EXPEDITION REPORT

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The frontline of conservation: Defending the Kenyan Maasai Mara from biodiversity loss

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ABSTRACT

Enonkishu Conservancy is on the northernmost boundary of the Mara-Serengeti Ecosystem (MSE). The conservancy is secured year to year by renting the land from Maasai title-deed owners who, as conservancy members, abide by land-use regulations (restricting permanent structures, arable farming, fences, utilisation of natural resources and regulating the number of livestock). The land rent for Enonkishu was first paid in 2014 and many wildlife species have re-inhabited the conservancy since then. As a result of this, resource competition between ungulates and livestock is a concern, especially because Enonkishu aims to be a showcase site for sustainable, community-based rangeland management. In 2019 Enonkishu started a cooperation with Biosphere Expeditions, based around an annual citizen science expedition, to help with monitoring and create more monitoring capacity.

In 2020 the second one-month long citizen science wildlife monitoring expedition took place with the aim of continuing to develop monitoring strategies. The expedition undertook six monitoring methods to document a range of biodiversity across a range of spatial and temporal scales: (1) vehicle line transects to document mammal abundance, (2) 'mammal mapping' to cover spatial distribution of both wildlife and domestic animals inside and outside the conservancy, (3) bird mapping using the SABAP2 atlassing protocol at the pentad level, (4) waterhole monitoring to determine patterns of visitation of mammals, (5) biodiversity inventory of plants and miscellaneous wildlife using the iNaturalist global citizen science platform and (6) camera trapping using an established grid system as well as monitoring so-called hotspots of high animal activity.

The results of the above in brief are: (1) warthog and impala remain the most common animals at Enonkishu; (2) there is clear spatial partitioning of domestic and wildlife mammals, with some overlap; (3) over 230 bird species were recorded in and around Enonkishu; (4) waterhole visitation was low due to high rainfall during this monitoring period; (5) over 300 records of a range of non-charismatic flora and fauna (plants and insects) were documented; (6) camera trapping confirmed impala as the dominant ungulate, but also produced sightings of rare or elusive animals (leopard and African civet), as well as documenting activity at the mineral claylick, used by baboon, impala, dik-dik, elephant and cattle. A high density of a range of wildlife was observed, including top predators and elephants. This suggests that the Enonkishu Conservancy is playing a valuable role in conservation in the northern Mara region.

Enonkishu employs seven rangers who are responsible for protection of wildlife, livestock and people within the conservancy. Rangers are tasked with collecting data on wildlife populations. However, historic monitoring has been haphazard due to lack of resources. Therefore, next to collecting baseline data, another objective of the expedition was to introduce the rangers to automated data collection using the CyberTracker software. This software was used to record data during mammal mapping, line transects and waterhole monitoring. Date, time and GPS are recorded automatically by smartphones, and options are usually selected from lists, reducing data transcription errors. Rangers supported the expedition throughout and in doing so built their skills, confidence and pride in their work to such an extent that a less intensive version of monitoring can now be conducted in the absence of citizen scientists.

In addition, two expedition days were dedicated to an educational workshop for participants from the Emarti Secondary School, which is the closest community to the Mara Training Centre expedition base. Participants introduced the students to monitoring protocol and wildlife, and engaged in discussions on the theme of protecting the environment.

MUHTASARI

Hifadhi ya Enonkishu iko kaskazini mwa mpaka ya mazingira ya Mara-Serengeti na inapata hifadhi wake kila mwaka kwa kukodisha ardhi kutoka kwa wenye hati ya umiliki wa ardhi wenye asili ya jamii ya maasai, ambao kama washiriki wa hafidhi hii hufuata kanuni za utumiaji wa ardhi (kutojenga majengo ya kudumu, kilimo endelevu, kutounda vizio, matumizi ya maliasili na kudhibiti idadi ya mifugo). Kodi ya ardhi ya Enonkishu ililipwa kwa mara ya kwanza mnamo 2014, spishi nyingi za wanyamapori wamerejea kwenye makaazi yao hivyo basi kuzua suala nyeti la ushindani wa rasilimali kati ya wanyama pori na mifugo haswaa ikizingatiwa kuwa Enonkishu inakusudia kuwa kielelezo njema kwa usimamizi endelevu katika harakati ya utunzaji wa rasilimali kwa njia inayo wahusisha jamii. Mnamo mwaka wa 2019, Enonkishu ilianzisha ushirikiano na kundi ya msafara,Biosphere Expeditons ambayo msingi yake huwahusisha raia wa sayansi ilikukuza uwezo na kuunga mkono harakati za utafiti ya ki ikolojia.

Mnamo mwaka 2020, msafara wa pili wa raia wa sayansi katika shugli ya utafiti ya wanyama pori iliyo chukuwa mwezi moja, ilitendeka na lengo kuu lilikiwa ni kukuza mikakati mbalimbali ya utafiti. Msafara huo ulihushisha njia sita za kutafiti ilikunakili na kuorodhesha aina mbali mbali ya bioanuwai katika pande zote za jiographia.Njia hizo ni: (1) mikondo ya mstari ya gari ili kuorodhesha idadi ya wanyama,(2) Matumizi ya ramani ya mamalia, ili kuonyesha orodha ya wanyama kijiografia nje na ndani ya hifadhi ya wanyama, (3) matumizi ya ramani kuorodhesha aina mbali mbali ya ndege, kwa kutumia SABP2 chenye kiwango cha pentad (4) utafiti kwenye kisima cha maji ili kubaini mienendo ya mamalia (5) Orodha ya bioanuai ya mimea na wanyama pori kwa kutumia jukwa la sayansi ya raia wa ulimwengu wa iNaturalist na (6)Matumizi ya kamera zilizotegwa mbugani kwa mfumo wa gridi, pamoja na kuangalia sehemu zilizo na shugli nyingi za wanyama.

Matokeo ya hapo juu kwa kifupi ni: (1)Ngiri na Swara ndio wanyama wa kawaida Enonkishu (2) Kuna ugavi kati ya wanyama pori na wanyama wakufugwa ingawa mwingiliano wao umeonekana. (3)Ndege zaidi ya miambili na thelathini wamenakiliwa ndani na nje ya Enonkishu ; (4) Ziara ya wanyama kwenye kisima cha maji ilikuwa chini kwasababu ya mvua kubwa ulioshuhudiwa wakati wa utafiti huo(5) rekodi zaidi ya 300 za aaina ya mimea isiyo ya haiba haiba na wanyama (mimea na wadudu) ziliandikwa(6) Utekaji wa kamera ulidhibitisha Swara ndiye mnyama anayetawala sehemu nyingi mbugani, isitoshe ilionyesha taswira ya wanyama adimu ama mashuhuri wakiwemo Chui na Ngawa. Shugli kwenye dimbwi la madini haswa ya Nyani, Swara, Diki diki, Tembo na Ng'ombe ilishuhudiwa. Uzani mkubwa wa idadi ya wanyama wa porini ulizingatiwa, pamoja na wanyama wanaowinda wanyama wengine na tembo. Hii inaonyesha kuwa Conservance ya Enonkishu inachukua jukumu muhimu katika uhifadhi katika mkoa wa kaskazini mwa Mara, hii ni ishara kuu kuwa hifadhi ya Enonkishu inachukuwa jukumu muhimu katika uhifadhi wa bioanuai kwenye mkoa wa kaskazini mwa Mara.

Enonkishu imewaajiri walinzi saba wa mbugani, wenye wa jukumu la kuwatunza wanyama pori,mifugo na watu wanaoishi ndani ya hifadhi hilo. Walinzi hao wamepewa jukumu la kukusanya data ya idadi ya wanyamapori. Walakini, utafiti na ufuatiliaji wa historia imekuwa hasi kwasababu ya ukosefu wa rasilimali, kwa hivyo kusudi linguine la msafara huo wa raia wa sayansi nin kuanzisha masafa ya ukusanyaji data otomatiki kwa kutumia programu ya CyberTracker. Programu hii ilitumiwa kurekodi data wakati wa uchoraji wa ramani ya mamalia, kwenye mikondo ya mistari ya magari na utafiti na ufuatiliaji kwenye Kisima cha maji. Tarehe, wakati na ratiba za kijiografia zilirekodiwa kiotomatiki na simu mahiri isitoshe, kuchagua wanayama kutoka kwa orodha ilioko kwa programu hiyo basi imepunguza makosa ya uandishi wa data. Walinzi wa wanyama pori waliunga msafara huo mkono na kwa kufanya hivyo kupokea na kujenga ustadi ,ujasiri na fahari katika kazi zao kiasi kwamba, utafiti usiowakidharura waweza tekelezwa bia raia wa sayansi kuwepo.

Kuongeza, siku mbili za msafara huo zilitengewa semina ilikuwaelimisha washiriki kutoka Shule ya Sekondari ya Emarti, ambayo ndio jamii ya karibu zaidi na Kituo cha Mafunzo cha Mara. Washiriki waliwajuza wanafunzi kuhusu itifaki za utafiti na ufuatiliaji wa wanyama pori, isitoshe, walishiriki kwenye majadiliano juu ya mada ya kulinda mazingira.

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1. Expedition Review

Matthias Hammer (editor)
Biosphere Expeditions

1.1. Background

Background information, location conditions and the research area are as per Karimi & Hammer (2019). The expedition focused on monitoring wildlife and biodiversity of Enonkishu Conservancy and surrounding areas within the Mara-Serengeti Ecosystem (MSE). The expedition undertook six types of monitoring activities across a range of taxa: vehicle line transects to record large mammals and birds in a standardised manner that contributes to long-term monitoring; 'mammal mapping' to cover spatial distribution of both wildlife and domestic animals inside and outside the conservancy; bird mapping using the SABAP2 atlassing protocol at the pentad level; waterhole monitoring to identify species most reliant on water; biodiversity inventory of plants and miscellaneous wildlife using the iNaturalist global citizen science platform; and camera trapping using an established grid system as well as monitoring areas with above average mammal activity (so-called hotspot monitoring). The project contributes to Enonkishu's vision to create resilient and economically viable conservancy systems and strategies that lead the way in biodiversity conservation and defend the Mara from settlement and agricultural encroachment, poaching and destruction.

1.2. Dates & team

The project ran over a period of one month divided into two 13-day slots, each composed of a team of national and international citizen scientists, a professional scientist and an expedition leader. Group dates were as shown in the team list below. Dates were chosen to coincide with the most favourable weather in the Mara. However, the period experienced above average rainfall during this expedition.

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of ages, nationalities and backgrounds. They were (in alphabetical order and with country of residence):

2 – 14 February 2020: Ralf Caspar (Germany), Sylvie Cyr (Canada), Peter Goodman (UK), Nanette Holliday** (Australia), Emmanuel Kilusu* (Kenya), Gabriele Koßmann (Germany), Michael Koßmann (Germany), Monika Plocek (Austria), Jaein Seo** (USA), Christina Shirt (UK), Margaret Simpson (UK), Brigitte Soucy (Canada), Peter Thoem (Canada).

16 – 28 February 2020: Fiona Anderson (UK), Christiane Flechtner** (Germany), Céline Geiger (France), Kathy Haan** (USA), Matthias Herold (Germany), Ariane Holzhauer (USA), Sipra Lahtinen (Finland), Heike Lange (Germany), Kuntusangpo Ling (Canada), Jet Long (USA), Brian Oikawa (Canada), Paul Serail (Netherlands).

*Placement supported by the Friends of Biosphere Expeditions
**Journalist/blogger (see coverage)

Alan Lee was the lead expedition scientist associated with the Universities of Cape Town and Kwa-Zulu Natal in South Africa. He serves as Editor-in-Chief of Ostrich: Journal of African Ornithology. He lives on the Blue Hill Nature Reserve, Western Cape, South African, where he hosts students and researchers investigating aspects of Fynbos ecology, as well as running a long term bird ringing site. With Biosphere Expeditions he has been involved in expeditions to the Peru Amazon and his native South Africa.

Malika Fettak, the expedition leader, is half Algerian, but was born and educated in Germany. She majored in Marketing & Communications and worked for more than a decade in both the creative department, and also in PR & marketing of a publishing company. Her love of nature, travelling and the outdoors (and taking part in a couple of Biosphere expeditions) showed her that a change of direction was in order. Joining Biosphere Expeditions in 2008, she runs the German-speaking operations and the German office and leads expeditions all over the world whenever she can. She has travelled extensively, is multilingual, a qualified off-road driver, diver, outdoor first aider, and a keen sportswoman.

A medical umbrella, safety and evacuation procedures were in place, but did not have to be invoked, because there were no medical or other incidences.

1.3. Partners

Biosphere Expeditions' two main partners for this expedition are the Mara Training Centre and Enonkishu Conservancy. The Mara Training Centre was built with the objective of training conservancy members within the Mara on enhancing their ecological knowledge of cattle husbandry and pastoralism. Enonkishu Conservancy, a local association dedicated to the protection of the environment and its resources, was created to preserve wildlife in tandem with ancient Maasai cow-herding culture.

1.4. Acknowledgements

We are very grateful to all the expedition citizen scientists, who not only dedicated their spare time to helping but also, through their expedition contributions, funded the research. We would also like to thank our key partners, Enonkishu Conservancy, especially its manager Rebekah Karimia and rangers Francis Dapash, Albert Cheruiyot, Nonyuat Lenkume, Meshack Chepuret, Joseah Langat, Mike Koriata and Salami Koriata, as well as the Mara Training Centre, especially Albanus Mutiso and Musa Kiseer. Biosphere Expeditions would also like to thank members of the Friends of Biosphere Expeditions and donors for their sponsorship, as well as Tarquin Wood for his help in making the expedition a reality. Last but not least, thanks to Eunice Chebet, David Kibet, Bernard Cheruiyot, Monicah Kimojino and Sarah Cherono for looking after us and keeping us well fed.

1.5. Further information & enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular including pictures, diary excerpts and a copy of this report can be found on the Biosphere Expeditions website www.biosphere-expeditions.org. Enquires should be addressed to Biosphere Expeditions at the address given on the website.

1.6. Expedition budget

Each citizen scientist paid a contribution of €2,880 per person per twelve-day period towards expedition costs. The contribution covered accommodation and meals, supervision and induction, special research equipment and all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses such as telephone bills, souvenirs etc., or visa and other travel expenses to and from the assembly point (e.g. international flights). Details on how this contribution was spent are given below.

Income	€
Expedition contributions	57,719
Expenditure	
Staff Includes local and Biosphere Expeditions staff salaries and travel expenses	7,579
Research Includes equipment and other research expenses	586
Transport Includes hire cars, fuel, taxis and other in-country transport	8,568
Expedition base Includes accommodation, food, services & conservancy fees	22,131
Miscellaneous Includes miscellaneous fees & sundries	63
Team recruitment Kenya As estimated % of annual PR costs for Biosphere Expeditions	6,668
Income – Expenditure	**12,124**
Total percentage spent directly on project*	**79%**

1.7. Recommendations for future expedition work

Enonkishu Conservancy supports a variety of habitats from dense forest, high elevation habitats and the iconic grasslands of the Mara-Serengeti ecosystem. It is essential to monitor all these habitats in a comprehensive manner, which is why the variety of monitoring methodologies described in this report were employed. In so doing, the expedition continues to be a showcase at the interface of monitoring, training and tourism.

Recommendations for future expedition work are:

1. Surveys should be continued to add to the baseline established. Modifications to surveys should be made as indicated below. Specifically, this involves recording data using the Mammal Mapping app, and a modification of the waterhole methodology to record data every 5 minutes (rather than 15) and distance from water; and recording perpendicular distances and angles (rather than bearings) during transects.

2. In the absence of very expensive high-power night time monitoring equipment, waterhole observations should be limited to dawn, dusk and daylight hours (06:00-20:00) once per month. Rangers and management suggest the following shifts: 06:00-10:00, 10:00-14:00, 14:00-18:00 and 18:00-20:00. Late night activity should be monitored instead through strategically placed camera traps.

3. Camera trap surveys could entail utilising already functioning camera trap stations throughout a grid in Naretoi, Enonkishu and Ol Chorro. Camera traps provided by Biosphere Expeditions should be used for strategic 'hotspot' monitoring, for example, locations with high animal density and problem animal locations. Ideally, Biosphere Expeditions should contribute 10 camera traps. Options for purchasing or obtaining camera traps to extend the monitoring grid should be explored.

4. Data sheets and citizen scientist training on how to collect and enter information using the preferred apps should be reviewed to allow efficient analysis of data and report writing after the expedition.

5. Formal nocturnal transects (rather than mammal mapping) should be investigated to calculate nocturnal mammal abundance.

6. The outreach programmes to involve local, early career conservationists as well as students from different schools in the neighboring village of Emarti should be continued.

7. The use of the iNaturalist app to provide a range of biodiversity sightings to the Enonkishu Biodiversity Project on iNaturalist should be encouraged. This platform facilitates the recording of plants and invertebrates. This activity can be undertaken by anyone: guests, rangers, staff etc.

8. Monitoring and surveying should be extended beyond Enonkishu towards the Mara. Traversing rights with Ol Chorro and Lemek conservancies should be sought.

9. It should be ensured that sufficient smartphones are present, with SIM cards to capture data and enable quick GPS locations. Smartphones without SIM cards took very long (>5 minutes) to capture GPS locations, which was too long given the quantity of biodiversity that required recording and negates any time saving associated with the automated data capture.

10. Waterhole monitoring should be extended to other dams and water resources to check whether the patterns detected at Memusi dam are reflective of water use patterns more broadly (not confounded by mineral-lick patterns).

