Agriculture, Forestry and Fisheries
2025, Vol. 14, No. 5, pp. 215-225
https://doi.org/10.11648/j.aff.20251405.15

Research Article

Butterflies' Diversity Indicates Habitat Quality in Magombera Nature Forest Reserve, Tanzania

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Abstract

Butterflies are widely recognized as biological indicators of habitat quality due to sensitivity to environmental changes and habitat disturbances. This study aimed to assess butterflies' species diversity in Magombera Nature Forest Reserve (MNFR), Tanzania as indication of forest recovery from the previous disturbances. Specifically, the study aimed to assess i) current status of butterfly species richness and diversity in MNFR, and (ii) butterfly species abundance, dominance and distribution in MNFR. Data collected through line transects using sweep nets and visual observations across the forest area of 2,623 ha. Species richness computed as a total number of species in a given area, species diversity computed using Shannon-Weiner Diversity Index (H') and abundance computed as a total count of all individuals. The results indicated that a total of 155 butterfly species belonging to six families and 64 genera recorded in MNFR. Closed forest had high species richness (105) and diversity values (H' = 4.06) and Grassland has least species (46) and diversity values (H' = 3.27). Variation in vegetation composition in MNFR influence higher butterfly species richness, diversity and abundance in closed forest and open woodland than in grassland and riparian vegetation indicating the improvement of forest recovery from prior disturbances after being upgraded to nature reserve in 2018. Therefore, intensive management approaches that currently implemented by the Tanzania Forest Services Agency (TFS) at MNFR should be maintained to overcome other ecological changes. This will assure proper ecological flow within the forest and between Udzungwa Mountain National Park and Selous Game Reserve.

Keywords

Species Richness, Species Diversity, Vegetation Types, Habitat Quality, Forest Recovery

1. Introduction

Tropical forests are among the most biodiverse ecosystems on Earth, providing essential ecological services such as carbon sequestration, climate regulation, and habitat for numerous species. However, these forests are increasingly threatened by anthropogenic disturbances, including deforestation, habitat fragmentation, and agricultural expansion [21]. The ability of a forest to recover from past disturbances is critical in determining its ecological integrity and long-term sustainability. One of the most effective ways to assess forest recovery is through biodiversity monitoring, particularly by using bioindicators such as butterflies [3].

Butterflies (Lepidoptera) are widely recognized as sensitive indicators of environmental change, responding rapidly to alterations in vegetation structure, microclimate, and resource availability [4]. Their diversity and abundance can therefore provide insights into the health and quality of recovering forests. In tropical

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Received: 20 May 2025; **Accepted:** 3 June 2025; **Published:** 18 October 2025

ecosystems, different butterfly species exhibit varying degrees of habitat specialization, with some thriving in closed-canopy forests while others are more common in open or degraded areas [1]. Factors like abundance of host plant species and vegetation diversity influence directly the diversity and butterfly communities' structure [24]. The diversity of butterfly in a particular habitat can be supported by presence and abundance of vegetation [24] that exist in different landscapes. Changes in habitat quality in a given ecosystem are the main factors that cause the reduction of butterfly species abundances [24]. Assessing butterfly diversity across different vegetation types can help evaluate the extent to which a forest has recovered from past disturbances and the effectiveness of conservation measures in place [6].

Magombera Nature Forest Reserve (MNFR), located in Kilombero District, Tanzania, has undergone significant ecological changes due to historical logging, shifting cultivation, and firewood collection [13, 14]. Recognizing its ecological importance, like a catchment area, wildlife corridor and existence of endangered and endemic species including Udzungwa red colobus monkey (*Procolobus gordonorum)* and an undescribed species of chameleon (*Kinyongia* sp. nov.), the forest was officially upgraded to a nature reserve in 2019, granting it greater legal protection and promoting its recovery [25, 15]. Since its designation as a protected area, natural regeneration processes have been expected to improve forest structure, enhance biodiversity, and restore habitat integrity. Different conservation initiatives and interventions were taken including creation of conservation awareness to the communities, beekeeping projects and restoration by planting native tree species in degraded areas of MNFR [13, 15]. However, the extent of this recovery remains largely unquantified. It has been hypothesized that the current status of habitat quality of MNFR has improved more than it was in 2018 before being upgraded to the status of Nature Forest Reserve in 2019. Previous research has shown that undisturbed or recovered forests tend to harbor higher butterfly diversity due to their structural complexity and stable microclimatic conditions [4].

In contrast, degraded or open habitats often have lower species richness but may still support certain generalist species [4]. By comparing butterfly diversity across different habitat types in MNFR, this study provides a critical assessment of the forest's ecological recovery since its protection status was upgraded. Whereas, the findings will contribute to conservation planning by informing management strategies that promote biodiversity conservation.

