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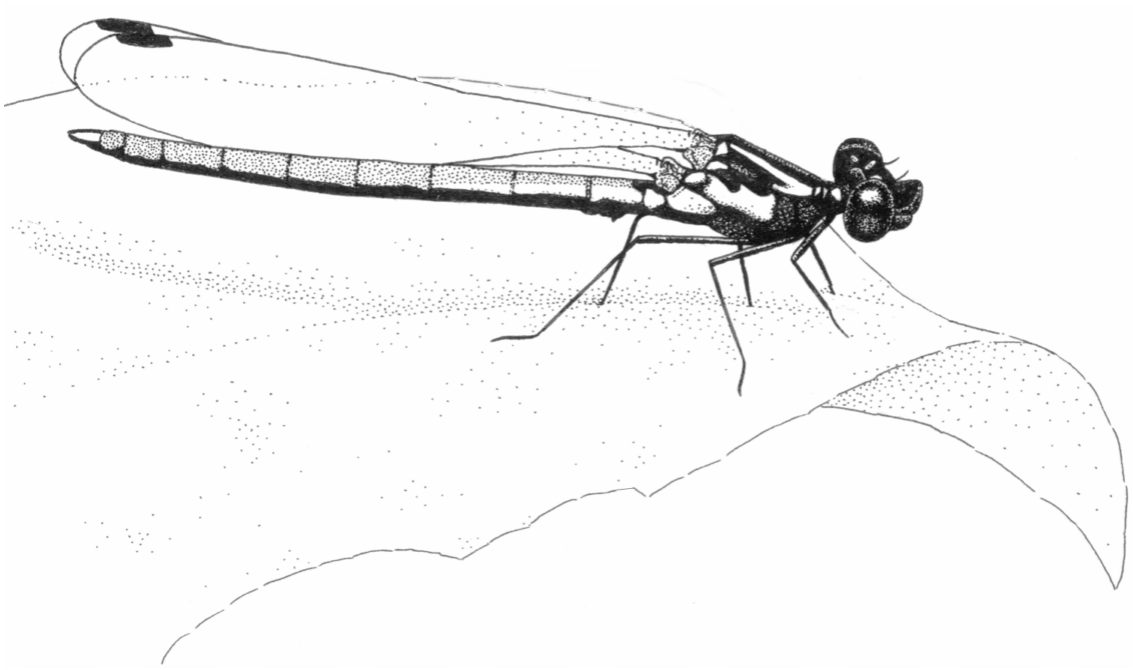

A Journal of Biodiversity

Journal of East African Natural History

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THE STATUS OF FLORA AND FAUNA IN THE NZOIA RIVER DRAINAGE BASIN IN WESTERN KENYA

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ABSTRACT

The species richness of flora and fauna in the Nzoia River drainage basin is documented through a study of museum specimens, catalogues and databases. The catchment area and basin covers 2.2% (12900/580367 km^2) of Kenya's total land area with an altitudinal range of 1140 to 4300 m and varied

ecosystem and land uses. We recorded approximately 9.3% (3239/34677) of Kenya's current known species of vascular plants, invertebrates (insects and spiders), fish, amphibians, reptiles, birds and mammals. Bird species made up the highest proportion 58.3% (650/1114) of the national total followed by amphibians 37.3% (41/110), reptiles 45.0% (86/191), mammals 31.3% (122/390), vascular plants 17.9% (1251/7000), fish 6.7% (58/872) (32.2% (58/180) for freshwater fish only) and invertebrates (insects and spiders) 4.1% (1031/25000). Ninety-five species recorded in this area are endemic to Kenya and 42 globally threatened. The species recorded contribute to several ecosystem services including pest control, pollination, bio-indicators, medicine and cosmetics, building materials, ecotourism, research and education. Data available differed substantially across counties and taxon groups with gaps apparent in five counties (Bungoma, Busia, Elgeyo Marakwet, Siaya and Usain Gishu) and four taxa plants, invertebrates, fungi and bacteria where a dearth of information exists. To fill these gaps we recommend prioritisng future survey effort on taxa and counties with fewer than 10% of the total numbers of records.

Keywords: biodiversity, species, ecosystem, drainage basin, catchment, landscape, socio-economics, IUCN Red List of endangered species