2. Mapping the mammals of Enonkishu Conservancy and surrounding northern Mara region

Alan Lee
Blue Hill Escape

Rebekah Karimi
Enonkishu Conservancy

2.1. Introduction

With a continually growing human population, Kenya and the people of the Mara need to find solutions to living with wildlife. Wildlife-based tourism provides high-end income earning opportunities, while the cultural system of the people living in and around the Mara is strongly focused on agriculture, especially cattle farming. Solutions that allow these livelihoods to co-exist are becoming increasingly important, given that there are many conflict situations that arise from facilitating Big Five tourism in and around cattle farming enterprises. For example, elephant *Loxodonta africana* break fences and raid maize crops; buffalo *Syncerus caffer* compete for grazing; lion *Panthera leo* predate cattle; and leopard *Panthera pardus* predate sheep and goats. Spatial patterns of land use are required as part of conflict resolution strategies (Linnell et al. 2010).

The Mara-Serengeti ecosystem (MSE) within Kenya contains 17 conservancies in addition to the Maasai Mara National Reserve (MMNR) (Figure 2.1a).

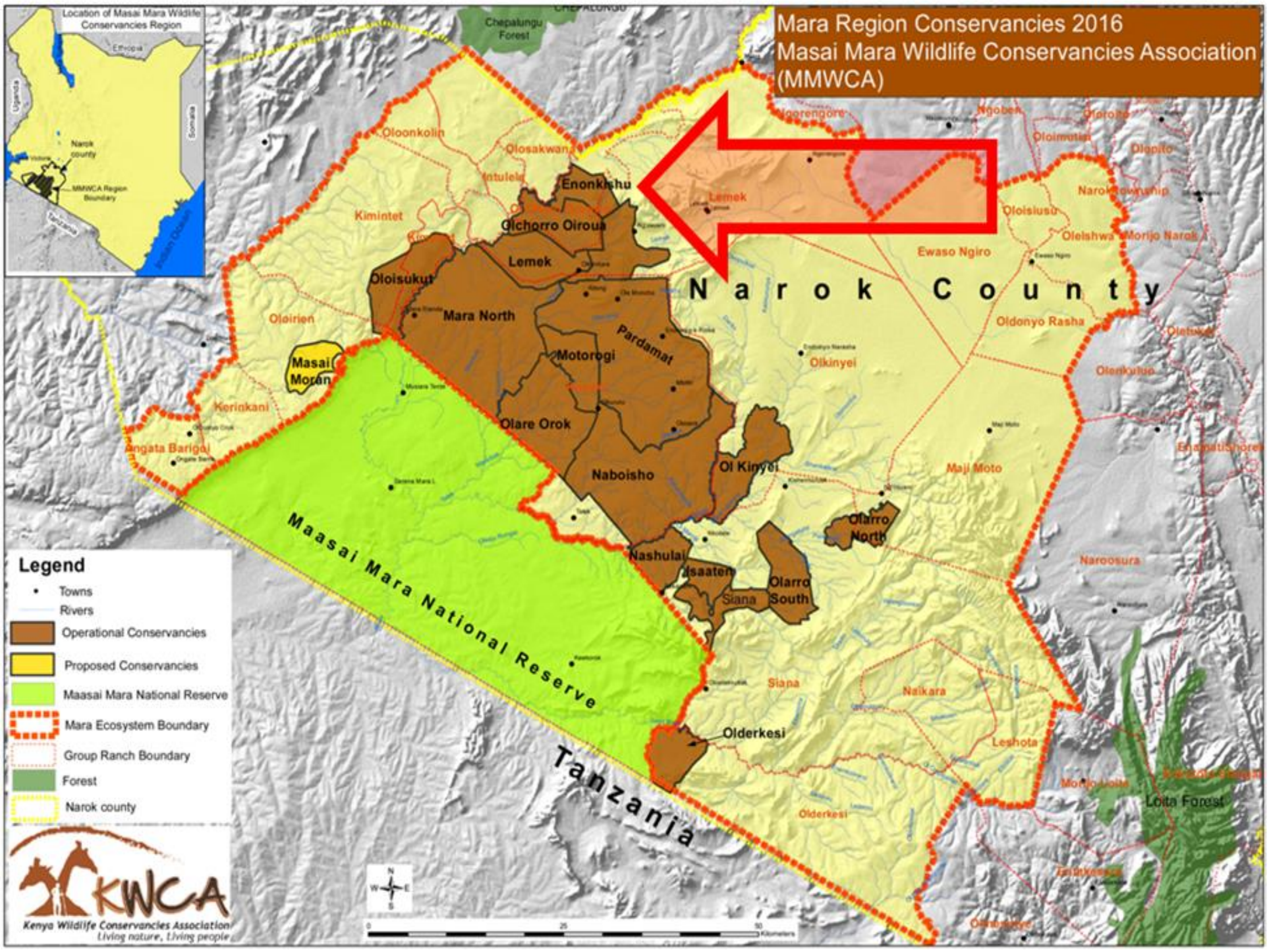

Figure 2.1a. Location of Enonkishu Conservancy, on the northern boundary of the Maasai Mara conservancies (image adapted from Kenya Wildlife Conservancy Association).

The 24 sq km Enonkishu Conservancy is the northernmost of these, with boundaries on the west beyond the Mara River buffering onto shifting-style agricultural land, consisting of small plots of mixed use, e.g. maize or pasture for small herds of goats, sheep or cattle. Small plots are fenced using a variety of traditional and modern techniques, ranging from the cactus-like *Euphorbia* species hedges to electric fences. Barriers to dispersal of medium to large sized game are high. To the north of the conservancy, community lands tend to consist of larger spaces, especially where they adjoin the hills to the east, which remain largely wooded. Adjacent conservancies to the south (Lemek and Ol Chorro) also have cattle and concentrate on tourism. Across these conservancies, there are no fences and wildlife are free to disperse over one of Africa's largest wildlife ecosystems, extending into the Serengeti in Tanzania. The region is famous for its annual wildebeest *Connochaetes taurinus mearnsi* migration and regular large sightings of large mammal species, including the 'Big Five'.

Land use of Enonkishu Conservancy consists of blocks of land where wildlife and the conservancy herd of cattle mix. Cattle are guarded at all times by Maasai herdsman, and taken to bomas at night to protect against attacks from predators, especially lion. Despite this, livestock loss to lion still occurs on rare occasions.

To better understand spatial patterns of both domestic and wildlife distribution, the Biosphere Expeditions 2020 team engaged in an extensive 'mammal mapping' exercise. This involved documenting the occurrence of both wildlife and domestic mammals in and around Enonkishu. Surveys were conducted in both protected areas (conservancy land), as well as unprotected land (agricultural) outside the conservancy boundaries. All medium to large sized mammals were recorded. Intensive surveys were conducted within the conservancy (camera trapping, transects, on foot surveys), while outside the conservancy roadside surveys were conducted. Spatial patterns were examined in the context of protected area status.

2.2. Methods

Biosphere Expeditions recruited two monitoring teams of citizen scientists for the periods 1 – 14 February (group 1) and 16 – 28 February (group 2). Each group consisted of participants of mixed age, gender and nationality composition (see chapter 1 for details). Citizen scientists were trained in local mammal identification, although many had prior experience both with Biosphere Expeditions and in Africa. Enonkishu rangers, permanent members of staff with extensive field experience, accompanied participants wherever possible.

Observers were tasked with recording all medium to large sized mammals. Rodents and bats were not surveyed, as these taxa require specialised monitoring methods. Sightings were recorded using custom-designed CyberTracker apps (Steventon et al. 2011). CyberTracker is a development environment that allows customised recording of information, designed with wildlife monitoring in mind. Alan Lee designed a simple application, which was uploaded onto citizen scientist Android smartphones (various models).

When an animal or group of animals were observed in or around Enonkishu, the distance, compass bearing, group size, ages, and sexes of the species were recorded. Date, time, altitude and GPS location information were automatically recorded each time an encounter was saved by CyberTracker.Distances were measured using a laser rangefinder whenever possible. The geographical coordinates of the target animals were then calculated using the bearing and distance to group information by applying a trigonometric formula as follows:

Longitude of animal = Longitude of observer + (Distance * sin(Bearing * (pi/180)) / meter_in_degree)

Latitude of animal = Latitude of observer + (Distance * cos(Bearing * (pi/180)) / metre_in_degree)

And where metre_in_degree is the number of metres in a degree at the equator (111319.9)

The habitat associated with each encounter was also recorded (see appendix II for habitat descriptions). During the second group, vegetation mapping without mammal encounters was also conducted as a means to illustrate survey coverage, i.e. to separate areas with no animals from areas which observers had been unable to access. Nocturnal mammal mapping was only conducted with rigour after 15 February due to poor road conditions prior to this period.

Initially, observers were asked to record all mammals encountered. Each evening, data were downloaded and examined using Google Earth, which allowed for the identification of coverage gaps. Monitoring groups were then sent specifically to target these gaps. After two weeks, monitoring was stopped on popular routes except for nocturnal animals, and recording was only conducted in areas where gaps had been identified. Some of these gaps were inaccessible, e.g. the woodland to the north east of the conservancy, due to rain, which closed access routes through this area as well as lack of road infrastructure. While walks were conducted in open and lightly wooded areas, the dense woodland was regarded as being too dangerous for these patrols, especially after several close encounters with large game species.

On the other hand, a noticeable gap was also initially associated with the Kileleoni Hill. Multiple attempts were made to cover this landscape feature, with ascents from both west and east. Citizen scientists, accompanied by two rangers, climbed to vantage points from the base of Kileleoni Hill. The group climbed as quietly and vigilantly as possible, passing through dense vegetation. Once a suitable hilltop observation location was reached, participants spent up to an hour quietly surveying for animals in the surrounding area.

Surveying for nocturnal mammals was a focus during the second group (post 15 February). Five night transects were conducted along existing transect routes (see chapter 3), using the mammal mapping protocol. During these transects, only nocturnal or rare animals were recorded. Red lights were used to minimise disturbance. Surveys were conducted between 20:00 and 24:00. Nocturnal mammals were also recorded in the early mornings (05:30 to 6:00) en-route to a waterhole monitoring activity (chapter 4).

Camera trapping

Eight Bushnell TrailCam™ (Model #119837) camera traps were deployed at so-called 'hotspots' (areas with above average mammal activity) within Enonkishu, using the rangers' knowledge of areas frequented by wildlife. This included waterholes or paths through thick vegetation where a concentration of tracks occurred. Cameras were set up at the beginning of February by the first group, and five cameras were redeployed to the coverage gap areas during the second group, including a salt lick. Data collected during the initial setup included GPS coordinates, a physical description of the area and persons involved in the camera setup. Traps were set up approximately 1 to 2 m from the ground, aiming slightly downward. Most camera traps were equipped with a protective case with a lock to secure them from hyaenas and other wildlife (Figure 2.2a).

Figure 2.2a. Installing a camera trap.

Camera traps were serviced periodically by replacing batteries and switching the SD cards. Expedition participants went through all photos and videos captured, selecting photos of species of interest (excluding diurnal ungulates commonly observed by other methods of monitoring). At the end of February, a tally of the number of photograph encounters was made for each species.

In addition to the hotspot cameras, there was a established camera trap array at Enonkishu as part of a long-term wildlife monitoring project: 'The Lion Center', working with Abby Guthmann of the University of Minnesota. At the time of the expedition, 19 camera traps were installed in a grid array. Photos from these are retrieved periodically and uploaded to an online database for identification by a global pool of citizen scientists.

To assist this project, Biosphere Expeditions citizen scientists accessed this website and identified animals from photos using the snapshot-safari identification protocol. This activity was conducted at the expedition base using the Mara Training Centre (MTC) internet.

This was a useful exercise for expedition members that preferred to stay at base during one of the scheduled morning or afternoon activities. This task was easy to perform, with species identification, group count and basic behaviour and demographic activity recorded automatically via the website submission form associated with each photo. It was possible to identify multiple species from one photo: not an unusual situation at this species-rich location. Expedition members made over 1,800 classifications using the group sign in account, but multiple classifications were also made using member specific accounts or no login details. By 20 February, all photos had been categorised. Camera trap results will be provided by A Guthmann to Enonkishu, and are not part of this report, which is why this result is mentioned here and not in the results section below.

2.3. Results

Over 1,900 records (mammal presence or vegetation type) were contributed to the mammal mapping survey in and around the Enonkishu Conservancy by Biosphere Expeditions, over a roughly 40 x 40 km area centred on the conservancy. Generally good coverage of the conservancy was acquired during February: noticeable gaps included northern Kileleoni Hill and the woodlands to the east of the conservancy, but also the wetland/woodland area running through the centre of the conservancy, as well as the eastern section of the private Naretoi estate. We present spatial maps as plots using decimal degree format, excluding fine-scale geographical information that may be used by poachers or other aggravated parties. These maps are of sufficient resolution for managers to identify key areas, and provide broad-scale patterns of distribution for other interested parties.

2.3.1 Spatial livestock and wildlife distribution patterns

The lack of wildlife to the north and north west of Enonkishu beyond the Mara River in the heavily populated rural areas is noticeable (Figure 2.3.1a). At Enonkishu and further south, zones of intermixing between wildlife and domestic animals are clearly evident, especially around Aitong community, and westwards towards Mara Rianta, and eastwards towards Lemek (Figure 2.3.1b). Within Enonkishu, domestic herds were observed at the periphery of the conservancy, with the exception of the conservancy herd (approx. 600 cattle) associated with the settlement zone. A large diversity of mammals was recorded at Enonkishu, and so the resulting spatial map is dominated by wildlife encounters (Figure 2.3.1b).

2.3.2. General patterns of abundance

In the larger survey area, counts were dominated by cattle and goats (Figure 2.3.2a), mostly explained by the almost complete lack of encounters with any form of medium to large mammalian wildlife north and west of the Mara River. By contrast, within the conservancy and immediate adjacent areas, impala were the most frequently mapped species, followed by warthog and wildebeest (Figure 2.3.2b). As this activity was primarily aimed at drawing spatial patterns, relative abundance between species should be read with caution as the sampling design did not account for issues of detectability. For instance, nocturnal animals were generally poorly represented in the survey as most of the mammal mapping activities were conducted during daylight hours (Figure 2.3.2c).

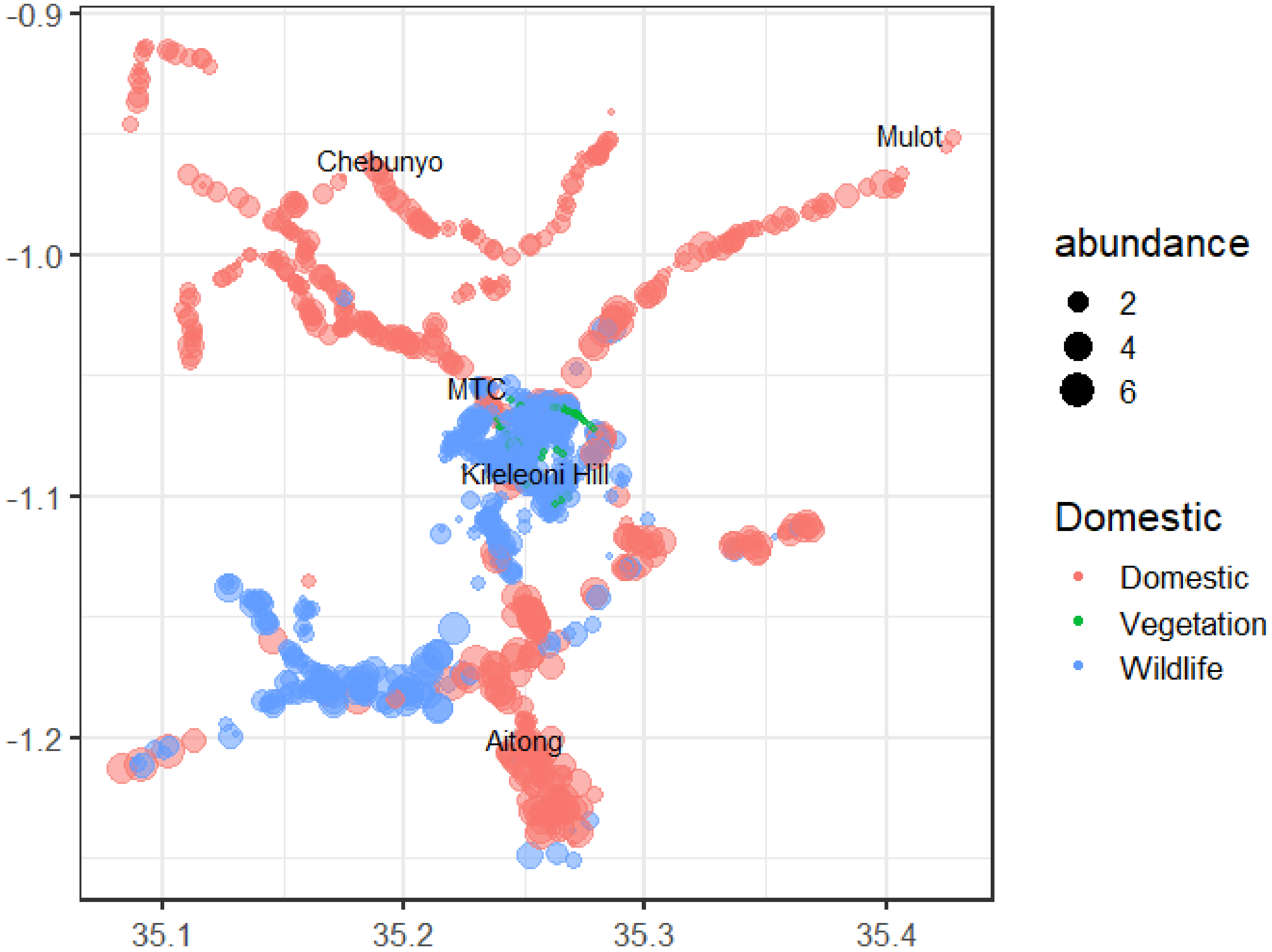

Figure 2.3.1a. Spatial coverage of the mammal mapping survey conducted by Biosphere Expeditions 2020 teams during February: each point represents the location of a group of mammals, here broadly divided into domestic (cattle, goats etc), wildlife (impala, lion etc) or vegetation mapping point only (included to indicate coverage). Key features include the Mara Training Centre (MTC), Kileleoni Hill, and the villages of Mulot, Chebunyo and Aitong. Size of the points is the log of the group size associated with a sighting (abundance).

