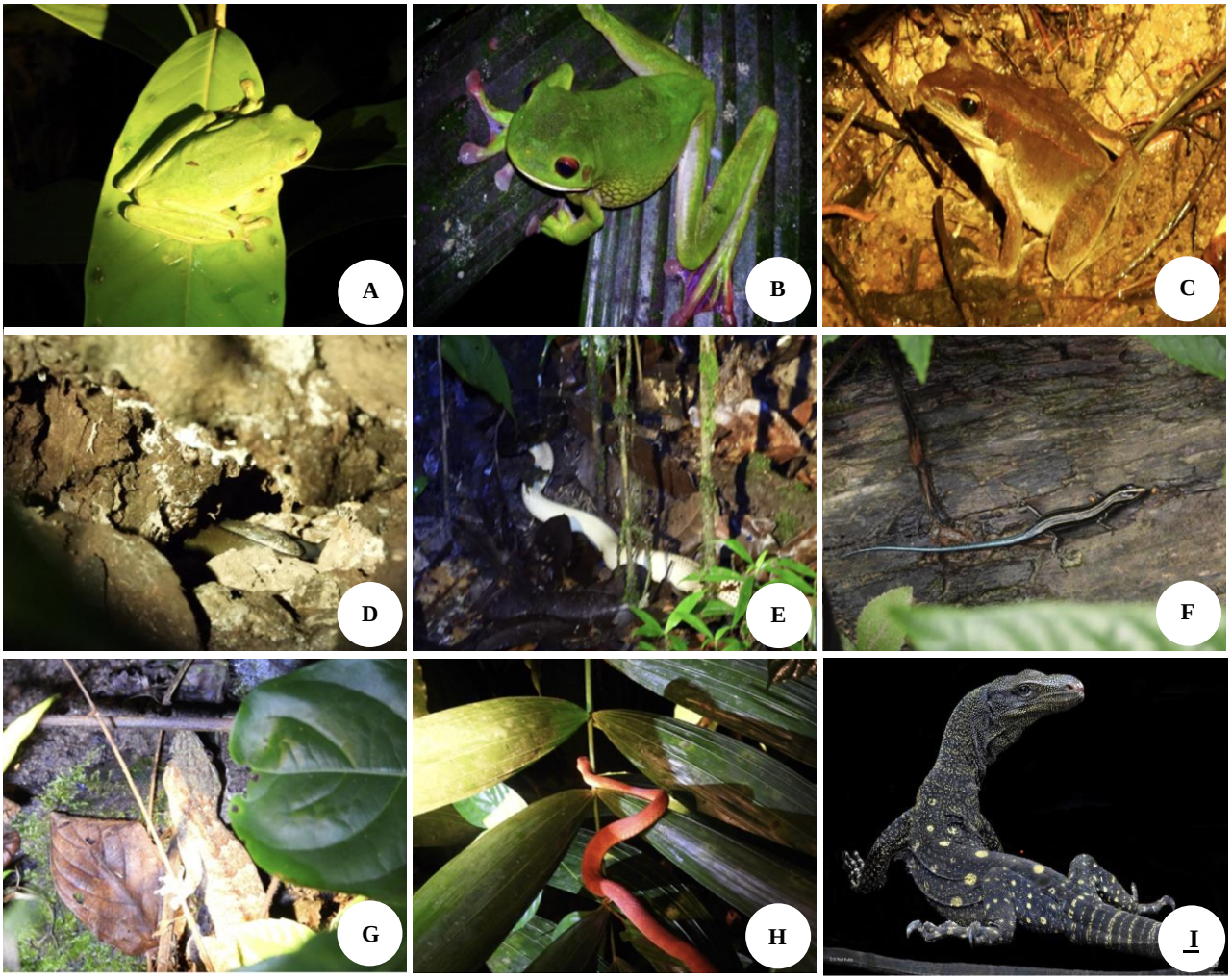

Figure 5. Species of Amphibians and Reptiles in the Malagufuk Forest Area, West Papua, Indonesia. A. *Litoria infrafrenata*; B. *Litoria lubisi*; C. *Hylarana daemeli*; D. *Leiopython albertisii*; E. *Micropechis ikaheka*; F. *Eutropis multifasciata*; G. *Gehyra mutilata*; H. *Dendrelaphis calligaster*;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