INTRODUCTION

Biodiversity and ecosystem services are intrinsically linked (Bai *et al.*, 2011). This link is increasingly being recognized among conservationists, researchers and policy makers (Balvanera *et al.*, 2015; Casetta *et al.*, 2019; Isbell *et al.*, 2017; Naeem *et al.*, 2016; Norris, 2012; Saraev *et al.*, 2017). Good information on biodiversity is essential for a number of reasons including planning for development, conservation and assessing changes (Gagné *et al.*, 2019). However biodiversity information is often incomplete, fragmented and hard to access. Hence the need for studies that compile biodiversity information at a landscape scale to provide a baseline and highlight gaps in knowledge. Biodiversity in Kenya is relatively well documented, and Kenya has *ca*. 35000 known species in various groups of plants and animals (GOK, 2015; Nakhauka, 2009). This number is a gross underestimate and unreliable as there are many undescribed species, especially among microbes, fungi, non-vascular plants and invertebrates. The known species in Kenya include about 7000 species of vascular plants, 25000 species of invertebrates (of which about 21500 are insects), 1114 species of birds (Bird Committee, 2019); 390 species of mammals (Musila *et al.*, 2019); 191 species of reptiles and 110 species of amphibians (Spawls *et al.*, 2019); 872 species of fish (of which 180 are adapted to fresh water and 692 to marine and brackish water) and about 2000 species of fungi and bacteria (GOK, 2015; Kung'u & Boa, 1997; Mironga, 2004). It is apparent that more species are yet to be added to Kenya's official record of species especially for non-vascular plants, fungi, bacteria and invertebrates. Few studies bring together species information at the landscape or catchment scale in Kenya. The Nzoia River is Kenya's largest river system within the Lake Victoria Basin (GOK, 2016; Okungu *et al.*, 2005). This drainage basin encompasses forests, riparian areas, farmlands, grasslands, floodplains, wetlands and parts of the open waters of Lake Victoria. These areas provide habitat for wildlife, recreation, education, research and stabilization of climatic effects among other ecosystem services (Mwanuzi *et al.*, 2005). Even though a range of ecosystem and biodiversity related studies have been carried out in this drainage basin, its proportional importance to the national species richness has not yet been documented. This study reviews the specimen collections and databases housed by the National Museums of Kenya, to document the species of the Nzoia River drainage basin as a measure of its biodiversity status. This paper focuses on vascular plants, invertebrates, reptiles, amphibians, fish, birds and mammals. It excludes microbes, fungi, bacteria and a significant portion of invertebrates.

DESCRIPTION OF STUDY AREA

The Nzoia River drainage basin encompasses an area of about 2.2% (12900 km^2) of Kenya's total area estimated at 580876 km^2. Its extents lie between 34°00'-36°00'E and 00°00'-01°15'N, covering parts of the Cherangany Hills, Mount Elgon and Uasin Gishu (Simiyu *et al.*, 2006). The landscape descends from an altitude of 4300 m in the mountainous areas to about 1140 m above sea level at Lake Victoria (Wepukhulu & Rees, 2015). This drainage basin encompasses parts of seven administrative counties namely (name (centroid)): Uasin Gishu (0°28'46"N, 35°20'48"E), Elgeyo Marakwet (0°58'52"N, 35°33'41"E), Trans Nzoia (1°1'19"N, 35°0'5"E), Bungoma (0°33'49"N, 34°33'38"), Kakamega (0°16′56″N, 34°45′14″E), Busia (0°25'60"N, 34°08'60"E) and Siaya (0°5'59''S, 34°16'29''E) (figure 1).

