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Community Perspectives on Natural Resource Values in Liuwa Plain National Park, Western Zambia

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Abstract

Understanding local community perspectives on natural resource values is critical for reconciling biodiversity conservation with livelihood strategies, particularly in shared landscapes where protected areas overlap with resident human populations. To address this gap, this study explored community perspectives on natural resource values in Liuwa Plain National Park, western Zambia, employing participatory non-market valuation methods through a mixed-methods approach comprising semi-structured household surveys (n = 309) and focus group discussions conducted in November 2024. Data were analysed using frequentist approaches, Chi-square, and Friedman tests. Results revealed that local communities highly valued and prioritised wildlife and fisheries, particularly Bubble fish (*Tetraodontidae*), for economic roles, and forest products, i.e., Mubula (*Parinari curatellifolia*), for cultural and ecological roles, followed by water and agricultural land. The findings showed that socio-demographic factors, such as length of residency and ethnic affiliation, particularly among the Lozi-speaking people, were the strongest predictors of conservation awareness and sustainable natural resource management attitudes, while significant environmental challenges and pressures, such as climate change, poaching, deforestation, decline in fish stocks, such as Tiger fish (*Hydrocynus vittatus*), and changes in water availability over time, were also identified. These findings underscore the urgency of integrating local perspectives into protected area management contributing to global sustainable development goals and adding to the discourses on inclusiveness and ecological integrity in balancing biodiversity conservation and livelihood strategies.

Keywords: biodiversity conservation; community perceptions; non-market valuation; protected areas; shared landscapes

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1. Introduction

Local communities inside and around protected areas interact with natural resources and ecosystem services (ESs) based on perceived values [1,2], often with non-market value or no market prices [3]. However, threats such as climate change and unsustainable anthropogenic activities limit the value realised from these natural resources and ESs [4]. Numerous studies have emphasised the importance of establishing conservation priorities

and valuing natural resources to ensure the persistence of biodiversity [5,6] and identify regions where biodiversity and ESs co-occur with natural resource-dependent local communities [7,8].

Protected areas (PAs) are a cornerstone of biodiversity conservation, principally focusing on eliminating or minimising the value-eroding environmental threats and human pressures within their boundaries [9]. Despite multiple PA-based benefits [10,11], PAs are often burdened with conflicts between environmental managers and the neighbouring communities [12]. Chronic funding shortages compound inefficiencies in PA management [13]. Moreover, the rights of the local communities living in and around PAs are rarely recognised and respected by stakeholders, local communities' customary sustainable use practices are not safeguarded, and their essential role for effective and equitable biodiversity governance in collective conservation actions are not integrated [14].

With consideration of human–wildlife co-existence [15], this study was centred around a shared landscape within the Liuwa Plain National Park (NP) which is under a co-management framework involving the African Parks Network (APN), the Barotse Royal Establishment (BRE), representing the local and indigenous communities, and Zambia's department of National Parks and Wildlife (DNPW). The APN serves as the operational and technical management partner responsible for park infrastructure, wildlife monitoring, and community development support; the DNPW is the statutory national government authority mandated to regulate and enforce wildlife and natural resource legislation within Zambia's protected area estate; and the BRE is the customary governance institution of the Lozi people whose traditional authority over the surrounding Barotse Landscape provides the cultural legitimacy and community mobilisation capacity underpinning the co-management framework [16], making community-level evidence particularly critical to equitable natural resource governance [17]. Despite the growing recognition of traditional ecological knowledge (TEK) in conservation governance, local communities' inclusion in the decision-making process is commonly lacking in many such shared landscapes [18,19]. The local communities possess in-depth knowledge of ecosystem functioning which should be integrated into sustainable natural resource use and management strategies [20]. Such integration should also consider local community perspectives, needs and values, which inform management decisions about the ecosystems [21]. Moreover, hitherto there is no peer-reviewed study that has provided systematic community-level natural resource valuation data from within the Liuwa Plain National Park (LPNP), representing a critical gap in the evidence base needed for effective co-management. Through the integration of TEK and scientific knowledge [2], meaningful participation of the local communities in decision making can enable effective natural resource and ES use adapted to the local context and culture [22]. However, the lack of demonstration of stewardship practices by the local communities are exacerbated by the disparities in conservation-related value systems [23].

The Value–Belief–Norm (VBN) theory explains how deeply held personal values shape community beliefs and moral norms [24–26], guiding how people in the Liuwa Plain NP value and use natural resources. VBN theory links held values, beliefs, personal norms and behaviour. However, while this theory offers a basis to study assigned values for specific places, these values could include numerous potential influences on behaviour, such as assigned values and a range of socio-demographic factors [24].

The study aimed to assess community perspectives on natural resource values in the Liuwa Plain NP, western Zambia. To achieve this objective, we: 1. quantify the relative importance that resident communities assign to five (5) key natural resources, including fisheries, forests, land, water, and wildlife, using ranked preference data; 2. determine the socio-demographic factors, including gender, ethnicity, education level and duration of residence, which significantly influence community natural resource valuations; and 3.

identify which natural resources are perceived as the most threatened by environmental pressures in the Liuwa Plain NP. This study underscores the urgency to strengthen local community partnership critical to natural resource use and biodiversity conservation [27]. Furthermore, this study provides the first systematic and empirical baseline of multi-natural resource values from local communities in the Liuwa Plain NP, addressing a gap that has constrained evidence-based co-management planning. Additionally, the present study directly supports Zambia's obligations under CBD post-2020 Global Biodiversity Framework Target 22 [28–30], which mandates the meaningful inclusion of local and indigenous knowledge in natural resource governance, an obligation that requires empirical community data of the kind generated in this study. In addition, the study aligns with several sustainable development goals (SDGs), particularly, SDG 15 (Life on Land), SDG 2 (Zero Hunger), SDG 10 (Reduced inequalities), SDG 13 (Climate Action), SDG 16 (Peace, justice and strong institutions), and SDG 17 (Partnerships for goals).

2. Materials and Methods

2.1. Study Area

The study was conducted in Liuwa Plain NP (3660 km^2; 1050 m a.s.l.; 14°13′–14°51′ S, 22°18′22°55′ E, Figure 1) in western Zambia. Established in 1972 [14], Liuwa Plain NP is gazetted as a category II National Park under the Zambian National Parks and Wildlife Act No. 14 of 2015 and the International Union of Conservation for Nature (IUCN) [11,16]. The Liuwa Plain NP represents a rare and unique example of a multi-use, shared landscape with human–wildlife co-existence [15]. In 2003, the Department of National Parks and Wildlife (DNPW), African Parks Network (APN), and the Barotse Royal Establishment (BRE) established a formal agreement and partnership to jointly manage the Liuwa Plain NP along with the local communities, with the goal of promoting effective natural resource management, sustainable use, and enhanced community participation [6]. Under this tripartite arrangement, the DNPW exercises statutory authority and regulatory oversight as the mandated national government body for protected area governance; the APN provides technical, operational, and financial support for park management, wildlife monitoring, and community development programmes; and the BRE contributes cultural legitimacy, traditional governance authority, and community mobilisation capacity, ensuring that local Lozi customary institutions are embedded in all conservation decision-making processes [16].

The Liuwa Plain NP consists largely of seasonal floodplains that support rich wildlife [31,32]. It hosts over 300 bird species, including endangered wattled crane (*Grus carunculata*), grey crowned cranes (*Balearica regulorum*), saddlebill stocks (*Ephippiorhynchus senegalensis*), spurwinged geese (*Plectropterus gambensis*), and various waterfowl. Among the large herds of mammals are blue wildebeest (*Connochaetes taurinus*), Burchell's zebra (*Equus burchellii*), tsessebe (*Damaliscus lunatus*), and wild dogs (*Lycaon pictus*). Other species in the Liuwa Plain NP include Red Lechwe (*Kobus leche leche*), Lion (*Panthera leo*), Cheetah (*Acinonyx jubatus*), Spotted Hyaena (*Crocuta crocuta*), Spotted-necked Otter (*Lutra maculicollis*), Oribi (*Ourebia ourebi*) and Southern Reedbuck (*Redunca arundinum*). The annual migratory blue wildebeest population of the Liuwa Plain NP is probably second to Serengeti in East Africa [33]. Though a territorial-focused PA, the Liuwa Plain NP has a considerable water frontage that supports significant fishery resources along the Barotse Floodplain stretch, with a higher sport fishing value of Tiger fish (*Hydrocynus vittatus*) and Zambezi yellowfish (*Labeobarbus codringtonii*). In terms of spatial governance, the park management plan identifies distinct functional zones, including a core wildlife conservation area concentrated in the central floodplain, a game management area buffer zone, and designated fishing corridors along the Luanginga and Luambimba rivers, where regulated

subsistence fishing by local community households is permitted under the APN, DNPW and local leadership oversight.

