Camera Trap Survey to Assess Species Diversity in Burunge WMA and Kwakuchinja Wildlife Corridor

December 2019

Introduction

Kwakuchinja corridor and Burunge Wildlife Management Area (BWMA) are important in the Tarangire-Manyara Ecosystem for promoting biodiversity conservation and wildlife-based community economic benefits. A camera trap survey was initiated in this area with the aim of assessing mammalian species diversity and ecological potential of Kwakuchinja wildlife corridor; assessing anthropogenic activities and landscape factors influence wildlife distribution and providing baseline information for wildlife population monitoring.

The report for the first phase of the survey covered a period between 18th December to the 18th February 2019. Therefore, this report includes information from the original report but also provides more results from the combined dataset from phase one and phase 2 of the survey between February to July 2019.

Materials and Methods

Study area

Burunge WMA was established in 2003 and it encompasses Kwakuchinja wildlife corridor serving as a wildlife dispersal area and supports wildlife migration between Tarangire and Manyara NP. The WMA is in the Tarangire - Manyara ecosystem, specifically in the Babati District of Tanzania. As one of the four Tanzanian WMAs officially gazetted in July of 2006, the Burunge Wildlife Management Area covers 218 km^2, including Lake Burunge (Kaswamila, 2012). It borders Tarangire National Park to the east, Lake Manyara National Park to the west and Manyara Ranch to the north (Fig. 1). BWMA is semi-arid with an average yearly rainfall of 750 mm/annum. The two rainy seasons take place between February to May and November to January, respectively, while the dry season is from June to October (Kaswamila 2012). During every wet season, most of the wildlife migrates out of Tarangire National Park and Lake Manyara National Park into the BWMA. The WMA now contains ten villages, encompassing 0.4 km^2 of community land and about 300,000 residents. Pastoralism and agriculture are the main land uses practiced by about 94% of the local population. Other activities such as fishing, hunting and rising tourism related businesses are prevalent. The crop production level and grazing areas are low due to the arid condition of the land (Kaswamila, 2012).

Kwakuchinja corridor supports several resident and migratory wildlife species including the African elephant (*Loxodonta Africana*), Lion (*Panthera leo*), Hippopotamus (*Hippopotamus amphibius*), Impala (*Aepyceros melampus*), Giraffe (*Giraffa camelopardalis*), Zebra (*Equus grevyi*), Wildebeest (*Connochaetes taurinus*), Bushbuck (*Tragelaphus scriptus*), Leopard (*Panthera pardus*) etc. With its rich diversity in fauna and flora, Kwakuchinja has long been known for its support to strong ecotourism activities providing economic benefits to the local communities as well as a source of government revenue.