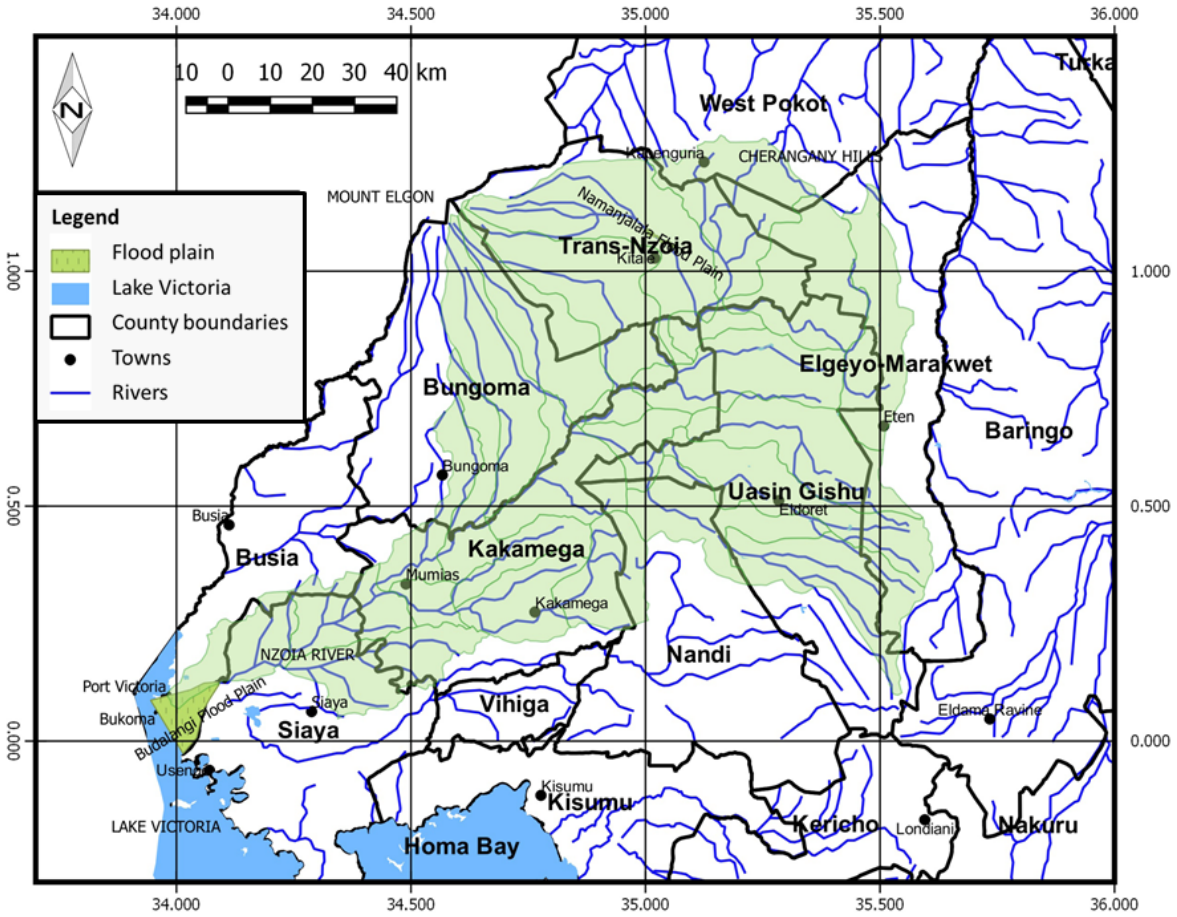

Figure 1. Map of the study area: Nzoia River drainage basin, western Kenya.

The Nzoia River is about 257 km long, arising from Mount Elgon, flowing south, and then west and eventually into Lake Victoria at Bukoma Town (0°04'02"N, 33°57'17"E) near Port Victoria Town (Wepukhulu & Rees, 2015). The Nzoia River's average annual discharge is about 1740 × 10^6 m^3 (Githui, 2008). This river's drainage basin dominates the northern half of the Lake Victoria Basin with 24 tributaries (Kirugara & Nevejan, 1996). The major tributaries originating from Mount Elgon (01°07′06″N, 34°31′30″E) include Ewaso Rongai, Koitobos, Kuywa, Sosio, and Kibingei and those originating from Cherangany Hills (1°16′02″N 35°29′59″E) include Noigamneget, Sergoit, Sosiani, Nureri and Kipkaren (figure 2).

Over the last ten years the human population in this area has increased from *ca*.3 million (when Kenya's total population was *ca*. 38.6 million (KNBS, 2010)) to *ca*. 8 million representing about 17% of Kenya's total current population of *ca*. 47.5 million (KNBS, 2019). The climate of the area is mainly tropical humid, with average temperatures ranging from 16°C in the highlands to 28°C in the lower semi-arid areas. Annual rainfall is also related to altitude with up to 2200 mm in the highlands and 900 mm in the lowlands (Simiyu *et al.*, 2006). From a physiographic perspective, the basin has four distinct zones: mountain zone, plateau zone, transition zone and lowland zone (Nyadawa & Mwangi, 2010; Odira *et al.*, 2010). From a land-use perspective, the area can be subdivided into three zones. The first zone, at altitudes above 1600 m, is characterized by relatively large-scale maize and horticulture farming, with small-scale tea farmers and large tea estates between altitudes 1900 and 2100 m. The middle zone consists of large-scale sugar plantations and smaller sugar plantations between altitude 1300 and 1700 m. The third zone is located between altitude 1100 and 1300 m, and includes parts of Busia and Siaya Counties. It contains gently-sloping areas with easily eroded surfaces consisting of wide, sometimes nearly flat land, separated by shallow river valleys. This area is characterized by small-scale subsistence maize and sorghum farming (Simiyu *et al.*, 2006). The constant water supply and flooding by Nzoia River and her tributaries makes land arable. The high population in the lower areas of the basin is vulnerable to frequent flood hazards (Wepukhulu & Rees, 2015). The river provides water for irrigation all year round, while the annual floods around the lowland area of Budalang'i

deposit sediment that contributes to the area's good agricultural production. The flow of the river is varied and has occasionally been recorded from lows of 20 m^3/s to highs surpassing 1100 m^3/s during floods (Githui, 2008). Destruction of infrastructure, crop failure, disease epidemics and general environmental damages are among the perennial problems brought about by the floods. Before the implementation of flood mitigation policies, the annual loss due to flooding in the Nzoia River basin approached US$ 1.8 million with displacement of 12000 people (Wepukhulu & Rees, 2015).