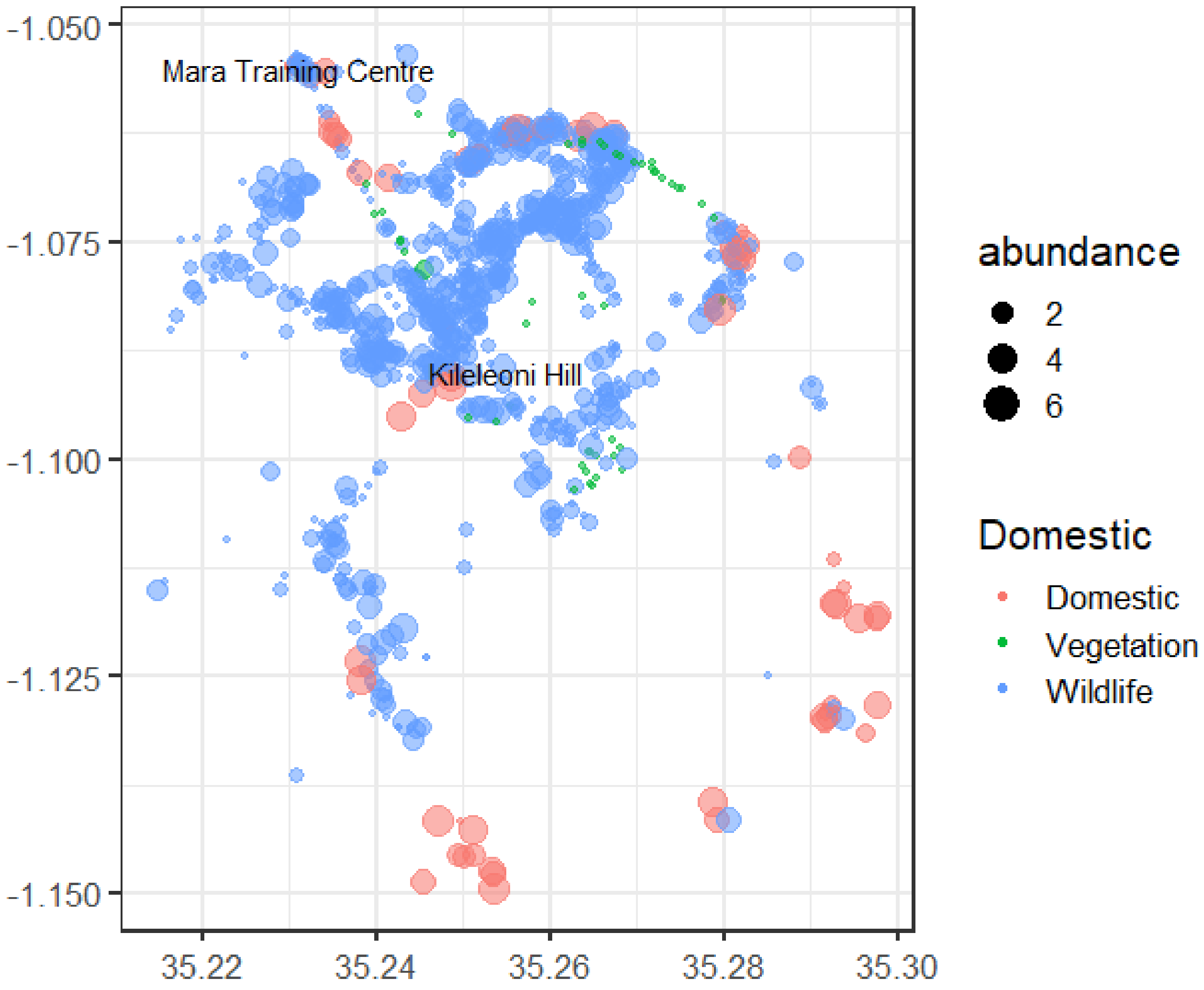

Figure 2.3.1b. Spatial coverage of the mammal mapping survey in and around Enonkishu: here only the conservancy and immediate surrounding area are included. Abundance is the log of group counts.

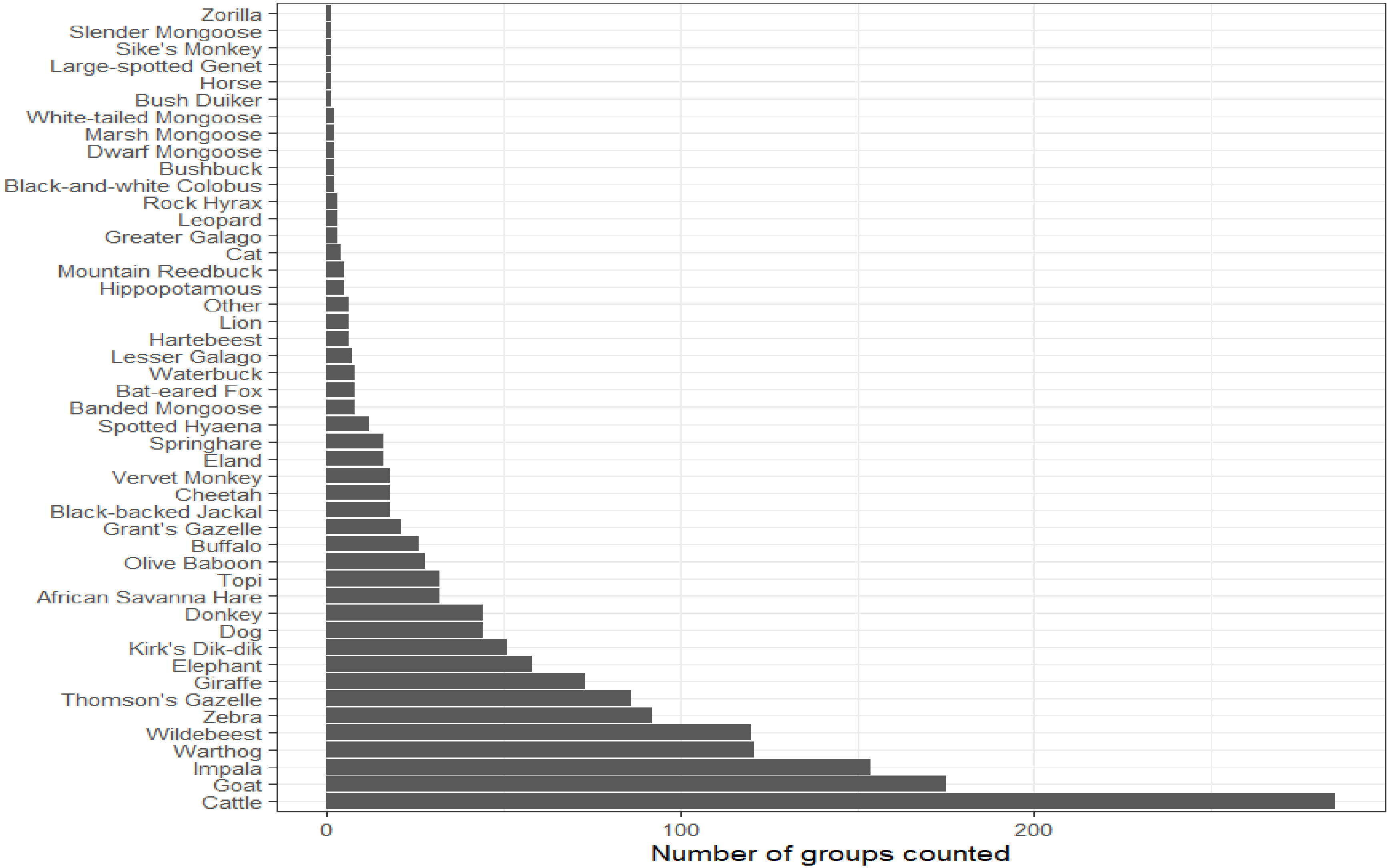

Figure 2.3.2a. Bar chart of the counts of mammals groups counted in total over the entire survey area.
Due to extensive surveys beyond Enonkishu, cattle and goat/sheep dominated the counts. These are data reflecting the spatial area indicated in Figure 2.3.1a.

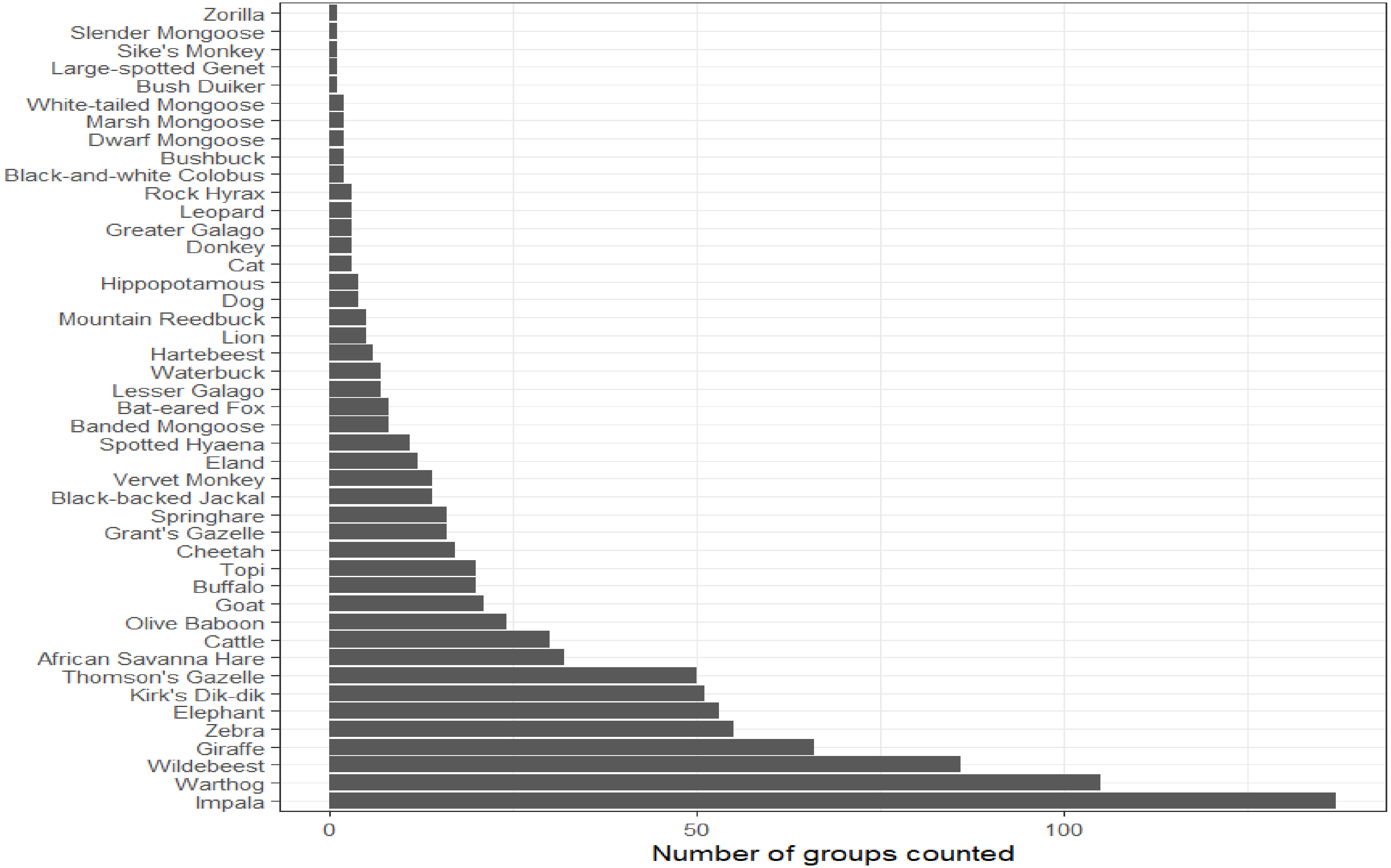

Figure 2.3.2b. Bar chart of the counts of groups of mammals counted in Enonkishu and immediate surrounding area. These are data reflecting the spatial area indicated in Figure 2.3.1b. This bar chart should not be used to infer relative abundance between species, as the data collection method was not suited for this task, e.g. there are almost certainly many more Kirk's dik-dik compared to elephant.

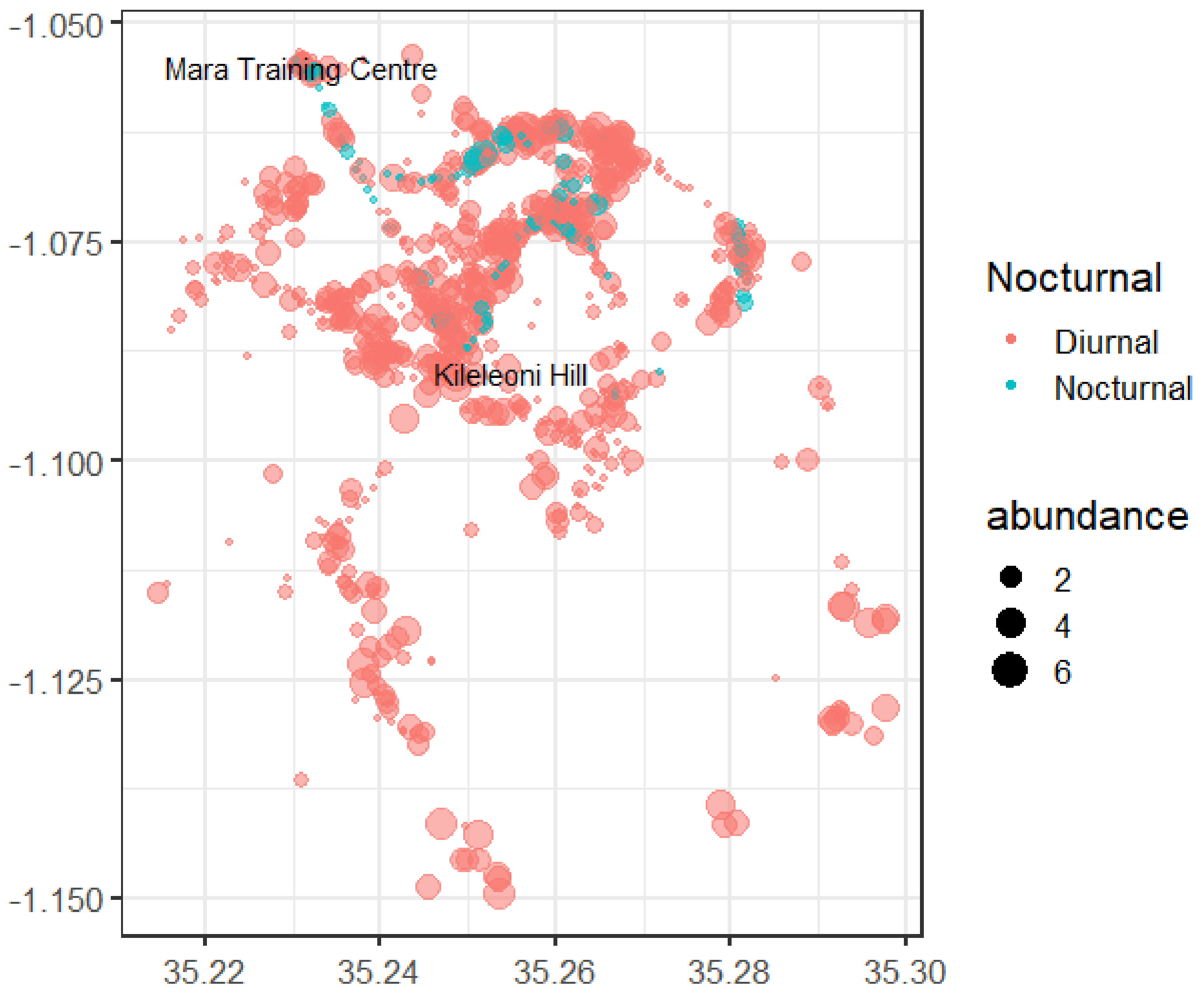

Figure 2.3.2c. Spatial distribution of diurnal and nocturnal mammal encounters in and around Enonkishu conservancy as a function of all sightings. Nocturnal sightings were concentrated on the main transect routes only.

2.3.3. Distribution of iconic mammals

Lion *Panthera leo*

A male lion breached an Enonkishu cattle boma on 30 January 2020. A lioness and two cubs of mixed age were observed on 7 February in the late morning, and again on 18 February. A group of six lions was observed on 17 February north of the Memusi dam. On 21 February, a pride of 9 (3 females, 6 young cubs as reported by guide John Tinga) was observed at the neighbouring conservancy. A group of at least 4 lions was observed on 25 February. Currently, the use of Enonkishu and surrounds as pride territory indicates a healthy local lion population.