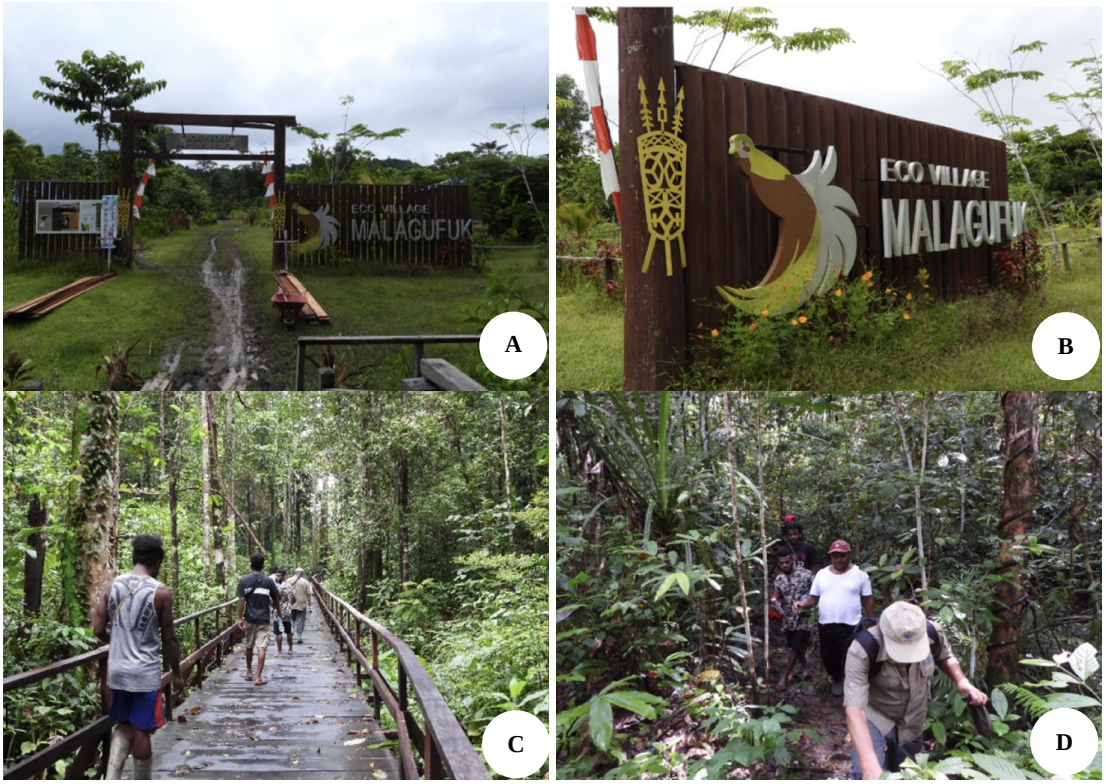

Figure 6. Condition of Malagufuk Forest, West Papua, Indonesia. A. Entrance; B. Signboards; C. Road tracks; D. Forest condition

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	There are no physical boundaries of the area in the field, except for imaginary boundaries on the map for management and allocation purposes Utilizing wooden roads/bridges that have been built as a means of transportation assistance to enter the area for more than 3 km Building rest huts every 1 km to rest and shelter in case of heavy rain Building and continuing the construction of roads/bridges to reach the cenderawasih observation zone Planning and building several homestays for the benefit of tourists and others
Criteria for stages and design of the second 5-year area	There are still no physical boundaries of the area in the field, but the map may be expanded (>1,000 ha) or narrowed for some purpose (<3,500 ha) 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 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 Setting the price of entrance tickets based on visitors' distance from the location (method of travel) 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
Criteria for stages and design of the third 5-year area	Gradually replacing wooden roads/bridges with more permanent types of infrastructure (paving blocks or others) Creating some means of information needed by visitors in places where few people can be found to answer questions Limiting the number of visitors per entry. Registration for entry can be conducted online Providing counseling to the community on various matters related to the conservation and preservation of species, both flora and fauna Planning the creation of physical boundaries in the field, taking many factors into consideration Determining whether it is necessary to build a buffer zone between the area and the surrounding villages and other areas

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.