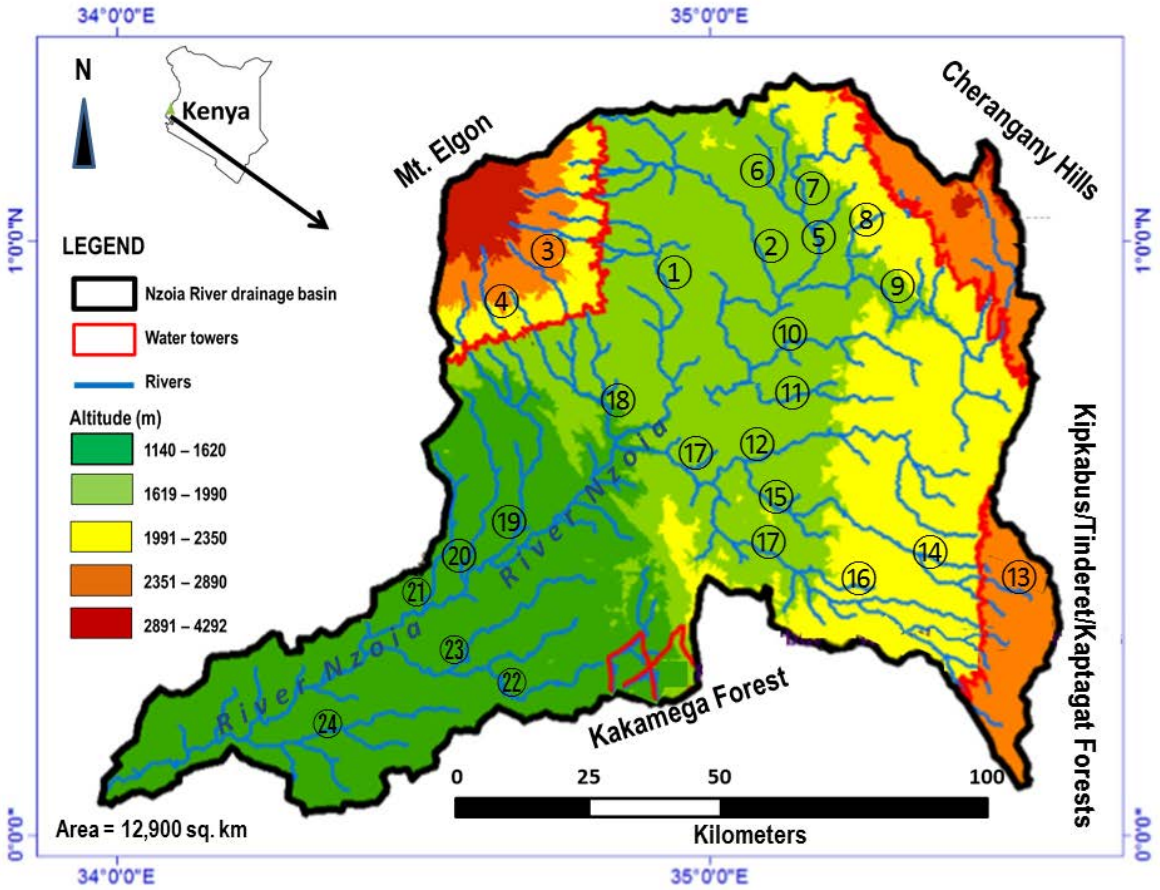

Figure 2. Map of study area: showing the elevations and river system of the Nzoia River drainage basin. Encircled numbers are the tributaries of the River Nzoia with names as follows: ①Ewaso Rongai; ②Koitobos; ③Sosio; ④Kabingei; ⑤Noigamneget; ⑥Saiwa; ⑦Kapolet; ⑧Losorua; ⑨Moiben; ⑩Little Nzoia; ⑪Kipsangwa; ⑫Sergoit; ⑬Kisinandi; ⑭Ellegerini; ⑮Sosiani; ⑯Nureri; ⑰Kipkaren; ⑱Kabisi; ⑲Kuywa; ⑳Chwele; ㉑Khalaba; ㉒Isiukhu; ㉓Lusumu; ㉔Wuoroya. Adapted from source map: (GOK, 2016).

MATERIALS AND METHODS

Between 1 July and 30 October 2019, we conducted a review exercise to document the species richness of flora and fauna of the Nzoia River drainage basin. This work was done by seven teams grouped under botany, invertebrate zoology, ichthyology, herpetology, ornithology, mammalogy and osteology. The teams examined records of vascular plants, invertebrates, fish, amphibians, reptiles, birds and mammals that are attributed to be from the study area using the geographical coordinates indicated on their locality. The task was to extract lists of species, their distribution and any information on their ecological and socio-economic importance. The information on plants, invertebrates, fish, amphibians, reptiles and mammals was extracted from the collections housed at the National Museums of Kenya. The information on birds was extracted from a database of the Kenya Bird Atlas (Lewis & Pomeroy, 1989) with updated records to 2010, and web-based bird mapping schemes—Kenya Bird Map Project (2020) and eBird (2020). The deviation from using the museum ornithological collection database was occasion by its state of incomplete data entry and verification at the time of the study. Hence the use of published and updated atlas and verified web-based mapping databases' records was considered more reliable. The gathered data were processed to generate lists of species

that have been recorded within the administrative county boundaries of Uasin Gishu, Elgeyo Marakwet, Trans Nzoia, Bungoma, Kakamega, Busia and Siaya. The information and coordinates on the locality of each species/record were used to group the species into the respective county boundaries. The conservation status of the all the species extracted was assessed using the IUCN Red List (IUCN, 2020)

RESULTS

We found that approximately 9.3% (3239/34655) of Kenya's total fauna and flora species appear in the records attributed to the Nzoia River drainage basin. The species composition consists of 17.9% (1251/7000) vascular plants, 4.1% (1031/25000) invertebrates (insects and spiders), 6.7% (58/872) all fish, 32.2% (58/180) freshwater fish, 37.3% (41/110) amphibians, 45.0% (86/191) reptiles, 58.3% (650/1114) birds and 31.3% (122/390) mammals (table 1).

Table 1. Numbers of species of flora and fauna by taxa in the Nzoia River drainage basin (NRDB) compared to national total records of species.