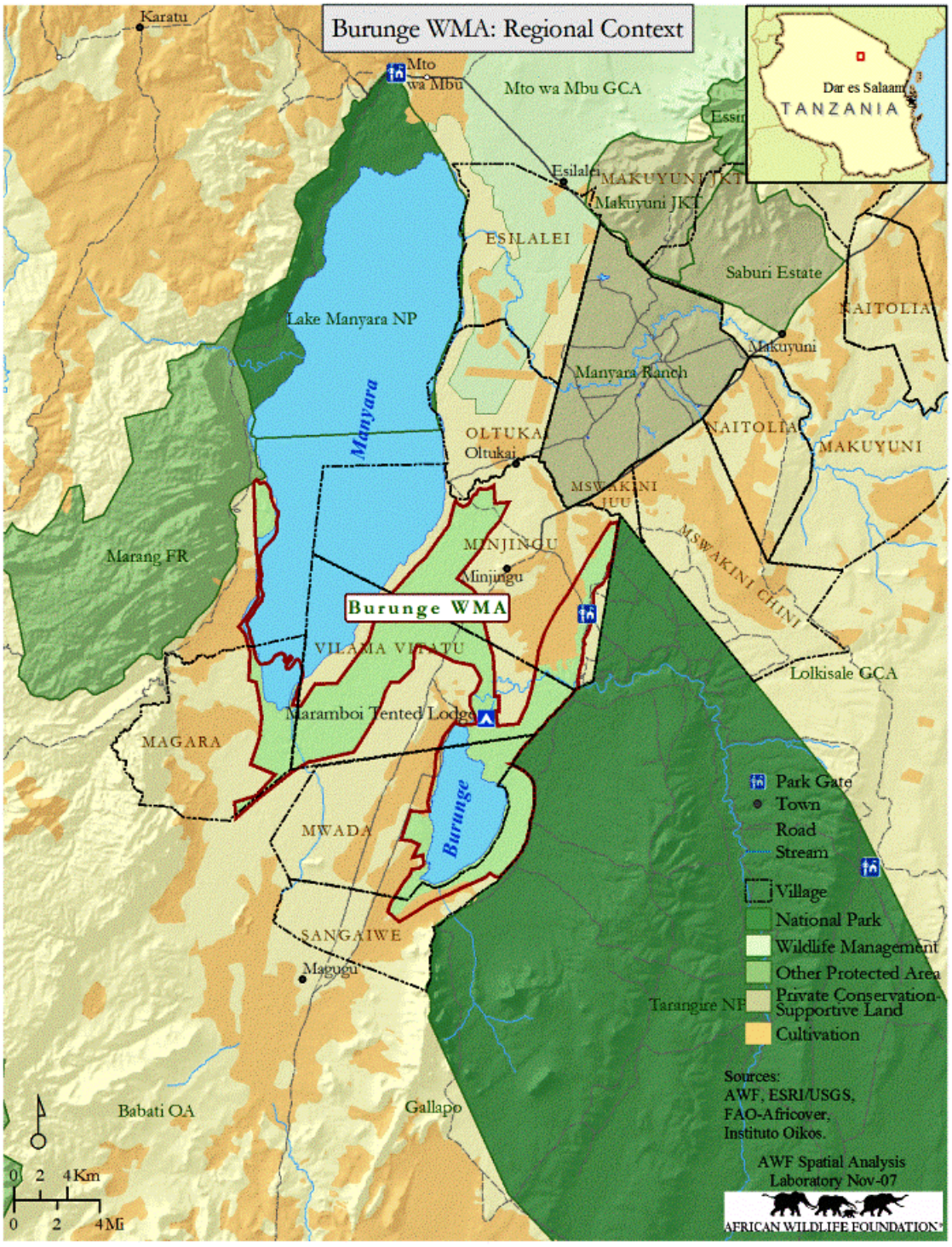

Figure 1. Burunge WMA section of Kwakuchinja corridor in relation to Tarangire and Manyara NP and other conservation units within the Maasai steppe of Northen Tanzania (**Source:** African Wildlife Foundation, Instituto OIKOS-2007)

Field data collection

Two models of camera traps were used in this survey; Reconyx HF 2 PRO white, digital and Reconyx HC500 HyperFire Semi-Covert IR digital. Camera trap stations were selected randomly using Google Earth map overlaid to the study area. Because the objective of the survey was to maximize species detection, camera traps were randomly placed at distances ranging between 150 and 650m apart without a systematic grid. At each camera trap station, vegetation type was recorded following the broad categorization (Wooded grassland, Bushland).

Camera traps were run between 18th December 2018 to 18th July 2019 with fortnightly visits to retrieve the pictures and service the cameras. Cameras were mounted on trees at a height that varied from 0.5m to 3m above the ground depending on the distance of the targeted wildlife trails from the camera. Camera traps were programmed to take photographs without delay between sequential photos and to operate 24hrs/day.

Data analysis

Camelot -1.4.5 (Hendry & Mann, 2017) and Wild.ID Version 0.9.28/S1 0.9.6 software were used to process photographs. The software were used to extract information about species identification, keep track of camera trap stations, record date and time when the photograph was taken based on the time stamp on the photo. The data were exported as CSV files and into Excel for further analysis. Due to the presence of gregarious species that move in large herds and tend to linger in front of the cameras such as wildebeest, zebra and impala in the study area, independent events were defined when consecutive photos of the same quantity of individuals of the same species were spaced for at least 2 minutes (T=2). However, additional rules were used to define independent events within the T=2 window as follows: when the quantity of individuals of the same species differ between consecutive sightings and when the life stage of the individuals in consecutive sightings were different. Because some of the camera traps either malfunctioned or were vandalized/stolen in the course of the survey, the sampling effort was calculated by multiplying the number of camera-traps by the trap nights per camera, which is the number of nights a camera-trap was operational in the field. Trap success rate or photographic rate was obtained by dividing the number of events (photographs) by the sampling effort.

