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Integrating baseline field surveys with local ecological knowledge to assess the diversity patterns and conservation needs of herpetofauna in highly disturbed areas of Uganda

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ABSTRACT – Uganda hosts a rich diversity of amphibians and reptiles, although many species remain Data Deficient, highlighting the need for comprehensive field studies. We report on the species richness, diversity patterns and local distribution of amphibians and reptiles in the Kagera riverine landscape of Uganda. A multidisciplinary approach was used, combining visual surveys, acoustic monitoring and Local Ecological Knowledge gathered through interviews. The study identified 21 amphibian and 12 reptile species, with distribution patterns influenced by both environmental conditions and human activities. Quantitative analysis demonstrated varying species richness across different sites, with mining activities showing the most pronounced negative effects on amphibian diversity. Ethno-herpetological surveys, based on a semi-structured questionnaire, revealed that local perceptions, particularly associating herpetofauna with misfortune and fear, could impact conservation efforts. This study emphasises the need for continued research to inform conservation strategies, particularly in unprotected and vulnerable habitats such as the Kagera basin.

INTRODUCTION

Globally, amphibians and reptiles are among the most threatened taxa, with 40.7% of amphibians and 21.1% of reptiles threatened with extinction (Stuart et al., 2004; Böhm et al., 2013; Catenazzi, 2015), and many of these threatened species inhabit wetlands and water bodies or their surrounding habitats (Stanford et al., 2020; Megantara et al., 2022). General evidence suggests that many of these threatened species depend on habitat integrity and availability, with river basins housing many natural habitats for both reptiles and amphibians (Stuart et al., 2004; Catenazzi, 2015; Yousefkhani, 2019).

In Uganda, there are around 86 amphibian species and 142 reptile species (Behangana et al., 2019) but there have been new species described more recently (e.g. Hughes et al., 2024). This fauna represents a very rich diversity of species and there are likely more species still to be discovered, as collections have been made from only a few relatively protected areas such as Bwindi Impenetrable National Park, Murchison Falls National Park, Budongo Forest etc.. According to the Red List of herpetofauna in Uganda (WCS, 2016), most of the amphibian and reptile species are Data Deficient (DD). Therefore, further research is needed to increase the database of Uganda's herpetofauna both in protected and unprotected areas, and to assess the conservation status of the DD species at the national level (Behangana et al., 2019). In this regard, although long-term population monitoring has never been carried out for any species in Uganda, field researchers have a perception of a noticeable and concerning decline in the diversity of species in several Ugandan sites. So, it is imperative to evaluate whether these negative perceptions are supported by robust evidence.

The present study is part of a more general country-wide research project to assess the diversity patterns, community structure and status of amphibians and reptiles among the various habitat types in Uganda (e.g. Behangana et al., 2009; 2023; 2024a; 2024b; Akoth et al., 2023) and was undertaken along the upland landscape crossed by the Kagera river at the Uganda/Tanzania border, for which there are no previous data on the herpetofauna. Environmental resources in the Kagera river basin are under great threat due to both biotic and abiotic factors that have led to widespread land degradation and biodiversity loss due to high inflow of refugees from the Rwandan 1994 genocide (Were, 2016). Activities such as stone quarrying, intentional bush fires in the hills created by cattle keepers in dry seasons, and increased crop farming along the riverine landscape, plus huge permanent settlements along the road have greatly impacted the general environment of this area.

In order to assess species composition and apparent status of herpetofauna across the different landscapes of Kagera riverine segments, we used a multidisciplinary approach combining quantitative field surveys with interview-based

ethno-zoological research. Previous studies have demonstrated that research on local ecological knowledge may have considerable importance for ecological studies in tropical regions (Sinthumule, 2023) including Africa (Stave et al., 2007; Sinthumule & Mashau, 2020; Dendi et al., 2023; Luiselli, 2024), and may even provide reliable information on the population trends of species (Akani et al., 2013; Luiselli et al., 2020), which have been confirmed directly by field monitoring and capture-mark-recapture protocols (Reading et al., 2010; Akani et al., 2013; Santos et al., 2022).

More specifically, our study objectives were:

1. To estimate the apparent abundance, diversity and distribution patterns of herpetofauna of the Kagera riverine landscape in Uganda;
2. To document the Local Ecological Knowledge (LEK) of amphibians and reptiles at the study area; and
3. To evaluate the potential for conservation initiatives for these animals at the local scale.