Therefore, the objective of this study was to assess forest recovery in MNFR using butterfly diversity as an indicator of habitat quality across four vegetation types namely closed forests, open woodland, grassland, and riparian vegetation. Specifically, the study aimed to determine: (i) butterfly species richness and diversity in four vegetation types in MNFR, ii) butterfly species abundance, dominance and distribution in four vegetation types in MNFR to understand its habitat quality in relation to the extent of forest recovery.

2. Materials and Methods

2.1. Description of Study Area

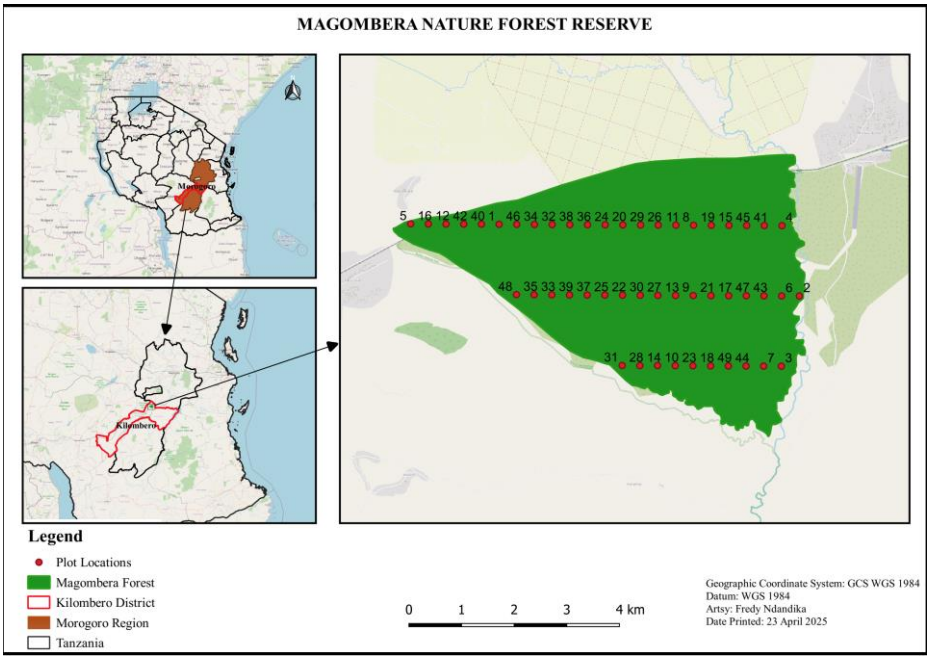

Figure 1. *Map of study location and layout of observation plot in the MNFR.*

Magombera Nature Forest Reserve (MNFR) is a lowland tropical forest located in Kilombero District, Morogoro Region, Tanzania, at latitude 07°46'40" – 07°52'0" S and longitude 36°57'30" – 37°01'30" E (Figure 1). It is positioned between Udzungwa Mountain National Park to the west and Selous Game Reserve to the east, lying approximately 270 meters above sea level. The forest is about 6 km from Udzungwa Mountain National Park and is bordered by Selous Game Reserve to the east [13]. The landscape is predominantly flat, with a humid climate, receiving an average annual rainfall of 1,500 mm and an average temperature of 32 ℃. The region experiences a bimodal rainfall pattern, with short rains occurring between October and December, followed by long rains from February to early May.

MNFR features diverse vegetation types, including closed forest, woodland, grassland, and riparian vegetation [18]. The soil composition is a mix of Karoo sandstone from the Msolwa floodplain and alluvial deposits from the Udzungwa Mountains [15]. The forest is surrounded by four villages, with agriculture being a primary activity in the area and the key crops cultivated near the reserve include sugarcane, rice (paddy), cassava, and maize [15].

2.2. Sampling Design and Data Collection

2.2.1. Sampling Design

Systematic sampling design was adopted for even distribution of sampling effort across the forest to reduce bias and improve representativeness [12]. A transect method employed to detect and record butterfly species along 3 transects linearly with 5m x 5m sided visual area started from forest edge of MNFR [22]. The distance of 700m in length between transects and 350m in width between plots established, following the standard butterfly survey protocol [20].

2.2.2. Data Collection

Data collection was conducted between 08:00 hrs and 10:30 hrs, the period when butterfly activity is highest due to optimal temperatures and sunlight availability [3]. Three complementary methods were employed to maximize species detection. These methods were; Line Transect Walks, field team walked along each transect at a slow and consistent pace and recorded all butterflies observed within 2.5 meters on either side [18]. Each butterfly seen was either identified in situ using field guides [10] or captured for closer inspection using sweep nets; Sweep Net Sampling, this was conducted alongside transect walks to capture fast-moving or cryptic species not easily detected visually [24]. Net-captured individuals were identified immediately and released back into their habitat; and Visual Observations and Photography [24]. Butterflies were categorized into morphospecies when immediate identification was not possible.

However, all observed and captured butterflies were identified to the lowest possible taxonomic level using standard field guides [10] with expert verification from Sokoine University of Agriculture (SUA). For individuals which were not identified kept in special envelope and identified later to species level by the aid of field guide book [19]. Data recorded on standardized data sheet included Species name, Abundance per species and Vegetation type.