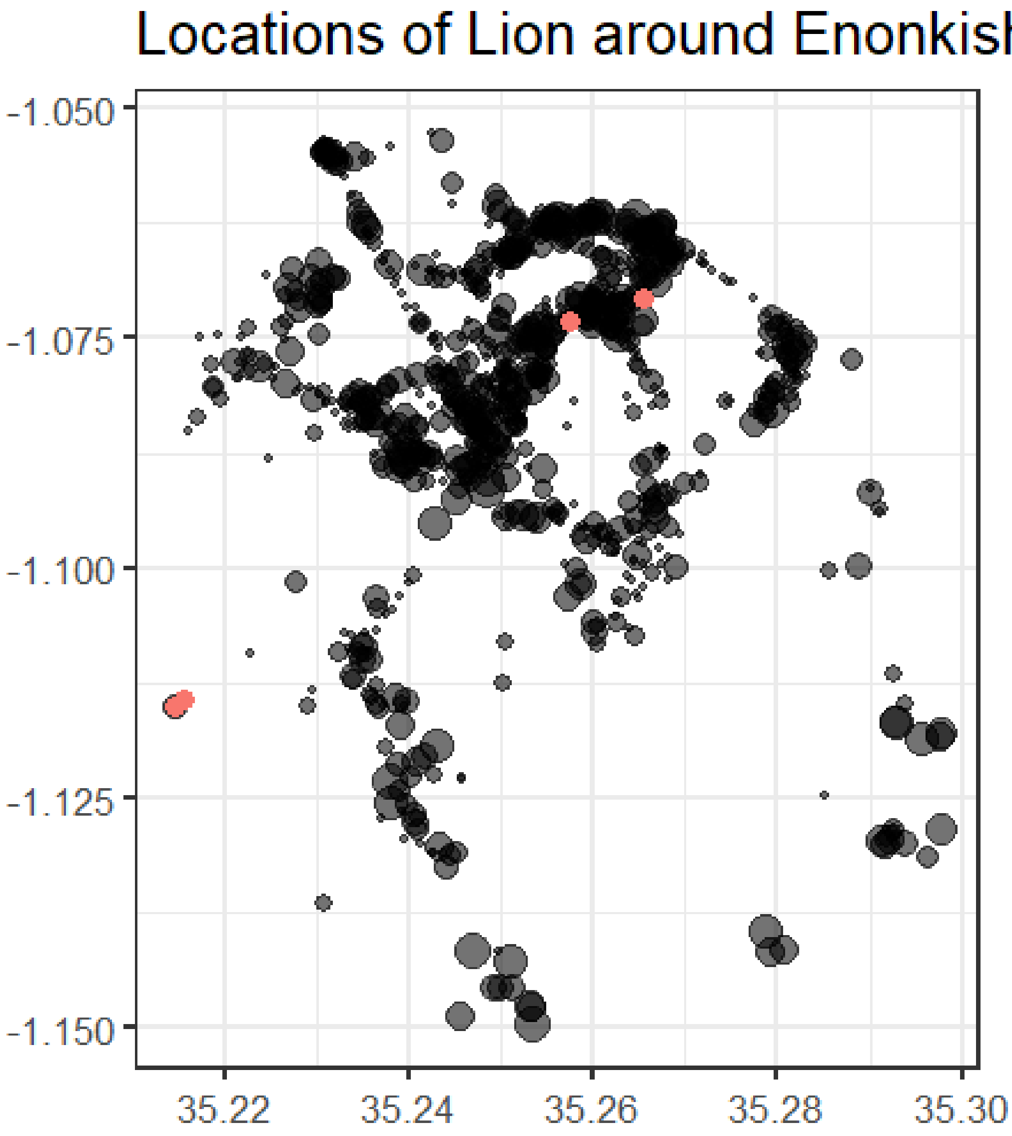

Figure 2.3.3a. A distribution map of the sightings of mammals of Enonkishu (grey circles), with circle size the log of the group size associated with the sighting at that location. The general location of lions is overlaid as coloured circles.

Cheetah *Acinonyx jubatus*

A female cheetah with six cubs (born July 2019) was observed on an almost daily basis. This female (Kisaru) is well known, attracting daily visits from staff and neighbouring conservancy visitors. A wound was reported on her left front leg, but this did not seem to be restricting successful hunting events. While the cubs frequently played in the presence of observers, Kisaru was normally reported to be 'resting'. Whether this is the case or if she is displaying 'stress immobility' requires further investigation. In this context, this document on the impact of tourists on cheetah behaviour is worth reading.

It is concerning to the conservancy managers and researchers that tourists approach the cheetah so closely: a lack of fear of humans has previously indirectly resulted in the death of habituated cheetah cubs in the area. A lack of fear of humans can result in livestock-wildlife conflict situations.

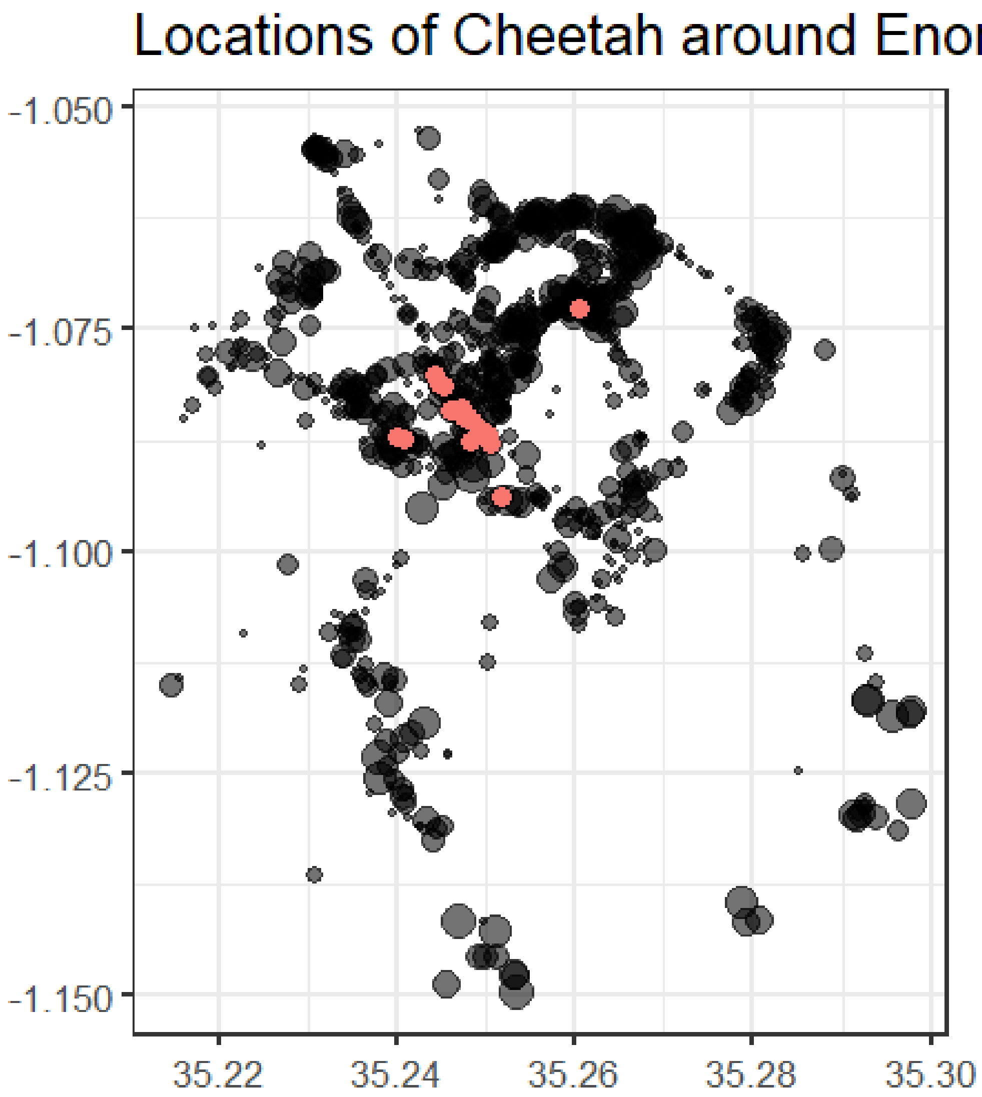

Figure 2.3.3b. Distribution of cheetah sightings (in pink) in relation to other mammal mapping sightings.

Leopard *Panthera pardus*

A photo was obtained of a female leopard from a hotspot Biosphere Expeditions camera on 4 February 2020 at 15:28 (Figure 2.3.3c). This leopard was also sighted during a mammal mapping exercise to the north of the Memusi dam. This encounter also provided a useful photo of the right flank, courtesy of expedition participant Christiane Flechtner (Figure 2.3.3d). Two mammal mapping encounters of leopard associated with Kileleoni may have been of this individual, although uncertainty around this is large as no coat identification features were obtained. Another leopard, possibly a male based on the heavy build, was obtained from a hotspot camera in the location of the Bingham ranger camp close to the Mara River (Figure 2.3.3e).

Figure 2.3.3c.. Kileleoni female, left flank from a Biosphere Expeditions hotspot camera.

Figure 2.3.3d.Kileleoni female, right flank, photo courtesy of Christiane Flechtner.

Figure 2.3.3e. Bingham male, left flank, camera trap image.

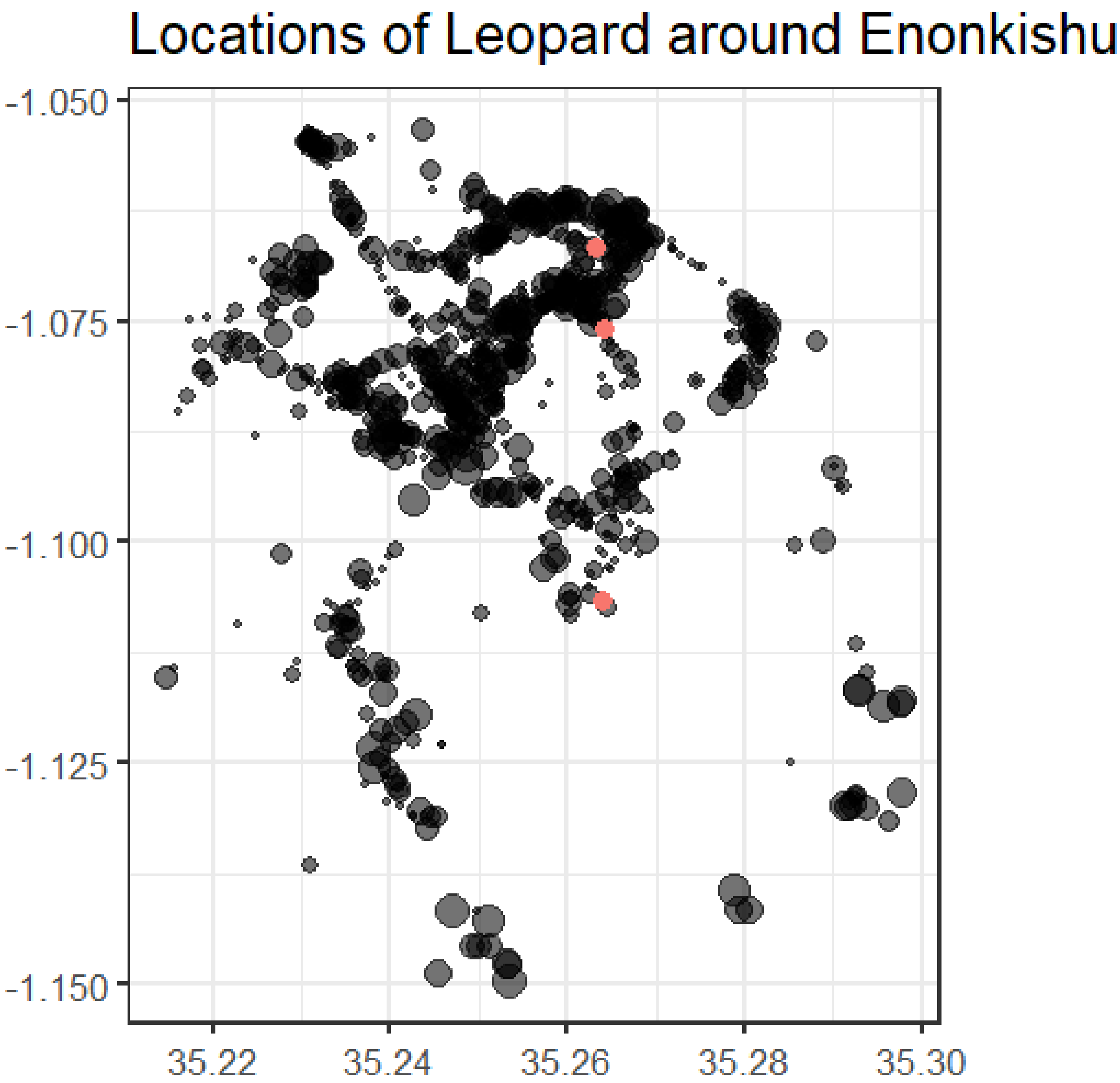

Figure 2.3.3f. Distribution of leopard sightings (in pink) in relation to other mammal mapping sightings.

Elephant *Loxodonta africana*

A breeding group of 7 elephantsm(females and calves) accompanied by 2 bulls were recorded during the first 2 weeks of February. However, during the latter part of February, at least 3 herds were observed during an ascent of Kileleoni Hill; elephants were encountered daily during the latter half of February throughout the conservancy and further south, most frequently observed feeding on the lush grass of the wetland areas. One breeding herd with associated males was estimated to be >20 individuals.

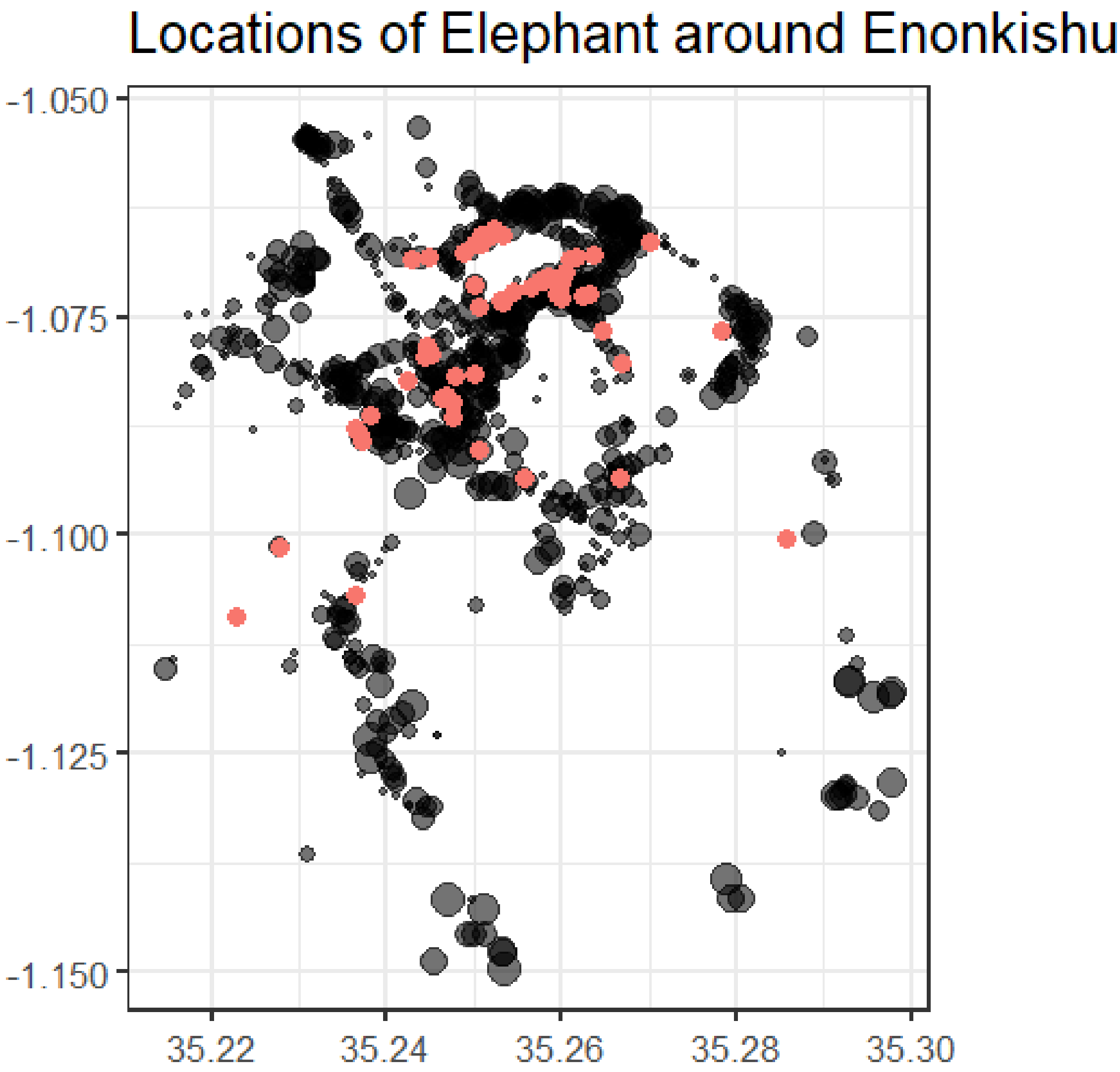

Figure 2.3.3g. Distribution of elephant sightings (pink) in relation to other mammal mapping sightings.

