Woody Species Composition and Diversity of Jessu Woodland, Gombe State, Nigeria

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WOODY SPECIES COMPOSITION AND DIVERSITY OF JESSU WOODLAND, GOMBE STATE, NIGERIA

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ABSTRACT

Background

This study investigated woody species composition and diversity using Point Centered Quarter and questionnaire methods. **Results**: A total of 36 woody species from 32 genera and 18 families were recorded— 30 species belonging to 27 genera and 16 families were trees, while 6 species belonging to 6 genera and 5 families were shrubs The Fabaceae family had the highest number of 6 tree species. Combretaceae, Chrysobalanaceae and Moraceae had 3 species each, Anacardiaceae, Annonaceae, Bombacaceae and Meliaceae had 2 species each and Arecaceae, Burseraceae, Ebenaceae,Rubiaceae,Sapotaceae, Sterculiaceae, Simaroubaceae and Verbanaceae had 1 species each. For the shrub species, the family Fabaceae had the highest number of 2 species while Anacardiaceae, Apocynaceae, Rutaceae and Sapotaceae had 1 species each. Diversity indices showed a Simpson's index of 0.40 and a Shannon-Wiener index of 2.07 for trees, while shrubs recorded 0.50 and 1.6, respectively. The main causes of deforestation identified were farming, firewood collection, and logging. About 98% of respondents reported a decline in key tree species such as *Holarhena floribunda* and *Vitex doniana,* while 94% observed soil and water degradation. Wildlife populations were also noted to be changing. Although 92% expressed support for conservation efforts, more than half were unaware of any existing initiatives, highlighting a significant gap in environmental awareness. **Conclusion**: The study concludesd that species with low Importance Value Index (IVI), such as *Piliostigma reticulatum, Holarhena floribunda, Acacia sieberiana, Vitex doniana, and Ficus polita,* require urgent conservation. This study recommends reforestation, environmental education, and stricter regulations to protect and restore the woodland ecosystem.

Keywords: Balanga, Diversity, Woody, Species, Composition, Jessu, Woodland Deforestation

INTRODUCTION

Woodlands, particularly in semi-arid regions like Gombe State, play a significant role in biodiversity conservation, carbon sequestration, and ecosystem services. Jessu woodland represents a crucial habitat with unique woody species composition. However, anthropogenic activities and environmental factors are increasingly threatening its diversity. Forests

resources are under pressure for increasing demand for farm lands, fuel wood, overgrazing and timber for housing construction (Ahmad *et al.*, 2018). This increasing rate of deforestation is under the increase because the awareness about the importance of forests is limited or lacking because people still regard forests as gifts of nature (Ikyaagba *et al.*, 2019). Forests have been reported to affect local and regional air quality and changing microclimates by lowering of temperature through shading and evapotranspiration (Raji and Babalola, 2018). Forests trees provide a lot of services such as species conservation, prevention of soil erosion and preservation of natural home for plants and animals (Cole and Kayode, 2020).Trees species are crucial parts of the ecosystem and they provide tangible and intangible benefits. The need for periodic assessment of these resources for management and conservation purposes is imperative (Hayatu *et al*., 2021). Therefore, ecosystem management in particular location is important and integral part for the conservation and protection of Biological diversity of Jessu. By understanding the status of the natural forest in terms of tree species composition, richness and diversity, recommendations could be made for the restoration and future management of Jessu woodland. Therefore, the study aims to address this gap by assessing the diversity and composition of woody species in Jessu Woodland.

MATERIALS AND METHODS

Study Area

Jessu woodland is situated in the Southern part of Balanga Local Government Area of Gombe State Nigeria. It laid along Latitude $9^0$44'0''North, Longitude 11^0 50'0 East, with an altitude of 565m (Field study, 2021). The woodland is sharing boarders with Adamawa State (Guyuk and Lamurde Local Government Areas) (Figure 1). Jessu climate has two distinctive seasons' dry season (November-March) and rainy season (April-October) with an average rainfall of 850mm the temperature of the study area is typically of the West African Sudan savannah climatic belt of Nigeria. It is characterized by marked diurnal temperature variation expressed by hot days and cod night and the average temperature of 28 degrees because of its high altitude from the sea level. The moisture of the air increases during rainy season (May-October) and the humidity is high while during dry season (November to April) the humidity uses to be very low (Usman *et al*., 2019).