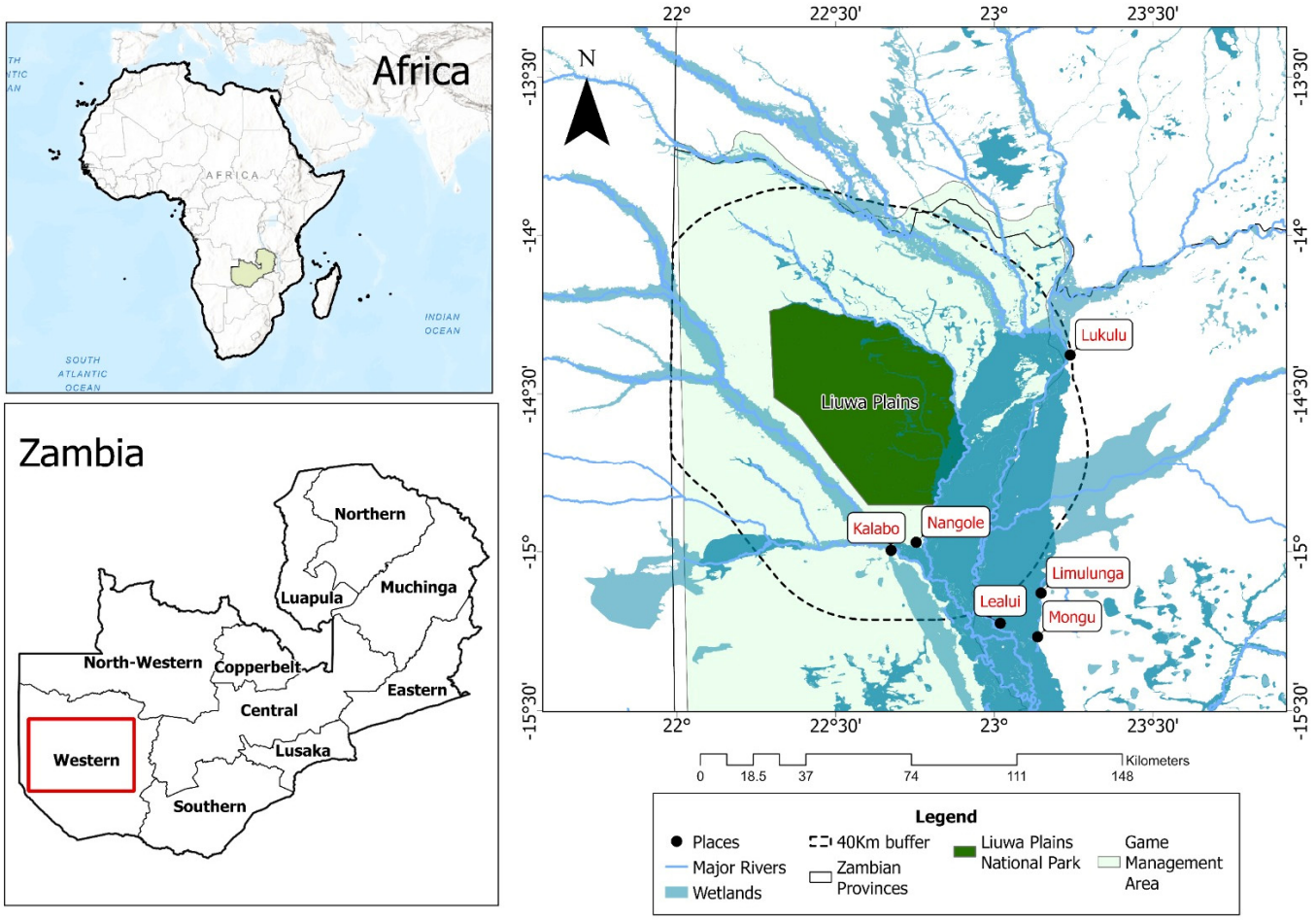


Figure 1. Location of the Liuwa Plain National Park in western Zambia.

The Liuwa Plain NP has three main seasons: a hot–dry season between September and November, a hot–wet season between December and April, and cold–dry season from May to August. Situated in Agro-Ecological Region IIb, the area receives mean annual rainfall of 800–1200 mm and has mean annual temperatures ranging from 8.1 to 34.9 °C. The Liuwa Plain NP is underlain by the Kalahari sands and alluvial deposits, forming an expansive sand-covered plain with minimal relief [31]. The Liuwa Plain NP is drained by the Luanginga and Luambimba rivers (Figure 1). The local communities in the Liuwa Plain NP engage in a wide range of natural resource-based activities, including fishing, farming, weaving, beekeeping, and small business trade for livelihoods, income generation and cultural practices.

2.2. Survey Participant Sampling Design and Eligibility Criteria

The study employed a multi-stage, stratified sampling procedure to assess the community perspectives on natural resource values in the Liuwa Plain NP as the users and producers of these natural resources. Sampling followed community stratification into Village Action Groups (VAGs), administrative clusters in the Liuwa Plain NP in the Kalabo District, western Zambia (Table S1, Supplementary Information). There were 309 (Table S2) purposively selected participating households from a human population of 4846 residents across 10 VAGs in the Liuwa Plain NP, while the five (5) VAGs included in the study were selected by simple random sampling from the ten VAGs constituting the park's administrative clusters, ensuring

that each VAG had an equal and independent probability of inclusion. Within each selected VAG, households were drawn systematically from village registers held by local traditional leaders, using a fixed sampling interval derived by dividing the total number of households in each VAG by the number of households required from that VAG. This two-stage process, consisting of random VAG selection followed by systematic within-VAG household selection, ensured that the final sample was both spatially representative across the Liuwa Plain NP and free from enumerator selection bias (Table S3).

To ensure a representative cross-section of participant natural resource users rather than a convenience sample, eligibility criteria were enforced by trained enumerators prior to questionnaire administration. Eligible participants were required to (i) be aged 18 years or older, in line with national recognition of the decision-making age; (ii) have primary residence within the study area for a minimum of one year; and (iii) be either the household head or a designated adult representative of the household. Households were further characterised by headship, specifically whether they were male-headed or female-headed, and the demographic profile of the final sample, disaggregated by VAG, sex, age, and primary livelihood, is presented in Table 1.

Table 1. Socio-demographic characteristics of survey participants in Liuwa Plain National Park, western Zambia, in 2024.

Characteristic	Category	Number (%)
Household head gender	Male	147 (47.6)
	Female	162 (52.4)
Village Action Group	Mulinga	83 (26.9)
	Mishilundu	69 (22.3)
	Luola	61 (19.7)
	Liuwa	60 (19.4)
	Lumei	36 (11.7)
Household head age, mean (years)		38.10 ± 0.79
Household head age, distribution	18–25 years	59 (19.1)
	26–33 years	78 (25.2)
	34–41 years	64 (20.7)
	42–49 years	45 (14.7)
	>50 years	63 (20.4)
Duration Lived in VAG, mean (years)		30.49 ± 0.98
Duration lived in VAG, mean	1–10 years	52 (16.8) 30.33 ± 6.86
	11–20 years	62 (20.1) 32.91 ± 1.21
	21–30 years	100 (32.4) 24.80 ± 1.52
	>31 years	95 (30.1) 20.60 ± 5.64
Education	No Education	12 (3.9)
	Primary	211 (68.3)
	Secondary	81 (26.2)
	Tertiary	5 (1.6)
Household size, mean		5.26 ± 0.13
Occupation	Farmer	33 (10.6)
	Fisher	214 (69.0)
	Crafts Producer	14 (4.5)
	Forestry Worker	3 (1.0)
	Market Trader	5 (1.6)
	Hunter/Gatherer	2 (0.6)
	Livestock	39 (12.6)

In this study, the use of local community members as study participants was grounded in a social–ecological value framework, in which the participants reported their lived experiences of, and material dependence on, specific natural resources, not technical ecological assessments. This epistemological distinction is fundamental; specifically, community members were asked to report their lived experience and material dependence on natural resources, including wildlife, fisheries, forests, water and agricultural land, rather than provide technical ecological data, an approach explicitly consistent with the IPBES recognition of multiple knowledge systems and the Millenium Ecosystem Assessment's endorsement of community-based valuation as scientifically legitimate and policy relevant [34]. Community-based natural resource valuation is a well-established and internationally endorsed methodology underpinning participatory rural appraisal [35], the Millennium Ecosystem Assessment [36], and the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES) [37] through its recognition of multiple knowledge systems [1]. Local communities who have resided within the Liuwa Plain NP for generations possess empirically grounded knowledge of seasonal natural resource availability, spatial distribution of wildlife, and subsistence use patterns that cannot be replicated by external expert assessment alone. Excluding community voices from conservation valuation has been increasingly recognised as both scientifically incomplete and ethically problematic, as noted by [38]. Therefore, the participatory approach adopted in this study reflects current best practice in conservation social science and aligns with international frameworks for inclusive biodiversity governance.

2.3. Survey and Data Collection Procedures

Semi-structured questionnaires were developed and administered to survey participants in November 2024. Semi-structured questionnaires were adopted for their flexibility in gathering both qualitative and quantitative data [39,40], including the use of a Likert scale and open- and closed-ended questions. The questionnaire was pre-tested with 30 non-survey participants for clarity, cultural relevance, and response consistency prior to deployment. The study employed a Likert scale where 1 indicated the highest and 5 represented the lowest importance of natural resources, meaning lower mean scores reflected greater perceived natural resource value. On other hand, 1 represented the highest risk and 5 indicated the lowest risk, revealing a hierarchy of natural resource vulnerability to environmental pressures. The Likert scale design elicited relative preferences rather than absolute natural resource valuations, reducing the risk of socio-desirability inflation. Data were collected by the first author, who was assisted by six (6) trained native Lozi-speaking research assistants engaged for the entire data collection period to ensure data consistency and comprehensiveness, while reducing language-induced translation distortions and interview context effects. The questionnaire was administered in the Lozi language with each survey taking a minimum average of 30 min per survey participant within the sampled VAGs in the study area. In addition, focus group discussions (FGDs) were also conducted alongside individual surveys to cross-validate responses and reduce individual social desirability effects [40–43]. To ensure accuracy and remove translation distortions, the questionnaire was collaboratively workshopped by the researchers, experts and the research assistants.

Furthermore, the Slovin formula generated a target sample of $n = 370$, which was calculated from a total household population of $N = 4846$ at a margin of error of $e = 0.05$, corresponding to a 95% confidence level. This margin of error indicates that conclusions drawn from the sample are accurate to within $\pm 5\%$, which is the conventionally accepted threshold in community-based social science and conservation research [44]. Of the 370 targeted households, 309 returned valid, fully completed questionnaires, representing a response

rate of 83.5%. This response rate exceeds the 70% minimum widely regarded as acceptable for survey-based studies [45], and the achieved sample remains within the statistical bounds of the original Slovin calculation, preserving the ±5% margin of error for all conclusions reported herein. However, the sample size varied in each VAG depending on the number of households per VAG (Table S3), resulting in a total sample size of 370 using the Slovin formula [46].

The sample size was calculated as

$$n = \frac{N}{1 + N(e^2)} \quad (1)$$

where n is the desired sample size, N is the total number of households in the Liuwa Plain NP (N = 4846), and e is the acceptable margin of error (e = 0.05).