Species composition and diversity

The number of all individual species captured at each camera station was used to compile species composition and determine diversity for each station. The data were analyzed using R-software version 3.5.1 in R Studio environment. Shannon Diversity Index, species accumulation and rarefaction curve were generated using R package Vegan (Oksanes et al 2019).

Species distribution (Occupancy modelling)

Occupancy modelling to assess species distribution was conducted for the four species with the highest capture rate. The data was divided into 5 sampling replications of 12 days each. Detection histories in each camera station were recorded as 1 if a species was captured during the sampling replications and recorded as 0 if the species was not captured during the sampling replications. Occupancy was only calculated for species with trap success rate of more than 1. Occupancy modelling was conducted in R-Software package UNMARKED where a single season model was fitted without any covariates (MacKenzie et al, 2002). The unmarked fit objects were back-transformed to normal scale using backTransform, and Standard errors computed using Delta method (Fiske & Chandler 2011, 2012). This provides an estimate of the expected probability that a site was occupied, and it applies to the hypothetical population of all possible sites, not the sites found in our sample (Fiske & Chandler, 2012). Only the basic model was fitted for each species to estimate occupancy.

Results

Sampling effort

At the start of the survey, thirty-one (31) camera traps were installed in the field, but only twenty-one (21) cameras provided data throughout the survey period. The other ten camera traps were either stolen or broken during the survey. Figure 2 shows the locations of all the camera trap stations that provided data over survey period.