REFERENCES

Ardiansyah R, Yusmur A, Marlinda S, Supriyanto, Bigcas E. 2023. Ecotourism and biodiversity conservation: Paradigm shifting and future action. Biotrop Sci Mag 2 (1): 19-26. DOI: 10.56060/bdv.2023.2.1.1992.

Arzeta SC, Hernandez IEZ, Villalobos SM, Malvindo JB. 2021. Landscape structure shapes the diversity of tree seedlings at multiple spatial scales in a fragmented tropical rainforest. Plos One 16 (7): e0253284. DOI: 10.1371/journal.pone.0253284.

Ausprey IJ, Newel FL, Robinson SK. 2023. Sensitivity of tropical montane birds to anthropogenic disturbance and management strategies for their conservation in agricultural landscapes. Conserv Biol 37 (6): e14136. DOI: 10.1111/cobi.14136.

Barri MF, Condro AA, Apriani I, Cahyono E, Prawardani DD, Hamdani A, Syam M, Ngingi AJ, Habibie A, Oktaviani AR, Jaya AF, Prasojo FA, Erwanto A, Situmorang N. 2019. Papua Bioregion: The Forest and Its People. Forest Watch Indonesia (FWI), Bogor.

Bha AH, Mir AH, Charoo SA. 2023. Influence of habitat heterogeneity on avian diversity in the Rajparian Wildlife Sanctuary, Kashmir Himalaya. J Basic Appl Zool 84: 4. DOI: 10.1186/s41936-023-00326-w

Burgos-Ayala A, Jiménez-Aceituno A, Torres-Torres AM, Rozas-Vásquez D, Lam DPM. 2020. Indigenous and local knowledge in environmental management for human-nature connectedness: A leverage points perspective. Ecosyst People 16 (1): 290-303. DOI: 10.1080/26395916.2020.1817152.

Carter S, Singh V. 2023. Carbon dynamics in fragmented tropical forests. Glob Change Biol 29 (1): 230-244. DOI: 10.1111/gcb.15824.

Cebrián-Piqueras MA, Filyushkina A, Johnson DN, Lo, VB, Lopez-Rodriguez MD, March H, Oteros-Rozas E, Peppler-Lisbach C, Quintas-Soriano C, Raymond CM, Ruiz-Mallen I, van Riper CJ, Zinngrebe Y, Plieninger T. 2020. Scientific and local ecological knowledge, shaping perceptions towards protected areas and related ecosystem services. Landsc Ecol 35: 2549-2567. DOI: 10.1007/s10980-020-01107-4.

Collina K, Ombugadu A, Tersoo AP, Janfa N, Junior FM, Tumba YC, Maryam MS. 2021. Bird species abundance and diversity in Montane Forest Research Station, Jos, Plateau State. Nig J Pure Appl Sci 34 (2): 4014-4027. DOI: 10.48198/NJPAS/21.A07.

Cortéz-Gómez AMM, Ruiz-Agudelo CA, Valencia-Aguilar A, Ladle RJ. 2015. Ecological functions of neotropical amphibians and reptiles: A review. Univ Sci 20 (2): 229-245. DOI: 10.11144/Javeriana.SC20-2.efna.

Crane MS, Strine CT, Knierim TK, Artchaawakom T, Suwanwaree P. 2018. Hepretofaunal species abudance, richness, and diversity in a dry tropical forest and agricultural matrix at the Sakaerat biosphere reserve, Thailand. Herpetol Conserv Biol 13 (3): 586-597.

Das I. 2011. A Field Guide to the Reptiles of Southeast Asia. New Holland Publisher, UK.