2.4. Statistical Data Analysis

The analysis was conducted using IBM SPSS Statistics for windows Version 23.0 (IBM Corp., Armonk, NY, USA). To assess the relative importance of natural resources and to answer the question on how community perceptions relate to natural resource values in the Liuwa Plain NP, specifically fisheries, forests, land, water, and wildlife, the Friedman test was applied. Furthermore, a Friedman test was also employed to assess survey participants' opinions on which natural resources are most at risk and vulnerable to the stresses of environmental pressures within the ecosystem. This non-parametric test, suitable for ordinal data and repeated measures, helped determine whether or not there were significant differences in how survey participants ranked the contribution of these natural resources to their livelihoods. The Friedman test is particularly appropriate for within-subject designs and was chosen over repeated measures ANOVA due to its robustness with non-normally distributed data [47]. Because a significant Friedman result indicates only that an overall difference exists among the five natural resource categories, without identifying which specific pairs differ, Wilcoxon signed-rank tests were subsequently conducted for all pairwise comparisons of natural resource rankings, with a Bonferroni-adjusted significance threshold (α = 0.005) applied to control the family wise error rate. In addition, Kendall's coefficient of concordance (W) was calculated to quantify the degree of agreement among respondents in their natural resource rankings, complementing the Friedman test by indicating how consistently this ranking pattern was shared across respondents rather than driven by a subset of divergent responses.

To explore associations between categorical variables, such as gender, ethnicity (tribe), duration of stay, education level, and perception of natural resource threats, and in order to answer the question on what factors influence community perceptions on natural resource values in the Liuwa Plain NP, Chi-square (χ^2) tests of independence were employed in the study. These χ^2-tests allowed for the identification of statistically significant associations, while Cramer's V was used to further evaluate the effect size of these relationships, offering insights into the strength of the associations [48]. In addition, this study further conducted an ordinal regression analysis to examine whether selected socio-demographic characteristics—specifically, duration of residence within the Village Action Group (VAG), leadership status, tribal affiliation, and gender—significantly predicted respondents' awareness and knowledge of conservation strategies and natural resources implemented within the Liuwa Plain NP ecosystem. Ordinal logistic regression was selected because the dependent variable, awareness and knowledge of conservation strategies, was measured on an ordered four-category scale (1 = No awareness, 2 = Low awareness, 3 = high awareness, 4 = very high awareness), and since response categories possess a natural order but unequal intervals between categories, this approach is more appropriate than linear regression

for ordered categorical outcome variables, as it estimates the cumulative odds of respondents being classified into progressively higher awareness categories while simultaneously adjusting for multiple predictor variables [49,50].

Prior to model estimation, multicollinearity among predictor variables was assessed using collinearity diagnostics, with the largest condition index recorded at 10.04, falling well below the threshold indicative of problematic multicollinearity, confirming that the predictor variables were sufficiently independent for reliable parameter estimation [51]. Model adequacy was subsequently evaluated using Pearson and Deviance goodness-of-fit statistics, both of which were non-significant (Pearson $\chi^2 = 568.35$, $p = 0.184$; Deviance $\chi^2 = 530.08$, $p = 0.600$), indicating that the fitted model adequately represented the observed data with no evidence of poor model fit [49]. Furthermore, descriptive statistics analysis was applied using frequentist and proportional distributions to determine, summarise and categorise survey responses regarding the demographic characteristics, perceptions of natural resource values, and the conservation challenges in the Liuwa Plain NP. This analytical approach was justified because it effectively presented categorical data from survey participants in a quantifiable manner. A threshold of $p < 0.05$ was used to determine statistical significance. In cases where p-values fell below 0.01 or 0.001, the associations were interpreted as strongly or highly significant, respectively, following conventional statistical guidelines [47].

2.5. Ethical Consideration

The study was conducted under research permit No. NPW/8/27/1 obtained from the Department of National Parks and Wildlife (DNPW) and ethical clearance No. 2023/2/13/1 issued by Copperbelt University's Ethical Committee. Participants were fully informed about the study's purpose, objectives, methods, and their rights, including the right to withdraw at any stage without any repercussions, after giving consent to participate. To protect participants' privacy, data confidentiality was strictly maintained, and personal information was anonymised. Data collection was conducted in a culturally sensitive manner, with careful consideration of local traditions and customs. Permission from community leaders, as well as the use of local research assistants who were aware of local traditions and customs, ensured that research activities were aligned with community norms and avoided disrupting traditional practices.

3. Results

3.1. Demographic Characteristics

A total of 309 participants were surveyed in the Liuwa Plain NP, with a relatively balanced gender distribution of females making up 52.4% and males 47.6% of the sample, with an average household size of 5.26 ± 0.13 (Table 1). The average age of the survey participants was 38.18 ± 0.79 years, with survey participants ranging from 18 to 50 years. The largest proportions of survey participants were aged between 26 and 33 years. In terms of educational attainment, a significant number of survey participants (68.3%) had attained only primary education (grades 1–7). A small proportion (3.9%) had no formal education, while only 1.6% had tertiary-level education. The mean education score was 32.91 ± 1.21 for those with primary education. Among the participants, 62.5% had resided in the area's VAGs for more than 20 years, with mean residence duration of 30.49 ± 0.98 years. Farming and fishing were the dominant sources of livelihoods. Fishing was the most frequently reported primary income source (69.4%), followed by livestock keeping (12.6%) and farming (10.4%). Only a very small proportion of the survey participants relied on activities such as forestry, trading, or gathering wild products.

Furthermore, out of the 309 survey participants, the largest proportion was from the Mulinga VAG (26.9%), followed by the Mishilundu VAG (22.3%). The Luola (19.7%) and Liuwa (19.4%) VAGs had comparable representation, while the Lumei VAG had the lowest participation rate at 11.7%. Meanwhile, beyond VAG distribution, household composition analysis revealed a mean household size of 5.27 ± 2.31 persons (range: 2–25), comprising a mean of 5.17 ± 1.76 adults (18+ years), 2.13 ± 1.44 children under 18 years, and 2.35 ± 1.73 elderly members (65+ years) per household. The household dependency ratio ranged from 0.00 to 8.00, with 34.4% of households recording ratios above 1.00, indicating that dependants outnumber economically active adults in a significant proportion of surveyed households. This high dependency burden, coupled with a mean of 2.13 children per household, signals considerable future pressure on natural resources as the current minor population enters resource-dependent adulthood, a concern consistent with the Western Province population growth rate of approximately 2.9% per annum [52]. Ethnically, the sample was Lozi-dominant (67.3%), followed by Luvale (22.3%), Mbunda (8.7%), Bemba (1.3%), and Tumbuka (0.3%), reflecting the Barotseland landscape's demographic character and providing important context for the ethnicity-based differences in conservation awareness reported in Section 3.5.

3.2. Community Perception of Natural Resource Values

3.2.1. Community Perception of Fishery Resource Values

The majority of the survey participants (76.2%) in the Liuwa Plain NP identified Bubble fish (*Tetraodontidae*) as the most valued fish species (Figure 2). Other less important species included breams (*Abramis brama*) (38.6%), Nembele (*Synodontis macrostoma*) (20.1%), and Tiger fish (*Hydrocynus vittatus*) (9.4%). Tupepe (*Petrocephalus catostoma*) was the least valued (1.7%).

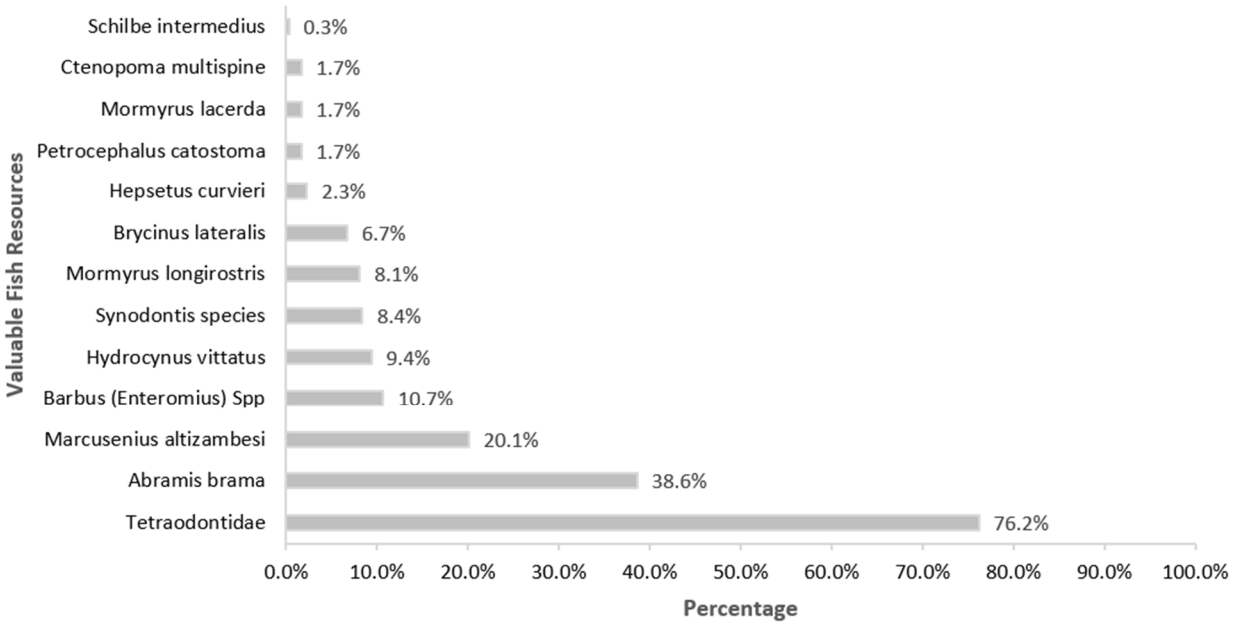


Figure 2. Perceived community values of fish resources in Liuwa Plain National Park, western Zambia, in 2024.

Meanwhile, participants emphasised the importance of avoiding harmful practices, such as using chemicals and mosquito nets (88.6%), while 11.1% highlighted net fishing as important, and a minimal proportion (0.3%) reported fish bans/seasonal closure periods as healthy or very healthy. Regarding illegal practices, it emerged as the most significant threat, cited by 37.4%, followed by drought (24.6%) and overfishing (24.3%). Climate

change impacts, such as fluctuating water levels, were mentioned by 13.1%. Lesser concerns included community awareness (0.3%) and resource use conflicts (0.3%). Among the reported declining species, Tiger fish (*Hydrocynus vittatus*) stood out significantly at 71.4%, followed by breams (*Abramis brama*) (20.0%), Milumeshi (*Clarias gariepinus*) (15.7%) and Ndikusi (*Mormyrus longirostris*) (11.4%). Despite the decline, 49.2% of participants reported that there have been no initiatives toward fishery conservation in the Liuwa Plain NP. Of those who noted interventions, 26.2% mentioned bans of harmful gear like mosquito nets and chemicals, while 24.6% cited seasonal fishing bans. In terms of solutions, 82.0% of the participants in the study answered "No". Only small proportions suggested options like seasonal fishing bans (3.9%), rotational grazing systems (3.0%), or collaborative management (2.3%).