Buffalo *Syncerus caffer*

Buffalo were frequently encountered as small breeding herds or single or small groups of males. The herds moved widely, were encountered in a variety of habitats, but most frequently in the wetland drainage lines running through the centre of the conservancy (Figure 2.3.3h)

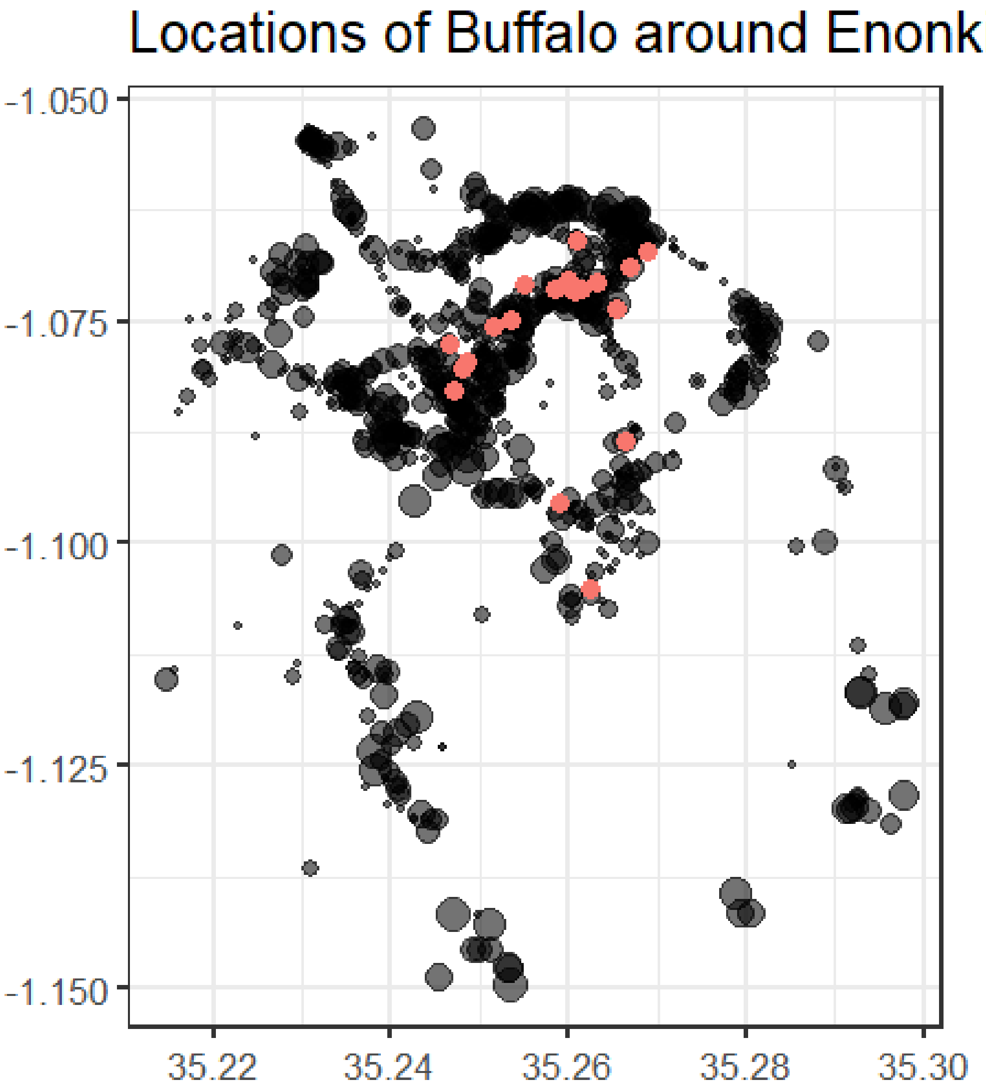

Figure 2.3.3h. Distribution of buffalo sightings (pink) in relation to other mammal mapping sightings.

2.3.4. Habitat associations

Each time a group of animals was encountered, habitat was assigned from the major habitat types found at Enonkishu (see Figure 2.3.4a and appendix II). We firstly examined patterns of potential spatial competition between wildlife and domestic wildlife for the set of records at Enonkishu and its immediate vicinity. Most of the domestic mammals were associated with agricultural lands and human settlements, rather than natural rangelands (Figure 2.3.4b). We also present results for habitat associations for the 12 most commonly encountered mammals at Enonkishu (Figure 2.3.4c) for this sampling period.

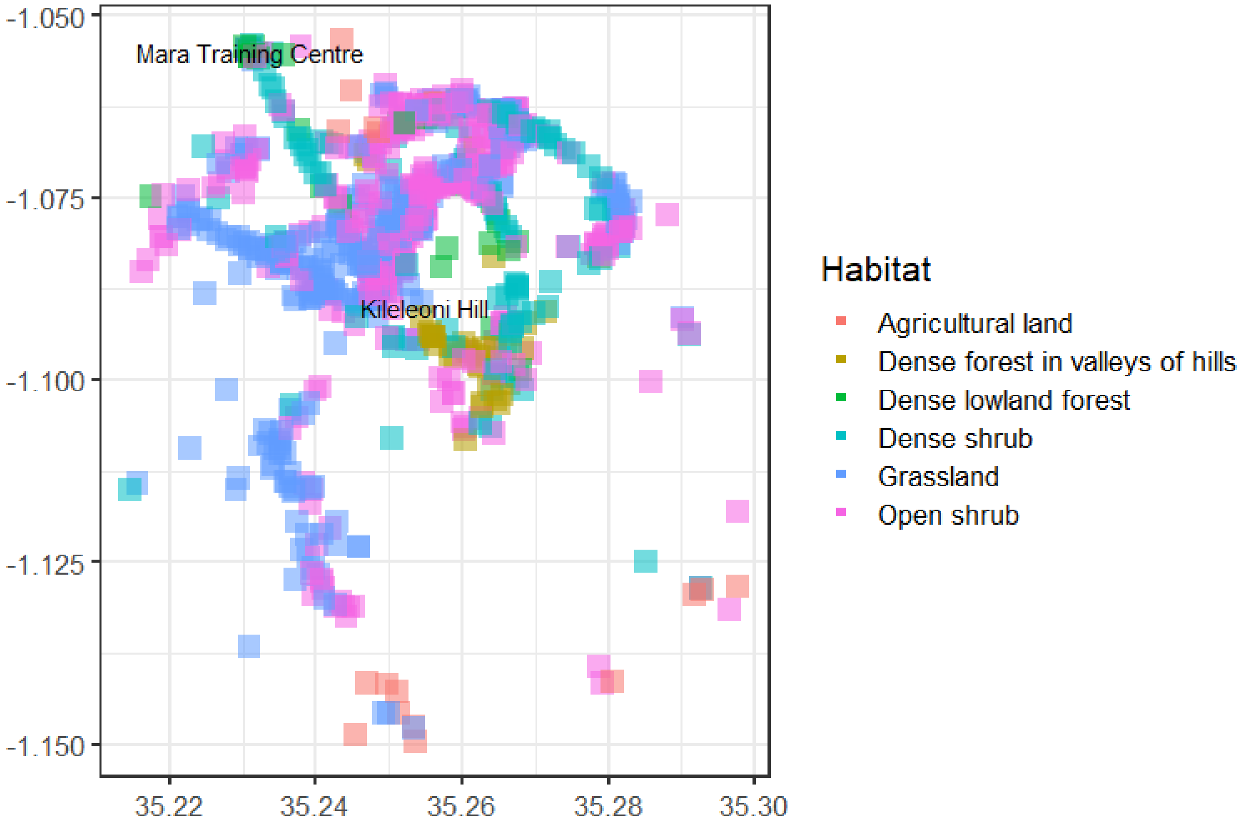

Figure 2.3.4a. A simple habitat map generated from habitat associations assigned to wildlife encounters during mammal mapping. The main habitat types are indicated here, excluding 'mixed' and 'human settlement'.

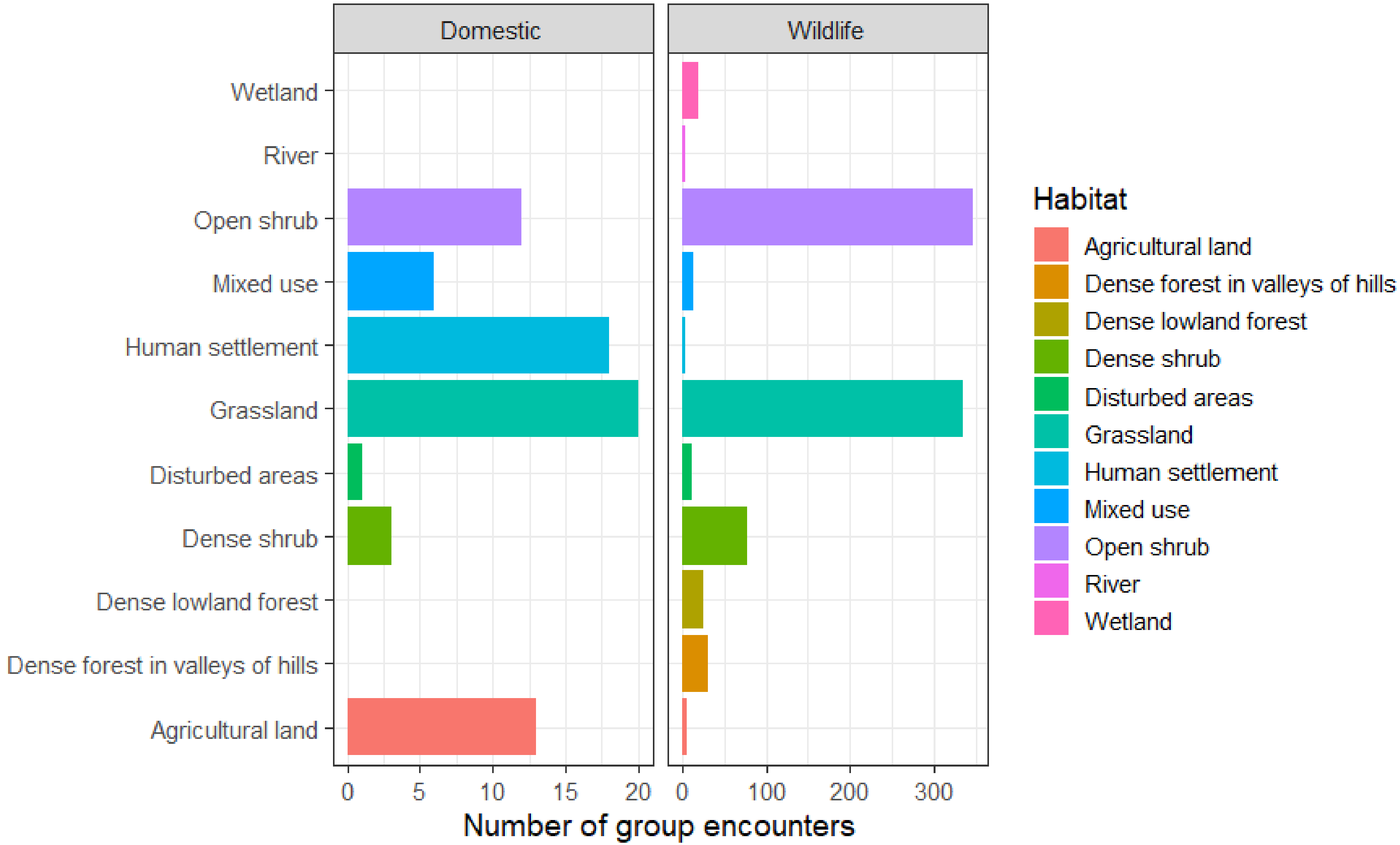

Figure 2.3.4b. Habitat association for 'wildlife' (all species) compared to 'domestic' (cattle, goats etc) for the greater Enonkishu area.

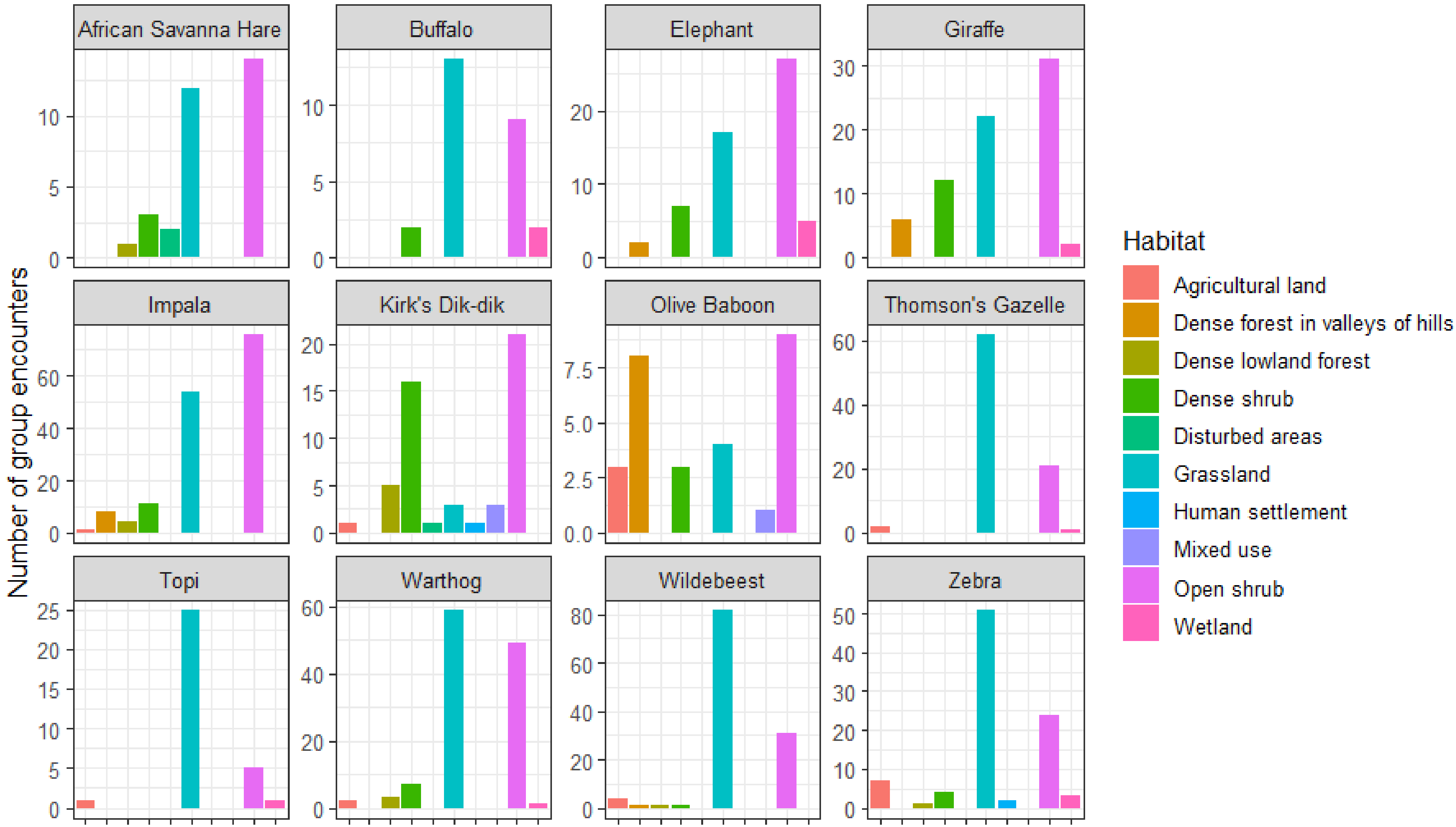

Figure 2.3.4c. Habitat associations for the 12 most frequently encountered wildlife species.

2.3.5. Camera trap highlights

Twenty-four species were identified from camera traps placed at wildlife hotspots or for targeted monitoring (including a fruiting fig tree, mineral (salt) lick and potential leopard tree). Impala *Aepyceros melampus* were most frequently recorded, followed by wildebeest and warthog *Phacochoerus africanus* (Figure 2.3.5a). Porcupine *Hystrix africaeaustralis* and African civet *Civettictis civetta* were only observed by camera traps. A selection of the 'best of' pictures are provided in appendix III.

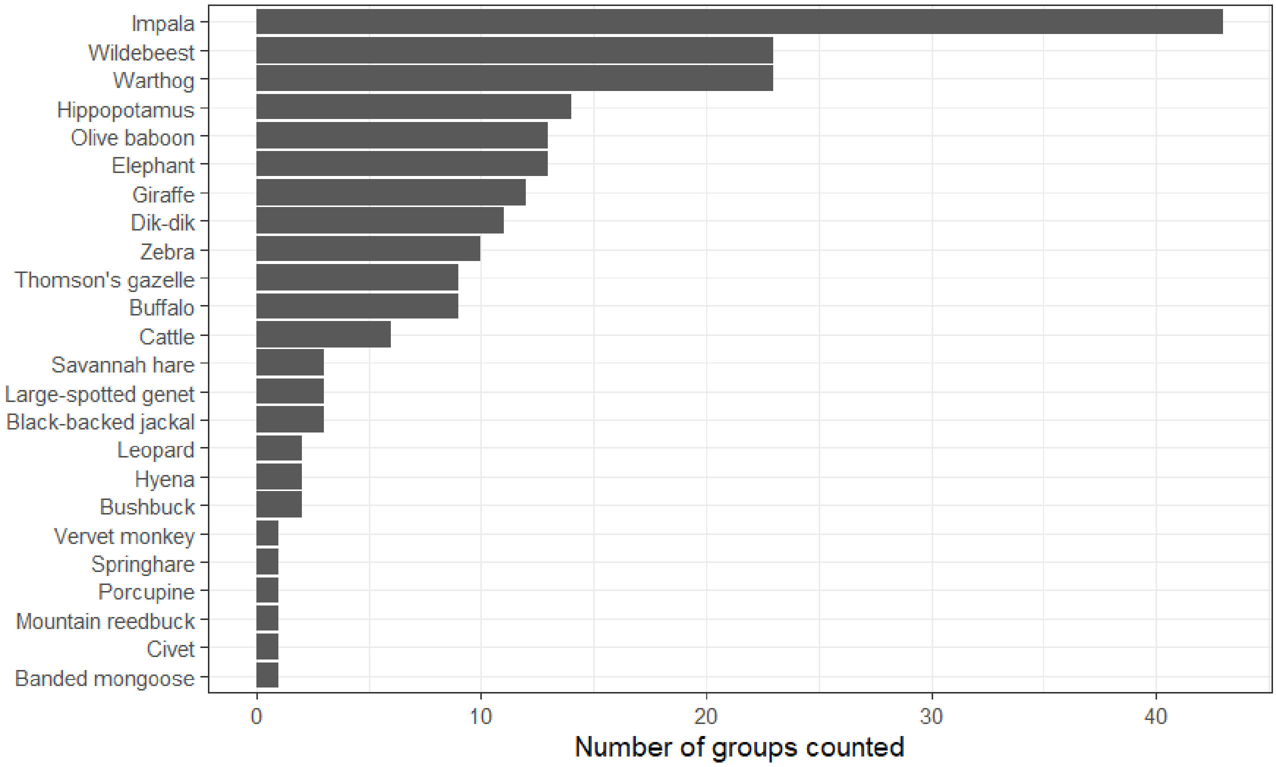

Figure 2.3.5a. Relative abundance of wildlife recorded by Biosphere Expeditions hotspot cameras.