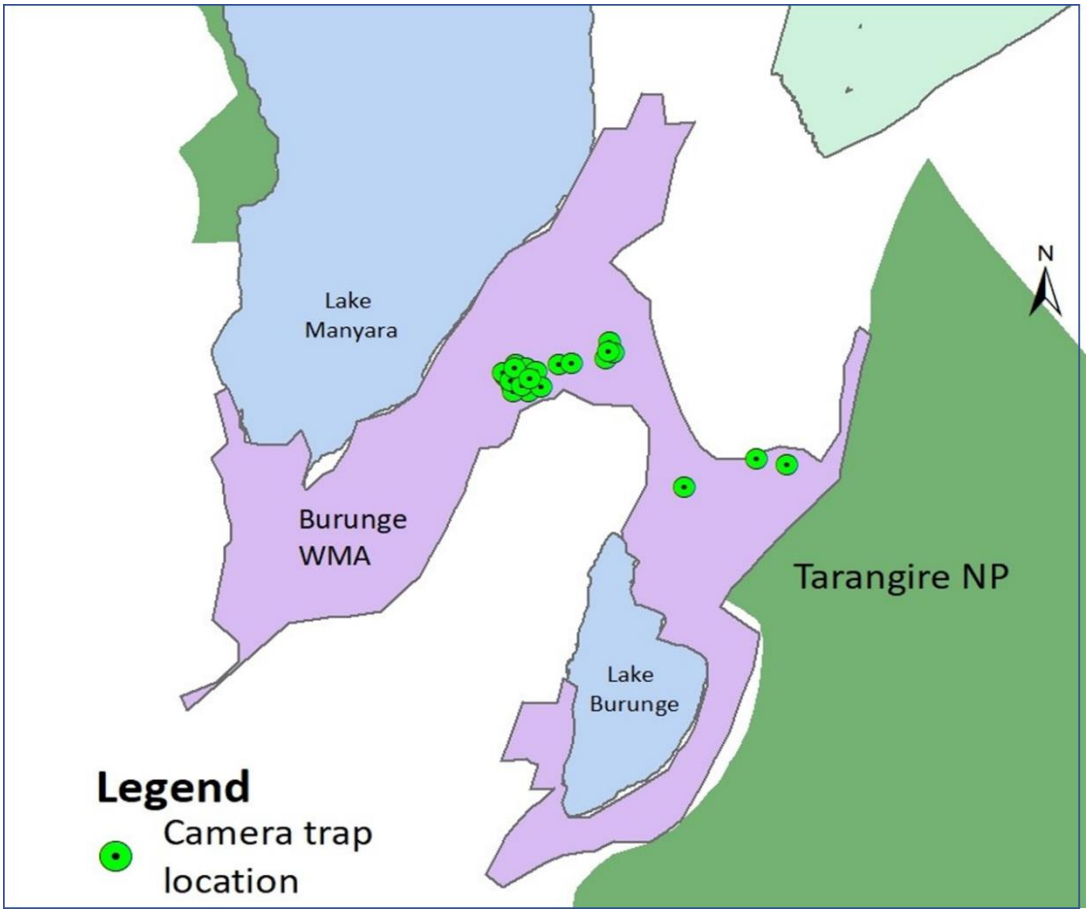

Figure 2. Locations of Camera traps in Burunge WMA

In total 435,650 photographs were taken by all the Camera traps during the entire survey period between 18th December 2018 to 18th July 2019. There were 182,841 photos that were Blank, mostly caused by wind moving grass or tree branches and 234 photos not possible to identify species. Blank and unidentified photos were not included in the final analysis. Therefore, the final sampling effort for this survey was 3,913 camera-trap days with 76,555 photo events. The overall trap success rate was 19.56, with a mean success rate of (0.24± 0.11SE). There was a large variation in trap success rate between species, with wildebeest having the highest trap success rate of 6.29, zebra 4.28, Impala 3.01 and warthog 1.50. Figure 3 presents the trap success rates for all species captured in the survey.

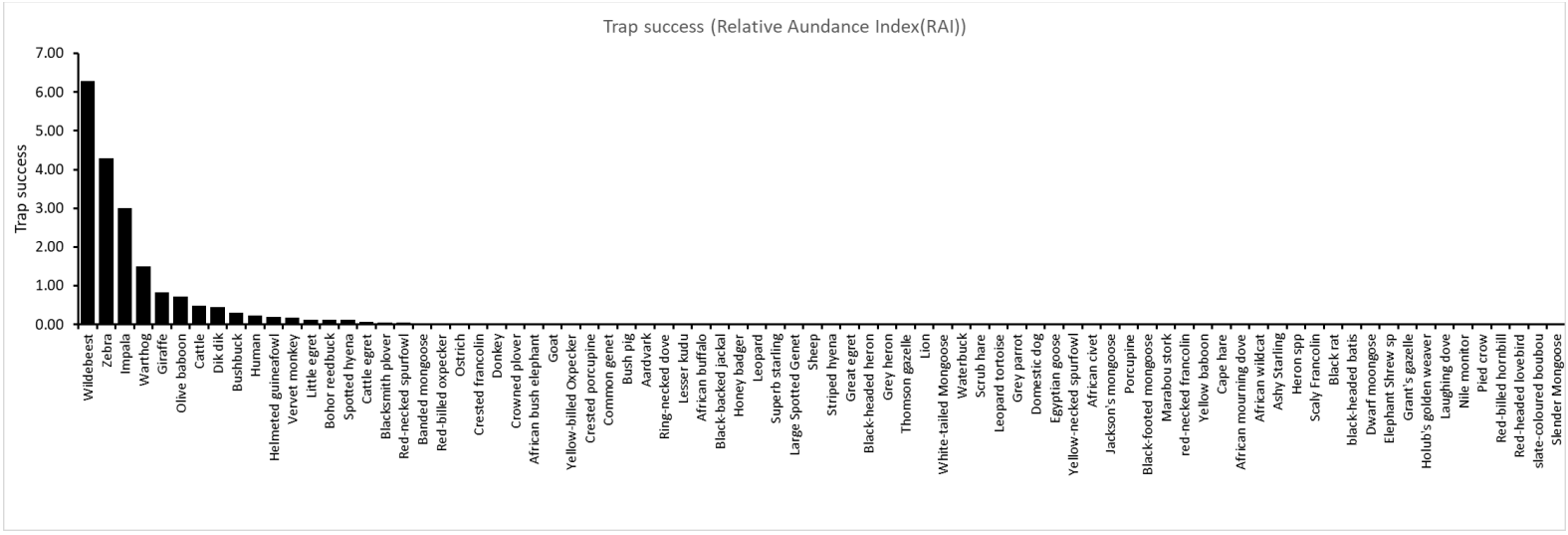

Figure 3. Trap success rates for wildlife species captured in a camera trap survey in Kwakuchinja corridor and Burunge WMA during the December 201 to July 2019 period

Species composition and accumulation curve

A total of 80 species of mammalian carnivores and herbivores, birds, livestock and human were recorded and identified during the survey period (Table 1).