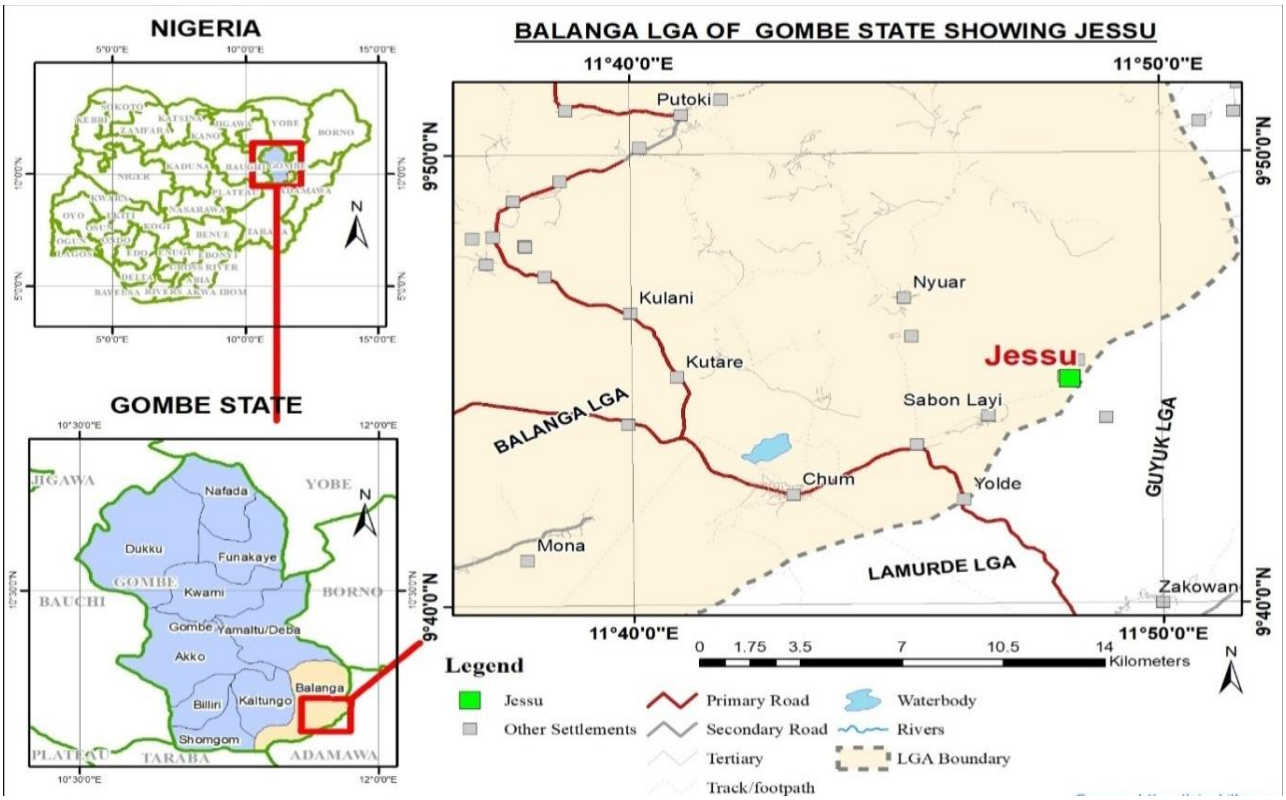

***Figure 1*: Map showing study site of data collection** **Source**: (Field Study, 2021).

Vegetation Sampling

Vegetation sampling was conducted using PCQ method (Adopting methods of Cottam and Curtis 1956; Dix, 1971 ; Abdullahi (2010) and Abba, 2022). Point Centered Quarter method was carried out by measurement of distances from randomly chosen points to the nearest woody plant species. Ten random sampling points were located along a series of line transects passing through the stand. At each sampling point, 4 quarters were established using a cross. The individual nearest to the point in each quadrant was located. The Diameter at Breast height (DBH) of trees and shrubs (DBH $\leq$ 10 cm, $\geq$ 4.5 cm respectively) were measured with measuring tape in each quarter and recorded.