Similarly, perceptions of major threats to fishery conservation, particularly illegal fishing practices, were predominantly categorised as economic concerns by 114 participants (36.9%). In addition, 150 participants (37.7%) highlighted Tiger fish (*Hydrocynus vittatus*) as a key species experiencing noticeable decline. When asked about initiatives or regulations in place to protect fishery resources, 152 participants (49.2%) indicated no initiatives were known or visible.

3.2.2. Community Perceptions of Forest Resource Values

The most valuable tree species in the study area included Mubula (*Parinari curatellifolia*) (88.2%) and Muzauli (*Gibourtia coleosperma*) (62.7%). The findings in this study revealed that forests in the Liuwa Plain NP hold significant functional and cultural value for local communities (Figure 3). The results indicated that the most commonly reported activity was the collection of non-timber forest products, such as fruits, nuts, honey, and medicinal plants, accounting for 44.1%. Harvesting fuel wood for domestic use was the second most prevalent activity, reported by 22.1% of survey participants. Meanwhile, slash-and-burn agriculture was cited by 19.65% of the participants. Logging for construction materials represented 13.9% of interactions. Only 0.4% of survey participants indicated grazing livestock in forested regions. About 61.2% of participants emphasised that forests primarily provide livelihood resources. Conversely, cultural and environmental roles were noted by smaller portions, with 8.1% citing cultural significance and 7.2% acknowledging the forests' contribution to environmental stability. An additional 23.5% pointed to other roles, such as windbreak services for crop protection of their farms, while also contributing essential materials for the construction of livestock shelter, as well as their role in supporting farming practices within the Liuwa Plain NP. Additionally, the survey participants also noted and highlighted regulating services including rainfall promotion and oxygen supply.

Furthermore, perceptions of forest health suggested a cautiously optimistic view, with 55.6% of survey participants rating forests as healthy and 12.2% as very healthy. However, concerns persist with 15.1% viewing forests as degraded and 9.5% as very degraded. When asked about perceived threats to forest resources, nearly a fifth (19.4%) cited deforestation as a primary concern, followed by wildfires (12.5%) and climate change and deforestation combined (13.8%). Notably, 30.3% of survey participants reported no threats. Specific threats, such as deforestation (29.8%) and wildfires (27.5%), emerged as the most acknowledged by the survey participants, while illegal logging was low at only 0.7%, despite its known ecological impacts. Again, 35.7% of survey participants reported no perceived threats. On the matter of recent conservation initiatives, responses were nearly split, with 52.1% indicating that no initiatives had been observed or implemented, while 47.9% acknowledged some form of activity. Regarding the functional role of forests, 60.8% cited the provision of livelihoods as the primary contribution forests make to daily life. This interaction was reported by a considerable portion of the survey participants (44.1%).

In terms of ecological awareness, a notable portion of the community (29.8%) perceived no threats to forests resources.

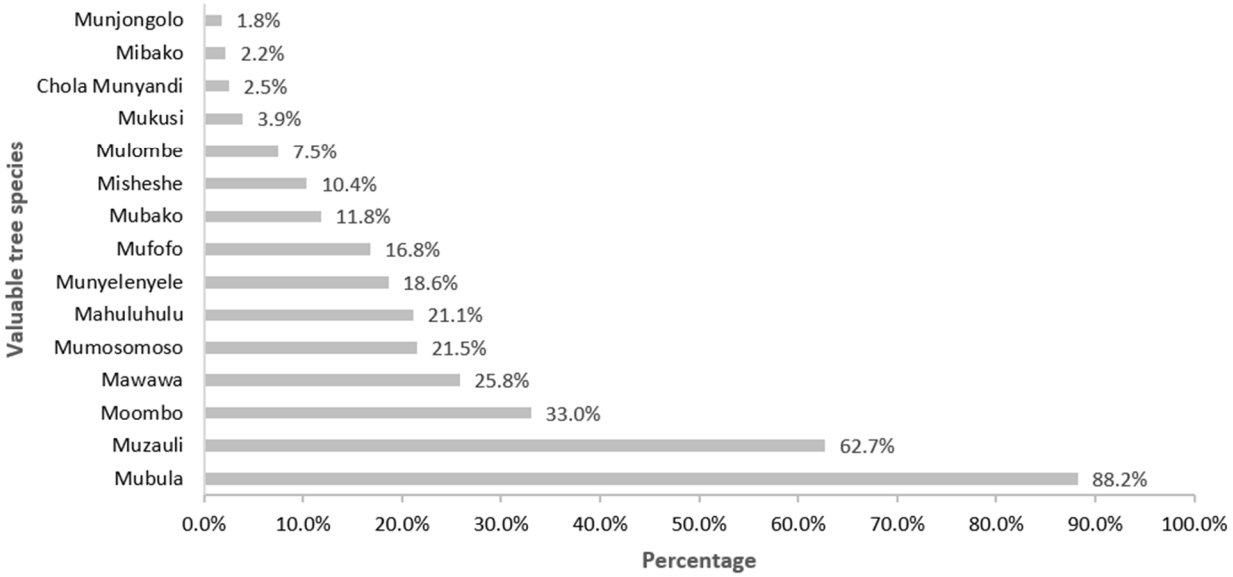


Figure 3. Perceived community values of tree species in Liuwa Plain National Park, western Zambia, in 2024.

3.2.3. Community Perceptions of Land Resource Values

Agricultural land is considered the most critical natural resource within the Liuwa Plain NP ecosystem, cited by 62.5% of the survey participants. This is followed by water (22.0%), while forests (6.5%), fisheries (5.5%), and wildlife (3.2%) were viewed as less prominent in relative importance. In terms of income and sustenance, 60.8% of the survey participants identified land as the primary contributor, with a smaller proportion recognising combined natural resource benefits, particularly land and forests (2.6%).

The dominant land use pattern is farming, accounting for 67.9% of valid responses. Other land use combinations, such as farming with settlements (19.2%) or with wildlife habitats, are less prevalent. Access to land was reported as very important (68.1%) by the survey participants, with an additional 30.0% considering it important. On land degradation drivers, deforestation (25.6%) and drought (13.9%) were among the most frequently cited, along with bad farming practices (12.3%) and soil erosion (9.4%). Notably, 25.6% of the survey participants saw no clear drivers. When asked about visible impacts, 33.4% pointed to the combined effects of deforestation, drought and severe land degradation, and 26.9% noted extensive erosion in large areas. However, 36.4% reported no noticeable issues. Despite the pressing challenges, 83.8% stated there had been no recent land conservation or planning efforts within the Liuwa Plain NP ecosystem (Table 2).

Furthermore, traditional land practices were largely absent, with 85.2% agreement, while only small fractions reported practices such as agroforestry (4.6%), shifting cultivation (2.6%), or communal farming (2.0%). Moreover, a majority of survey participants emphasised agricultural land and other economically aligned natural resources as central to their livelihoods, with 62.5% (n = 193) and 60.8% (n = 188), respectively, identifying them as the most important for income and sustenance.

Table 2. Perceived community values of land, water and wildlife resources in the Liuwa Plain National Park in western Zambia in 2024.

Category	Percent
Most important resource (Agricultural Land)	62.5%
Natural resource(s) in the ecosystem that contribute most to income and sustenance (Land)	60.8%
Valuable wildlife resources (Wildebeest)	37.2%
Reliance on water resources (Fishing, Drinking Water and Domestic Use)	35.9%

3.2.4. Community Perceptions of Water Resource Values

Community responses in this present study revealed that water resources play a vital role in daily livelihoods within the Liuwa Plain NP (Table 2). The most cited uses were drinking and domestic purposes (36.3%) and fishing (36.3%), jointly accounting for over 72% of all the responses. Additional uses, such as transport (13.1%), livestock watering (8.8%), and agriculture (5.6%), were mentioned less frequently. When asked to assess water quality and availability, 60.1% of the survey participants rated it as poor, with an additional 5.0% indicating it as very poor. Only a small proportion rated the situation positively, with 1.0% rating it as excellent and 26.7% as good. Regarding perceived changes in water availability over time, a strong majority of 80.9% observed a significant decline, while only 2.6% noted any level of improvement. When probed about concerns with water quality or access, 80.3% reported challenges related to accessing clean drinking water. Other concerns, such as seasonal shortages, were raised by 4.2%, while 14.9% expressed no major concerns. On the issue of pollution or contamination sources, wildlife was most frequently identified (46.4%), followed by natural causes, such as flooding (24.8%) and deforestation or erosion (5.6%). Smaller proportions pointed to agricultural runoff (4.9%) and sanitation issues, such as pit latrines (2.6%) and open defecation (2.3%).

When asked about existing conservation efforts within the Liuwa Plain NP, an overwhelming 86.9% of the survey participants indicated that no initiatives had been implemented to promote water conservation and watershed management in the study area. Only 13.1% acknowledged the presence of such efforts. Concerns about water quality and availability, particularly access to clean drinking water, were expressed by 80.3% (n = 248). Furthermore, 250 survey participants reported significant declines in water quantity or access over time.

3.2.5. Community Perceptions of Wildlife Resource Values

A majority of survey participants recognised the ecological and cultural importance of wildlife in the Liuwa Plain NP (Table 2). Specifically, 36.2% regarded wildlife as important, while an additional 14.7% viewed it as very important. Only 16.9% considered it not important, and 31.6% found it somewhat important. Regarding species-specific value, wildebeest (37.2%) and zebra (35.5%) were most frequently cited as valuable. Regarding population trends, a majority (55.6%) assessed the condition as good, while 12.5% considered it very good. However, 24.3% of participants reported either a poor or declining state.