Table 1. List of species captured during a camera trap survey in Kwakuchinja corridor and Burunge WMA indicating the number of events and trap rates for each species

Sn	Species	No. of photo events	% of all events
1	Wildebeest	24595	32.1272
2	Zebra	16767	21.9019
3	Impala	11766	15.3693
4	Warthog	5857	7.6507
5	Giraffe	3278	4.2819
6	Olive baboon	2833	3.7006
7	Cattle	1901	2.4832

8	Dik dik	1791	2.3395
9	Bushbuck	1175	1.5348
10	Human	930	1.2148
11	Helmeted guineafowl	766	1.0006
12	Vervet monkey	685	0.8948
13	Little egret	505	0.6597
14	Bohor reedbuck	501	0.6544
15	Spotted hyena	498	0.6505
16	Cattle egret	265	0.3462
17	Blacksmith plover	225	0.2939
18	Red-necked spurfowl	218	0.2848
19	Banded mongoose	167	0.2181
20	Red-billed oxpecker	156	0.2038
21	Ostrich	149	0.1946
22	Crested francolin	147	0.1920
23	Donkey	113	0.1476
24	Crowned plover	104	0.1359
25	African bush elephant	99	0.1293
26	Goat	94	0.1228
27	Yellow-billed Oxpecker	87	0.1136
28	Crested porcupine	83	0.1084
29	Common genet	75	0.0980

30	Bush pig	69	0.0901
31	Aardvark	52	0.0679
32	Ring-necked dove	50	0.0653
33	Lesser kudu	48	0.0627
34	African buffalo	42	0.0549
35	Black-backed jackal	41	0.0536
36	Honey badger	34	0.0444
37	Leopard	32	0.0418
38	Superb starling	27	0.0353
39	Large Spotted Genet	25	0.0327
40	Sheep	24	0.0314
41	Striped hyena	24	0.0314
42	Great egret	23	0.0300
43	Black-headed heron	18	0.0235
44	Grey heron	18	0.0235
45	Thomson gazelle	18	0.0235
46	Lion	17	0.0222
47	White-tailed Mongoose	17	0.0222
48	Waterbuck	15	0.0196
49	Scrub hare	14	0.0183
50	Leopard tortoise	12	0.0157
51	Grey parrot	11	0.0144

52	Domestic dog	10	0.0131
53	Egyptian goose	10	0.0131
54	Yellow-necked spurfowl	8	0.0105
55	African civet	7	0.0091
56	Jackson's mongoose	7	0.0091
57	Porcupine	6	0.0078
58	Black-footed mongoose	5	0.0065
59	Marabou stork	5	0.0065
60	red-necked francolin	5	0.0065
61	Yellow baboon	5	0.0065
62	Cape hare	3	0.0039
63	African mourning dove	2	0.0026
64	African wildcat	2	0.0026
65	Ashy Starling	2	0.0026
66	Heron spp	2	0.0026
67	Scaly Francolin	2	0.0026
68	Black rat	1	0.0013
69	black-headed batis	1	0.0013
70	Dwarf moongose	1	0.0013
71	Elephant Shrew sp	1	0.0013
72	Grant's gazelle	1	0.0013
73	Holub's golden weaver	1	0.0013

74	Laughing dove	1	0.0013
75	Nile monitor	1	0.0013
76	Pied crow	1	0.0013
77	Red-billed hornbill	1	0.0013
78	Red-headed lovebird	1	0.0013
79	slate-coloured boubou	1	0.0013
80	Slender Mongoose	1	0.0013

The species accumulation curve from phase I report suggested that more effort was needed, and 10 more species were captured during the second phase of the survey. The current results of the species accumulation curve has not completely leveled off, suggesting that that there could be more new species to be captured with more effort (Fig. 4).