A set of cameras was placed on the mineral lick adjacent to Memusi Dam. Impala were recorded most frequently eating soil, followed by olive baboon *Papio anubis*, elephant, buffalo, Kirk's dik-dik *Madoqua kirkii* and cattle (example as Figures 2.3.5b & c). Incidental records of giraffe *Giraffa camelopardalis*, hippo *Hippopotamus amphibius* and large-spotted genet *Genetta tigrina* were also recorded, but these species were passing through rather than eating soil. A camera trap placed with the aim of recording black-and-white colobus monkeys *Colobus angolensis* at a fruiting fig tree captured abundant olive baboon photos and an unidentified species of fruit bat, but no other primate species.

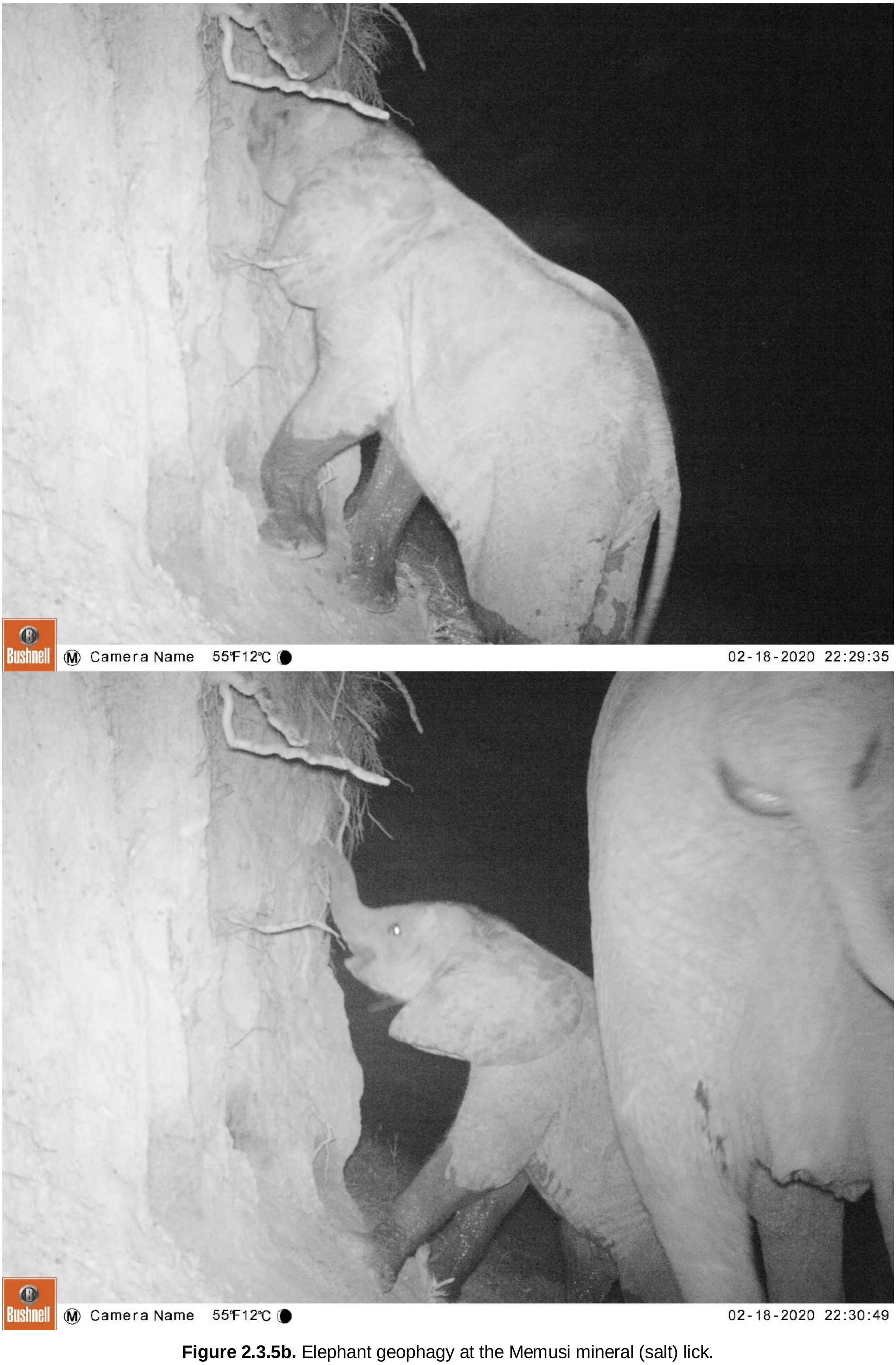

Figure 2.3.5b. Elephant geophagy at the Memusi mineral (salt) lick.

Figure 2.3.5c. Impala geophagy at the Memusi mineral (salt) lick, photo courtesy of Peter Thoem.

2.4. Discussion

Forty mammal species were recorded in or around the conservancy throughout February 2020, covering a range of sizes, from dwarf mongoose *Helogale parvula* to elephant *Loxodonta africana*. Species not recorded in 2020 that were recorded during 2019 were aardvark *Orycteropus afer*, klipspringer *Oreotragus oreotragus* and caracal *Caracal caracal*. By contrast, rock hyrax *Procavia capensis*, slender mongoose *Galerella sanguinea*, marsh mongoose *Atilax paludinosus*, zorilla *Ictonyx striatus*, African wild cat *Felis lybica*, lesser galago *Galago moholi*, common or bush duiker *Sylvicapra grimmia* and white rhino *Ceratotherium simum* were recorded during 2020. The rhinos seen were from the rhino sanctuary to the south of Kileleoni Hill, and are not free-roaming animals. Black rhino *Diceros bicornis*, reported from the Maasai Mara game reserve, have not been reported at Enonkishu or neighbouring conservancies.

The use of the CyberTracker app greatly facilitated the taking, data checking and analysis of data. In addition to the core data taken (mammal distribution), a range of supplementary information was also acquired that is potentially of use. For instance, the phones automatically captured altitude, allowing the creation of an elevation map of the area (appendix I), as well as a simple idea of habitat distributions.

The mammal mapping exercise clearly demonstrated the spatial partitioning of the landscape and its consequences for mammal wildlife. The heavily populated agricultural lands associated with the communities north and west of the Mara River (Chebunyo, Koboson, etc.) are devoid of medium to large mammalian wildlife: mammal biomass is dominated by cattle, sheep and goats. By contrast, the conservancies show a clear concentration of wildlife, although cattle and goats are also found in these areas.

Pastoral lands surrounding protected areas serve as vital extensions of wildlife habitat. Historically, buffer zones have been shaped by restrictive conservation policies, expropriation of land, efforts to include communities in conservation, both positive and negative wildlife/livestock interactions, and political tensions (Lankester and Davis 2016). The coexistence of livestock and wildlife has potential to ease tensions between the tourism industry and traditional local communities, many of whom are more interested in livestock than wildlife conservation. If tourists see the benefits of grazing livestock in wildlife habitat and both wild and domestic species thrive, both factions benefit. The local communities maintain their traditional livelihoods and gain additional income from the livestock. When sustainable rangeland management is employed, it improves resources utilised by wildlife species, promoting healthy ecosystem services, and preserving wildlife habitat (Lankester and Davis 2016, Veldhuis et al. 2019). Recruiting local communities to support conservation has been a challenge since the commencement of protected areas, but adding additional value by encouraging and supporting traditional land use has potential (Reid et al. 2016).

We are aware that some may argue that a lack of interest in wildlife may exist in the absence of 'consumption' (hunting). The assumption of these arguments is that in order to become competitive, wildlife should provide benefits at least similar to those of livestock. In this context it should be noted that hunting in the conservancy is illegal and that the conservancy concept in Kenya differs from that of other countries, e.g. hunting conservancies of Mozambique or Namibia. Rather than promoting hunting, Kenyan conservancies focus on maintaining wildlife for tourism. This is why animals in Kenyan protected areas can be viewed at close proximity with flight response significantly lower than in areas where hunting is allowed (Muposhi et al. 2016). We argue that this is a far more equitable and sustainable model for wildlife use. For example, one elephant can provide potentially limitless photo opportunities in the non-hunting ecotourism setting. The monetary value of this is magnitudes higher than the value that can be derived from a single hunt (Synam 20120), or worse, the economic value of the meat. Besides, hunting has been shown to remove breeding animals at unsustainable levels (Selier et al. 2014) or create undesirable evolutionary consequences (Coltman 2003). In contrast, wildlife that is not killed for so-called sport also has the benefit of bringing money to communities across a range of professions, from rangers to lodge service staff, rather than the low monetary value and calorific content of the meat. We believe it would be a dangerous precedent to follow the 'like for like' concept on the superficial potential of both cattle and wildlife to provide meat: there are other dimensions to this argument including economic and cultural, and the latter have far greater value than a comparison of calories.

Livestock/wildlife co-existence

Innovative tools and techniques are necessary to maintain and restore resilient biological and social systems (Mooney et al. 2009). The sustainable management of grasslands and rangelands to enhance pastoral livelihoods and the conservation of wildlife habitats is one form of ecosystem-based adaptation that can provide multiple socio-cultural, economic and biodiversity co-benefits (Leal Filho et al. 2013). Shifting from conflict with pastoralists into an integrated land use change that manages livestock grazing in a sustainable manner is one way of providing such benefits.
As species mutualisms shift with the added stress of resource competition, the species interactions and relationships have been disrupted (Mooney et al. 2009). Improving understanding of the key relationships between biodiversity and service provision will help guide effective management and protection strategies (Harrison et al. 2014, Veldhuis et al. 2019). The mammal mapping exercise undertaken here creates a simple visual guide to spatial partitioning of domestic and wildlife land-use patterns and indicates that these groups can clearly co-exist given the right attitudes, management techniques and material benefits that are not based on hunting as described.

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3. Long-term mammal population monitoring using fixed transects

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Blue Hill Escape

Rebekah Karimi
Enonkishu Conservancy

3.1. Introduction

Wildlife monitoring is important for conservation because it can provide early warning of population declines and local extinction (Oborny et al. 2005). If population changes can be linked to pressures such as poaching, draining wetlands, agricultural encroachment, development projects or disease, corrective measures may sometimes be possible. In Africa there is a real need for monitoring programmes because land use pressures on African reserves are growing. Agricultural expansion and population growth are occurring around reserve borders, as are massive development projects with adverse environmental consequences (Caro 2016). Moreover, where long-term population records are available, they suggest that mammal populations in west and east African protected areas are declining rapidly (Caro 2016). Monitoring is required to measure the effectiveness of protected area management programmes (Caro 2016).

African savannahs are undergoing management intensification and decision-makers are increasingly challenged to balance the needs of large mammal populations with the maintenance of vegetation and ecosystem diversity (Asner et al. 2009). Ensuring the sustainability of Africa's natural protected areas requires information on the efficacy of management decisions at large spatial scales, but often neither experimental treatments nor large-scale responses are available for analysis (Asner et al. 2009). Wildlife managers in poorer African nations often struggle with conflicting demands of anti-poaching activities (including rangers' salaries and vehicle costs), helping local communities to build health clinics and schools on the borders of reserves, and political expenses of visiting and receiving local dignitaries. More often than not, wildlife monitoring is treated as a luxury carried out by foreign researchers, but not important enough to take money and manpower away from other important managerial functions (Caro 2016).

In the dynamic rangelands of the northern Mara, Kenya, where Enonkishu Conservancy is located, constant wildlife monitoring is required, especially given the interface with nearby human settlements and high human presence. Given the component of ecotourism to the financial model that sustains the conservancy, monitoring and reporting on wildlife is required: ecotourism is more likely to be successful with greater large mammal biodiversity.

Transect monitoring is a cost-effective method for gauging the status of the local wildlife populations; it also engages rangers and other interested parties in a flexible manner. Where the transect monitoring protocol has been compared to other monitoring protocols in the context of monitoring large mammal wildlife (e.g. fixed wing airplane transects), results compare favourably (Caro 2016). In addition, transects allow the monitoring of smaller (e.g. mongoose) and cryptic species (e.g. leopard and nocturnal species), which may go undetected in aerial counts.

This report gives a summary of set-route transect monitoring conducted at Enonkishu from February 2019 until February 2020.

3.2. Methods

Four vehicle transects were established within Enonkishu Conservancy ranging from 3.3 to 11.3 km in length during the inaugural Biosphere Expeditions project in 2019 (Karimi & Hammer 2019 and Figure 3.2a). Since their establishment and in the absence of citizen scientists after the 2019 expedition, transects have been followed by rangers once a month. The monitoring follows a variable distance sampling protocol, with monitoring conducted from vehicles. Transects began at 07:00 and were completed by 11:00 to avoid the hottest part of the day when most animals are inactive.

Following the methodology developed for 2019, during the second Biosphere Expeditions project in February 2020, citizen scientists, together with Enonkishu rangers, used binoculars, smartphones with the CyberTracker app, rangefinder and compass to record all animals observed. Observers sat on a bench in the bed of a double cab Toyota Hilux with a metal cage. The driver of the vehicle drove slowly (<20 km/h) along the transect route waiting for a signal from the observers in the back of the truck when a group of animals was spotted. Target animals included all medium to large mammals (excluding small rodents, shrews, bats, etc.), as well as 10 large, easily identifiable bird species of conservation concern or local interest (ostrich *Struthio camelus*, Kori bustard *Ardeotis kori*, martial eagle *Polemaetus bellicosus*, black-breasted snake-eagle *Circaetus pectoralis*, bateleur *Terathopius ecaudatus*, secretarybird *Sagittarius serpentarius*, augur buzzard *Buteo augur*, tawny eagle *Aquila rapax*, southern ground hornbill *Bucorvus leadbeateri*, grey crowned crane *Balearica regulorum*, hooded vulture *Necrosyrtes monachus*, white-backed vulture *Gyps africanus*). The only change from 2019 was the addition of these 10 bird species as well as the CyberTracker app instead of paper datasheets.

The GPS location, date and time was recorded by the smartphones, while observers entered the species, age and sex composition (if known), group size and general behaviour. Perpendicular distances were measured as the shortest distance from the transect to the original position of the centre of the group of animals, following 'Distance Sampling' protocols (Buckland et al. 1993, Thomas et al. 2010). Where a perpendicular measure could not be measured, then an angle between 0 (vehicle trajectory) and 90 (perpendicular to the vehicle) was recorded to recalibrate distance measures accordingly. This information is required to calculate detection functions, or the 'effective strip width' and is required in distance sampling protocols. It should be noted that this was a change in the original 2019 protocol where a compass bearing from north was recorded providing geographic reference information, but not the information required to calculate detection functions. For each transect, total distance was recorded (in kilometres to the closest 100 m) using either a vehicle odometer or a GPS.

Due to unusually high rains during January and at the start of February 2020, coinciding with the start of the expedition, one of the transects (T3) was not accessible as the route became a permanent wetland. Various efforts were made to re-route this transect, but all efforts to find a safe parallel trajectory that also traversed the woodlands to the north east of the conservancy failed. A shorter, compromise transect (T5) consisted of the general route from start of the T3 transect.

We present summary data of encounters for the March 2019 – February 2020 period, calculating the most frequently encountered groups, individuals, and examine demographic data where available.