2.3. Data Analysis

The data collected from field were analyzed to determine the biodiversity value in terms of species richness, abundance, diversity and distribution pattern across vegetation types. Species richness was determined by taking a total number of species in a given area. Species diversity across vegetation type was determined using Shannon – Wiener Diversity Index (H') with a formula: $H' = \sum_{i=1}^{s} \text{Pi} * \text{In Pi}$ whereas; s = the number of species, Pi = the importance value of a species as a proportion of all species, In = the natural logarithm [9]. Species abundance computed by taking total count of individuals, dominance using Important Value Index (IVI) was computed as the sum of relative frequency, relative abundance of butterfly species and species distribution was analyzed by taking number of shared unique species across vegetation types distributed [24, 21, 16].

3. Results

3.1. Species Richness, Diversity and Dominance

The study reveals a total of 155 species belonging to 64 genera with six butterfly families in MNFR. Out of six families, Nymphalidae observed to be dominant with 50% (n=77) number of species, followed by Pieridae 20.6% (n=32), Lycaenidae 25 16% (n=25), Hesperiidae 17% (n=11), Papilionidae 5.8% (n=9), and least Libytheinae 0.6% (n=1). However, the closed forest was leading for having more species and the riparian vegetation was the least (Table 1). In general, many species observed were from the family Nymphalidae (527 individuals), followed by family Pieridae (258), family Lycaenidae (189 individuals), family Papilionidae (80 individuals), family Hesperiidae (15 individuals) and family Libytheinae (4 individuals) (Figure 2). Based on vegetation types, the closed forest dominated by Nymphalidae with 211, grassland by Pieridae with 56, open woodland by Nymphalidae with 234 and riparian vegetation by Nymphalidae with 34 (Figure 3).

Table 1. *A summary of butterfly species richness, abundance, and diversity identified in each vegetation type found in Magombera Nature Forest Reserve, Tanzania.*

Vegetation Type	Families	Species richness	Abundance (counts / individuals)	Relative abundance (%)	Shannon-Wiener Diversity Index (H')
Closed forest	Nymphalidae, Pieridae, Lycaenidae, Papilionidae, Hesperiidae and Libytheinae	105	393	37	4.06
Grassland	Nymphalidae, Pieridae, Lycaenidae and Papilionidae	46	132	12	3.27
Open woodland	Nymphalidae, Pieridae, Lycaenidae, Papilionidae and Hesperiidae	91	484	45	3.96
Riparian vegetation	Nymphalidae, Pieridae, Lycaenidae, Papilionidae and Hesperiidae	38	64	6	3.47
Grand total		155	1073	100	4.26