MATERIALS & METHODS

Study area

Field research was undertaken in the Kikagati subcounty (centre co-ordinates 01° 02′42″ S, 30° 40′07″ E, 1,282 m a.s.l.) of Isingiro District, Western Region, Uganda (Fig. 1). In 1991, a national census estimated the population to be 226,400, in 2002 the population was recorded as 316,000, and in 2014 it was 486,360. Main human activities include agriculture (80%) (Fig. 2) and livestock rearing (15%) (Statistics of the Uganda Republic, 2017). The climate is warm and overcast over the course of the year with mean monthly temperatures of 18–22.2 °C. The soils are generally loam, i.e. a mixture of sandy and clay. Mean rainfall during the wet season is about 300 mm/month, and in the dry season about 50 mm/month.

In Kikagati subcounty, the Kagera River forms the border with Tanzania in some areas. Kikagati town sits beside the Kagera River and opposite the town of Murongo, in the Kagera Region of Tanzania, nestled between hills that rise to 1,420 m on the Ugandan side and 1,560 m on the Tanzanian side. Kikagati is a major crossing point between the two countries.

There were five study sites, each of which had a different combination of habitats, similar altitudes and all had been altered by human activities. The study sites were as follows:

Kikagati featured human settlements and agricultural activities, including cattle grazing farms, banana plantations, and houses along the tarmac road, which were 100 m from the riverbanks. The flat landscape is characterised by papyrus wetlands, short grasses, scattered short trees, and *Euphorbia* trees used as farm fences. Patches of shrub trees separated the wetlands from the river. Fishing grounds, motorcycle washing spots and a hydroelectric power station highlighted the river's importance for local livelihoods, reflecting a dynamic interaction between human activity and the natural environment.

Kyamushija is shaped by significant human settlement and agriculture, including banana plantations, bean, maize and sorghum gardens. The site has wetlands with papyrus, coffee, *Eucalyptus* tree plantations, and houses along a tarmac road which were 200 m from the riverbank, indicating a bustling community. Although similar to the previous study site, this one has a much more steeply sloping terrain, with bushlands growing along the slopes. The steep sloping terrain and the nearby river were vital for local livelihoods, with fishing grounds contributing to economic activities.

Nsongezi presented a mix of natural and agricultural landscapes, including patches of short grass, cattle kraals with *Euphorbia* trees, stone quarrying activities near the road, steep slopes and noisy water draining operations. The area has banana and bean gardens along the riverbanks, scattered trees, a few houses that were 200 m from the riverbank, and fewer patches of papyrus wetlands, contributing to its ecological diversity. A tarmac road near the river integrates modern infrastructure into the varied terrain, offering a varied topographical appearance.

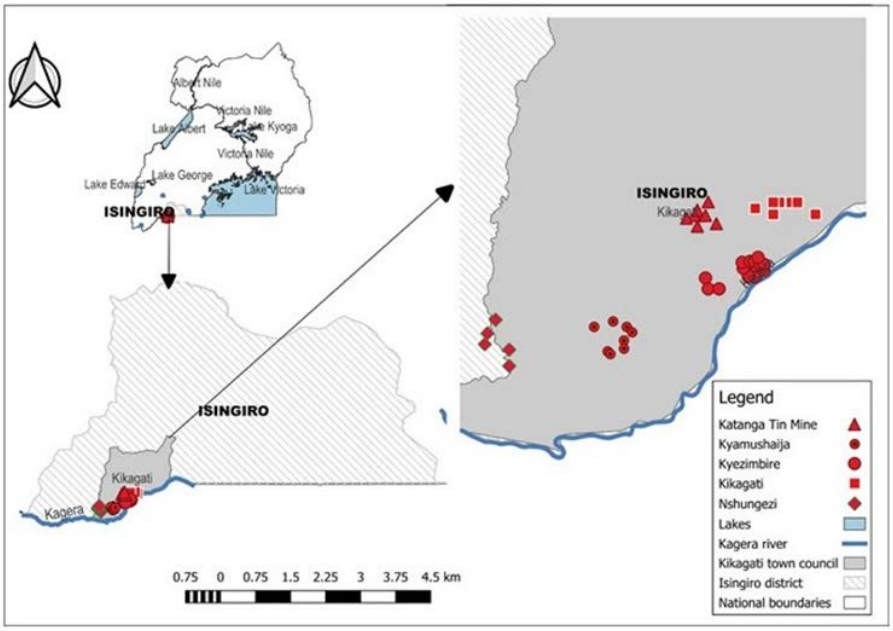


Figure 1. A map of Uganda showing Isingiro District and Kikagati Trading Centre with the study sites along Kagera riverine segments