Taxa	Number of recorded species in NRDB	Estimated number of known species recorded in Kenya	% of known species recorded in NRDB	Number of IUCN Red List species in NRDB/in Kenya	
Vascular plants	1251	7000	17.9%	10	103
Invertebrates	1031	25000	4.1%	3	11
Fish all	58	872	6.7%	3	81
Freshwater fish	58	180	32.2%	3	26
Reptiles	86	191	45.0%	1	2
Amphibians	41	110	37.3%	1	8
Birds	650	1114	58.3%	19	43
Mammals	122	390	31.3%	5	30
Total	3239	34677	9.3%	42	278

A total of 42 species consisting of 10 plants, three invertebrates, three fish, one reptile, one amphibian, 19 birds and five mammals are globally threatened according to the IUCN Red List (IUCN, 2020) (table 2).

Table 2. Globally threatened species of flora and fauna in the Nzoia River drainage basin. The status is according to the IUCN Red List: Vulnerable (VU), Endangered (EN) and Critically Endangered (CR).

Globally threatened species accepted name	Family	Status	Year assessed
Plants			
Helichrysum ellipticifolium Moeser	Asteraceae	VU	2017
Croton alienus Pax	Euphorbiaceae	EN	2018
Deschampsia angusta Stapf & C.E.Hubb.	Gramineae	VU	2004
Luzula campestris (L.) DC. var. *gracilis* S. Carter	Juncaceae	VU	2016
Entandrophragma angolense (Welw.) C.DC.	Meliaceae	VU	1998
Ansellia africana Lindl.	Orchidaceae	VU	2006
Disperis aphylla Kraenzl.	Orchidaceae	VU	2013
Prunus africana (Hook. f.) Kalkman	Rosaceae	VU	1998
Craterispermum longipedunculatum Verdc.	Rosaceae	VU	1998
Vitex keniensis Turrill	Verbenaceae	VU	2018
Dragonflies			
Platycypha amboniensis (Martin, 1915)	Chlorocyphidae	CR	2015
Notogomphus maathaiae Clausnitzer & Dijkstra, 2005	Gomphidae	EN	2015
Pseudagrion bicoerulans Martin, 1907	Coenagrionidae	VU	2015

Globally threatened species accepted name	Family	Status	Year assessed
Fish			
Labeo victorianus Boulenger, 1901	Cyprinidae	CR	2015
Oreochromis variabilis (Boulenger 1906)	Cichlidae	CR	2006
Oreochromis esculentus (Graham, 1928)	Cichlidae	CR	2006
Amphibians			
Arthroleptides dutoiti Loveridge, 1935	Petropedetidae	CR	2015
Reptiles			
Cnemaspis elgonensis Loveridge, 1936	Gekkonidae	VU	2014
Birds			
Grey Crowned Crane *Balearica regulorum* (Bennett, 1834)	Gruidae	EN	2016
Madagascar Pond Heron *Ardeola idae* (Hartlaub, 1860)	Ardeidae	EN	2016
Secretarybird *Sagittarius serpentarius* (Miller, 1779)	Accipitridae	VU	2016
Egyptian Vulture *Neophron percnopterus* (Linnaeus, 1758)	Accipitridae	EN	2019
White-backed Vulture *Gyps africanus* Salvadori, 1865	Accipitridae	CR	2018
Hooded Vulture *Necrosyrtes monachus* (Temminck, 1823)	Accipitridae	CR	2016
White-headed Vulture *Trigonoceps occipitalis* (Burchell, 1824)	Accipitridae	CR	2016
Martial Eagle *Polemaetus bellicosus* (Daudin, 1800)	Accipitridae	VU	2018
Greater Spotted Eagle *Clanga clanga* (Pallas, 1811)	Accipitridae	VU	2016
Tawny Eagle *Aquila rapax* (Temminck, 1828)	Accipitridae	VU	2018
Steppe Eagle *Aquila nipalensis* Hodgson, 1833	Accipitridae	EN	2016
Abyssinian Ground Hornbill *Bucorvus abyssinicus* (Boddaert, 1783)	Bucorvidae	VU	2018
Southern Ground Hornbill *Bucorvus leadbeateri* (Vigors, 1825)	Bucorvidae	VU	2016
Sooty Falcon *Falco concolor* Temminck, 1825	Falconidae	VU	2017
Grey Parrot *Psittacus erithacus* Linnaeus, 1758	Psittacidae	EN	2018
Papyrus Yellow Warbler *Calamonastides gracilirostris* (Ogilvie-Grant, 1906)	Acrocephalidae	VU	2016
Blue Swallow *Hirundo atrocaerulea* Sundevall, 1850	Hirundinidae	VU	2016
Chapin's Flycatcher *Muscicapa lendu* (Chapin, 1932)	Muscicapidae	VU	2016
Sharpe's Longclaw *Macronyx sharpei* Jackson, 1904	Motacillidae	EN	2016
Mammals			
Barbour's Vlei Rat *Otomys barbouri* Lawrence & Loveridge, 1953	Muridae	EN	2016
White-bellied Pangolin *Phataginus tricuspis* (Rafinesque, 1821)	Manidae	EN	2019
African Elephant *Loxodonta africana* (Blumenbach, 1797)	Elephantidae	VU	2008
Hippopotamus *Hippopotamus amphibius* Linnaeus, 1758	Hippopotamidae	VU	2016
Leopard *Panthera pardus* (Linnaeus, 1758)	Felidae	VU	2015