Identification of species

Species were identified on site using field guides, Floras, and morphological characteristics (Adopting methods of Keay, 1989; Von Maydell, 1989; Gillespie *et al*, 1998; Hawthorne, 2005; Abba, 2014). Specimens were collected, identified by a specialist, and compared with herbarium specimens at Gombe State University herbarium. Voucher numbers were then given for each species encountered.

Data Analysis

Parameters obtained by this method include tree species composition, density, diameter and frequency. The following computations were made: **(a)** Plant species point to point distance; (m). **(b)** tree species mean point distance; (m). **(c)** Mean area (M.A,)/ tree species (m^2); and

(d) Total (Absolute) density (Trees/hectare). Data obtained was quantitatively analyzed for Total densities, relative and absolute densities, frequency, relative frequencies, dominance, relative dominance and importance value index as per (Adopting methods of Cottam and Curtis 1956; Dix, 1971; Abdullahi .2010 and Abba, 2022). The formula used to calculate were as follows:

Frequency and Relative Frequency

$$\text{Frequency} = \frac{\text{Number of point at which a species occurs}}{\text{Total number of points sampled}}$$

$$\text{Relative Frequency} = \frac{\text{Frequency of a species}}{\text{Total frequencies of all species}} \times 100$$

Density and Relative Density

$$\text{Density} = \frac{\text{Number of a species}}{\text{Total area sampled}}$$

$$\text{Relative density} = \frac{\text{Density of a species}}{\text{Total Density of all species}} \times 100$$

Dominance and Relative Dominance

$$\text{Dominance} = \frac{\text{Total basal area of a species}}{\text{Total area sampled}}$$

$$\text{Relative Dominance} = \frac{\text{Absolute Dominance of a species}}{\text{Total Dominance of all species}} \times 100$$

IVI = Relative Density + Relative Dominance + Relative Frequency

$$\text{Relative importance value} = \frac{\text{Relative Density} + \text{Relative Frequecny} + \text{Relative Dominance}}{3}$$

Species diversity index was calculated using Simpson's index and Shannon Weiner index of diversity (Adopting the method of Ojo (1996); Simpson (1949); Shannon (1948), Abba *et al.,* 2022).

Socioeconomic Survey: Impact of Anthropogenic Activities on the Tree Species Composition and Diversity in Jessu Woodland, Gombe State

1. Questionnaire Administration:

   Structured questionnaires were distributed to 100 respondents from local communities around the woodland. Respondents included farmers, herdsmen, traders, and other stakeholders involved in woodland activities.

2. Key Informant Interviews (KII):

Interviews were conducted with village head, forest officers, and community elders to gather insights on historical changes in vegetation and human pressures.

3. Focus Group Discussions (FGDs):

   FGDs was conducted with different community groups to gain a broader understanding of land-use patterns and conservation attitudes.

RESULTS AND DISCUSION

Woody Species (Trees and Shrubs) Composition

A total of 36 woody species belonging to 18 families and 32 genera were obtained in Jessu woodland. Out of this total number 30 species belonging to 27 genera and 16 families were trees while 6 species belonging to 6 genera and 5 families were shrubs as shown in (Table 1). This is not in consistence with the works of Abba *et al.* (2022), who obtained a total number of 51 species, in their study of Wawa-Zange forest reserve, Gombe State Nigeria, this could be due to difference in the size of the reserve, climate, geological, topography, diversity and edaphic factors. It is also not consistent with the works of Amomum *et al.* (2019) who obtained 39 tree species in the College of Forestry University of Agriculture Makurdi, Benue State Nigeria. This difference could be due to difference in the study areas geology, climate, and precipitation. However, the findings is similar to the works of Abba *et al.* (2015) who obtained 25 tree species in the Kanawa forest reserve. This could be due to similarity in the environmental factors in the study areas.