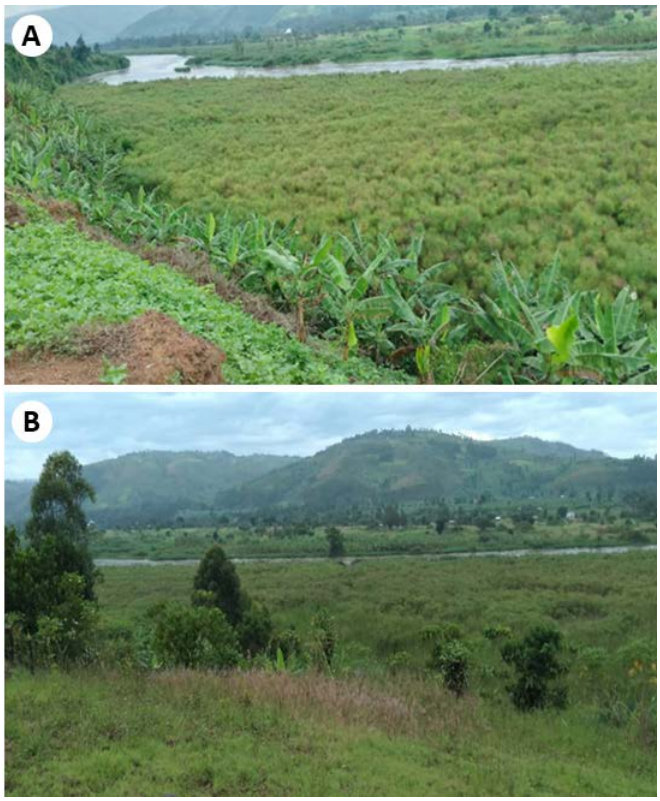


Figure 2. Typical highly altered (agriculture-based) wetland landscapes at the study area in Uganda, with dominant *Cyperus papyrus* vegetation

Kyezimbire has a mix of natural and agricultural landscapes, a tarmac road near the river, and a small town 200 m from the river. The area has numerous swampy wetlands, patches of *Eucalyptus* plantations, and seasonal farm gardens such as millet, maize and beans. The terrain is notably flat, especially toward the river, with many streams and a tendency to flood during rains. The site also features sugarcane and coffee plantations along the riverbank, with scattered wetlands and patches of short grass.

Katanga Mines site is characterised by a steep, rugged slope with tall grasses, large stones, and numerous holes resulting from tin mining activities. The area has few scattered trees, small streams in valleys, banana plantations and houses at the hill's base, along with temporary ponds that form during rains. These mining activities have significantly altered the environment, reducing tree cover and creating a rugged terrain. The site is connected to the tarmac road leading to Kikagati, linking the industrial activities at the mines with the agricultural and settlement areas of Kikagati.

Field protocol

A suite of different methods (see below) was used to search for amphibians and reptiles. The locations of all sampling sites were georeferenced by GPS. Field effort was identical in each study site (140 man-hours per site).

Random linear transects were established to gather herpetofaunal data across most of the study area, while at the Katanga Mines site transects were located in accessible areas that were not steep. The number of transects surveyed at each site varied from 5 to 8 (Fig. 1). Transects were walked during both daytime and night-time. Daytime surveys, from 09:00 h to 13:00 h were along one-kilometre transects divided into 100 m sections. These sections were systematically searched for amphibians and reptiles in both wetlands and farmlands or gardens, covering the entire distance. Night-time surveys, from 19:00 h to 20:00 h were focused on wetlands for observation of amphibians. Typically, three transects were covered during daytime surveys, while night-time surveys covered one or half a transect, depending on wetland size and accessibility.

While walking on transects during the daytime, we applied a Visual Encounter Surveys (VES) method. At night, strong torches were used to observe species, while during the day we used binoculars to zoom in on distant species in trees (particularly for snakes) and by the river following the established transect. Binoculars were also used to observe sun-basking reptiles, especially along river banks and caves (Eekhout, 2010). While walking along transects, the observers also checked within and under natural and artificial covers (e.g. logs and rocks) multiple times, mostly during day surveys.

Dip nets with a mesh size of 3 mm, as recommended by Fellers (1995) were used to sweep through rivers and ponds, and were dragged along the substrate to capture amphibian larvae and some snakes in stagnant water and slow-flowing streams.

Sound recording equipment (GARMAY Digital Voice Recorder, Model TF-32, Capacity: 16GB) was used during auditory surveys (day and night surveys) to identify different calls of frogs and toads, especially in rainy season (Wasonga & Opiyo, 2018). Species that were detected acoustically were: *Afrixalus fulvovitattus, Hyperolius cinnamomeoventris, Hyperolius kivuensis, Hyperolius viridiflavus variabilis, Kassina senegalensis, Leptopelis bocagii, Phrynobatrachus acridoides, Phrynobatrachus mababiensis, Phrynobatravhus natalensis, Ptychadena nilotica, Sclerophrys gutturalis, Sclerophrys regularis* and *Hoplobatrachus occipitalis*. They were identified by acoustic analysis, referencing publicly available call recordings from AmphibiaWeb (https://amphibiaweb.org/lists/sound.shtml) alongside a private repository of amphibian vocalisations maintained by the Principal Investigator (MB).