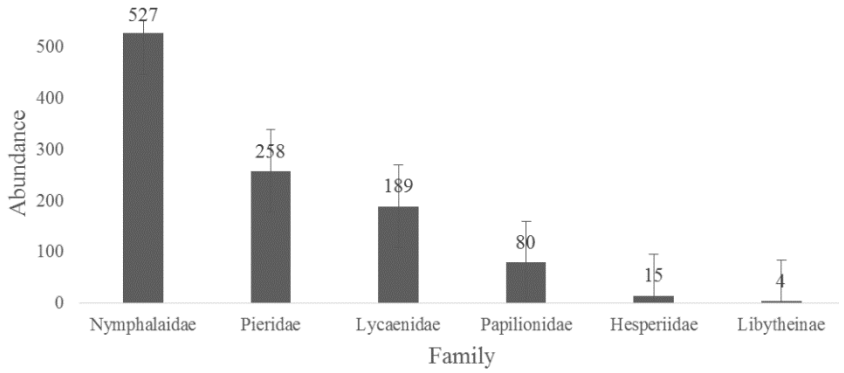

Figure 2. *Species abundance across each butterfly family in MNFR, Tanzania.*

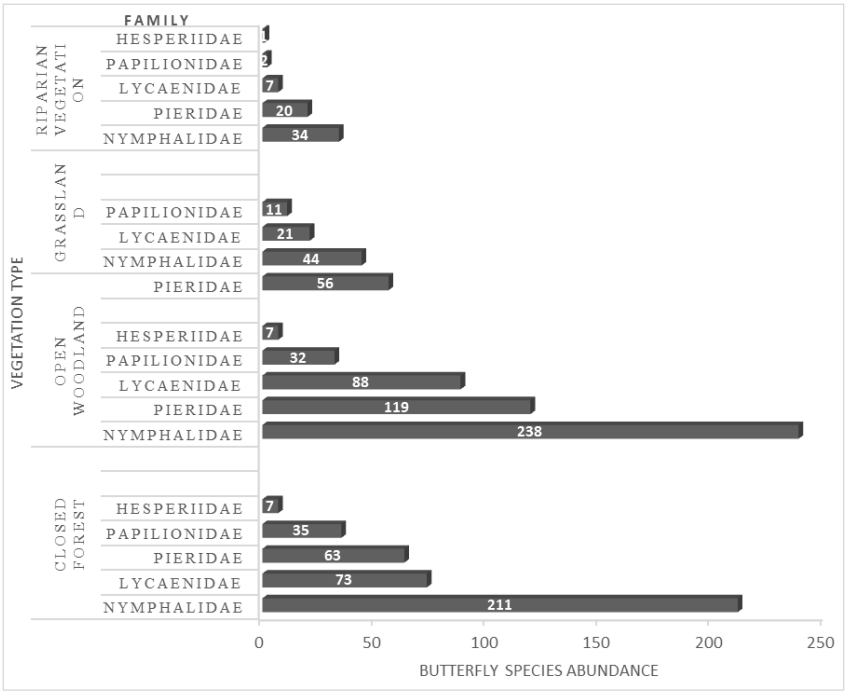

Figure 3. *Species abundance in top 5 family per vegetation types in MNFR, Tanzania.*

The overall Shannon Weiner diversity index (H') for butterfly species in MNFR was 4.26 and varied across each vegetation types (Table 1). The closed forest observed to have higher H values (H'=4.06) with 105 species and the grassland areas had the least diversity value (H'=3.27) with 46 species (Table 1). According to Importance Value Index (IVI), *Catopsilia florella* (22.1) and *Azanus jesous* (15.9) were the most dominant species across all vegetation types (Table A1).

3.2. Species Abundance and Distribution

During this study, a total of 1073 individuals of butterfly species were recorded in MNFR. Open woodland was leading for having more butterfly individuals 484 (45%) and riparian vegetation 64 (6%) was the least (Table 1). Out of six families, Nymphalidae observed to have the highest abundant butterfly individuals 527 (49.11%) and Libytheinae had the least abundant 4 (0.37%) (Figure 2). From 155 species, only 13 species appeared in each vegetation type (Figure 4). However, *Colotis evenina* founded only in grassland and riparian vegetation and, *Eurema desjardinsii* founded only in closed forest, grassland and riparian vegetation.

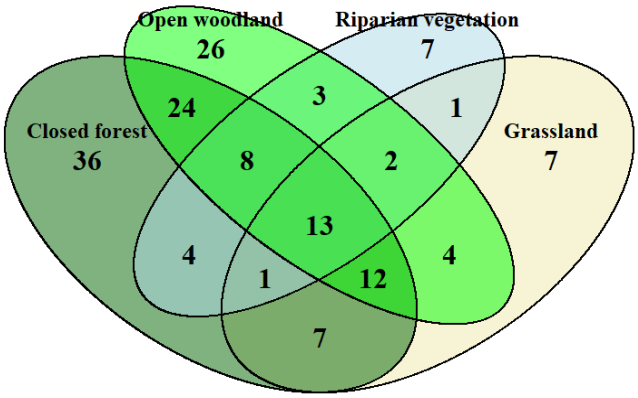

Figure 4. *Distribution of butterfly species across vegetation types in MNFR, Tanzania.*

4. Discussion

4.1. Species Richness, Diversity and Dominance

This is the first study to document butterfly species richness in MNFR. Species richness of 155 reported in this study is lower than other findings reported from tropical forests. For instance, [16] from a tropical forest of Kihansi gorge forest in Tanzania found a total of 213 butterfly species. However, [2] from a tropical forest of Northern Coast of East Java, Indonesia reported a total of 126 species which is lower than that founded in MNFR during this study. Species richness in MNFR indicates the forest is healthier and more resilient [2, 23]. Species richness in family Nymphalidae from MNFR is lower than other findings reported from tropical forests. For instance, [16] from a tropical forest of Kihansi gorge Forest in Tanzania reported 107 out of 213 species from family Nymphalidae. Though, [23] from a tropical forest of Rupa Wetland in Nepal reported 62 out of 138 species dominated by family Nymphalidae which is lower than 77 out of 155 from family Nymphalidae founded in MNFR. The dominance of Nymphalidae in study area suggests the forest has minimal habitat disturbances and good habitat quality favoring the survival of various species [24, 21, 16]. Higher species richness reported in closed forest and least in riparian vegetation in MNFR correspond with other findings from tropical forests based on their vegetation types. For instance, [11] from a tropical forest of West Bengal, India reported that the dense forest had higher species richness than the lower density vegetation. Existence of higher butterfly species in closed forest seemed to be supported by the availability of food resources (nectar) and light for their life cycle [7]. Generally, the canopy cover and vegetation composition in MNFR strongly influence the richness of butterflies [24].