Five (6) species of shrubs belonging to 5 genera and 5 families were identified within the study area. Anacardiaceae and Fabaceae families had the highest number of shrubs species, these families were known to be native species in most savannah-woodland in Africa and more typical of Sahelian zones. A similar report was presented by (Abba, 2015) in Kanawa Forest Reserved, Gombe State, Nigeria. The study is also similar to that of Amomum *et al.* (2019) who also recorded the family Fabaceae as the dominant family. These may be due to their geographic and topographic similarities in the study areas. Ezekwesili *et al.* (2019) in their work titled floristic composition, structure, and species association of dry Miombo woodland in Tanzania reported that family Fabaceae

Table 1: Woody Species (Trees and Shrubs) Composition at Jessu woodland

S/N	FAMILY	SCIENTIFIC NAME	GENERA	HABIT	COMMON NAMES
1	Anacardiacea	*Mangifera indica* L	*Mangifera*	Tree	Mango tree
		Heamatostophis barteri	*Heamatostophis*	Shrub	Blood plum
		Lannea velutina A. Rich.	*Lannea*	Tree	Goat fat
2	Annanoceae	*Annona squamosa* L	*Annona*	Tree	Custard apple
		Holarhena floribunda (G.Don) T. Durand & Schinz	*Holarhena*	Tree	False rubber
3	Apocynaceae	*Adenium obesum* (Forsk)	*Adenium*	Shrub	Desert rose
4	Arecaceae	*Borassus aethiopium*	*Borassus*	Tree	Elephant palm
5	Bombacaceae	*Bombax costatum* Pelleg. & Vuilet	*Bombax*	Tree	Redkapok tree
		Adamsonia digitata L	*Adamsonia*	Tree	Baobab tree
6	Burseraceae	*Boswelia dalzielii* Hutch	*Boswelia*	Tree	Frankincense
7	Combretaceae	*Combretum hypopilinum* Diel	*Combretum*	Tree	White denehi
		Combretum collinum Fresen		Tree	
		Anogeissus leiocarpus (DC) Guill. & Perr.	*Anogeissus*	Tree	African birch
8	Chrysobalanaceae	*Parinari curatellifolia* Plunch. Ex.Benth	*Parinari*	Tree	Mmupudu
		Marenthes polyandra Benth Prance	*Marenthes*	Tree	Manding-Bambaratudu
9	Ebenaceae	*Diospyros mespiliformis* Hotchust ex A. Rich	*Diospyro*	Tree	WestAfrican ebony
10	Fabaceae	*Detarium microcarpum* Guill	*Detarium*	Tree	Tallow tree
		Piliostigma reticulum	*Piliostigma*	Shrub	Camels foot
		Tamariindus indica L.	*Tamarindus*	Tree	Tamarind
		Parkia biglobosa (Jacq) R.Br.Ex G.Don	*Parkia*	Tree	Affrican locust bean
		Tetrapleura tetraptera	*Tetrapleura*	Tree	Prekese
		Cassia seiberiana DC	*Cassia*	Tree	Drum stick
		Acacia sieberiana DC	*Acacia*	Tree	White thorn
		Cassia singuaena Del	*Cassia*	Shrub	Winter cassia
11	Meliaceae	*Azadirachta indica* A.Juss	*Azadirachta*	Tree	Neem
		Khaya senegalensis (Desr) A.Juss	*Khaya*	Tree	Senegal Mahogany
12	Moraceae	*Ficus polita* Vall.	*Ficus*	Tree	Heart-leaved fig
		Ficus platyphyla Del.	*Ficus*	Tree	Flake rubber
		Ficus thonningii	*Ficus*	Tree	Tree strangler
13	Rubiaceae	*Nuclea latifolia Sm*	*Nuclea*	Tree	African peach
14	Rutaceae	*Vepris heterophylla* (Engl.)	*Vepris*	Shrubs	Kinkelibade
15	Sapotaceae	*Vitellaria paradoxa Gaertnf*	*Vitellaria*	Tree	Shea-butter

		Malacantha alniofolia (Bak)per	*Malacantha*	Shrub	Fogny
16	Sterculiaceae	*Sterculia setigera* Del.	*Stercularia*	Tree	Karaya gum
17	Simaroubaceae	*Hannoa undulate* Guill. And Perr	*Hannoa*	Tree	
18	Verbanaceae	*Vitex doniana* (Sweet)	*Vitex*	Tree	Black plum

Source: (Field Study, 2021).