The highest proportion of the number of species in the Nzoia River drainage basin by county was from Kakamega with 57.1%, followed by Trans Nzoia 44.3%, then by Busia 10.4%, Elgeyo Marakwet 9.7%, Uasin Gishu 9.5%, Bungoma 7.5% and Siaya 6.5% (figure 3). Kakamega County is generally more studied than the other counties. The high proportional representation of species for example of fish in Uasin Gishu

(50.0%), mammals in Bungoma (49.2%) and amphibians in Elgeyo Marakwet (51.2%) are attributed to the disparities in the study effort for each taxon across the counties.

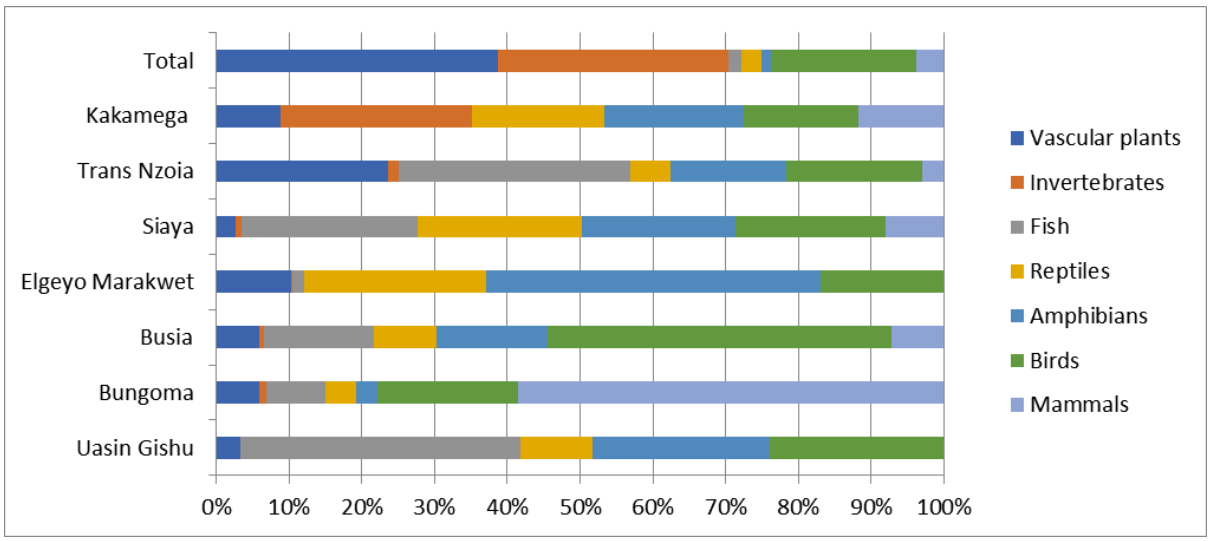

Figure 3. Percentage number of species records of flora and fauna by taxa and county from the Nzoia River drainage basin in the National Museums of Kenya collections. Data on birds was extracted from Lewis & Pomeroy 1989, Kenya Bird Map Project (2020) and eBird (2020). Invertebrate records include only insects and spiders.

Plants

Approximately 17.9% (1251/7000) of Kenya's nationally known vascular plant species, in the National Museum collection, catalogues and database, are recorded in the Nzoia River drainage basin. The highest proportion of the number of species per county to the drainage basin area is from Trans Nzoia with 72.9% (912/1251), followed by Kakamega 31.4% (393/1251), Elgeyo Marakwet 11.4% (142/1251), Bungoma 4.9% (61/1251), Busia 4.7% (59/1251), Uasin Gishu 4.2% (53/1251) and Siaya 2.5% (31/1251). Out of the total 1251 species of plants, ninety are endemic to Kenya and 10 are listed as globally threatened (table 2).

Invertebrates

Approximately 4.1% (1031/25000) of Kenya's national total of known invertebrate (insects and spiders) species in the National Museum collection, catalogues and database are recorded in the Nzoia River drainage basin. The highest proportion of the number of species per county to the entire drainage basin is from Kakamega 93.3% (962/1031), followed by Trans Nzoia 4.2% (43/1031), Bungoma 0.8% (9/1031), Siaya 0.8% (8/1031), Busia 0.6%(6/1031), Elgeyo Marakwet 0.3% (3/1031) and no record from Uasin Gishu. Other than in Kakamega, few or no invertebrate studies have been undertaken in the Nzoia River drainage basin, and this is reflected in the low proportion of species recorded for the other counties. The data also indicate that the specimens collected, identified and cataloged represented the species and county where it was first collected and hence no data on distribution across the counties. Most groups of invertebrates are poorly studied in Kenya, but Odonata are relatively well known. Njoroge *et al.* (2017) documented 172 species of Odonata for Kenya. Of these, 49 species have been recorded in the Nzoia River drainage basin area. Three of these invertebrate species are globally threatened of which one is endemic.