The H' value of 4.26 for butterfly species reported in this study is higher than other findings reported from tropical lowland forests. For instance, the H' value reported by [5] from a tropical lowland forest of Soraipung range of Dehing Patkai National Park, Assam, India (H'=3.6), [8] from a tropical forest of Cirahab Sumber area Curuggoong Village Padarincang District, Serang Regency (H'=2.94) and [9] from a tropical lowland rain forest of Bukit Reban Kambing, Bukit Belading and Bukit Takau, Johor, Malaysia (H'=2.272). It has been reported that, the higher the value (H' $\geq$ 3.00) the higher species diversity [23]. The higher diversity indices in MNFR reflects stable ecosystem from prior disturbances with a good habitat quality [24, 21]. However, species diversity varied from one vegetation type to another in the study area as reported by [24] in a tropical forest of Kedung Klurak Tourism Area, East Java, Indonesia. For instance, the closed forest and open woodland founded to have higher species diversity while the riparian vegetation and grassland area founded to have moderate species diversity. Probably this is due to factors like plant diversification for food resources (nectar), light availability, and other microclimatic factors [24, 3] leading to existence of generalist and/or specialist species. The dominance of specific species in closed forest, grassland, open woodland and the riparian vegetation reflect existence of specialist species in MNFR.

4.2. Species Abundance and Distribution

The abundance of 1073 individuals of butterfly species reported in MNFR is lower compared to other findings reported from tropical forests. For instance, [21] from a tropical montane forest of Kihansi gorge forest, Tanzania reported a total abundance of 1271 individuals of butterfly whereas [24] in a tropical forest of Kedung Klurak Tourism Area, Indone-

sia reported 593 individuals of butterfly. The species abundance in MNFR still suggests the ecosystem is healthier and more diverse [5]. However, open woodland was leading for having more butterfly individuals and riparian vegetation was the least due to variability of microclimatic conditions [3]. The high abundant of Nymphalidae in MNFR suggest a healthy ecosystem with diverse habitats while Libytheinae had the least abundant [24]. Distribution of 13 species across all vegetation types suggest the forest shares crucial resources with similar environmental condition necessary for butterfly survival. Though, existence of *Colotis evenina* as signal changes in grassland and riparian vegetation suggest MNFR has good habitat quality while *Eurema desjardinsii* in closed forest, grassland and riparian vegetation influence the stability of ecosystem structure and habitat dynamics [17].

5. Conclusions and Recommendation

5.1. Conclusions

In this study, it was confirmed that butterfly species diversity and abundance varied with the state of habitat quality. Among other factors, vegetation composition influences higher butterfly species abundance, richness and diversity in closed forest and open woodland than in grassland and riparian vegetation. Vegetation composition impacted through forest recovery from prior disturbances in MNFR after being upgraded. Therefore, the study highlights that there is improvement of forest recovery in MNFR after being upgraded to Nature Reserve in 2018.

5.2. Recommendation

Thorough management approaches which are currently being implemented by the Tanzania Forest Services Agency (TFS) at MNFR should be maintained since it has proven to overcome the ecological changes that support the fast forest recovery from previous disturbances. These management approaches will assure the life and movement of wildlife within the forest and between the two adjacent protected areas (Udzungwa Mountain National Park and Selous Game Reserve).

Abbreviations

MNFR	Magombera Nature Forest Reserve
TFS	Tanzania Forest Services Agency
SUA	Sokoine University of Agriculture
IVI	Importance Value Index

Acknowledgments

The authors would like to thank Mr. John Shisheghe, Mr. Adili Nyanganoye and Fredy Lyimo for their crucial assistance during data collection. Tanzania Forest Services Agency (TFS) is acknowledged for the financial support.

Conflicts of Interest

Authors declares no conflicts of interest.

Appendix

Table A1. *Checklist of butterfly species sorted by vegetation types identified in the Magombera Nature Forest Reserve, Tanzania. Note: H'= Shannon Wiener Diversity Index, IVI=Importance Value Index.*

Vegetation Types	Scientific Name	Family	Frequency (%)	H'	IVI
Closed forest, Grassland, Open woodland & Riparian Vegetation	Catopsilia florella	Pieridae	4.71	0.19	22.1
Closed forest, Grassland, Open woodland & Riparian Vegetation	Azanus jesous	Lycaenidae	1.29	0.15	15.9
Closed forest, Open woodland & Riparian vegetation	Euphaedra neophron	Nymphalidae	3.29	0.15	15.3
Closed forest, Grassland & Open woodland	Leptotes pirithous	Lycaenidae	2.43	0.14	13.3
Closed forest, Grassland, Open woodland & Riparian Vegetation	Neptis serena	Nymphalidae	3.14	0.13	11.9
Closed forest, Grassland, Open woodland & Riparian Vegetation	Terias brigitta	Pieridae	2.71	0.12	10.8
Closed forest, Open woodland & Riparian vegetation	Eurytela dryope	Nymphalidae	2.71	0.11	9.9
Closed forest, Grassland, Open woodland & Riparian Vegetation	Byblia anvatara	Nymphalidae	3.14	0.10	8.8