Importance Value Index for Trees and Shrubs

The tree species with the highest importance value index in the study area was *Marenthes polyandra* (50.89)(Table2).This could be due to the ability of the plant to have viable seeds, adequate means of seed dispersal and ability to regenerate easily as well as preference of its use by the residents as fuel wood. This is not consistent with the works of (Soumana, 2017) on Biodiversity and Structure of Woody Plants of Sahelian Rangeland of Baban Rafi, Niger. The tree species with the lowest importance value index was while *Ficus polita* (1.10%), is the tree species with lowest IVI. This could be due to its poor adaptation and excessive exploitation by residents for food and medicinal purposes. The plant produces latex which has antimicrobial activities. The present study is not consistent with the works of (David, 2018) on the analysis of Structure and Diversity of the Kilengwe Forest in the Morogoro Region, Tanzania.

Haematostaphis barteri has the highest important value index (7.73%) of shrub species in the study area (Table3). This could be due to proper adaptation and adequate means of seed dispersal in the study area. This in not consistent with the study of (Idris *et al.*, 2017) who recorded low value of *H. barteri* while *Piliostigma reticulatum* is the shrub species with the lowest important value of (0.72%) this could be due to its excessive usage as medicine and as well as fuel wood by the residents. The existence of many species with low important value in this study is an indication that the majority of species are rare in the woodland as reported by David (2018).

Table 2: Importance Value Index (IVI) for Trees in Jessu woodland

S/N	SCIENTIFIC NAMES	R.F (%)	R.D (%)	R.DOM(%)	IVI (%)
1	*Acacia sieberiana* DC.	0.67	0.67	0.01	1.35
2	*Adamsonia digitata* L	1.33	1.33	0.20	2.86
3	*Annona squamosa* L	0.67(	0.66	0.13	1.46
4	*Anogeissus leiocarpus* (DC) Guill. & Perr	1.00	1.00	0.29	2.29
5	*Azadirachta indica* A.Juss.	4.00	4.00	2.48	10.48
6	*Borassus aethiopium* Mart.	2.67	0.66	1.60	4.93
7	*Bombax costatum* Pellegr. & Vuilet.	2.00	2.00	1.74	5.74
8	*Boswelia dalzieli* Hutch.	3.67	3.66	2.77	10.1
9	*Cassia seiberiana* DC.	2.67	2.66	0.58	5.91
10	*Combretum collinum* Fresen	5.00	4.99	4.65	14.64
11	*Combretum hypopilinum* Diel.	2.00	2.00	0.58	4.58
12	*Detarium microcarpum* guill.&per	7.67	7.66	11.94	27.27
13	*Diospyros mespiliformis* Hochst. ex A. Rich	3.00	4.66	1.60	9.26
14	*Ficus platyphyla* Del.	2.33	2.33	0.87	5.53
15	*Ficus polita* Vahl	0.33	0.33	0.44	1.10
16	*Ficus thonningii* Blume	9.33	9.32	16.01	34.66
17	*Hannoa undulate* Guill. &Perr.	2.67	2.66	2.32	7.65
18	*Holarhena floribunda* (G.Don) T.Durand &Schinz	0.33	0.33	1.66	2.32
19	*Khaya senegalensis* (Desr.) A. Juss	1.00	1.00	0.72	2.72
20	*Lannea velutina* A. Rich	4.00	3.99	3.20	11.19
21	*Mangifera indica* L	0.69	0.69	1.45	2.83
22	*Maranthes polyandra* Benth. Prance	11.33	11.31	28.25	**50.89**
23	*Nauclea latifolia* Sm.	1.33	1.33	0.28	2.94
24	*Parinari curatellifolia* Plunch. Ex Benth	2.00	2.00	0.06	4.06
25	*Parkia biglobosa* (Jacq.)R. Br. ex G. Don	2.00	2.99	1.89	6.88
26	*Sterculia setigera* Del.	3.00	2.99	1.89	7.88
27	*Tamarindus indica* L	2.66	2.66	1.89	7.21
28	*Tetrapleura tetraptera*	6.67	4.66	6.12	17.45
29	*Vitellaria paradoxa* Gaertn f.	4.33	4.33	3.20	11.86
30	*Vitex doniana* Sweet	1.00	1.00	0.02	2.02

Source: (Field Study, 2021).