Desforges JE, Clarke J, Harmsen EJ, Jardine AM, Robichaud JA, Serré S, Chakrabarty P, Bennett JR, Hanna DEL, Smol JP, Rytwinski T, Taylor JJ, Martel AL, Winegardner AK, Marty J, Taylor MK, O'Connor CM, Robinson SA, Reid AJ, Creed IF, Eaves IG, Lapointe NWR, Cooke SJ. 2022. The alarming state of freshwater biodiversity in Canada. Can J Fish Aquat Sci 79 (2): 352-365. DOI: 10.1139/cjfas-2021-0073.

Fatem SM, Syuf Y, Baru J, Marwa J, Runtuboi YY, Tawer V, Situmorang S, Runtuboi FR. 2020. The Sausapor declaration: Challenges in promoting good governance to protect customary communities and natural resources in Tambrauw district, West Papua. For Soc 4 (2): 330-337. DOI: 10.24259/fs. v4i2.9346.

Flores ABA, Diesmos AC, Nuneza OM. 2023. Morphological description and life history of the Philippine Swamp Frog *Limnonectes leytensis* (Boettger, 1893). Biodiversitas 24 (1): 133-139. DOI: 10.13057/biodiv/d240117.

Frost DR. 2018. Amphibian Species of the World: An Online Reference Version 6.0. http://research.amnh.org/herpetology/amphibian/index.html.

Garg S, Joshl RK, Garkoti SC. 2020. Effect of tree canopy on species composition, diversity and biomass of herbaceous vegetation and soil characteristics in semi-arid forests of the Aravalli hills. Res Sq 1-19. DOI: 10.21203/rs.3.rs-96664/v1.

Gillespie GR, Howard S, Stroud JT, Hassanah AUI, Campling M, Lardner B, Scroggle MP, Kusrini M. 2015. Responses of tropical forest herpetofauna to moderate anthropogenic disturbance and effects of natural habitat variation in Sulawesi, Indonesia. Biol Conserv 192: 161-173. DOI: 10.1016/j.biocon.2015.08.034.

Gomez DF, Patel SK. 2020. Connectivity and conservation in fragmented forest landscapes. Landsc Ecol 35 (1): 25-40. DOI: 10.1007/s10980-019-00945-4.

Gurung DB, Katel O, Tobgay T, Dorji P, Phuntsho T, Acharja IP, Lungten. 2022. Protocol for Rapid Biodiversity Assesment. Royal Society for Protection of Nature, Bhutan.

Haq SM, Pieroni A, Bussmann RW, Abd-Elgawad AM, EL-Ansary HO. 2023. Integrating traditional ecological knowledge into habitat restoration: Implications for meeting forest restoration challenges. J Ethnobiol Ethnomed 19: 33. DOI: 10.1186/s13002-023-00606-3.

Hocking DJ, Babbitt KL. 2014. Amphibian contribution to ecosystem services. Herpetol Conserv Biol 9 (1): 1-17.

Iyai DA, Sada Y, Koibur JF, Bauw A, Worabay M, Wajo MJ, Pakage S, Wambaruw. 2020. Potential and utilization of wildlife in Pasir Putih Village, Fakfak Regency, West Papua. J Trop Biol 20 (2): 203-210. DOI: 10.29303/jbt.v20i2.1788.

Jaya PHI, Izudin A, Aditya R. 2024. The role of ecotourism in developing local communities in Indonesia. J Ecotour 23 (1): 20-37. DOI: 10.1080/14724049.2022.2117368.

Jenny R. 2024. Impacts of habitat fragmentation on terrestrial biodiversity in tropical forests in Democratic Republic of Congo. Intern J Environ Sci 7 (1): 43-53. DOI: 10.47604/ijes.2612.

Kaban A, Mardiastuti, Mulyani YA. 2017. Response of bird community to various plantation forest in Gunung Walet West Java, Indonesia. Hayati J 24 (2): 72. DOI: 10.4308/hjb.24.2.72.

Karuniyanti DED, Santosa Y, Sugiharti W. 2018. Bird species diversity in various land covers in oil palm plantation of PT GSIP, Central Kalimantan. AIP Conf Proc 2019: 040007. DOI: 10.1063/1.5061877.