Fish

Approximately 32.2% (58/180) of the national total of freshwater fish (6.7% (58/872) of all fish species, i.e. including the marine and brackish water species) were recorded in the Nzoia River drainage basin. Most species are records from Trans Nzoia 98.3%(57/58), followed by Uasin Gishu 50.0% (29/58), then by Siaya 22.4% (13/58), Busia 12.1% (7/58), Bungoma 6.9% (4/58), Elgeyo Marakwet 1.7% (1/58) and no record from Kakamega. Despite the high number of records from Uasin Gishu and Trans Nzoia, most of these records are from a small area. For example, in Uasin Gishu, most of the records are from Marura Swamp (0°32'30"N, 35°20'23"E) and its surroundings while in Trans Nzoia, most of the records are from Saiwa Swamp (1°05'48"N, 35°07'12"E) and environs. The three threatened species of fish in the basin are all Critically Endangered (table 2).

Amphibians

Approximately 37.3% (41/110) of Kenya's total amphibian species have been recorded in the Nzoia River drainage basin area. The highest number of species was recorded in Kakamega 68.3% (28/41); followed by Elgeyo Marakwet 51.2% (21/41); then by Trans-Nzoia 48.8% (20/41); Uasin Gishu 31.7% (13/41); Siaya 19.5% (8/41); Busia 12.2% (5/41) and Bungoma 2.4% (1/41). Kakamega, Elgeyo Marakwet and Trans Nzoia counties are better studied than Bungoma, Busia and Siaya where lower numbers of species are recorded. The only one threatened amphibian species is Critically Endangered (table 2).

Reptiles

Approximately 45.0% (86/191) of Kenya's total reptile species have been recorded in the Nzoia River drainage basin area. The highest number of species was recorded in Kakamega 64.0% (55/86); followed by Elgeyo Marakwet 27.9% (24/86); then by Siaya 20.9% (18/86); Trans-Nzoia 17.4% (15/86); Uasin Gishu 12.8% (11/86); Busia 7.0% (6/86) and Bungoma 3.5% (3/86). Kakamega and Elgeyo Marakwet counties are better studied than Trans Nzoia, Bungoma, Busia and Siaya where lower numbers of species are recorded. The area has one threatened species that is vulnerable (table 2). The inclusion of species records from historical osteological analysis increases the number of reptiles from 86 to 88.

Birds

Approximately 58.3% (650/1114) of Kenya's total number of bird species are recorded from the Nzoia River drainage basin. The Kenya Bird Atlas came up with 624 species, Kenya Bird Map Project with 620 bird species and eBird with 608 species. An analysis of all these lists that cover records from 1917 to date gave a total of about 650 species for the study area. The highest number of species were recorded in Trans Nzoia with 57.8% (376/650), followed by Kakamega 55.5% (361/650), Busia 38.0% (247/650), Uasin Gishu 31.1% (202/650), Siaya 19.2% (125/650), Elgeyo Marakwet 18.8% (122/650) and Bungoma 16.3% (106/659). While the numbers may indicate the relative species richness by county, a lot less effort and coverage has been done, at least based on the number of pentads visited by the Kenya Bird Map Project, in the counties indicating relatively lower species numbers. Nineteen of these species are threatened according to the IUCN Red List (IUCN, 2020) (table 2). Approximately 41.5% (270/650) of the bird species are associated with forests. The forest categories include 81 forest specialists (FF), 97 forest generalists (F) and 92 forest visitors (f) according to the classification of Bennun *et al.* (1996). Approximately 17.2% (112/650) are listed as waterbirds according to the categorisation by Delany & Scott (2006).

Mammals

Approximately 31.3% (122/390) of Kenya's mammal species were recorded from the Nzoia River drainage basin area. The highest number of species were recorded in Bungoma 49.2% (60/122), followed by Kakamega 41.8% (51/122), then Trans Nzoia 9.0%(11/122), Siaya 7.4%(9/122), Busia 5.7%(7/122) and Elgeyo Marakwet with none. Species extracted from archeological and osteological records from the Nzoia drainage basin in Prendergast (2010) and Prendergast & Lane (2010) and Kimitei (2013) increase the total number of mammal species from 122 to 154. However these additional 32 species are missing in the current records (Tóth *et al.*, 2014). A total of five mammal species are threatened according to the IUCN Red List (IUCN, 2020), while three species are endemic (table 2). The historical presence of the Critically Endangered Black Rhino *Diceros bicornis* (Linnaeus, 1758) and three other species noted as globally or locally extinct with no confirmed record, include the Kenyan Oribi *Ourebia ourebi kenyae* Meinhertzhagen, 1905, Roan Antelope *Hippotragus equinus* (É. Geoffroy St.-Hilaire, 1803) and Mountain Bongo *Tragelaphus eurycerus isaaci* (Thomas, 1902). Kimitei (2013) reports a significant loss in suitable habitat for Mountain Bongo in the Cheranganyi Hills between 1973 and 2011 and no confirmed record of this species.