Local Ecological Knowledge (LEK) surveys

Local Ecological Knowledge was collected using a local interviewer. Respondents were left free to speak once they were asked a particular open question, and the main points of each interview were recorded (semi-structured questionnaire). Before the interviews, informed consent was obtained from all participants to ensure transparency. No minors were interviewed.

The respondents were drawn from villages inside the Kagera riverine landscape and the participants were randomly sampled within the area using a simple random sampling method. This was done by assigning a number to each household through random number generation methods to ensure equal opportunity for participation (LaCivita, 2016). A total of 250 household members were selected to ensure a representative sample reflecting diverse perspectives and practices regarding amphibians and reptiles. This included 152 males and 98 females, which catered for potential gender-based variations in knowledge, interactions and perceptions of

the herpetofauna. All interviews were carried out individually, with no group discussions.

All interviewees were asked to answer a series of questions (Appendix 1S, see Supplementary Material). The questionnaire was uploaded onto a smartphone for convenient access and data collection, and informants were briefed on the research's main objective and their rights. This ensured their comprehension and active participation throughout the process. Each interview lasted on average 30–40 minutes.

Statistical analyses

For each of the study sites and for both amphibians and reptiles, we calculated the following indices, all of which are described in Magurran (1988):

i) Species richness (S), that is the total number of species encountered at each of the selected study sites;
ii) Abundance index: the number of recorded individuals for each species and in total across all species;
iii) Chao-1, as an estimate of total species richness that is potentially present at each of the selected study sites

Chao-1 is defined as:

Chao-1 index = S + F1(F1 - 1)/(2(F2 + 1)

where F1 is the number of singleton species (i.e. with only a single individual in the samples for that species), F2 the number of doubleton species (i.e. with two individuals in the samples for that species) and S is the number of observed species (Magurran & McGill, 2010);

iv) Shannon–Wiener index:

H' = Σfr × (lnfr)

where fr = n/N, where n is the number of individuals of each species in each of the selected study sites) and N is the total number of amphibians and/or reptiles that were recorded;

v) Dominance index, that is the ratio in the number of observed individuals of the most abundant species by the total number of observed individuals;
vi) Evenness index, calculated as:

e = H'/H'max

where H'max = lnS, with H' representing Shannon-Wiener's index (see above), and S the total number of species recorded.

To assess the completeness of our herpetofauna diversity assessment, we generated species accumulation curves to measure reptile and amphibian species richness across different sites over six months.

To classify the five survey sites in terms of the dissimilarity of the composition and abundance of their amphibian and reptile species, we used UPGMA (unweighted pair group method with arithmetic mean) hierarchical clustering. In this dendrogram analysis, Euclidean distance was used as a diversity metric between sites. The analysis was undertaken using Palaeontological Statistics (PAST) software 4.3 version (Hammer & Harper, 2001), with alpha set at 5%.

Species identification

Identification of herpetofauna species followed Schiøtz (1999), Spawls et al. (2002; 2006), Channing & Howell (2006), and Channing & Rödel (2019). The AmphibiaWeb (2024) and The Reptile Database (Uetz & Hošek (Eds.) 2024) were also used for confirmation. The conservation status of the herpetofauna has be reported using the IUCN Red Listing (International Union for Conservation of Nature (IUCN), 2024) and the Ugandan Red List (WCS, 2016).

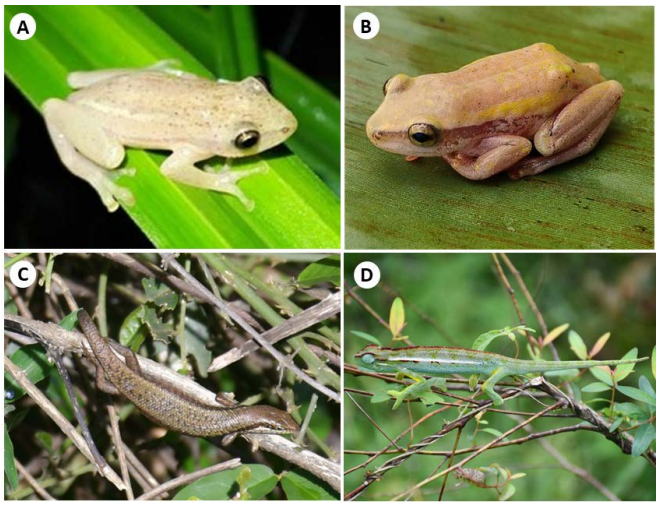


Figure 3. Some of the amphibian and reptile species encountered at the study area - **A.** *Hyperolius cinnamomeoventris*, **B.** *Hyperolius kivuensis*, **C.** *Trachylepis maculilabris*, **D.** *Trioceros ellioti*

RESULTS & DISCUSSION

Species diversity, richness and distribution patterns

Across the five study areas, we observed a total of 21 amphibian species belonging to 8 families, and 12 reptile species belonging to 10 families (Table 1). Some examples of the observed species are shown in Figure 3.