Kristiningrum R, Lahjie AM, Masjaya, Yusuf S, Ruslim Y, Ma'ruf A. 2020. Fauna diversity, production potential and total economic value of mangrove ecosystem in Mentawir Village, East Kalimantan, Indonesia. Biodiversitas 21 (5): 1940-1953. DOI: 10.13057/biodiv/d210522.

Kusrini MD, Khairunnisa LR, Nusantara A, Kartono AP, Prasetyo LB, Ayuningrum NT, Faz FH. 2020. Diversity of amphibians and reptiles in various anthropogenic disturbance habitats in Nantu Forest, Sulawesi, Indonesia. J Trop For Manag 26 (3): 291. DOI: 10.7226/jtfm.26.3.291.

Lahallo W, Tanjung RHR, Suharno, Sujarta P. 2022. Diversity, composition and important tree species for Cenderawasih bird activities in Rhepang Muaif ecotourism forest, Jayapura, Papua, Indonesia. Biodiversitas 23 (2): 741-749. DOI: 10.13057/biodiv/d230219.

Lee SY, Lee J, Sung HC. 2023. The impact of forest characteristics, and bird and insect diversity on the occurrence of the Great Spotted Woodpecker *Dendrocopos major* and Grey-headed Woodpecker *Picus canus* in South Korea. Bird Stud 70 (3): 161-171. DOI: 10.1080/00063657.2023.2245192.

Lense ON, Wanma JF, Kesaulija FF, Mansyur FI, Rachim AK, Krey K, Wanma B, Kesaulija R, Simanjorang D, Simbiak F. 2024. Diversity of flora and fauna in various forest ecosystem types of South Sorong District, Southwest Papua Province, Indonesia. Biodiversitas 25 (10): 3884-3898. DOI: 10.13057/biodiv/d251049.

Leslie G, Rahayu MIF. 2023. Tantangan dalam menerapkan undang-undang perlindungan satwa di Indonesia. Kertha Semaya 11 (8) 1766-1779. DOI: 10.24843/KS. 2023.v11. i08.p03. [Indonesia]

Magurran AE. 2004. Measuring biological diversity. Afr J Aquat Sci 29 (2). DOI: 10.2307/4126959.

Morgan D, Sanz C, Onononga JR, Strindberg S. 2016. Factors influencing the survival of sympatric gorilla and chimpanzee (*pan troglodytes*) nests. Intl J Primatol 37: 718-737. DOI: 10.1007/s10764-016-9934-9.

Nugraha FAD, Kaprawi F, Satria R, Kadafi AM, Agung AP. 2021. Herpetofaunal assemblages in the lowland regions of West Sumatera. J Trop Biodivers Biotechnol 6 (2): 63820. DOI: 10.22146/jtbb.63820.

O'Shea M. 1996. A Guide to the Snake of Papua New Guinea: The First Comprehensive Guide to the Snake Fauna of Papua New Guinea. Independent Publishing, Indonesia.

Pattiselanno F, Apituley JRM, Arobaya AYS, Koibur JF. 2019. Using wildlife for local livelihood-experiences from the bird's Head Peninsula, West Papua, Indonesia. Biodiversitas 20 (7): 1839-1845. DOI: 10.13057/biodiv/d200708.

Pattiselanno F, Krockenberger A. 2021. Road development and Indigenous hunting in Tanah Papua: Connecting the facts for future wildlife conservation agendas. For Soc 5 (1): 181-189. DOI: 10.24259/fs. v5i1.12528.