Vegetation Types	Scientific Name	Family	Frequency (%)	H'	IVI
Closed forest, Grassland, Open woodland & Riparian Vegetation	Pentila tropicalis	Lycaenidae	2.86	0.10	8.8
Closed forest, Grassland, Open woodland & Riparian Vegetation	Hamanumida daedalus	Nymphalidae	2.14	0.10	8.5
Closed forest, Grassland & Open woodland	Papilio dardanus	Papilionidae	2.43	0.10	7.9
Closed forest, Grassland & Open woodland	Bicyclus safitza	Nymphalidae	2.57	0.09	7.4
Closed forest, Grassland & Open woodland	Junonia terea	Nymphalidae	2.43	0.08	6.0
Closed forest, Grassland, Open woodland & Riparian Vegetation	Graphium angolanus	Papilionidae	2.14	0.07	5.4
Closed forest, Grassland, Open woodland & Riparian Vegetation	Mylothris agathina	Pieridae	1.86	0.07	4.8
Grassland, Open woodland & Riparian vegetation	Junonia natalica	Nymphalidae	1.71	0.06	4.3
Open woodland	Sallya amulia rosa	Nymphalidae	0.57	0.06	4.0
Closed forest, Grassland, Open woodland & Riparian Vegetation	Tirumala petiverana	Nymphalidae	1.57	0.06	4.0
Closed forest, Grassland & Open woodland	Terias desjardinsi	Pieridae	1.29	0.05	3.7
Closed forest, Grassland & Open woodland	Terias hecabe	Pieridae	1.00	0.05	3.7
Closed forest & Open woodland	Azanus mirza	Lycaenidae	0.57	0.05	3.4
Closed forest, Grassland, Open woodland & Riparian Vegetation	Bicyclus ena	Nymphalidae	1.71	0.05	3.4
Closed forest, Open woodland & Riparian vegetation	Catacroptera cloanthe	Nymphalinae	1.57	0.05	3.4
Closed forest & Open woodland	Hypolimnas anthedon	Nymphalidae	1.14	0.05	3.1
Closed forest, Open woodland & Riparian vegetation	Melanitis leda	Nymphalidae	1.43	0.05	3.1
Closed forest & Open woodland	Bicyclus campinus	Nymphalidae	1.14	0.04	2.8
Closed forest, Open woodland & Riparian vegetation	Colotis regina	Pieridae	1.14	0.04	2.8
Closed forest, Grassland, Open woodland & Riparian Vegetation	Amauris niavius	Nymphalidae	1.14	0.04	2.6
Closed forest & Open woodland	Appias epaphia	Pieridae	1.00	0.04	2.6
Closed forest, Grassland & Open woodland	Baliochila hildegarda	Lycaenidae	1.00	0.04	2.6
Closed forest, Grassland & Open woodland	Belenois aurota	Pieridae	1.00	0.04	2.6
Closed forest, Open woodland & Riparian vegetation	Belenois thysa	Pieridae	1.14	0.04	2.6
Closed forest, Grassland, Open woodland & Riparian Vegetation	Danaus chrysippus	Nymphalidae	0.86	0.04	2.6
Closed forest, Grassland & Open woodland	Papilio demodocus	Papilionidae	1.14	0.04	2.6
Closed forest & Open woodland	Acraea natalica	Nymphalidae	0.86	0.04	2.3
Closed forest, Grassland & Open woodland	Colotis ione	Pieridae	1.00	0.04	2.3
Closed forest, Open woodland & Riparian vegetation	Graphium policenes	Papilionidae	0.71	0.04	2.3
Closed forest, Open woodland & Riparian vegetation	Phalanta phalantha	Nymphalidae	1.00	0.04	2.3
Closed forest, Grassland & Open woodland	Gnophodes betsimena	Nymphalidae	1.00	0.03	2.0
Grassland & Open woodland	Acraea anemosa	Nymphalidae	0.71	0.03	1.7
Closed forest	Bebearia orientis	Nymphalidae	0.71	0.03	1.7