The saturation curves analyses for amphibians showed that all the study sites were sampled sufficiently to determine the true species richness (Fig. 4), and that Kyezinbire and Nsongezi had the higher species diversity in terms of both richness and evenness (Fig. 4). These main results were clearly confirmed also by the univariate diversity metrics (Table 2). Chao-1 index also showed that, for all five sites, there was an identical number of species observed and of those expected to occur therein (Table 2).

Concerning reptiles, the sampling was also sufficient for having a good 'picture' of the species richness and diversity patterns at most sites (Fig. 5), and this was also confirmed by Chao-1 index showing that at most sites we likely detected the great majority of the species present (Table 3). However, at Kyezimbire the sampling effort was not sufficient, and that Chao-1 index (Table 3) predicts that many more species occur there. This site showed also the lowest evenness index despite having a higher species richness than all other sites. At Kyamushija also the number of detected species was remarkably lower than that expected by Chao-1 index, and this was certainly due to the small sample size (Table 3). For both amphibians and reptiles, the most impacted site (Katanga mines) had a relatively low species richness but other diversity metrics differed little from the other four sites (Tables 2 & 3).

Interestingly, UPGMA dendrograms showed that Katanga Mines grouped alone from all other sites when species richness and distribution of amphibians are entered into the analysis (Fig. 6A), but the same pattern did not occur for reptiles (Fig. 6B), indicating different effects of mining activities on the two

Table 1. Amphibian and reptile species recorded during the survey and their numbers at the various study sites

Class/Family	Species	Nsongezi	Kyezimbire	Kyamushija	Katanga Mines	Kikagati	TOTAL
Amphibia							
Hyperoliidae	*Afrixalus fulvovittatus*	4	6	23	0	26	59
	Afrixalus quadrivittatus	0	9	0	0	0	9
	Hyperolius cinnamomeoventris	27	8	0	7	0	42
	Hyperolius kivuensis	42	28	0	10	0	80
	Hyperolius variabilis	7	2	0	0	0	9
	Kassina senegalensis	8	24	16	7	16	71
Arthroleptidae	*Leptopelis bocagii*	0	7	5	9	19	40
Phrynobatrachidae	*Phrynobatrachus acridoides*	12	9	6	4	31	62
	Phrynobatrachus mababiensis	23	11	3	6	0	43
	Phrynobatrachus natalensis	30	26	11	15	0	82
	Ptychadena nilotica	113	67	0	0	0	180
Ptychadenidae	*Ptychadena nilotica*	113	67	0	0	0	180
	Ptychadena oxyrhynchus	35	3	0	0	0	38
	Ptychadena porosissima	53	32	0	0	0	85
Pyxicephalidae	*Amietia nutti*	0	0	2	0	0	2
Bufonidae	*Sclerophrys regularis*	22	17	6	0	10	55
	Sclerophrys gutturalis	31	10	8	0	18	67
Pipidae	*Xenopus victorianus*	5	2	2	11	9	29
Dicroglossidae	*Hoplobatrachus occipitalis*	0	2	0	0	0	2
Reptilia							
Agamidae	*Agama agama*	0	1	1	0	1	3
Scincidae	*Trachylepis striata*	15	19	0	16	11	61
	Trachylepis maculilabris	101	66	0	25	21	213
Varanidae	*Varanus niloticus*	0	7	8	2	2	19
Chamaeleonidae	*Chamaeleo gracilis*	0	1	0	0	0	1
	Trioceros ellioti	5	1	0	0	0	6
Gekkonidae	*Hemidactylus angulatus*	1	2	0	4	6	13
Elapidae	*Naja nigricollis*	0	1	0	0	0	1
Colubridae	*Natriciteres olivacea*	0	1	0	0	0	1
	Philothamnus spp	0	1	0	0	1	2
Lamprophiidae	*Boaedon fuliginosus*	0	1	1	1	0	3
Crocodylidae	*Crocodylus niloticus*	1	0	0	0	0	1

Table 2. Amphibian diversity indices for the five study sites surveyed in the present study

	Study Sites				
Diversity indices	**Nsongezi**	**Kyezimbire**	**Kyamushija**	**Katanga Mines**	**Kikagati**
Species richness	14	17	10	8	7
Number of Individuals	412	263	82	69	129
Chao-1 index	14	17	10	8	7
Shannon index	2.290	2.407	2.027	2.012	1.865
Dominance index	0.132	0.121	0.161	0.142	0.166
Evenness index	0.705	0.653	0.760	0.935	0.923