Pattiwael M. 2018. Konsep pengembangan ekowisata berbasis konservasi di Kampung Malagufuk Kabupaten Sorong. J Dedic Papua Commun 7 (2): 151-162. DOI: 10.34124/269163. [Indonesian]

Pattiwael M, Turot A. 2020. Species composition and population of birds-of-paradise in Malagufuk Village, Klayili District, Sorong Regency, West Papua Province. Jurnal Ilmu Pertanian Kehutanan 7 (2): 151-162. DOI: 10.33084/daun. v7i2.2014. [Indonesian]

PERMEN KLHK (2016). Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.106/MENLHK/SETJEN/KUM.1/12/2018 tentang Jenis Tumbuhan dan Satwa yang Dilindungi. [Indonesian]

Pillay R, Venter M, Aragon-Osejo J, González-del-Pliego P, Hansen AJ, Watson JEM, Venter O. Tropical forests are home to over half of the world's vertebrate species. Front Ecol Environ 2022; 20(1): 10–15 DOI:10.1002/fee.2420

Pradhan A, Yonle R, Bhutia D. 2018. Observations and documentation of amphibian diversity from a human-modified ecosystem of Darjeeling, with record occurrence of *Polypedates himalayanus* from Darjeeling Hills, West Bengal. Asian J Conserv Biol 7 (1): 66-72.

Rahman RF. 2023. Protecting the Home of Birds-of-Paradise and Endemic Wildlife in Papua's Forests. Telusu RI. https://telusuri.id/menjaga-rumah-cenderawasih-dan-satwa-endemik-di-hutan-papua/?utm_source=chatgpt.com.

Ramlah S, Santosa Y, Santoso N, Rushayati SB. 2021. The variation of bird diversity in various oil palm land cover in North Mamuju, West Sulawesi, Indonesia. Biodiversitas 22 (7): 3068-2074. DOI: 10.13057/biodiv/d220761.

Report PNG. 2017. Papua New Guinea's Fifth National Report to the Convention on Biological Diversity.

Richards SJ. 2015. Field Guide to Frogs of the Mimika Region, Papua Indonesia. PT Freeport Indonesia, Indonesia.

Rustam. 2017. Survey singkat mamalia di Hutan Dipterokarpa dataran rendah, hutan lindung batu berok, Long Pahangai, Kalimantan Timur. Jurnal Hutan Tropis 1 (1): 59-70. DOI: 10.32522/ujht. v1il.805. [Indonesia]

Rustam, Hearn AJ, Ross J et al. 2016. Predicted distribution of the marbled cat *Pardofelis marmorata* (Mammalia: Carnivora: Felidae) on Borneo. Raffles Bull Zool 33: 157-164.

Sakti AD, Adillah KP, Santoso C, Al Faruqi I, Hendrawan VSA, Sofan P, Rustam, Fauzi AI, Setiawan Y, Utami I, Zain AFM, Kamal M. 2024. Modeling Proboscis monkey conservation sites on Borneo using ensemble machine learning. Glob Ecol Conserv 54: e03101. DOI: 10.1016/j.gecco. 2024.e03101.

Samal R, Dash M. 2023. Ecotourism, biodiversity conservation and local livelihoods: understanding convergence and divergence. Intl J Geoherit Parks 11 (6): 1-20. DOI: 10.1016/j.ijgeop.2022.11.001.

Samperante F. 2024. Malagufuk Residents Protect Birdwatching Sites in Papua to Ensure Conservation. Kompas.com. https://lestari.kompas.com/read/2024/07/02/200000786/warga-malagufuk-jaga-tempat-pengamatan-burung-di-papua-tetap-lestari?utm_source=chatgpt.com.

Santosa Y, Sugiharti W, Erniwati. 2018. The variation of bird diversity in different landcover at oil palm plantation: case study at Asm Oil Palm Estate in Central Kalimantan, Indonesia. E3S Web Conf 52: 00051. DOI: 10.1051/e3sconf/20185200051.

Sapary FE, Rai IN, Sunarta IN. 2017. Ecotourism management strategy to support environmental conservation in Mokwam Area, Manokwari Regency, West Papua. Echothropic 11 (2): 156-165. DOI: 10.24843/EJES. 2017.v11. i02.p06.

Schrader J, Parsch C, Moeljono S, Kalor JD, Hofmann T, Weinrich C, Mühlberger F, Stinn C, Mühlenberg M, Sattler C. 2020. An annotated bird checklist for Gam island, Raja Ampat, including field notes on species monitoring and conservation. For Soc 4(2):310-329 DOI: 10.24259/fs.v4i2.8664

Shahabuddin G, Goswami R, Krishnadas M, Menon T. 2021. Decline in forest bird species and guilds due to land use change in the Western Himalaya. Glob Ecol Consev 25: e01447. DOI: 10.1016/j.gecco. 2020.e01447.