The most frequently cited causes of wildlife habitat loss were illegal poaching (32.3%), climate change (20.6%) and drought (18.2%), highlighting both anthropogenic and environmental pressures. Deforestation was mentioned by 9.3% of participants. Patterns of perceived species decline closely mirrored those socio-economically and culturally valued most by the local communities. Wildebeest (16.1%), impala (12.7%), wild dogs (11.9%), eland (7.4%), buffalo (11.1%), and zebra (8.4%) were among the most frequently mentioned as declining. Moreover, almost all survey participants (99.3%) affirmed that wildlife conservation initiatives had been implemented in the area. Survey participants, when asked about ongoing projects, had divided responses, with about 49.2% confirming, while

50.5% indicated their non-existence. Cultural beliefs about wildlife were reported by a small fraction of survey participants, while 93.1% stated no association of beliefs. Minor proportions acknowledged that some species are regarded as sacred (1.3%), used in rituals (0.3%), linked to ancestral spirits (2.6%), symbolise good fortune (1.3%), or are protected due to traditional authority (0.7%).

A majority of the survey participants, 37.2% (n = 173), identified wildebeest as the most ecologically valued wildlife species in the ecosystem. Similarly, perceptions of species decline were also notably centred on wildebeest, with 16.1% (n = 61) identifying it as among the most affected.

3.2.6. Perceived Resource Values and Management Measures by Local Communities

A large proportion of survey participants (42.3%) rated the current state of natural resource management in their community as good, while 29.9% perceived it as very good. Overall, these categories accounted for over 71%. With regard to conservation priorities, 65.7% emphasised the need to enhance conservation education and awareness within the local community. An additional 31.4% prioritised the promotion of sustainable agricultural practices to mitigate land degradation. Only a small minority of survey participants emphasised alternative livelihood options (2.6%) or better funding access (0.3%). Among the suggested conservation measures, stricter fishing rules (33.1%) were most frequently proposed, with NGO and government partnerships (7.7%) emerging second. Other notable recommendations were tree planting initiatives (4.3%), sustainable forestry practices (4.3%) and greater community participation (3.0%), though nearly a third of survey participants (30.4%) offered no specific proposals. Regarding stakeholder responsibilities, opinions varied, with 26.5% highlighting that communities are active conservation participants, while 24.5% advocated for education and training on sustainability education. Financial support (10.3%) and integrated policies (94.65%) received moderate attention, with traditional knowledge (1.7%) and research (1.35%) being rarely mentioned. For specific community-benefiting projects aligned with conservation goals, 38.8% favoured the introduction of alternative livelihoods, such as beekeeping and eco-tourism. Establishing community-run protected areas followed at 30.7%; afforestation/reforestation projects (17.8%) and sustainable natural resource management training (9.7%) were also noted. Only 2.9% prioritised enhanced water management systems.

The findings in the present study also revealed distinct patterns in community perceptions and interactions with key ecological and economic resources within the Liuwa Plain NP ecosystem (Table 3). Fish resources within the Liuwa Plain NP, particularly Bubble fish (*Tetraodontidae*), were regarded as economically valuable by 76.2% of the survey participants, while 71.4% observed a decline in Tiger fish (*Hydrocynus vittatus*) populations. Illegal fishing practices were identified as the primary threat to fishery conservation by 36.9% of the survey participants sampled. Notably, 49.2% reported the absence of any visible conservation initiatives targeting fishery resource protection, reflecting potential governance or policy gaps. In addition, forest resources were highly valued, with 88.2% citing Mubula (*Parinari curatellifolia*) as the most important tree species, and 60.8% recognising forests for their livelihood roles. Furthermore, 40.1% of the survey participants engaged in the collection of non-timber forest products, including honey, nuts, and medicinal plants. Regarding wildlife, 68.9% identified wildebeest as ecologically significant, although only 25.0% perceived them as declining. Agricultural land emerged as the most important natural resource for livelihoods (62.5%) and income generation (60.8). Water was also a critical resource, with 35.9% depending on it for fishing, drinking and domestic use and 80.3% expressing concerns about access to clean drinking water. However, 80.9% reported noticeable declines in water availability and quality over time in the Liuwa Plain

NP. Further, despite the significance of forest resources, 29.8% perceived no threats to forest resources within the ecosystem.

Table 3. Summary of responses on natural resource values, threats and suggested management measures in Liuwa Plain National Park, western Zambia, 2024.

Response	Category	Number (%)
Knowledge		
Valuable fish resources (Bubble fish)	Economic	227 (76.2)
Major threats to fishery conservation (illegal practices)	Economic	114 (36.9)
Fish resources declining (Tiger Fish)	Economic	150 (71.4)
Initiatives regarding fishery conservation or regulations being implemented to protect fisheries in the ecosystem (no initiatives)	Ecological	152 (49.2)
Tree species most valued (Mubula)	Economic	246 (88.2)
Roles played by forests in the daily lives of the community members (provide livelihoods)	Economic/social	188 (60.8)
Interaction with forest resources (collecting non-timber products (e.g., fruits, nuts, honey and medicinal plants)	Economic	124 (40.1)
Valuable wildlife resources (wildebeest)	Ecological	173 (68.9)
Perception		
Most important resource (Agricultural land)	Economic	193 (62.5)
Resource(s) in the ecosystem that contribute most to income and sustenance (land)	Economic	188 (60.8)
Reliance on water resources (fishing; drinking water and domestic use)	Economic/social	111 (35.9)
Water quality or availability concerns (issues with access to clean drinking water)	Economic/social	248 (80.3)
Perceived changes in water or access over time (significant decline)	Ecological	250 (80.9)
Wildlife resources declining (wildebeest)	Ecological	61 (25.0)
Perceived the threats to forest resources (no threats)	Ecological	92 (29.8)
Suggested management measures across different VAGs in Liuwa Plain NP		
Recommendations or priorities in improving conservation (enhance conservation education and awareness campaigns within local communities)	Social	203 (65.7)
Recommendations or priorities in improving conservation (introduce stricter fishing regulations, e.g., seasonal bans, size limits)	Social	99 (32)
Roles of local communities, governments, and organisations in conserving the ecosystem (participate actively in community-based conservation initiatives)	Social	80 (25.9)
Specific projects or interventions believed to benefit local communities and also promoting conservation goals (introducing alternative livelihoods, e.g., beekeeping, eco-tourism)	Ecological/social	120 (38.8)

The study also revealed strong community support for conservation education, with 65.7% (n = 203) emphasising awareness campaigns as crucial for improving conservation outcomes. Stricter fishing regulations emerged as another major focus, with 32% (n = 99) advocating for measures like seasonal bans and catch size limits, an approach showing particularly strong community alignment. Approximately 25.9% (n = 80) of survey participants showed a willingness to actively participate in community-based conservation initiatives. Furthermore, introducing alternative livelihoods, such as beekeeping and eco-tourism, was endorsed by 38.8% (n = 120).

3.3. Perceived Community Natural Resource Values

3.3.1. Natural Resources That Contribute to Income

The results indicated that land was overwhelmingly perceived as the most important resource, with 60.8% of survey participants identifying it as their primary source of income and sustenance in the Liuwa Plain NP ecosystem. While other resources played supporting roles—such as water (10.0%), fish (7.1%), and wildlife (3.6%)—their economic contributions paled in comparison. Notably, 12.9% of survey participants reported relying on a combination of land and water resources. Resources like forests (1.6%), and combined

options like land and forests (2.6%), land and wildlife (0.6%), and forests and water (0.6%), received minimal responses, collectively representing less than 5% of valid responses. When considering both standalone and combined responses involving land, over three quarters (75%) of community members confirmed its fundamental role in sustaining the Liuwa ecosystem's economy.

3.3.2. Top Natural Resource Priorities for Conservation

Forests emerged as the most prioritised resource for conservation, with 37.9% of survey participants emphasising their protection. Wildlife conservation ranked second at 20.4%, and fisheries followed closely at 18.1%, both recognised as vital resources. Agricultural land, while crucial for income generation, was prioritised by only 13.9%. Water resources, while crucial for domestic use and income generation, received the least focus at 9.7%.

3.3.3. Ranking of Natural Resources in Order of Importance

Wildlife (mean rank = 4.38) was the most valued resource for local livelihoods, followed closely by fishery resources (mean rank = 3.89). Forest resources occupied the immediate position (mean rank = 3.31). In addition, water resources (mean rank = 1.79) and agricultural land (mean rank = 1.63) ranked fourth and fifth, respectively (Table 4). Using Friedman's test, these rankings differed significantly from each other (χ^2 = 735.940, df = 4, $p < 0.001$).

Table 4. Friedman test for resource ranking in terms of importance for livelihoods in Liuwa Plain National Park, western Zambia, in 2024.

Resource Type	Mean	Std.Deviation	Min	Max	Mean Rank	Chi−Sqaure χ^2	df	*p*-Value
						735.94	4	<0.001 ***
Wildlife	4.38	0.73	1.00	5.00	4.38			
Fisheries	3.89	1.12	1.00	5.00	3.89			
Forestry	3.31	0.72	1.00	5.00	3.31			
Water resources	1.79	0.59	1.00	4.00	1.79			
Agricultural Land	1.62	1.10	1.00	5.00	1.63			

*** *Very highly significant*.

3.3.4. Rank of Natural Resources Which Are Most Vulnerable to Environmental Pressures

Agricultural land (mean rank = 2.09) emerged as the most at-risk resource, followed by wildlife (2.31), fisheries (2.74), and then forestry (3.69) and water (4.17), which were perceived as significantly less vulnerable (Table 5). Using Friedman's test, these rankings differed significantly from each other (χ^2 = 396.142, df = 4, $p < 0.001$).

Table 5. Friedman test for resource ranking for vulnerability to environmental pressures in Liuwa Plain National Park, western Zambia, in 2024.