Table 3. Reptile diversity indices for the five study sites surveyed in the present study

	Study Sites				
Diversity indices	**Nsongezi**	**Kyezimbire**	**Kyamushija**	**Katanga Mines**	**Kikagati**
Species richness	5	10	3	5	6
Number of Individuals	123	100	9	47	42
Chao-1 index	6	17.5	5	6.5	6.5
Shannon index	0.627	1.130	0.349	1.047	1.298
Dominance index	0.691	0.448	0.803	0.408	0.342
Evenness index	0.374	0.310	0.709	0.712	0.611

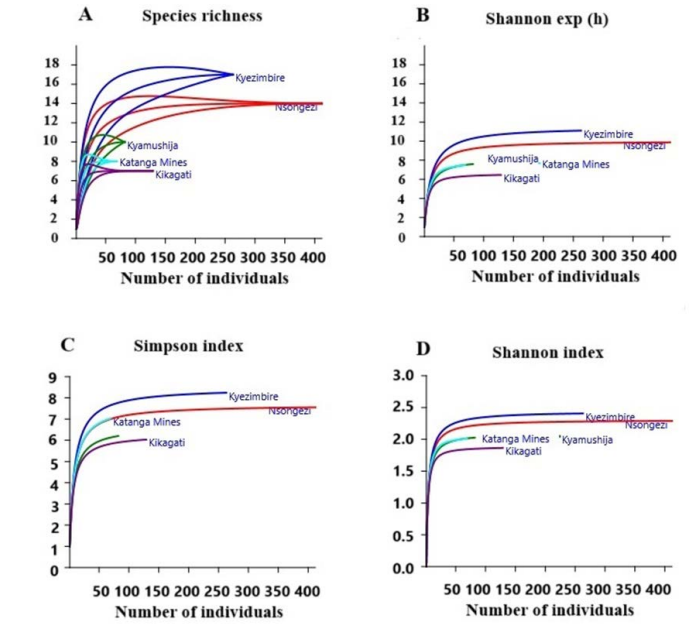


Figure 4. Saturation curves for the amphibians at the various study sites surveyed during the present investigations- **A.** Species richness with 95% confidence intervals generated by 9999 random Monte Carlo permutations, **B.** Shannon exp (H'), **C.** Simpson's index, and **D.** Shannon index H'

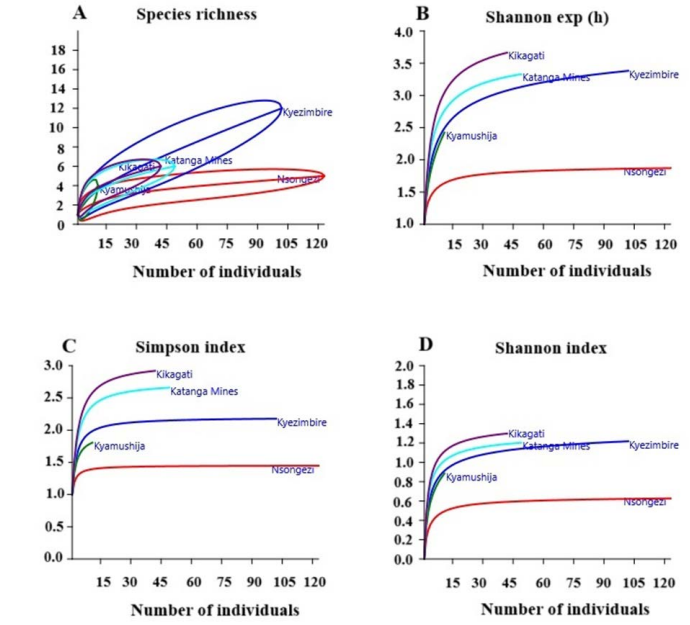


Figure 5. Saturation curves for the reptiles at the various study sites surveyed during the present investigations - **A.** Species richness with 95% confidence intervals generated by 9999 random Monte Carlo permutations, **B.** Shannon exp (H'), **C.** Simpson's index, and **D.** Shannon index (H')

taxa. The reptiles are less affected by this type of disturbance than the amphibian communities. In the case of reptiles, Kyamushija was the most distinct site (Fig. 6B), probably due to the very low species richness. The grouping of Nsongezi and Kyezimbire for amphibians was likely due to the presence of shared water bodies (River Kagera) connecting these two sites, as well as similarities in vegetation, water-logged areas and short grasses.