Importance Value Index for shrub species in Jessu woodland

Table 3: Importance Value Index (IVI) for Shrubs in Jessu woodland

S/N	SCIENTIFIC NAMES	R.F (%)	R.D	R.DOM	IVI
1	*Adenium obesum* (Forsk.)Roem &schult	1.33	1.33	0.07	2.73
2	*Cassia singueana* Del	2.67	2.66	0.01	5.34
3	*Haematostaphis barteri* Hook. F	4.00	1.99	1.74	7.73
4	*Malacantha alnifolia* (Bak.) Pierrr.	1.00	1.00	0.58	2.58
5	*Piliostigma reticulatum* (DC) Hochst	0.33	0.33	0.06	0.72
6	*Vepris heterophylla*(Engl.) Letouzey	1.33	1.33	0.04	2.70

Source: (Field Study, 2021**).**

Tree and Shrubs Species Diversity

Simpson index of diversity (1-D) for trees was (0.40). The species index of diversity of the study area is not in consistence with the studies of Abba, 2015 who obtained (0.946) in Kanawa Forest Reserve Gombe State; Abdullahi, 2010, obtained (0.984) in Yankari National Park, Bauchi State, Nigeria; Richard *et al.,* 2011 obtained (0.957) in the Miombo woodland of Bereku Forest Reserve in Tanzania,, and Wakawa *et al.* (2017) who obtained 0.8 in Gashu'a, Yobe State, Nigeria. Even though all the study areas are in savannah but they differ in climatic conditions. This could be the reason of the variation of values recorded from each study area since climate has been regarded as one of the most environmental factor affecting growth and distribution of vegetation (Zakaluk and Ranjan, 2008: Aregheore, 2009). The Shannon Weiner Index of diversity for trees reported by Abba (2015) to be (4.43) in Kanawa Forest was relatively high more than the value of (2.07) obtained in Jessu woodland. The values were moderately low probably due to level of deforestation going on in the study area indicating a more stable, ancient and complex and healthy community with greater variety of species allowing for more species interactions.

Simpson's index of diversity (1-D) was (0.50) for shrubs, this study is not in consistence with the works of Abba, (2014) who obtained (0.998). Abdullahi, (2010) and that of Wakawa *et al.* (2017). This indicates that there is high level of human disturbance in the study area and it means that the diversity is low. The Shannon Weiner index for shrub species was (1.6), this value is very low compare to that of Ashish *et al.* (2006) who obtained (4.26) on Tree Species Diversity and Distribution patterns in Tropical Forest of Garo hills, India. The high diversity

could be due to the low moisture contents and environmental factors. It could also be due to differences in field size, sample size and dimensions, and other environmental conditions and other site factors (Ashish *et al.*, 2006).

Impact of Anthropogenic Activities on the Woody Species Composition and Diversity in Jessu Woodland, Gombe State