Stone MT, Nyaupane GP. 2018. Protected areas, wildlife-based community tourism and community livelihoods dynamics: Spiraling up and down of community capitals. J Sustain Tour 26 (2): 307-324. DOI: 10.1080/09669582.2017.1349774.

Stronza A, Hunt CA, Fitzgerald LA. 2019. Ecotourism for conservation? Ann Rev Environ Resour 44 (1): 229-253. DOI: 10.1146/annurev-environ-101718-033046.

Suyadnya IW, Prianti DD, Kanto S, Putra IND. 2025. The local dynamics of global ecotourism trend in the old Balinese village, Indonesia. Cogent Arts Hum 12 (1): 2451516. DOI: 10.1080/23311983.2025.2451516.

Suyadnya IW. 2021. Interaksi Kekuasaan adat dan negara dalam perspektif masyarakat Bali Kuno Tenganan Pegringsingan. J Bali Stud 11 (2): 517-538. DOI: 10.24843/JKB. 2021.v11.i02.p15.

Turot A, Boer CD, Matius P, Marwa J, Rustam, Ruslim Y, Kristiningrum R. 2024. Land cover analysis and vegetation diversity in Malagufuk Forest Southwest Papau Province: Implication for sustainable nature tourism development. Proceeding in the 4th International Conference on Tropical Agrifood, Feed and Fuel. Samarinda, 9-10 October 2024.

Ungirwalu A, Awang SA, Rutuboi YY, Peday MY, Marwa J, Maitar B, Murdjoko A, Fatem SM. 2021. Customary forest in West Papua: Contestation of desires or needs? For Soc 5 (2): 365-375. DOI: 10.24259/fs. v5i2.12250.

Wang S, Yao W, Ma Y, Erping SE, Shuyan Z, Fu C, Yi Z. 2024. Optimizing natural boundary definition and functional zoning in protected areas: An integrated framework encompassing species, landscapes, and ecosystems. Glob Ecol Conserv 49: e02781. DOI: 10.1016/j.gecco.2023.e02781.

Watson JEM, Evans T, Venter O et al. 2018. The exceptional value of intact forest ecosystems. Nat Ecol Evol 2 (4): 599-610. DOI: 10.1038/s41559-018-0490-x.

Wiraputra AANA. 2023. Ecotourism based sustainable tourism development. Law Doc Comm Serv J 2 (1): 1-7. DOI: 10.55637/ldcsj.2.1.6192.1-7.

Withaningsih S, Parikesit, Alham RF. 2020. Diversity of bird species in the coffee agroforestry landscape: Case study in the Pangalengan Sub-district, Bandung District, West Java, Indonesia. Biodiversitas 1 (6): 2467-2480. DOI: 10.13057/biodiv/d210619.

Zakaria N, Allahudin MIH, Ma'ad SNS, Sulaiman AA, Abdullah NA, Zamri MIM, Mamat MA, Deraman MY. 2022. Diversity amphibians and reptiles at Sungai Kerteh mangrove forest, Terengganu, Malaysia. Biodiversitas 23 (11): 5574-5584. DOI: 10.13057/biodiv/d231105.

Zewdu A, Girma Z, Belay T. 2024. Traditional knowledge and attitude of the local communities towards wildlife conservation on and around fragmented forest of Germeba Mountain in Southern Ethopia. J For Nat Resour 3 (2): 61-75.

Zwerts JA, Stephenson PJ, Maisels F, Rowcliffe M, Astaras C, Jansen PA, van der Waarde J, Sterck LEHM, Verweij PA, Bruce T, Brittain S, van Kuijk M. 2021. Methods for wildlife monitoring in tropical forests: Comparing human observations, camera traps, and passive acoustic sensors. Coserv Sci Pract 3 (12): e568. DOI: 10.1111/csp2.568.