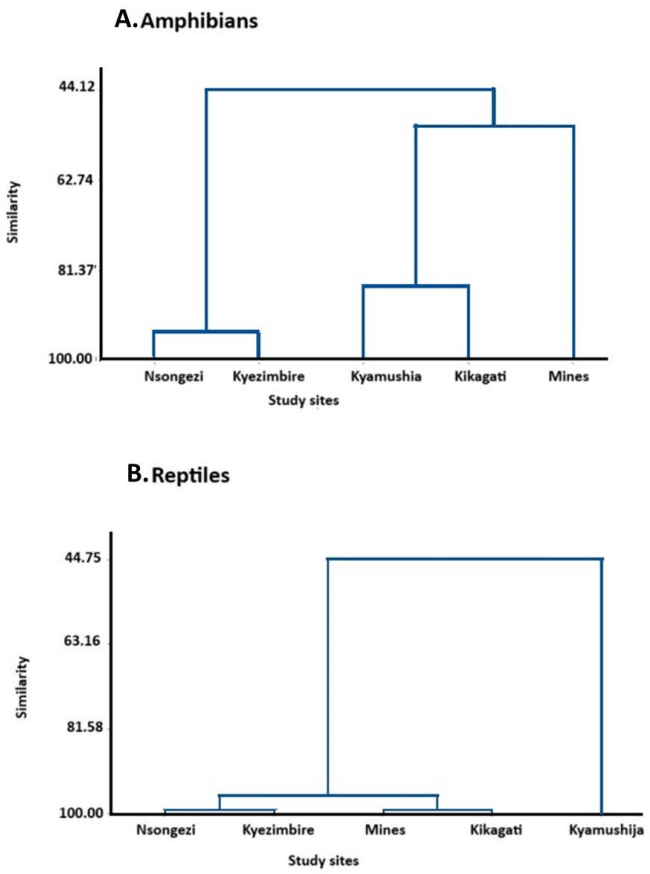


Figure 6. UPGMA dendrogram showing the cluster hierarchy across the five sites in Isingiro District, S. Uganda for- **A.** Amphibians and **B.** Reptiles

Most of the amphibians had terrestrial habits, while arboreal habits were least common. Reptiles predominantly exhibited terrestrial lifestyles. All the amphibian and reptile species in the Kagera riverine segment are classified as Least Concern (LC) on the International Union for Conservation of Nature (IUCN, 2024).

For amphibians, several species such as *Afrixalus* spp., *Phrynobatrachus* spp. and *Hyperolius* spp. were recorded across multiple locations, indicating a broad distribution and adaptability to different environments within the study area. Conversely, species such as *Amietia nutti, Xenopus victorianus*, and *Hoplobatrachus occipitalis* were absent in several sites, suggesting more specialised habitat requirements or limited distribution.

For reptiles, species such as *Trachylepis maculilabris* and *Hemidactylus angulatus* were observed at multiple sites, demonstrating their adaptability to a range of environmental conditions. However, more specialised/elusive species such as *Crocodylus niloticus* and *Naja nigricollis* were only detected in specific locations, pointing to their preference for particular habitats or environmental conditions.

Local Ecological Knowledge survey

The human demographics of the area showed that the community was predominantly composed of younger adults aged 18 to 40, closely followed by middle-aged individuals aged 41 to 60. Older adults aged 61 and above represented

a smaller fraction of the population. In terms of gender distribution, men slightly outnumbered women in the sampled population from the study area (Appendix 2S, see Supplementary Material).

Occupationally, small-holder farmers constituted the largest group, followed by teachers, herdsmen and fishermen. A considerable portion of the population had not pursued formal education, while primary education was the most common level attained, followed by tertiary and secondary education (Appendix 2S, see Supplementary Material).

The interviewees knowledge and interactions with herpetofauna revealed snakes as the most encountered species, followed by frogs and crocodiles. These encounters primarily occurred near rivers and in swamps within the study area. The frequency of encounters varied, with some reporting frequent encounters, others rare, constant or single encounters (Appendix 2S, Supplementary Material).

Observations of herpetofauna activities included basking in the sun, calling, foraging, climbing, and less frequently, egg laying and mating (Appendix 2S, Supplementary Material).

Perceptions and uses of herpetofauna within the sampled population showed no statistically significant differences across social demographic categories (age, gender, occupation and education level), with all p-values above 0.05 at observed-versus expected χ^2 test (for a synthesis of the raw data see Appendix 3S, Supplementary Material). In general, a significant percentage of respondents believed that the herpetofauna was associated with evil or misfortune. This belief was consistent across different age groups, suggesting no significant age-related variation. Chameleons were specifically seen as symbols of misfortune, a perception that did not vary significantly with age. Venomous snakes were particularly disliked, and the perception of various snakes as sources of misfortune was consistent across genders. Frogs, toads and geckos were also associated with misfortune, though to a lesser extent than snakes (Appendix 3S, Supplementary Material). Snakes were overwhelmingly considered dangerous, followed by chameleons and large lizards and the perception of snakes as dangerous did not vary significantly with age.