Resource Type	Mean	Std.Deviation	Min	Max	Mean Rank	Chi−Sqaure χ^2	df	*p*-Value
						396.14	4	<0.001 ***
Agricultural Land	2.09	0.80	1.00	4.00	2.09			
Wildlife	2.31	1.04	1.00	5.00	2.31			
Fisheries	2.74	1.20	1.00	5.00	2.74			
Forestry	3.69	1.15	1.00	5.00	3.69			
Water	4.17	1.52	1.00	5.00	4.17			

*** *Very highly significant*.

3.3.5. Pairwise Comparisons Following the Friedman Test

Following the significant Friedman test, post hoc pairwise comparisons were conducted using the Wilcoxon signed-rank test with a Bonferroni-adjusted significance level of $\alpha = 0.005$ (Table 6). The results showed that all pairwise comparisons between the five natural resource categories were statistically significant (all $p \leq 0.001$). Wildlife was ranked significantly higher than fisheries ($Z = -5.570$, $p < 0.001$), forestry ($Z = -11.766$, $p < 0.001$), water resources ($Z = -15.121$, $p < 0.001$), and agricultural land ($Z = -14.658$, $p < 0.001$). Similarly, fisheries were ranked significantly higher than forestry ($Z = -6.874$, $p < 0.001$), water resources ($Z = -14.522$, $p < 0.001$), and agricultural land ($Z = -12.680$, $p < 0.001$). Forestry was also ranked significantly higher than both water resources ($Z = -14.546$, $p < 0.001$) and agricultural land ($Z = -12.864$, $p < 0.001$), while water resources were ranked significantly higher than agricultural land ($Z = -3.207$, $p = 0.001$). These findings indicate that respondents clearly distinguished the relative importance of each natural resource category for local livelihoods, supporting the hierarchical ranking observed in the Friedman analysis, with wildlife ranked highest, followed by fisheries, forestry, water resources, and agricultural land.

Table 6. Friedman post hoc analysis.

Comparison	Z	*p*-Value	Bonferroni Significant
Wildlife vs. Fisheries	−5.57	<0.001	Yes
Wildlife vs. Forestry	−11.77	<0.001	Yes
Wildlife vs. Water	−15.12	<0.001	Yes
Wildlife vs. Agricultural Land	−14.66	<0.001	Yes
Fisheries vs. Forestry	−6.87	<0.001	Yes
Fisheries vs. Water	−14.52	<0.001	Yes
Fisheries vs. Agricultural Land	−12.68	<0.001	Yes
Forestry vs. Water	−14.55	<0.001	Yes
Forestry vs. Agricultural Land	−12.86	<0.001	Yes
Water vs. Agricultural Land	−3.21	0.001	Yes

3.3.6. Effect Size

To assess whether the observed differences in natural resource rankings reflected a consistent pattern of community priorities, rather than only statistically significant differences, Kendall's coefficient of concordance (W) was calculated alongside the Friedman test (Table 7). The results indicated a statistically significant level of agreement among respondents regarding the relative importance of natural resources for local livelihoods, Kendall's $W = 0.611$, χ^2 (4, N = 299) = 730.473, $p < 0.001$. This finding indicates substantial agreement among respondents in ranking wildlife as the most important livelihood resource, followed by fisheries, forestry, water resources, and agricultural land.

Table 7. Kendall's W test.

Measure	Value
Number of respondents (N)	299
Kendall's coefficient of concordance (W)	0.61
Chi-square (χ^2)	730.47
Degrees of freedom (df)	4
Asymptotic significance (*p*-value)	<0.001

3.4. Factors Influencing Community Perceptions of Natural Resources

Based on the analysis of the factors affecting community perceptions in the Liuwa Plain NP (Table 8), there was a statistically significant association between ethnicity and

the level of awareness of conservation strategies (χ^2 = 90.481, df = 16, $p < 0.000$, Cramér's V = 0.283). Among the Lozi survey participants, constituting the majority, 89.5% reported very high awareness, while 51.7% indicated high awareness. For Mbunda participants, 6.3% reported very high awareness and 7.5% had high awareness. In contrast, Luvale survey participants displayed a different pattern. Only 2.1% fell into the very high awareness category, whereas a 39.2% were in the high awareness category. Among the Bemba, 2.1% of the survey participants reported very high awareness and another 1.7% reported high awareness. The Tumbuka group, on the other hand, had no representation in either the very high or high awareness categories.

Table 8. Statistical association of local people's perceptions of community resources and socio-demographic factors influencing Liuwa Plain National Park in western Zambia in 2024.

Variable	Likelihood Ratio	df	*p*-Value	Cramer's V
Duration vs. Awareness of Conservation Strategies	39.735	12	0.000 ***	0.196
Duration vs. Importance of Fisheries	18.661	12	0.097	0.147
Duration vs. Fishing Practices	13.135	6	0.041 *	0.151
Duration vs. Importance of Wildlife	13.947	12	0.304	0.120
Gender vs. Awareness of Conservation Strategies	5.934	5	0.204	0.138
Gender vs. Importance of Fisheries	5.629	4	0.229	0.130
Gender vs. Fishing Practices	1.512	2	0.470	0.061
Gender vs. Importance of Wildlife	5.979	4	0.201	0.130
Ethnicity vs. Importance of Fisheries	8.118	16	0.945	0.072
Ethnicity vs. Awareness of Conservation Strategies	90.481	16	0.000 ***	0.283
Ethnicity vs. Specific Fishing Practices for Sustainability	8.434	8	0.392	0.145
Ethnicity vs. Perceived Importance of Wildlife	14.498	16	0.562	0.112
Education level vs. Awareness of Conservation Strategies	18.136	12	0.112	0.144
Education level vs. Perceived Importance of Wildlife	13.228	12	0.353	0.149
Education level vs. Importance of Fisheries	9.913	12	0.624	0.125
Education level vs. Specific Fishing Practices Crucial for Fish Sustainability	3.285	6	0.772	0.064

*** *Very highly significant*; * *significant*.

Furthermore, there was a statistically significant association between duration of stay in the area and awareness of conservation strategies, with notable differences particularly within the "very high awareness" and "high awareness" categories (χ^2 = 39.735, df = 12, $p < 0.001$; Cramér's V = 0.196). However, among the participants in duration category I, about 22.5% reported high awareness and 9.5% reported very high awareness. In category II, 20.0% indicated awareness, with 18.9% registering very high awareness. For category III, 33.7% recorded very high awareness, but only 14.2% reported high awareness. In category IV, 43.3% indicated high awareness, with 37.9% reporting very high awareness.

There was a statistically significant association between survey participants' length of stay and their perception of sustainable fishing practices (χ^2 = 13.135, df = 6, p = 0.041, Cramer's V = 0.151), where duration category I (newer residents), constituting 14.8% of survey participants, avoided chemicals and mosquito nets as a fishing practice. Additionally, duration category II also reflected high endorsement, with 17.7% supporting the avoidance of destructive gear and 8.8% supporting fishing. However, duration category III showed a slight shift, where 22.1% agreed on avoiding chemicals and mosquito nets, while a notable 47.1% supported gillnet fishing. Furthermore, duration category IV (longest-settled residents) showed a return to strong support for gear avoidance, at 45.4%, and 38.2% endorsed net fishing.

Predictors of Conservation Awareness: Model Fit and Significance

The ordinal logistic regression model was statistically significant (Table 9) (Likelihood Ratio $\chi^2 = 29.037$, df = 4, $p < 0.001$), indicating that the predictors collectively improved prediction of awareness. Goodness-of-fit statistics suggested adequate model fit (Pearson $\chi^2 = 568.352$, $p = 0.184$; Deviance $\chi^2 = 530.081$, $p = 0.600$). The model explained approximately 9.7% of the variance in awareness (Nagelkerke $R^2 = 0.097$).

Table 9. Parameter estimates from the ordinal logistic regression predicting awareness of conservation strategies.

Predictor	β	SE	*p*	Odds Ratio (Exp(β))	95% CI for β	Interpretation
Duration lived	−0.01	0.006	0.073	0.99	−0.024 to 0.001	Not significant
Leadership (0 vs. 1)	0.72	0.283	0.011	2.06	0.166 to 1.277	Significant
Tribe (Other vs. Lozi)	−0.88	0.227	<0.001	0.42	−1.322 to −0.431	Significant
Gender (Male vs. Female)	−0.22	0.214	0.298	0.80	−0.642 to 0.196	Not significant

As seen in Table 9 above, leadership status was a significant predictor of the awareness of conservation strategies and resources (β = 0.721, $p = 0.011$). The estimated odds ratio (OR = 2.06) indicates that respondents who held a leadership position or served as members of the village leadership structure had approximately twice the odds of being in a higher awareness category compared with respondents who did not hold any leadership or membership role, after controlling for the other variables in the model. In addition, tribal affiliation was also a significant predictor of awareness (β = −0.876, OR = 0.42, $p < 0.001$). Respondents who identified as Lozi had significantly lower odds of being in a higher awareness category than respondents from other tribal groups. Specifically, the odds of reporting a higher level of awareness among Lozi respondents were approximately 58% lower than those of respondents from other tribes, holding all other variables constant. Furthermore, duration of residence within the Village Action Group (VAG) area (β = −0.011, $p = 0.073$) and gender (β = −0.223, $p = 0.298$) were not statistically significant predictors of awareness. Consequently, gender was also not a statistically significant predictor of awareness and knowledge of conservation strategies (β = −0.223, OR = 0.80, $p = 0.298$). Male respondents had approximately 20% lower odds of reporting higher awareness than female respondents after adjusting for duration of residence, leadership status, and tribal affiliation.

3.5. Perceived Conservation Threats

More than half of the survey participants (54.7%) cited the effects of climate change, such as droughts and floods, as the most important conservation challenge in the Liuwa Plain NP ecosystem (Figure 4). Significant issues that showed the ongoing human pressures on wildlife and forest resources were poaching (9.7%), deforestation (8.4%), and human–wildlife conflicts (8.1%), while 7.1% acknowledged overfishing as a conservation challenge. Issues like water scarcity and pollution (6.1%), insufficient community participation in conservation (1.9%), and insufficient farming inputs (1.3%) were reported by fewer survey participants. Remarkably, only 2.3% of the survey participants said there were no conservation issues in their communities within the Liuwa Plain NP.