Vegetation Types	Scientific Name	Family	Frequency (%)	H'	IVI
Open woodland	Eurema regularis	Pieridae	0.57	0.03	1.7
Closed forest, Grassland & Open woodland	Graphium antheus	Papilionidae	0.86	0.03	1.7
Open woodland	Hypolimnas misippus	Nymphalidae	0.43	0.03	1.7
Closed forest & Grassland	Neptis goochi	Nymphalidae	0.71	0.03	1.7
Grassland & Open woodland	Pardopsis punctatissima	Nymphalidae	0.86	0.03	1.7
Closed forest & Open woodland	Pseudacraea dolomena	Nymphalidae	0.71	0.03	1.7
Closed forest & Open woodland	Belenois creona	Pieridae	0.43	0.03	1.4
Grassland & Riparian vegetation	Colotis evenina	Pieridae	0.57	0.03	1.4
Grassland, Opn woodland & Riparian vegetation	Colotis evippe	Pieridae	0.14	0.03	1.4
Closed forest & Open woodland	Euphaedra orientalis	Nymphalidae	0.57	0.03	1.4
Closed forest, Grassland & Riparian vegetation	Eurema desjardinsii	Pieridae	0.57	0.03	1.4
Closed forest & Open woodland	Protogoniomorpha parhassus	Nymphalidae	0.57	0.03	1.4
Closed forest & Grassland	Acraea acara	Nymphalidae	0.43	0.02	1.1
Closed forest	Amauris echeria	Nymphalidae	0.57	0.02	1.1
Closed forest & Open woodland	Bicyclus anynana	Nymphalidae	0.29	0.02	1.1
Closed forest & Open woodland	Euptera pluto kinugnana	Nymphalidae	0.57	0.02	1.1
Closed forest	Euryphura achlys	Nymphalidae	0.57	0.02	1.1
Grassland & Open woodland	Junonia oenone	Nymphalidae	0.29	0.02	1.1
Closed forest	Libythea labdaca	Libytheinae	0.43	0.02	1.1
Closed forest	Nepheronia argia	Pieridae	0.57	0.02	1.1
Open woodland	Ornipholidotos peucetia	Lycaenidae	0.57	0.02	1.1
Closed forest	Pentila pauli	Lycaenidae	0.43	0.02	1.1
Closed forest & Riparian vegetation	Phalanta eurytis	Nymphalidae	0.57	0.02	1.1
Closed forest & Open woodland	Pseudacraea boisduvali	Nymphalidae	0.57	0.02	1.1
Closed forest	Amauris ochlea	Nymphalidae	0.43	0.02	0.9
Open woodland	Anthene amarah	Lycaenidae	0.14	0.02	0.9
Closed forest & Open woodland	Anthene definita	Lycaenidae	0.43	0.02	0.9
Closed forest	Aterica galene	Nymphalidae	0.29	0.02	0.9
Open woodland	Axiocerses amanga	Lycaenidae	0.43	0.02	0.9
Closed forest & Open woodland	Coeliades forestan	Hesperiidae	0.43	0.02	0.9
Open woodland	Euryphura concoria	Nymphalidae	0.14	0.02	0.9
Open woodland & Riparian woodland	Heteropsis perspicua	Nymphalidae	0.43	0.02	0.9
Closed forest & Open woodland	Neptis laeta	Nymphalidae	0.29	0.02	0.9
Closed forest & Open woodland	Papilio nireus	Papilionidae	0.43	0.02	0.9
Closed forest & Open woodland	Pseudacraea lucretia	Nymphalidae	0.43	0.02	0.9
Closed forest & Open woodland	Sarangesa maculata	Hesperiidae	0.43	0.02	0.9
Open woodland	Acraea (Actinote) encedon	Nymphalidae	0.14	0.01	0.6
Closed forest & Riparian vegetation	Acraea egina	Nymphalidae	0.29	0.01	0.6
Closed forest & Open woodland	Acraea insignis	Nymphalidae	0.29	0.01	0.6

Vegetation Types	Scientific Name	Family	Frequency (%)	H'	IVI
Closed forest & Grassland	Acraea oncaea	Nymphalidae	0.29	0.01	0.6
Closed forest & Riparian vegetation	Amauris albimaculata	Nymphalidae	0.29	0.01	0.6
Closed forest & Open woodland	Axiocerses harpax	Lycaenidae	0.29	0.01	0.6
Closed forest & Grassland	Charaxes bohemani	Nymphalidae	0.29	0.01	0.6
Closed forest	Charaxes brutus	Nymphalidae	0.29	0.01	0.6
Closed forest & Open woodland	Charaxes candiope	Nymphalidae	0.29	0.01	0.6
Closed forest & Grassland	Charaxes varanes	Nymphalidae	0.29	0.01	0.6
Grassland & Open woodland	Colotis evagore	Pieridae	0.29	0.01	0.6
Open woodland & Riparian vegetation	Colotis evippe ssp omphale	Pieridae	0.29	0.01	0.6
Open woodland & Riparian vegetation	Dixeia pigea	Pieridae	0.29	0.01	0.6
Open woodland	Eurema brigitta	Pieridae	0.29	0.01	0.6
Closed forest	Eurema hapale	Pieridae	0.14	0.01	0.6
Closed forest	Eurema hecabe	Pieridae	0.29	0.01	0.6
Closed forest & Open woodland	Graphium colonna	Papilionidae	0.29	0.01	0.6
Open woodland	Junonia hierta	Nymphalidae	0.14	0.01	0.6
Open woodland	Lampides boeticus	Lycaenidae	0.29	0.01	0.6
Open woodland	Leptosia alcesta	Pieridae	0.29	0.01	0.6
Closed forest	Nepheronia thalassina	Pieridae	0.29	0.01	0.6
Closed forest	Neptidopsis ophione	Nymphalidae	0.29	0.01	0.6
Open woodland	Neptis alta	Nymphalidae	0.14	0.01	0.6
Closed forest	Neptis carcassoni	Nymphalidae	0.29	0.01	0.6
Closed forest & Grassland	Neptis kiriakofi	Nymphalidae	0.29	0.01	0.6
Closed forest & Grassland	Papilio echerioides	Papilionidae	0.29	0.01	0.6
Closed forest & Open woodland	Papilio echerioides ssp pseudowertheri	Papilionidae	0.29	0.01	0.6
Closed forest & Riparian vegetation	Precis antilope	Nymphalidae	0.29	0.01	0.6
Closed forest	Precis octavia	Nymphalidae	0.29	0.01	0.6
Open woodland	Protogoniomorpha anacardii	Nymphalidae	0.14	0.01	0.6
Closed forest & Open woodland	Sarangesa motozi	Hesperiidae	0.29	0.01	0.6
Closed forest	Acraea petraea	Nymphalidae	0.14	0.01	0.3
Riparian vegetation	Acraea utengulensis	Nymphalidae	0.14	0.01	0.3
Closed forest	Amauris crawshayi	Nymphalidae	0.14	0.01	0.3
Closed forest	Anthene amarah amarah	Lycaenidae	0.14	0.01	0.3
Open woodland	Anthene liodes	Lycaenidae	0.14	0.01	0.3
Open woodland	Azanus natalensis	Lycaenidae	0.14	0.01	0.3
Closed forest	Baliochila abri	Lycaenidae	0.14	0.01	0.3
Grassland	Belenois zochalia agrippinides	Pieridae	0.14	0.01	0.3
Closed forest	Bicyclus campus	Nymphalidae	0.14	0.01	0.3
Closed forest	Celaenorrhinus zanqua	Hesperiidae	0.14	0.01	0.3