Ecosystem services

The data gleaned from the National Museums of Kenya databases and catalogues indicate ecosystem services provided by the species recorded in Nzoia River drainage basin. Generally the main ecosystem services are indicated as biodiversity, ecological balance and provision of socio-economic benefits. The species are part of the food chains and food webs with plants as primary producers and the other taxa playing the roles of grazers, prey, predator, pollinators and/or seed dispersers among others. They support agriculture as well as provide goods directly and indirectly for subsistence and commercial uses. Over 39.2% (490/1251) of the plant species are indicated as food—for cooking, seasoning, fruits, vegetables, beverages, condiments, resins and oils; medicines—including anti-fungal agents, toothbrush, perfumes, pesticides and poisons; fodder—for livestock and bees; timber- for construction, furniture, building houses, fencing, bee-hives and boats; personal effects—carvings, baskets, clothes, strings, ropes, walking sticks, spoons, tools, soap substitutes, tannins,

dyes, stains, inks and ornaments; weapons—bows and arrows; and fuel- charcoal and firewood. This study did not look into the records of fungi and bacteria that are known to represent large groups of organisms that are ecologically very important. Most natural processes within ecosystems depend on microorganisms (including fungi and bacteria) such as carbon and nitrogen cycles, biodegradation of environmental pollutants (e.g. sewage and agrochemicals) and production of humus (recycling of nutrients) (Kung'u & Boa, 1997). Macro-fungi receive little attention, even though they are known to contribute greatly to balancing the ecosystem in terms of ecological niche, nutrient recycling and symbiotic associations (Tibuhwa *et al.*, 2011). Invertebrates are indicated as food, pollinators and detritivores, while some are pests and disease vectors. The Grey Dungball Roller *Neosisyphus spinipes* (Thunberg, 1818) is noted as useful in ranching and farming. Fish species are indicated as useful for food, game fishing, aquaculture, aquaria (as ornamentals) and have commercial export value. Amphibians and reptiles are indicated as good bio-indicators of pollution, flooding, drought, climatic and environmental changes. Amphibians and reptiles have potential of being used in the development of crocodile and chameleon farming for meat, skin and pet trade as well as exhibition parks to boost eco-tourism. Birds and mammals are indicated to have many uses including part of the food chains and food webs, balancing the ecosystem dynamics and as biological indicators.

DISCUSSION

This study brings out the species richness for the focal taxa (*i.e.* vascular plants, fish, invertebrates—insects and spiders, amphibians, birds and mammals) of the Nzoia River drainage basin and their conservation status. Documentation of their ecological and socio-economic importance provides an underpinning to promote policies that may enhance their conservation, research and upscaling of their ecosystem services in the Nzoia River drainage basin and beyond. The global and national importance of this area is underscored by the fact that it occupies only 2.2% of Kenya's total land mass, with 17% of Kenya's human population, 9.3% of known (vascular plant, invertebrates, fish, amphibians, reptiles, birds and mammals) species, and 15% (42/278) of Kenya's known threatened species listed according the IUCN Red List of Endangered Species, as either Vulnerable, Endangered or Critically Endangered. There is much more to be unveiled as this study exposes major gaps especially for non-vascular plants, fungi, bacteria and invertebrates. The species of Kakamega Forest in Kakamega County are by far the most studied than any other part of the Nzoia drainage basin. This study is based on the National Museums of Kenya specimen collection that gives a total of 962 species of insects and spiders from Kakamega Forest. Looking at other published sources, Bagine *et al.* (2014) gives an estimate of 1278 invertebrate (insects and molluscs) species for Kakamega Forest. According to Bagine *et al.* (2014), the number of insect species (Lepidoptera, Odonata and Tephritidae) for Kakamega Forest alone represented by voucher specimens in the NMK added to species documented by Kühne *et al.* (2004), Clausnitzer (1999), Copeland (2010), Clausnitzer (2010), Kühne *et al.* (2010), Clausnitzer (2005) and Garcia *et al.* (2009) give an estimated total of 1792 (1566 Lepidoptera, 76 Odonata and 150 Tephritidae) species. An addition of 288 species of ants reported by Garcia & Fischer (2010) and 242 species of bees reported by Gikungu & Hagen (2010) give a total of 2322 invertebrate species for Kakamega Forest alone.

The number of species across taxa appears to have changed over time. For example, archeological and osteological data indicate that there are a number of missing and added species of mammals in modern (1950-2013) compared to historical (1890-1950) records from Mount Elgon National Park and Kakamega Forest (Tóth *et al.*, 2014). While the reasons for these discrepancies are not yet established, the missing taxa are known to have specialised habitat preferences, hence their loss may be as a result of habitat changes (Tóth *et al.*, 2014). Limited resources predispose museum research to target rare species and expeditions that focus on filling the missing specimens in the collections. Advancing technological changes and stochastic variation in specimen collection methods and priorities obscure the certainty of underpinning the ecological processes taking place. To remedy the disparity exposed by the data, future studies have to prioritise taxa and counties that have contributed less than 10% of the records indicated in this study. They also need to strategise on the methodology used and take a landscape approach that will look at the Nzoia River drainage basin as one unit of an ecosystem. The ecological processes effecting changes in species composition and numbers may be mainly due to immigration, emigration and local extinctions caused by changes in land use, habitat loss, persecution and climatic change.

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