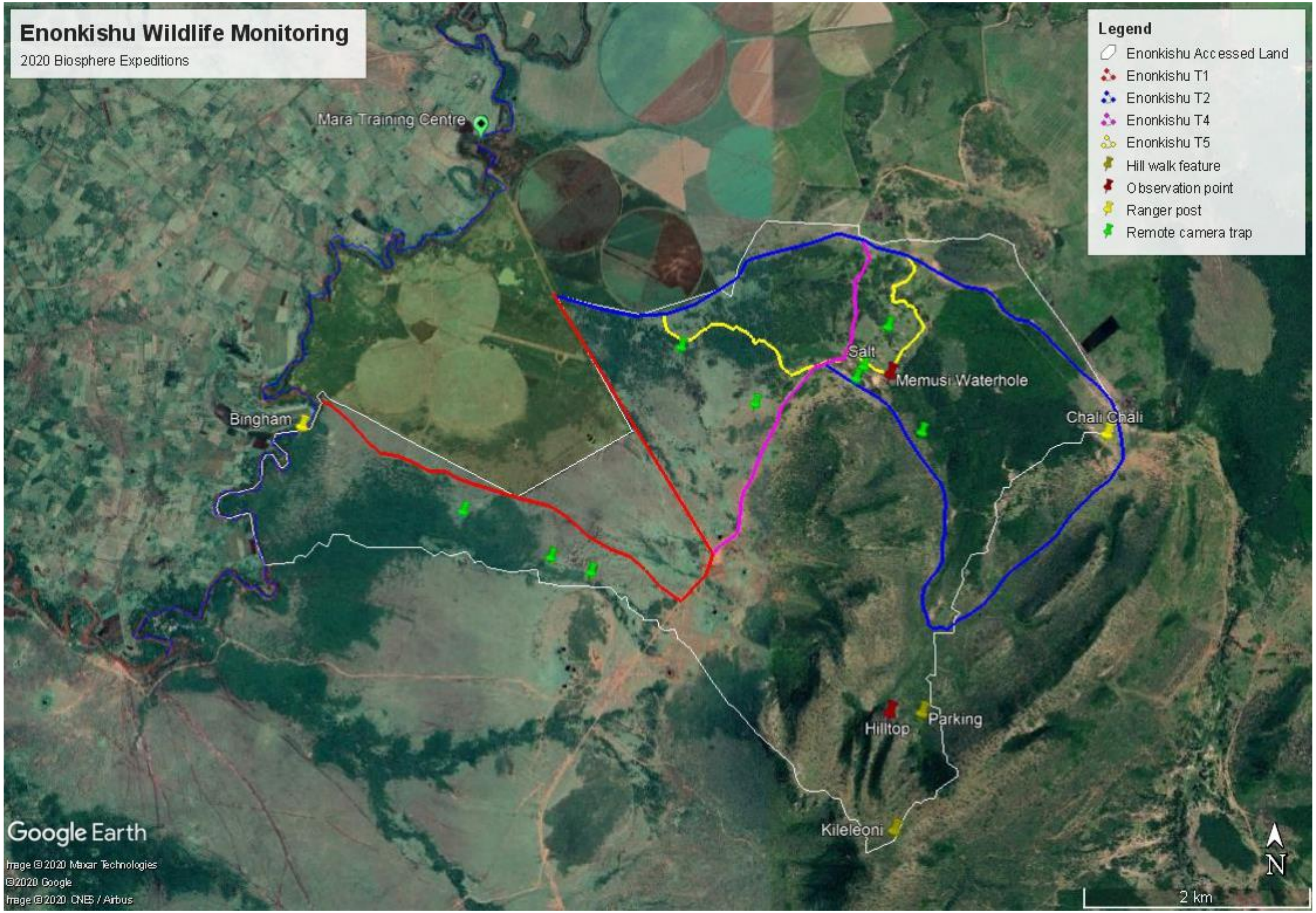

Figure 3.2a. Map of Enonkishu with study locations and routes. T = vehicle transects, Mara Training Centre = expedition base.

3.3. Results

A total of 50 transects were driven from 3 April 2019 to 28 February 2020, with 8 diurnal transects contributed by Biosphere Expeditions citizen scientists in 2020. Twenty-four species of mammals were recorded with 1,600 records accumulated, 260 of which were contributed during February 2020. Warthog were the most commonly observed groups of mammals (Figure 3.3a), while impala dominated in terms of abundance (total number of individuals; Figure 3.3b). Zebra were next most abundant. With the exception of grey-crowned crane, no bird species of conservation concern were recorded during transects.

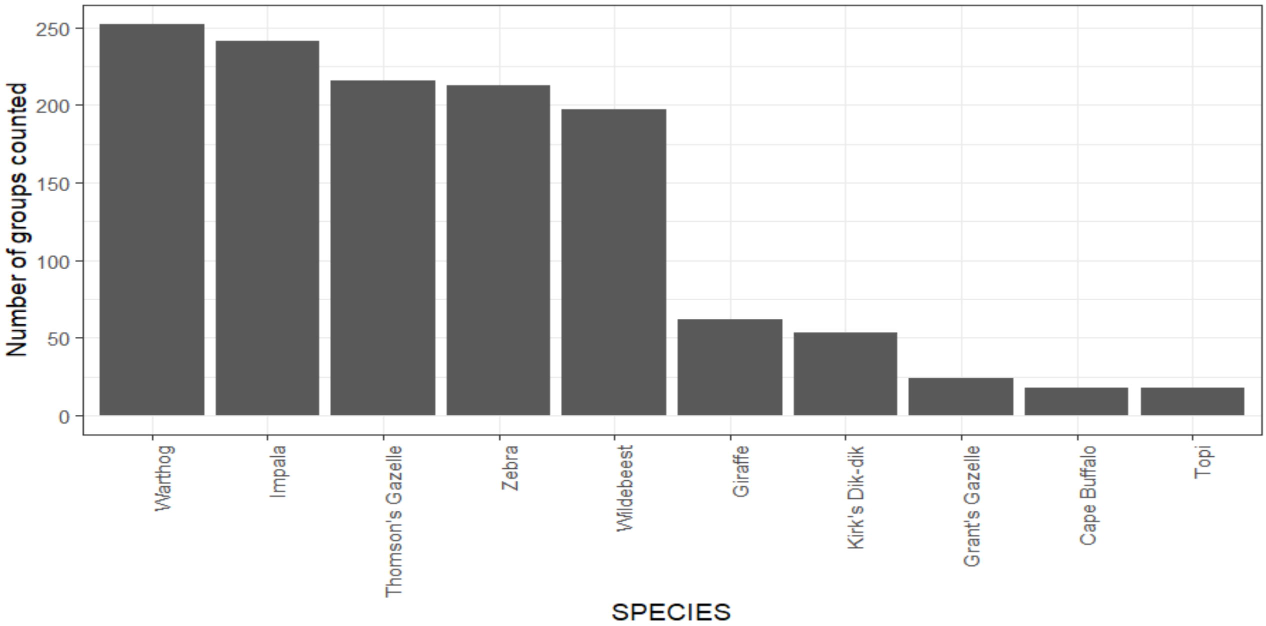

Figure 3.3a. Cumulative barchart of the 10 most frequently encountered species groups.

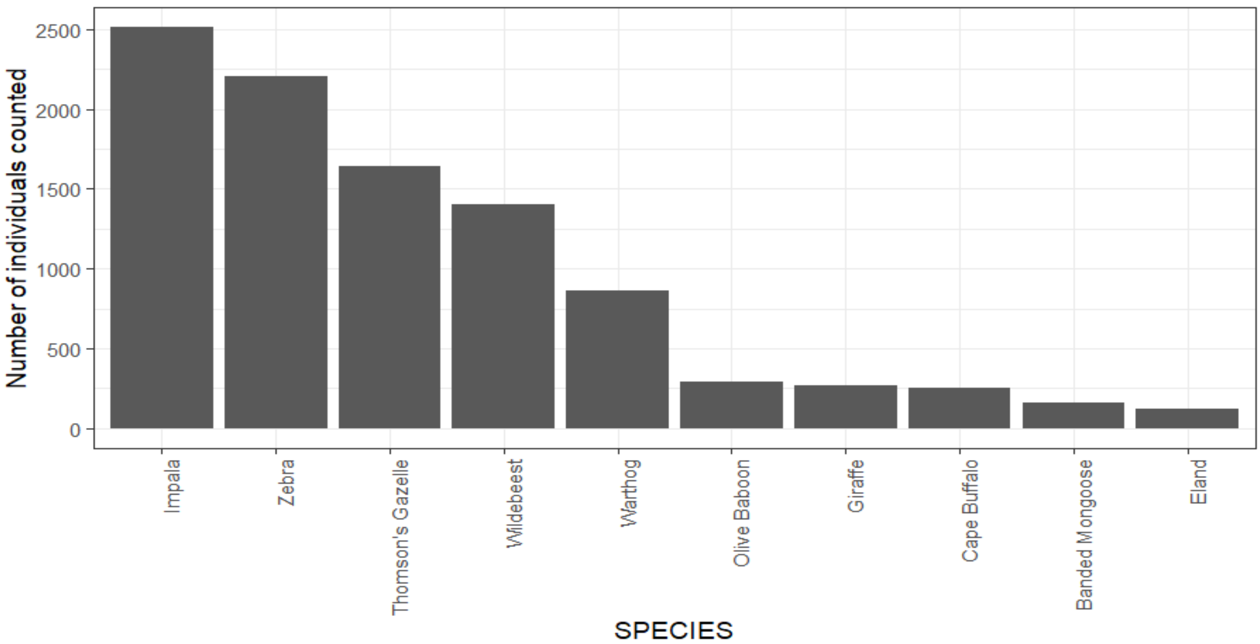

Figure 3.3b. The 10 most frequently counted individuals (sum of counts).
Note that these figures represent relative abundance and are not representative of populations.

Olive baboon, buffalo and banded mongoose were found in the largest groups, followed by zebra and impala (Table 3.3a).

Table 3.3a. Species summary data for groups encountered. Groups is the total number of groups encountered, n is the total number of individuals counted summed over all transects from all surveys (these are not population estimates), mean and SD are the mean and standard deviation of group sizes.

Species	Scientific name	n	Groups	Mean	SD
Impala	*Aepyceros melampus*	2514	241	10.47	14.29
Zebra	*Equus quagga*	2203	213	10.34	12.35
Thomson's gazelle	*Eudorcas thomsonii*	1640	216	7.59	9.06
Wildebeest	*Connochaetes taurinus*	1406	197	7.14	11.55
Warthog	*Phacochoerus africanus*	860	252	3.41	2.78
Olive baboon	*Papio anubis*	291	17	17.12	15.04
Giraffe	*Giraffa tippelskirchi*	272	62	4.39	11.35
Cape buffalo	*Syncerus caffer caffer*	254	18	14.11	15.61
Banded mongoose	*Mungos mungo*	161	12	13.42	6.23
Eland	*Taurotragus oryx*	124	16	7.75	8.75
Grant's gazelle	*Nanger granti*	122	24	5.08	3.73
Kirk’s dik-dik	*Madoqua kirkii*	81	53	1.53	0.67
Waterbuck	*Kobus ellipsiprymnus*	71	15	4.73	4.01
Topi	*Damaliscus lunatus*	47	18	2.61	2.99
Spotted hyaena	*Crocuta crocuta*	28	12	2.33	2.71
Elephant	*Loxodonta africana*	23	5	4.6	2.51
Vervet monkey	*Chlorocebus pygerythrus*	14	3	4.67	3.21
Black-backed jackal	*Canis mesomelas*	9	6	1.8	0.45
Bat-eared Fox	*Otocyon megalotis*	8	3	2.67	0.58
Cheetah	*Acinonyx jubatus*	8	2	4	4.24
Lion	*Panthera leo*	5	1	5	NA
African savannah hare	*Lepus microtis*	4	4	1	0
Hartebeest	*Alcelaphus buselaphus*	3	3	1	0
Dwarf mongoose	*Helogale parvula*	1	1	10	NA

3.4. Discussion

A high encounter rate with a range of wildlife indicates healthy mammal populations. Whether this is a result of the integrated livestock management, conservation attitudes or higher than average rainfall levels still needs to be determined. One of the advantages of long-term monitoring using transects is that it will allow land managers to do this. Transects continue to capture the range of biodiversity at Enonkishu across a variety of mammal sizes: from banded mongoose and dik-dik to elephant.

The most abundant mammal in terms of group encounters and individuals counted is impala. This was also reflected in the camera trap records, which were dominated by impala. Impala are generalist browsers that often dominate wildlife assemblages across protected areas of eastern Africa. They are often the focus of several studies that consider their health and management as part of game ranch management and venison production (Fairall 1985).

Long-term monitoring is vital for understanding mammal population dynamics in the reserve. At this stage, the transects allow comparisons for relative abundance: further monitoring will allow managers to understand drivers behind changes in animal abundance, as well as calculate density estimates. This will be the subject of future reports.

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4. Atlassing: Mapping the birds of Enonkishu and surrounding area

Alan Lee
Blue Hill Escape

4.1. Introduction

The tropical ecosystems of the world are renowned for their diverse avian communities. There are currently around 11,000 species of bird recognised by the International Ornithological Union, with just shy of 3,000 recorded in Africa, and with Kenya's bird list just over 1,000.

Atlassing: birdwatching meets citizen science

Citizen science has become extremely popular in recent decades (Robertson et al. 2010). Citizens contribute information because they are motivated to contribute to "real" science, and conservation (Wright et al. 2015). Scientists can direct large numbers of volunteers to collect information that would otherwise not be achievable in terms of time, scale, funding or manpower (Dickinson and Bonney 2012, Bonney et al. 2014). Some of the longest-running and largest of these citizen science programmes in Africa are broad-scale bird monitoring projects (Harrison et al. 2014), where bird watchers submit lists of birds to centrally managed databases (atlassing or atlasing). The first Southern African Bird Atlas Project (SABAP) ran from 1987 to 1991, while the second (SABAP2) was initiated in 2007 and is ongoing. The Kenya Bird Atlas project, initiated in 2013, follows the protocol of SABAP. Collectively, projects that use this protocol are referred to as the BirdMap project, coordinated by the FitzPatrick Institute of African Ornithology based at the University of Cape Town.

By using the BirdMap protocol, multiple lists allow scientists not only to map where birds are, but also to create indices of relative abundance. These can be regionally tuned to then calculate actual abundances (density estimates), which then in turn - with the range maps or distribution data from the atlas projects - can be used to infer populations (Lee and Barnard 2017, Lee et al. 2018). For areas with long-term contributions, it is also possible to infer bird trends (whether a species is increasing or decreasing) (Lee et al. 2017, Brown et al. 2019). The BirdMap protocol is thus a very useful tool for contributing data that informs conservation decisions.

Contributions to the BirdMap project are easily facilitated through the BirdLasser App, available for both Android and iPhone smartphone operating systems (Lee and Nel 2020). BirdLasser allows any user to record the birds they see by simply creating a trip list and then 'logging' birds seen. Date, time and GPS location retrieved from the phone are automatically recorded. Records are then synced to an online cloud storage system. Trip lists are easily exportable using a variety of formats, e.g. comma separated value (csv) files.

An option exists within BirdLasser to contribute records to the BirdMap projects: however, prior registration with the BirdMap project is required to obtain a user ID. Lists recorded within the BirdLasser app then automatically assigns records to the appropriate BirdMap recording format. These lists then need to be submitted to the BirdMap project via BirdLasser. BirdMap users can easily see where, when and how many bird species and records they have contributed to the project.

It should be noted that BirdLasser app is not a bird identification tool, it is merely a recording tool. As such, prior knowledge or an active interest in birds is required to participate in bird atlassing. During the expedition, an optional activity was recording bird sightings using BirdLasser.

4.2. Methods

Various expedition participants with a background or interest in birds compiled bird lists using the BirdLasser app. This app automatically records the date, time and GPS location of encounters, and compiles bird lists as trip lists. The author compiled lists according to the BirdMap protocol (this option is selected in the app): this involves compiling lists in 'pentads' (geographic areas of 5x5 minutes, roughly 8-10 x 10 km), with contributions in 'full protocol' format requiring between 2 hours and 5 days' worth of bird searching. These lists are submitted to the BirdMap project. Sightings of birds that do not meet the above criteria (inadequate coverage or sampling time) can be contributed to the BirdMap project as *ad hoc* protocol records, which can assist distribution modelling, but cannot be used to calculate relative abundance.

Field efforts during the expedition were guided by the coverage maps of the Kenya Bird Map project, which is the country-specific BirdMap project. This revealed that although the pentads associated with the conservancy had reasonable coverage (6-10 lists), the pentads to the north and west of the conservancy associated with the agricultural lands between the conservancy and the B3 highway had not been surveyed for the bird atlas project.

For the most part, bird lists were compiled opportunistically during transect or mammal mapping activities during February 2020 (chapters 2 and 3), but blank pentads (pentads with no bird lists submitted) were targeted specifically. In addition, pentads covering the spectrum of agricultural and conservancy land were targeted to examine patterns of bird species richness for this sampling period. We summarise list data by recording over all pentads how many days each species had been recorded. More common, easily recognisable and large species tended to be more frequently reported (Lee and Barnard 2017).

To examine contributions to the Kenya Bird Map project, data were extracted from 38 pentads, including the Masai Mara Nature Reserve, surrounding rangeland (human settled land with cattle and wildlife, but not formally protected), conservancy land (formally protected rangeland usually dominated by mammalian wildlife) and agricultural land (land dominated by cultivation of crops). The aim of this exercise was to examine contribution of number of lists and atlassing time to bird species richness patterns. Data were downloaded from the BirdMap project using the rabm package for R. Data were manipulated using dplyr package (Wickham et al. 2019), with plots created in ggplot2 (Wickham 2016).

4.3. Results

The combined expedition list was 233 species (appendix IV). All species for which photographs were obtained can be viewed on iNaturalist.

The expedition submitted 20 full protocol lists for 12 pentads, including six blank pentads. A comparison of the Kenya Bird Map coverage maps from before and after the expedition is shown in Figures 4.3a. For a full month of field effort, this is a moderate contribution to the Kenya bird map by atlassing standards, where with good road infrastructure up to four full protocol cards have been achieved per day. However, several efforts to tackle distant pentads were thwarted by unpassable roads (trucks stuck, bridges washed away, dangerous road conditions, etc.). Also, the main form of navigation, Google Maps, was unreliable for this region. If weather conditions had been more accommodating, greater coverage could have been achieved.