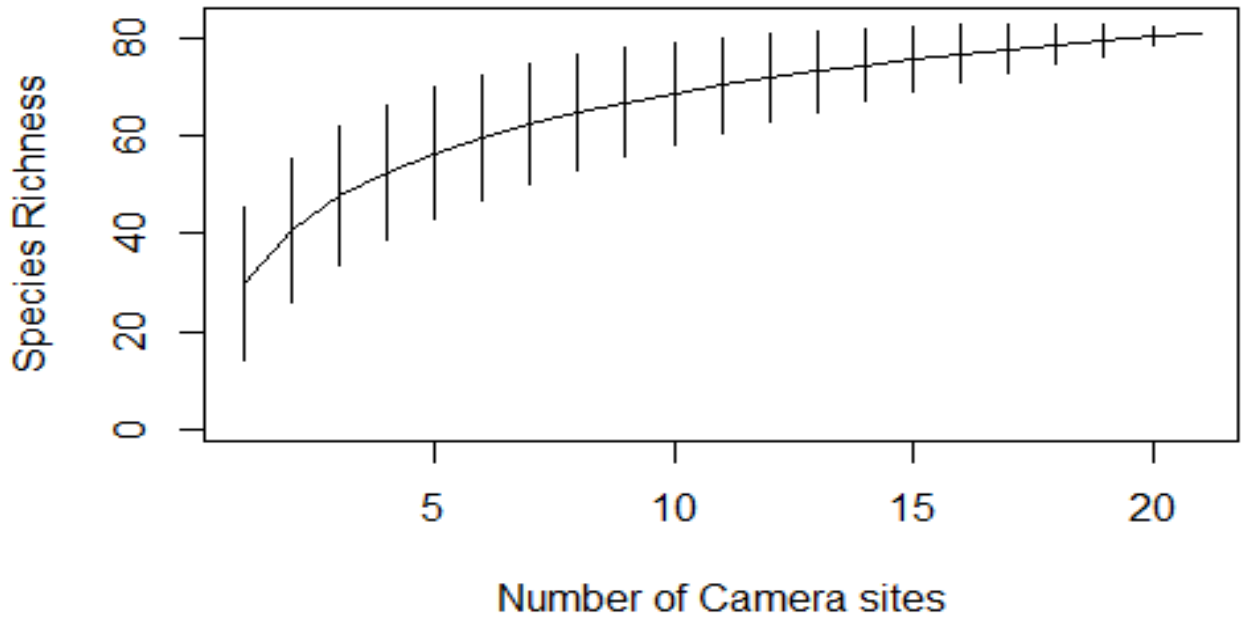

Figure 4. Species accumulation curve for all species recorded in Kwakuchinja corridor and Burunge WMA during the December 2018 to July 2019 survey period.

Species Richness and Diversity

Shannon Wiener (H) species diversity Index was calculated for each camera trap station and the results are presented in Table 2. Diversity index suggest that most of the camera traps stations have evenly distributed diversity even though the number of species detected at a camera trap station showed positive correlation with the Diversity index at the station (Fig 5).

Table 2. Diversity Index (H) and species richness for camera trap stations in Kwakuchinja corridor

Camera Trap ID	Species Richness	Shannon Wiener Diversity Index (H)
Camera1	43	1.65
Camera2	33	1.52
Camera3	24	2.00
Camera4	31	2.04
Camera5	25	2.23
Camera6	34	2.42
Camera7	32	2.17
Camera8	38	2.41
Camera9	26	1.78
Camera11	17	2.28
Camera12	37	2.29
Camera14	29	2.26
Camera15	14	1.72
Camera16	24	1.54
Camera17	35	2.13
Camera18	29	2.17
Camera19	35	2.42
Camera20	26	2.29