The demographic profile of respondents in this study highlights the predominance of middle-aged and older individuals, particularly males, actively involved in woodland-related activities such as farming, firewood collection, and livestock rearing. This finding corroborates those of Jiren *et al.* (2020) and Lawal *et al.* (2021), who emphasize that middle-aged rural dwellers—especially men—are often the most engaged in land use and natural resource extraction due to their economic responsibilities and generational experience. The dominance of farming as the primary occupation (66%) underscores the strong dependence of local livelihoods on land and natural vegetation, a pattern also observed by Ouedraogo *et al.* (2014), who noted that diversified rural economies in Sub-Saharan Africa often intensify land use through agriculture and logging. The expansion of farmland and demand for firewood emerged as the principal drivers of vegetation loss in Jessu Woodland. Nearly all respondents (99%) engaged in farming, and 86% in firewood collection—figures that reflect the high anthropogenic pressure on the ecosystem. This aligns with findings by Hosonuma *et al.* (2012), who reported that agriculture and fuelwood collection are responsible for about 80% of deforestation across Africa. These activities contribute not only to vegetation degradation but also to biodiversity loss, particularly of species like *Holarhena floribunda*, *Acacia sieberiana*, and *Vitex doniana*, which were commonly cited by respondents as declining. Such species-specific vulnerability is supported by Newbold *et al.* (2020), who found that economically valuable or ecologically specialized species are more susceptible to overharvesting and habitat disturbance.The environmental impact of these activities is profound. A significant 94% of respondents observed declining soil fertility and water availability, consistent with studies by Ouedraogo *et al.* (2014) and Lawal *et al.* (2021), which found that deforestation exacerbates land degradation and reduces water retention in arid and semi-arid zones like Northern Nigeria. This reinforces the critical nexus between forest cover, soil productivity, and hydrological balance in woodland ecosystems.Wildlife responses to habitat modification in Jessu Woodland present a mixed scenario. While 76% of respondents observed minor changes and 16% noted major declines, the continued presence of generalist species (e.g., rodents and birds) reflects ecosystem resilience. This trend supports Bobo *et al.* (2014) and Ude *et al.* (2021), who documented that adaptable species can persist in modified habitats provided some vegetation structure remains. However, the long-term ecological integrity of such systems remains in jeopardy if degradation continues unchecked.

Focus Group Discussions (FGDs) echoed these observations, highlighting agricultural expansion and grazing as primary causes of biodiversity loss. The decline in species such as *Piliostigma reticulatum* and *Ficus polita* points to selective pressures exerted by human activities. This observation is in line with Curtis *et al.* (2018) and Harris *et al.* (2020), who noted that land-use intensification disproportionately affects tree species with high ecological or economic value. A concerning aspect of the findings is the low level of conservation awareness. While 92% of respondents expressed willingness to support

conservation, 56% were unaware of existing efforts, and 33% lacked knowledge of government policies. This reflects an implementation gap that hinders community-based conservation strategies. As argued by Shackleton *et al.* (2021), effective conservation in communal lands requires not only policy frameworks but also participatory engagement and environmental education to build local stewardship.

Conclusion

The study assessed the woody species composition and diversity in Jessu Woodland, Balanga Local Government Area, Gombe State, Nigeria. Using the Point-Centered Quarter technique and questionnaires. 36 woody species from 32 genera and 18 families were identified. Among the, 30 species were trees and 6 were shrubs. The family Fabaceae had the highest tree and shrub species diversity. The biodiversity indices revealed a medium diversity among trees (Simpson index of diversity :(0.593**,** Shannon-Wiener index: 2.07) but lower diversity among shrubs (Simpson index of diversity: 0.5801, Shannon-Wiener index: 1.5637). The study highlighted significant anthropogenic threats, including farming and firewood collection, which contribute to biodiversity loss. Despite limited awareness of conservation policies, there was strong community support for conservation initiatives.The findings emphasize that sustainable management of Jessu Woodland must integrate demographic realities, livelihood dependencies, and ecological vulnerabilities. Conservation interventions should prioritize awareness campaigns, community participation, and alternative livelihood strategies to reduce direct reliance on forest resources, as recommended by FAO (2022) and supported by local realities uncovered in this study.. This study recommends that management, and conservation approaches such as afforestation of species with low Importance Value Index (IVI) such as *Piliostigma reticulatum, Holarhena floribunda, Acacia sieberiana, Vitex doniana, Ficus polita* need conservation measures.

Declarations

Ethics approval and consent to participate

NOT APPLICABLE

Consent for publication

NOT APPLICABLE

Availability of data and material

The data sets used and or analysed during the current study are available from the corresponding author on reasonable request

Competing interests

The authors declare that they have no competing interests in this section.

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Authors' Contributions

H.M A: Conceptualization of the study, supervision, data interpretation, and manuscript review.

H. I: Field work, data collection, and initial draft of the Statistical analysis,

A Is S Literature review, and editing of the final manuscriptL

All authors read and approved the final manuscript for publication.

Authors information (optional)

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