Snakes were the most commonly used herpetofauna in traditional medicine, followed by chameleons, frogs and certain lizards, which were also reported to be used medicinally but less frequently, and this usage did not differ significantly across age groups (Appendix 3S, Supplementary Material).

Snakes, including venomous species, were reported as popular pets, followed by lizards, turtles and frogs, and the perception of snakes as pets was consistent across genders (Appendix 3S, Supplementary Material). The population generally regarded all snakes as hazardous and venomous, and the idea of keeping venomous snakes as pets was largely a myth based on hearsay. Many people believe that snakes are kept by witch doctors or traditional healers for their perceived anti-venom properties, which are thought to come from a mythical stone in the snake's mouth. Indeed, some people keep venomous snakes in captivity, but this is a minority compared to the frequency with which the interviewees report this information. However, the farming community, which encounters these species most frequently, does not keep them as pets. Instead, they often suffer snake bites during their activities and subsequently seek treatment from traditional doctors, as these healers are reportedly common in the area.

The interviews concerning the conservation needs for amphibians and reptiles revealed traditional knowledge of local species, highlighting cultural values, medicinal uses, and conservation challenges (Appendix 4S, Supplementary Material). Overall, responses emphasised the importance of integrated management practices to conserve herpetofauna. Indeed, according to the interviewees, the most significant threat to both amphibians and reptiles was habitat loss, indicating widespread destruction of their natural environments and notable proportion of threats stemmed from the intentional killing of these animals, while pollution also posed a considerable threat (Appendix 4S, Supplementary Material).

Interactive exhibits were the primary method of education and raising awareness about herpetofauna, with educational workshops providing additional opportunities reported. Public talks and seminars were less common but still significant in spreading awareness. Conservation campaigns, nature walks and field trips were rarely used or experienced by the population (Appendix 4S, Supplementary Material). The majority of the interviewees had educational resources available covering topics such as conservation, wetland management and land use. These resources included text books on community engagement for conserving wildlife in Uganda, local community participation and wildlife conservation in Uganda, sustainable management and conservation of wetland resources in Uganda. Most of these resources have been through public presentations by government officers, university personnel and private organisations.

The most widely practiced conservation effort was habitat restoration, emphasising the importance of restoring natural environments for amphibians and reptiles and proper waste disposal practices were also recognised as crucial for conservation. Corridor creation and monitoring and research practices were minimally implemented but still considered essential for connecting habitats for herpetofauna populations (Appendix 4S, Supplementary Material).

The primary challenge was considered to be habitat loss, highlighting the ongoing destruction and division of natural habitats. Lack of awareness and education, climate change, road mortality, invasive species, pollution and contamination and human-wildlife conflict were less dominant but collectively represented significant barriers to effective conservation (Appendix 4S, Supplementary Material).

The predominance of farmers and the rural nature of the area suggested that many community members may have had regular, direct contact with herpetofauna due to agricultural activities and this direct interaction could have led to a higher frequency of encounters with species such as snakes, frogs and crocodiles, especially in habitats near rivers and swamps where these activities often took place (Letnic et al., 2008). Overall, although the varied educational levels within the community impacted the knowledge and attitudes towards herpetofauna, those with higher education levels had a better understanding of the ecological roles and importance of these

species, potentially leading to more informed and positive interactions (Ceríaco, 2012). The interviewees showed a generally good understanding of the ongoing threats to the native herpetofaunas.

The reported high frequency of encounters with snakes, particularly near water bodies, raised concerns about human-snake conflicts and potential threats to both human safety and snake conservation. Further studies are of priority importance in this regard.

Education and awareness initiatives should play a major role in fostering public understanding and support for herpetofaunal conservation (Rommel et al., 2016) and minimising snake-human conflicts. Interactive exhibits were recognised as effective tools for engaging communities and promoting conservation messages such as wetland restoration, though a small portion of the population lacked access to these educational resources, highlighting an outreach gap in relation to conservation concerns.

Conservation practices such as habitat restoration, proper waste management, and corridor creation (Markle et al., 2018), are essential strategies endorsed by survey respondents to enhance habitat quality and connectivity. There is therefore a good opportunity for the future to implement these types of conservation activities in the study area. Future involvement strategies outlined included community workshops to empower local people with conservation knowledge, awareness campaigns utilising diverse communication channels, and robust research and monitoring efforts to inform evidence-based conservation practices.

In conclusion, our survey underscored the urgent need for collaborative action among stakeholders to implement effective conservation strategies that are essential for protecting herpetofaunal diversity and maintaining ecosystem health in the Kagera riverine segment and beyond.

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