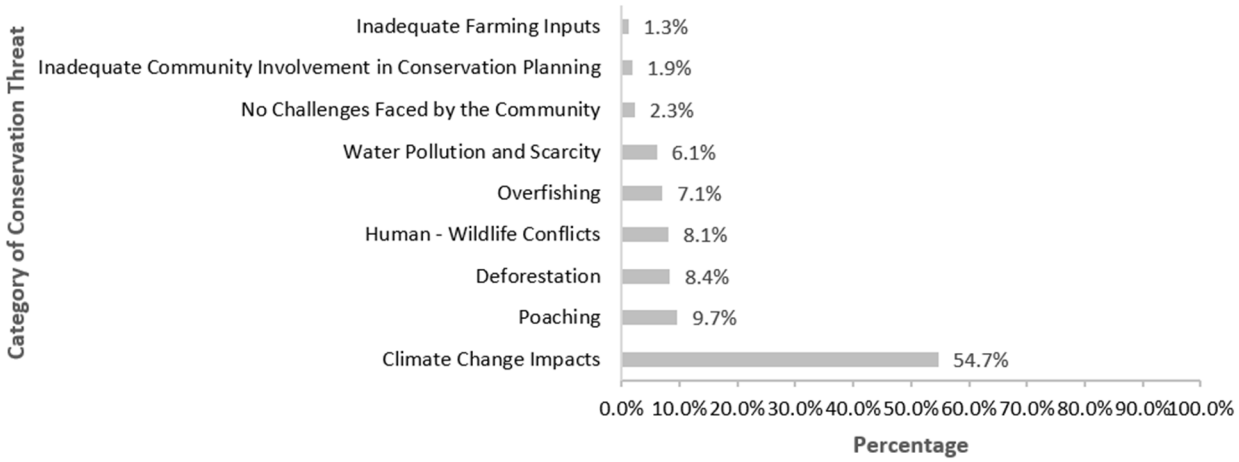


Figure 4. Conservation threats in Liuwa Plain National Park, western Zambia, in 2024.

4. Discussion

This study revealed that the local communities in the Liuwa Plain NP hold multi-dimensional perceptions of natural resource values, remarkably shaped by socio-demographic characteristics and localised contextual ecological stressors. Furthermore, the multi-dimensional natural resource valuation patterns documented in the Liuwa Plain NP span instrumental, relational, and cultural dimensions, which align with the inclusive typology of nature's values proposed by [52]. This demonstrates that communities simultaneously hold instrumental (livelihood-provisioning), relational (cultural identity, reciprocity), and intrinsic values for natural resources, and that effective conservation governance must recognise all three rather than prioritising market-based values alone. The assessments of the perceptions of natural resources in the Liuwa Plain NP revealed a clear hierarchical pattern of community natural resource valuations, with wildlife ranking and valued as the most critical and important resource for livelihoods, followed by fishery resources, forestry resources (including timber and non-timber products, such as mushrooms and honey), water resources and agricultural land. Local communities demonstrate differentiation among these natural resources based on their perceived livelihood contributions, reflecting a complex interplay between traditional subsistence practices, economic opportunities, and evolving human environment interactions within the Liuwa Plain NP. In addition, the local communities in the Liuwa Plain NP confirmed critical awareness of natural resource significance for both livelihood support and ecological stability, with significant recognition and valuation of wildlife and fisheries, particularly Bubble fish (*Tetraodontidae*).

Fisheries, identified by over 93% of the survey participants as important or very important, exhibited strong ecological and economic salience across all demographic strata. However, a decline in iconic species such as Tiger fish (*Hydrocynus vittatus*) is an indication of both cultural attachment and ecological awareness, reinforcing a strong association between perceived species decline and illegal fishing practices. Notably, community perception of Tiger fish (*Hydrocynus vittatus*) is consistent with available secondary ecological evidence, with studies such as [53–55] documenting population pressures on this species across the sub-Saharan African river systems, thereby, validating community-based ecological knowledge as a reliable and scientifically corroborated indicator of natural resource change in co-managed protected areas. Conversely, advocacy for gillnet fishing by a midterm dweller may be linked to the desire to increase catches and economic returns, as opposed to use of more traditional fishing methods. To add to that, the observed quantitative differences in fish resources across species, as seen in Figure 2, are attributable to three interacting factors. First, differential habitat dependency and constraints on to access certain species

are connected: large-bodied, high-value species such as Tiger fish (*Hydrocynus vittatus*) and breams (*Abramis brama*) are confined to deep, fast-flowing main-channel habitats that are accessible only to households with canoes and specialist gear, limiting fish resource volume relative to community demand [56]. In contrast, small-bodied cyprinids, such as Barbus (*Enteromius*) spp., and species tolerant to low-oxygen floodplain pools are by a substantially larger proportion of households across a wider spatial extent. Second, seasonal accessibility further amplifies these differences: stenotopic riverine species are catchable only during peak flood and early recession phases, reducing annual frequency to as few as one or two months, whereas generalist species remain accessible across multiple seasons. Third, cultural and dietary preferences among Lozi communities confer high subsistence salience on select species irrespective of raw abundance: Bubble fish (*Tetraodontidae*), for instance, are preferentially targeted for household consumption, sustaining disproportionately high reported importance. Collectively, these ecological, logistical, and socio-cultural filters explain the magnitude of the inter-species variation captured in Figure 2. Furthermore, forest products, such as Mubula (*Parinari curatellifolia*) tree species, were the most valued tree species, and they are indispensable for supporting community livelihoods, emphasising their provisioning role, notably through non-timber forest products [57]. This supports previous findings across the Miombo and Kalahari woodlands where it was found that communities depend heavily on fuelwood, wild fruits and honey [58,59].

Despite the natural resource-linked dependence, deforestation and wildfires were inconsistently recognised as threats, with a sizable portion reporting no known forest threats. This perceptual asymmetry warrants analytical consideration [60]. Unlike fishery decline, which is experienced acutely through reduced catches, forest degradation through deforestation and fire is often gradual and spatially diffuse, potentially falling below perceptual thresholds for many community members. Additionally, communities residing in the park for generations may have normalised baseline forest cover loss, reducing their sensitivity to incremental change [60]. This perceptual gap highlights the need for targeted conservation education specifically addressing forest ecosystem services and the early indicators of forest degradation and threat. This perceptual asymmetry suggests the need for enhanced conservation education and awareness campaigns within local communities and the ecosystem, while expressing strong support for community-led management interventions, including stricter fishing regulations (e.g., seasonal bans/closures, mesh size limits) and NGO collaborations. Furthermore, other interventions could include [61] introducing alternative and integrated livelihood strategies, such as beekeeping, eco-tourism and reforestation programmes, in response to observed ecological changes such as declining water availability over time in the Liuwa Plain NP. Regarding wildlife, while the most valued economically, it was still recognised for its cultural and ecological importance. Species, such as wildebeest and zebra, were perceived as both valuable and vulnerable, though facing threats from anthropogenic and environmental factors, such as poaching and climate change, respectively, as shown in [62], and consistent with findings from the Lomami Landscape in DR Congo, where hunters' own perceptions of wildlife decline were shown to be a critical, and frequently overlooked, input for protected-area governance and resource use management [63]. These patterns confirm the concept of species-specific valuation, which influences conservation support; however,, weak associations between ethnic affiliation and wildlife perceptions indicated a relatively uniform cultural valuation.

Furthermore, the study affirms that perceptions of natural resource vulnerability closely mirror their livelihood importance, while this concern for landscape ecosystem service degradation resonates with [61]. A study in Hubei Province, China, demonstrated that even government-intended resource protection scenarios resulted in declining ecosystem service value, underscoring that conservation governance frameworks must explicitly

account for the differential vulnerability of ecosystem services to land use change, a finding mirrored in the present study's identification of agricultural land as the most environmentally vulnerable natural resource in the Liuwa Plain NP. Agricultural land was not only valued and ranked the lowest by the local communities, but also emerged the most vulnerable to environmental pressures, including drought, erosion, and deforestation. The study uncovered strong differentiation in community prioritisation and risk awareness. These insights are vital for adaptive natural resource governance and spatially differentiated management approaches. For instance, while land is economically paramount, forests and fisheries were prioritised for conservation efforts, indicating an implicit community acknowledgment of ecological fragility. The study further revealed that socio-demographic factors, such as length of residency and ethnic affiliations, particularly among the Lozi-speaking people, underpinned the importance of conservation awareness strategies and sustainable natural resource management attitudes.

Previous studies show a strong alignment with the wider literature on natural resource valuation in rural African socio-ecological systems. For instance, in their study in Zimbabwe, Shereni and Saarinen [64] asked survey participants to indicate the key natural resources they considered present in their community; according to the participants, firewood, construction materials, wild fruits and grazing land for livestock were the most important natural resources for the communities living adjacent to the Hwange NP, similar to the Liuwa Plain NP. Similarly, a recent study around Kilimanjaro National Park in Tanzania found that community perceptions of conservation were closely tied to perceived livelihood vulnerability and quality of life, reinforcing the view that conservation attitudes in shared landscapes may not be separated from the material well-being of resident communities [65]. In the Liuwa Plain NP, local communities recognised the critical importance and value of natural resources for livelihoods and cultural practices around the use of wildlife, fisheries and forestry, which were the most prominently valued for livelihood support, food security, and cultural identity. Our study also aligns with other previous studies that documented the influence of education, residency, and occupation on perceptions in Ghana and Uganda [66,67]. Furthermore, in the Liuwa Plain NP, significant environmental challenges and pressures, such as climate change in the form of droughts and floods, poaching, deforestation [68], perceived decline in fish stocks, particularly Tiger fish (*Hydrocynus vittatus*), and changes in water availability over time, resonate very well with a study in Northern Benin [69]. Additionally, the widespread forest degradation and habitat loss due to deforestation and climate change impacts in the Liuwa Plain NP mirrors [9], who identified hunting, logging and fire as key threats globally across the sampled PAs in their study. Our study in the Liuwa Plain NP further revealed differences in perceived vulnerability across natural resources, indicating that communities recognise differential susceptibility patterns among their most valued livelihood natural resources within the Liuwa Plain NP ecosystem.

The findings from this study present critical policy implications for natural resource management in the Liuwa Plain NP that necessitate a fundamental shift toward differentiated, community-responsive governance frameworks. The findings from this study further supports [52] argument that conservation policies achieve greater legitimacy and effectiveness when they explicitly integrate the diverse values communities hold for nature, including relational and intrinsic dimensions, alongside livelihood-based instrumental values [70]. Given a hierarchical valuation of natural resources with wildlife and fisheries as a primary livelihood foundation, policymakers must prioritise integrated land use planning that explicitly safeguards critical wildlife corridors and aquatic habitats, while ensuring that surrounding agricultural zones are managed in a manner that reduces encroachment, habitat degradation, and overfishing pressure. Building on the existing formal tripartite co-

management agreement between the APN, BRE, and DNPW in 2003 [17], which provides an institutional foundation for collaborative governance of the Liuwa Plain NP, is essential [71]. The partnership reflects a broader global shift toward participatory governance models in protected area management [72]; specifically, Mulinga and Mishilundu VAGs, where fishing constitutes the primary livelihood for the majority of respondents, should be prioritised for the establishment of community fishery co-management committees, the enforcement of seasonal fishing bans, and the introduction of mesh size regulations to reduce pressure on declining species such as Tiger fish (*Hydrocynus vittatus*). In operationalising these recommendations, the DNPW should exercise its statutory authority for the enforcement of resource protection, including fishing ban regulations and anti-poaching control, while the APN provides the requisite technical and financial support for fishing gear regulation programmes, community-based wildlife monitoring systems, and the development of alternative livelihood programmes, such as eco-tourism and beekeeping. VAG committees should lead local-level natural resource monitoring, community compliance facilitation, and participatory natural resource management planning to ensure accountability and grassroots ownership of conservation outcomes.