Camera21	29	2.26
Camear22	33	2.36
Camera26	11	2.04

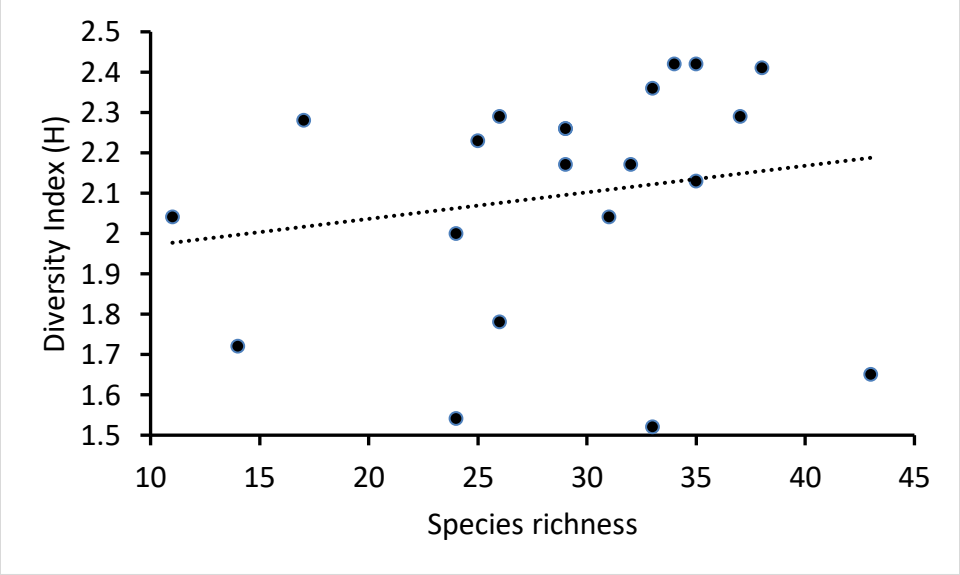

Figure 5. Relationship between the number of species sighted at each camera trap station and the Shannon Wiener Diversity Index (H)

Species distribution (Occupancy)

The results from phase I indicated wildebeest, zebra, Giraffe, Impala and Warthog to have high occupancy ranging from 70-100%. These high occupancy results could partly be due to lack of spatial independence between camera trap stations. In September 2019, a grid system was set-up across the study area in order to collect data for analyzing species occupancy.

Discussion

This camera trap survey is the first to be conducted in Kwakuchinja corridor encompassing Burunge WMA, and thus provides the first comprehensive checklist of species of 80 species of

large and small mammals (carnivores & herbivores), birds, found in the area. Results indicate high trap success rate but there was high variation in the trap success rate between species with only five species including wildebeest, zebra, Impala, giraffe, olive baboon, warthog and cattle dominating the area. This suggests that the study area is dominated by only a few species occurring at high abundancies. This could also mean that the camera trap stations might have been unevenly distributed across the different habitats, concentrated in habitats preferred by these species.

For species occupancy and distribution, it is recommended the analysis be carried out once the data from the grid becomes available in order to overcome the issue of lack of spatial independence between camera trap stations.

As indicated in the phase I report, cattle show high photographic rate which suggests that Kwakuchinja corridor and Burunge WMA could be experiencing a higher than normal abundance of livestock in the area.

Species accumulation curve appears to have not completely levelled off suggesting that there might still be more species in some sites that have not yet been recorded. Ten (10) new species were captured during the phase II survey period, thus increasing the number of species from 70 in phase I to 80.

Recommendations and challenges encountered

- The number of livestock recorded in the WMA has consistently been higher from the results of this camera survey as well as from previous censuses conducted using ground walking transects. The WMA management should consider this issue and plan appropriate actions to reduce the number of livestock in the WMA as too many livestock will have negative impact in the WMA.
- A 1KM grid system covering 20sqkm was created and 40 cameras were deployed, but there was a high rate of camera theft and vandalism; some of the cameras have been

removed from the field. Up to now, about 11 cameras have been stolen or intentionally broken by people.

Acknowledgements

We would like to thank USAID PROTECT for financial support through a grant to Chem Chem Association (CCA). We thank CCA for providing on the ground logistical support during field data collection, TAWIRI for providing additional cameras used in the study and technical input during fieldwork and for providing permits for the study and SFS for the technical input and participation in field data collection, data entry, analysis, and preparation of the report. We thank the community and management of Burunge WMA for providing scouts who teamed up with CCA scouts in the fieldwork and for allowing the study to take place in the BWMA.

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