Vegetation Types	Scientific Name	Family	Frequency (%)	H'	IVI
Closed forest	Charaxes guderiana	Nymphalidae	0.14	0.01	0.3
Open woodland	Charaxes jasius	Nymphalidae	0.14	0.01	0.3
Grassland	Colotis antevippe	Pieridae	0.14	0.01	0.3
Grassland	Colotis evagore ssp antigone	Pieridae	0.14	0.01	0.3
Closed forest	Common club dot sailer	Nymphalidae	0.14	0.01	0.3
Closed forest	Eretis melania	Hesperiidae	0.14	0.01	0.3
Open woodland	Eronia leda	Pieridae	0.14	0.01	0.3
Closed forest	Eurema floricola	Pieridae	0.14	0.01	0.3
Open woodland	Gegenes niso	Hesperiidae	0.14	0.01	0.3
Open woodland	Graphium porthaon	Papilionidae	0.14	0.01	0.3
Grassland	Hypolimnas deceptor	Nymphalidae	0.14	0.01	0.3
Open woodland	Hypolimnas usambara	Nymphalidae	0.14	0.01	0.3
Riparian vegetation	Lepidochrysops cupreus	Lycaenidae	0.14	0.01	0.3
Riparian vegetation	Leptotes babaulti	Lycaenidae	0.14	0.01	0.3
Grassland	Lycaena abbottii	Lycaenidae	0.14	0.01	0.3
Riparian vegetation	Metisella midas	Hesperiidae	0.14	0.01	0.3
Closed forest	Metisella willemi	Hesperiidae	0.14	0.01	0.3
Open woodland	Mimacraea marshalli	Lycaenidae	0.14	0.01	0.3
Closed forest	Mylothris rueppellii	Pieridae	0.14	0.01	0.3
Closed forest	Mylothris ruppellii ssp rhodesiana	Pieridae	0.14	0.01	0.3
Grassland	Neocoenyra heckmanni	Nymphalidae	0.14	0.01	0.3
Grassland	Neocoenyra ypthimoides	Nymphalidae	0.14	0.01	0.3
Open woodland	Neptis nina	Nymphalidae	0.14	0.01	0.3
Closed forest	Neptis saclava	Nymphalidae	0.14	0.01	0.3
Closed forest	Neptis saclava ssp marpessa	Nymphalidae	0.14	0.01	0.3
Closed forest	Ornipholidotos peucetia peuceda	Lycaenidae	0.14	0.01	0.3
Closed forest	Pentila rogersi	Lycaenidae	0.14	0.01	0.3
Riparian vegetation	Physcaeneura pione	Nymphalidae	0.14	0.01	0.3
Open woodland	Pinacopteryx eriphia	Pieridae	0.14	0.01	0.3
Riparian vegetation	Precis actia	Nymphalidae	0.14	0.01	0.3
Riparian vegetation	Precis ceryne	Nymphalidae	0.14	0.01	0.3
Closed forest	Salamis anacardii	Nymphalidae	0.14	0.01	0.3
Closed forest	Tagiades flesus	Hesperiidae	0.14	0.01	0.3
Open woodland	Teniorhinus harona	Hesperiidae	0.14	0.01	0.3
Closed forest	Teriomima subpunctata	Lycaenidae	0.14	0.01	0.3
Open woodland	Virachola jacksoni	Lycaenidae	0.14	0.01	0.3
Closed forest	Zizeeria knysna	Lycaenidae	0.14	0.01	0.3

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