Additionally, the integration of community-led fisheries management and participatory wildlife monitoring in the Liuwa Plain NP may strengthen compliance, enhance resource regeneration, and promote equitable benefit sharing. Therefore, by aligning conservation innervations with the socio-economic centrality of wildlife and fisheries, management strategies can achieve greater legitimacy and effectiveness. Such an approach not only sustains biodiversity, but also reinforces the long-term viability of livelihoods, ensuring that conservation goals are inseparable from well-being of the communities that highly value and depend on these critical natural resources. The strong influence of the socio-demographic factors, particularly the exceptional conservation awareness among Lozi communities, demands for the integration of indigenous knowledge systems [73,74] into the park management protocols and the establishment of culturally sensitive co-management plans. Specifically, the BRE should assume a lead role in integrating traditional ecological knowledge (TEK) into park management protocols and in leveraging traditional leadership structures for community mobilisation around conservation education, ensuring that cultural legitimacy underpins co-management planning at all levels. For VAGs reporting high forest threat perception, such as Luola and Liuwa, targeted conservation education campaigns and community-led restoration programmes should be prioritised [75], with the APN and DNPW assuming shared institutional responsibility: the APN should resource and design the interventions, and the DNPW should provide statutory oversight in collaboration with local traditional leaders and the Barotse Royal Establishment (BRE).

Furthermore, given the identified perceptual gap whereby a substantial proportion of respondents did not recognise forest threats, the APN, DNPW, and BRE should collaboratively design and implement tailored conservation education programmes specifically targeting communities demonstrating low forest threat awareness, incorporating visual forest monitoring indicators and community-accessible early warning tools that bridge the gap between gradual ecological change and local perception. In addition, the spatial variations in natural resource valuation and the universal importance of fisheries across demographic groups call for geographically targeted management strategies that include community-specific fishing quotas, localised enforcement mechanisms, and the development of alternative and integrated livelihood programmes in areas where natural resource dependency is highest. To address the identified environmental pressures, including climate-induced droughts, declining Tiger fish (*Hydrocynus vittatus*) populations and fish stocks, and deforestation, policy frameworks must incorporate adaptive management principles that enable flexible responses to ecological changes, while strengthening community-led initiatives, such as reforestation

programmes, sustainable fishing methods and climate-resilient agricultural practices, which align with local priorities and traditional conservation practices. Therefore, we recommend that the APN, BRE, and DNPW collaboratively develop VAG-specific conservation action plans directly informed by the natural resource value rankings presented in Tables 3 and 4. Within this framework, the APN should provide technical and financial support, the DNPW should ensure statutory compliance and enforcement, the BRE should facilitate cultural mobilisation and the embedding of TEK, and VAG committees should lead local monitoring and participatory planning with each plan, clearly defining targeted actions, responsible institutional parties, and implementation timelines for each VAG to enhance the operational feasibility and practical applicability of conservation governance in the Liuwa Plain NP. However, we acknowledge that the detailed design of benefit-sharing mechanisms and rights allocation frameworks between these institutional actors requires a dedicated institutional governance study, while the perception-based methodology of the present study cannot provide the empirical basis necessary for such prescriptions, and this is recommended as a priority area for future research.

Additionally, despite the weaker gender correlations observed in the Liuwa Plain NP study compared to residency factors, the absence of statistical significance in quantitative gender comparisons does not imply the absence of gender-based inequalities in natural resource governance. Quantitative survey methods are limited in their capacity to capture the participation barriers, power inequalities, and customary restrictions that women in the Liuwa Plain NP may face in accessing and governing fisheries and forestry resources, including customary norms that restrict women's ownership of fishing gear, their exclusion from VAG decision-making structures, and their limited voice in seasonal fishing regulation processes. Accordingly, the quantitative findings on gender should be interpreted with caution, as they reflect reported perceptions of natural resource importance rather than the underlying equity of access or governance participation. The prominence of fishery resources as the most valued natural resource necessitates gender-sensitive policies that address the specific customary barriers women face in accessing fisheries resources in the Liuwa Plain NP, including inequitable access to canoes and specialist fishing gear, exclusion from co-management committee membership, and customary norms that limit their participation in fishing governance, while ensuring inclusive participation in conservation decisions for effective ecosystem stewardship. This mirrors a study in Tanzania [76–78], which argued that unless these customary practices are addressed, women's issues, especially in the access to and use of natural resources, specifically land, will remain unchanged.

Nonetheless, this study has inherent limitations. 1. The reliance on self-reported community perceptions can potentially introduce biases from survey participants. Moreover, despite these bias-control measures, including native-language enumerators, questionnaire pre-testing, FGD triangulation, and relative Likert-scale ranking, self-reported data may retain residual social desirability bias, and future studies could further strengthen data reliability through the incorporation of reverse-coded questions and internal consistency checks. Meanwhile, the cross-sectional nature of study captures only a temporal snapshot, limiting our understanding of dynamic changes in perceptions. Notably, community perceptions of natural resources were captured at a single point in time in November 2024, and this restricts inference about dynamic, long-term changes in community natural resource valuations. Thus, the cross-section design captured community perceptions only at a temporal interval instead of time series. Therefore, this approach prevented assessments of how perceptions evolve in response to climate change variability, policy changes or ecological shifts over time. Future research should explore longitudinal designs to track evolving community perceptions of natural resource values in response to climate variability and conservation interventions with repeated annual or multi-seasonal surveys

to build a monitoring database of perception dynamics, as [64] reported in their study that communities go through social and economic changes over time. 2. Perceptions of natural resource importance were not directly matched with ecological data, an integration that could further substantiate or challenge the findings; specifically, community perception were not cross-validated against field ecological data such as wildlife and fish stock counts or vegetation surveys, water quantity analysis and land assessments. Therefore, future research should integrate community natural resource valuation with ecological monitoring through a coupled socio-ecological assessment framework to strengthen the empirical basis of the natural resource evaluation findings. 3. While the study targeted permanent resident households to ensure comparability, seasonal migrants and mobile natural resource users, such as temporary fishers and grazers from outside the park, were excluded, which limits the comprehensiveness of findings with respect to the full range of resource stakeholders interacting with the Liuwa Plain NP. Therefore, future studies should employ stratified sampling frameworks that explicitly include mobile and seasonal natural resource users to provide a more complete and representative assessment of natural resource valuation across all park key stakeholder groups. 4. A further limitation relates to seasonality, as data collection was conducted during the early wet season, which may have influenced respondents' perceptions of natural resource importance. Specifically, the increased availability of water and fishery resources during this period may have inflated their perceived value relative to conditions in the dry season. This temporal bias suggests that future studies should incorporate multi-seasonal data collection to capture more representative and balanced assessments of the natural resource valuation across varying ecological conditions. Furthermore, researchers should consider multi-seasonal surveys, such as hot–dry: September–November; cold–dry: May–August; and wet: December–April), to capture more representative aspects of community perceptions of natural resource valuations in the Liuwa Plain NP and similar protected areas.

5. Conclusions

This study provided the first statistically robust, community-derived baseline of natural resource valuation in the Liuwa Plain NP (n = 309), showing that local communities value wildlife and fisheries most highly for their livelihoods, while agricultural land, despite being their principal source of income, is perceived as the most environmentally vulnerable resource. Meanwhile, conservation awareness was significantly shaped by leadership status and ethnic affiliation, particularly among the Lozi community, underscoring the importance of embedding traditional ecological knowledge and local leadership structures into co-management planning. Furthermore, a notable gap in threat recognition for forest degradation, relative to the more acutely experienced declines in fisheries and water availability, points to shifting baseline effects that targeted conservation education could address. Collectively, these findings indicate that durable conservation outcomes in the Liuwa Plain NP depend on aligning management priorities with this locally validated resource hierarchy, strengthening fishery co-management and regulation, closing the forest threat awareness gap through targeted education, and integrating community valuation data into the existing APN–DNPW–BRE co-management framework. We recommend longitudinal, multi-seasonal monitoring of community perceptions to track how these valuations evolve under continuing climate and land use pressures.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/conservation6040125/s1: Table S1: The sampled Village Action Groups (VAGs) in Liuwa Plain National Park, Western Zambia, 2024; Table S2: Gender distribution of respondents in Liuwa Plain National Park, Western Zambia, 2024; Table S3: Number of villages and households in Village Action Groups (VAGs) and Community Resource Boards (CRBs) in Liuwa Plain National Park, Western Zambia,

2024; Table S4: Summary responses on resource values, threats, and suggested management measures in Liuwa Plain National Park, Western Zambia, 2024; Questionnaire S1: Household questionnaire used for assessing community perspectives on resource values in Liuwa Plain National Park, Western Zambia.

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Informed Consent Statement: Informed consent was obtained from all individual participants included in this study. Verbal consent was obtained rather than written consent because of the prevailing illiteracy.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors upon request.

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Abbreviations

The following abbreviations are used in this manuscript.

AP	African Park
APN	African Parks Network
BRE	Barotse Royal Establishment
DNPW	Department of National Parks and Wildlife
ELNAC	Enhanced Livelihoods and Natural Resource Management under accelerated Climate Change
ES	Ecosystem Service
NP	National Park
PA	Protected Area
SASSCAL	Southern African Science Service Centre for climate Change and Adaptive Land Management
SDG	Sustainable Development Goal
TEK	Traditional Ecological Knowledge
VAG	Village Action Group
VBN	Value–Belief–Norm
ZAWA	Zambia Wildlife Authority

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