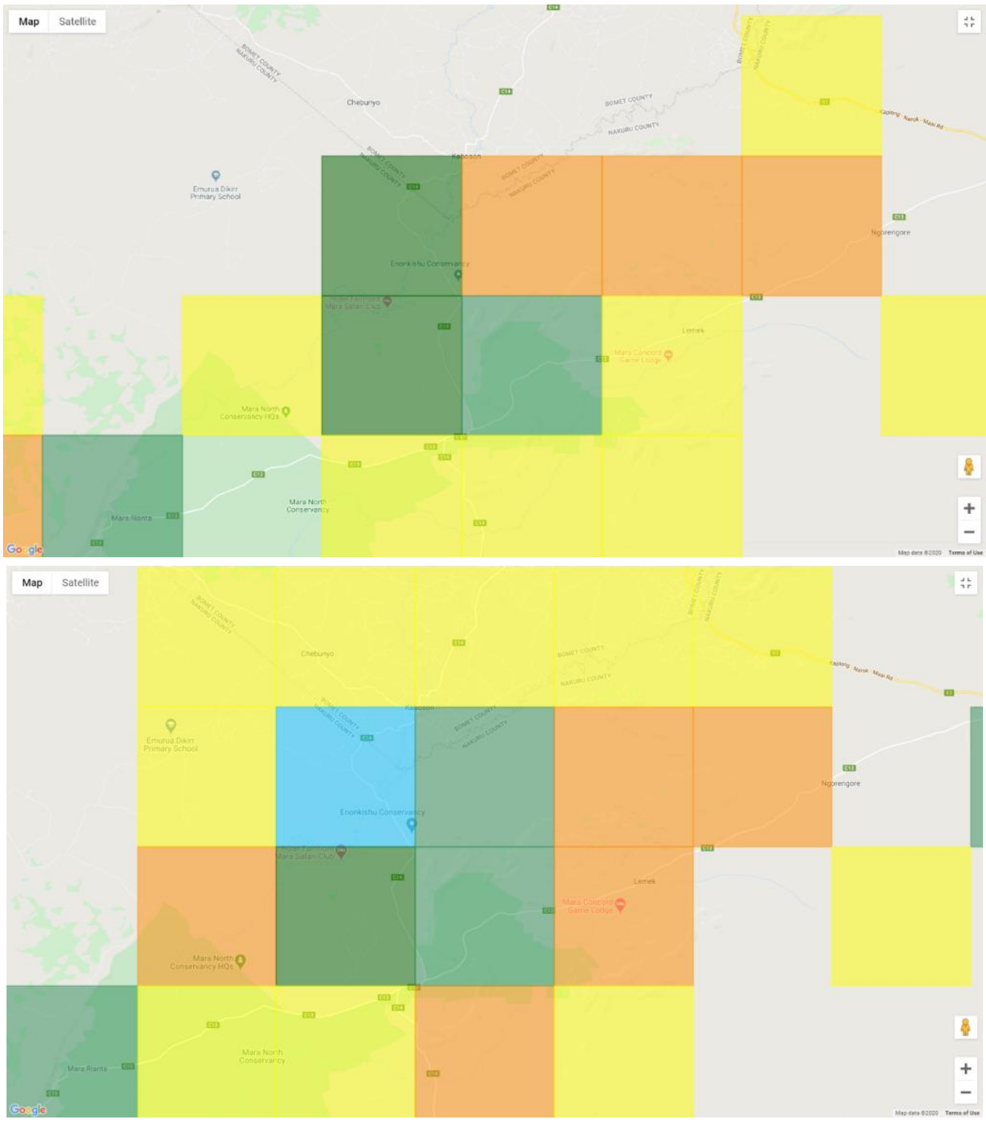


Figure 4.3a. Coverage map of the Kenya bird project before (top) and after (bottom) the expedition. Pentads are the coloured squares, with each colour indicating the number of full-protocol bird lists submitted to the BirdMap project. Yellow = 1 list, orange = 2-4, green = 5-10, blue 10-25. Areas with grey squares have no lists associated with the BirdMap project. The pentad where the base-camp at MTC is located has changed from green to blue, with the adjacent pentad (including Kileleoni Hill) now green. Six pentads with no prior coverage had full protocol bird lists submitted.

The complete list of birds is presented in appendix IV, ordered by relative abundance. The top 10 most frequently reported birds are also reproduced in Table 4.3a. Top amongst these was the northern fiscal *Lanius humeralis*, a medium sized, boldly marked black and white bird that perches in open positions to hawk insects (Figure 4.3b). All the other species recorded were generally common 'bushveld' birds. However, the majority of birds were recorded only once (Figure 4.3c).

Table 4.3a. The 10 most commonly recorded bird species for Enonkishu conservancy and surrounding area. Records are the number of times a species was reported out of a total of 26 days of monitoring.

English name (IOC)	Scientific name	Records
Northern fiscal	*Lanius humeralis*	25
Superb starling	*Lamprotornis superbus*	23
Cape turtle dove	*Streptopelia capicola*	22
Northern grey-headed sparrow	*Passer griseus*	21
Tawny-flanked prinia	*Prinia subflava*	21
Yellow-fronted canary	*Crithagra mozambica*	21
Dark-capped bulbul	*Pycnonotus tricolor*	20
European bee-eater	*Merops apiaster*	18
Purple grenadier	*Uraeginthus ianthinogaster*	18
Rattling cisticola	*Cisticola chiniana*	18

Figure 4.3b. Northern fiscal: the most frequently recorded bird species.

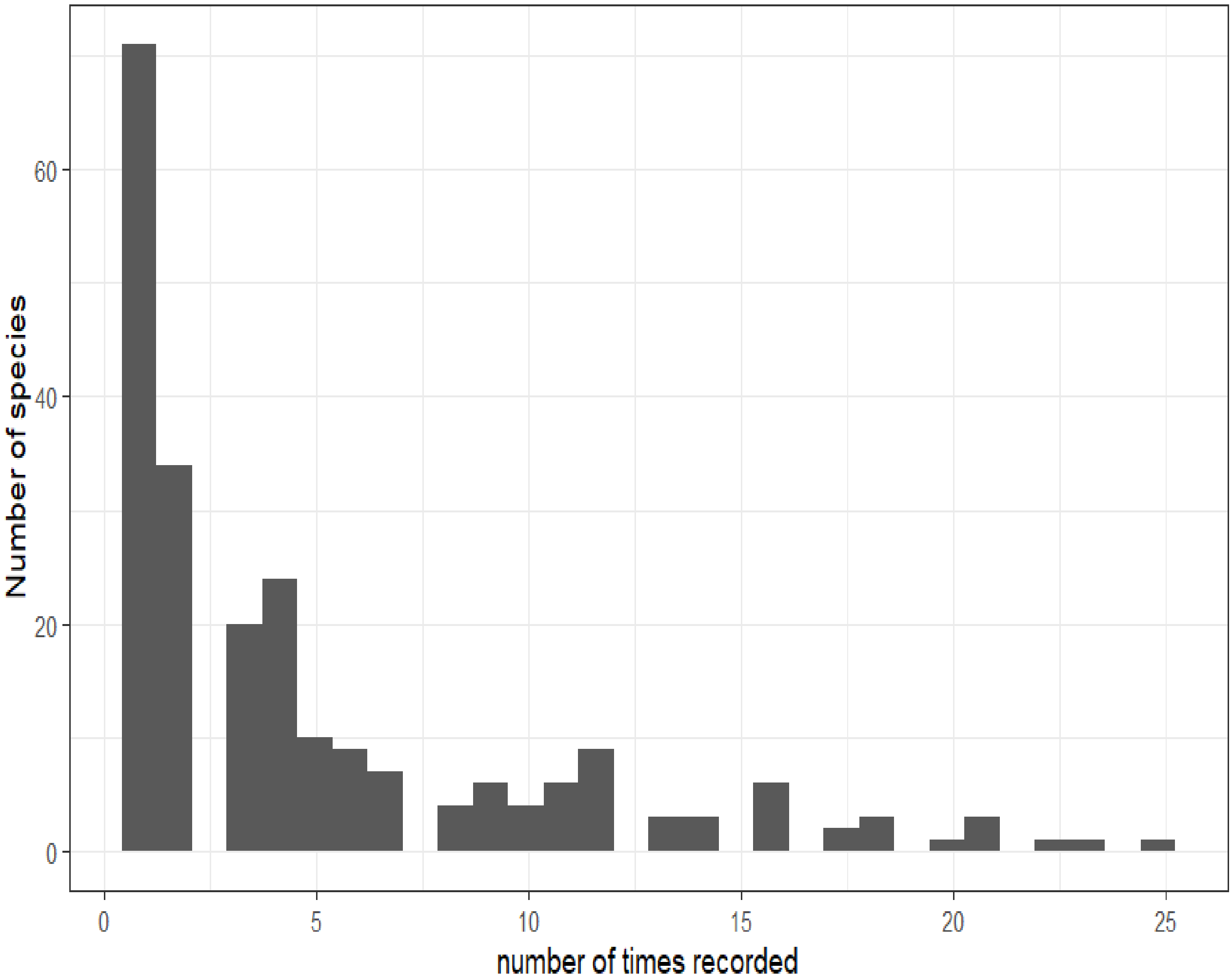
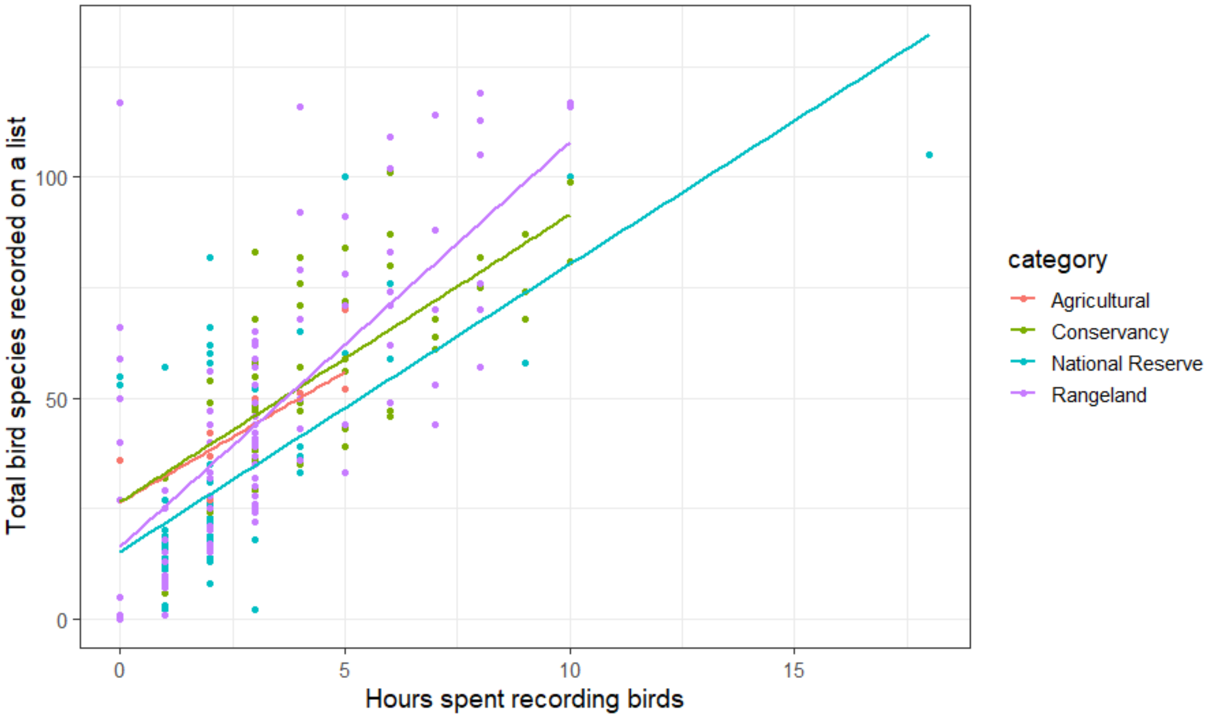


Figure 4.3c. Of the 233 bird species recorded in and around Enonkishu, most were recorded only once, as shown by this histogram assigning species to count bins. In other words, the chart shows that the bird community was dominated by a handful of common species and many rarer species.

An exploration of the 38 pentads of the Mara region reveals that species richness for this region is strongly tied to monitoring effort. This is firstly seen at the pentad level, with pentads with more bird lists having the greatest species richness. In this case, the pentad in rangelands associated with the town of Talek, south of the conservancy bordering the Maasai Mara Nature reserve had the highest bird species richness and the greatest number of bird lists submitted to the bird map project (Figure 4.3d). In addition, the number of hours spent atlassing was also strongly correlated with the number of bird species submitted for a list (Figure 4.3d).

Pentads mostly represented by agricultural land use had the fewest numbers of bird lists, and these lists were associated with the lowest number of hours of monitoring: there are few incentives to visit and spend time in these areas for most people interested in wildlife. Thus, without correcting for these factors, bird species richness patterns can be very misleading. Given the low sampling efforts in agricultural land pentads, it is thus not advisable to compare species richness patterns between land use types at this time without considerable thought as to methods to correct for reporting bias.



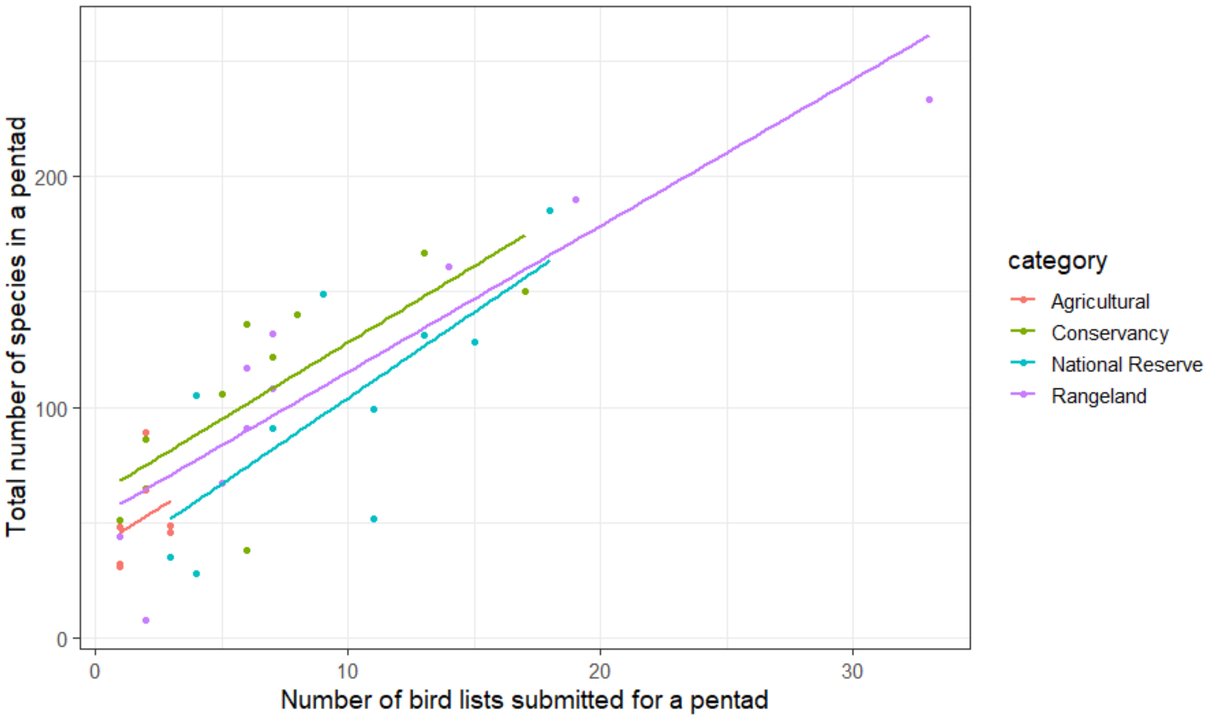


Figure 4.3d. These two charts indicate how bird species richness is a function of effort both at the list and pentads levels: correlations between the number of bird species recorded on a list in relation to the number of hours spent recording birds in a pentad (top); and the correlation between the species richness of a pentad (number of unique bird species) and the number of lists submitted to the BirdMap project for a pentad. Lines are linear regression fits (standard error omitted for clarity), coloured by dominant land use category. From the top chart, the truncation of the red regression line for agricultural pentads is an indication that less time is spent recording bird species in this land type, while in the bottom chart the low sampling effort for agricultural land pentads is also clearly evident (none of the pentads had >3 lists, by contrast the Talek rangeland pentad had >30 lists and the highest species richness: outlying point on the top right in the right chart).

4.4. Discussion

Given the adverse weather and road conditions, and that atlassing was not the principal aim of the expedition, the coverage and lists obtained represent a substantial achievement and a significant contribution to the Kenya Bird Map project.

On the study site, the juxtaposition of wildlife rangelands, agricultural lands, forested and riverine ecosystems resulted in an extraordinary rich diversity of birds observed in and around Enonkishu Conservancy. Despite only a limited number of contributors to the bird mapping, using the simple monitoring protocol allowed extra information to be extracted from the simple process of creating birds lists. While we concentrated only on relative abundance for this report, spatial patterns could be further explored, which would be of value especially for birds of conservation interest.

Several birds of conservation interest were observed, and we comment on these species here to inform readers of their importance within the context of Enonkishu Conservancy.

Birds of conservation interest

Grey crowned crane *Balearica regulorum* Endangered

The grey crowned crane's generalist foraging strategy has allowed this species to adapt to human settlement, and it is often seen in human-modified environments (Stabach et al. 2009). Birds also forage frequently in agricultural lands, including pastures, irrigated areas, fallow fields, recently harvested fields, and newly planted cereal crops (Gichuki 2000). Further, the species has been observed feeding on standing wheat in East Africa, plucking seeds of standing crop (Olupot 2016). As a result, conflicts with farmers arise, although the perceived damage caused to crops is higher than the actual damage (van Velden et al. 2016). Grey crowned cranes are vulnerable to poisoning and pet collection (Olupot 2016), and collision with power line infrastructure (Jenkins et al. 2010; Shaw et al. 2010).

Several pairs of breeding crane were reported in or around the conservancy. A large flock (>50 individuals) was also observed occasionally. The northern Mara region, including Enonkishu, is thus a population stronghold for this species. Continued efforts to monitor and protect this species should be ongoing.

Southern ground hornbill *Bucorvus leadbeateri* Vulnerable
[Information in this species paragraph is summarised from the species account at Sanbi.]

At nearly 4 kg, the southern ground hornbill is the largest hornbill species in the world. Very distinctive with their black plumage and red facial skin, they are found from South Africa through to Kenya. They rely on large trees with natural cavities for nesting. Threats that the species face are mostly anthropogenic, including poisoning, habitat loss due to logging where large trees are lost, electrocution and hunting for traditional medicine in some part of the distribution range. In some countries within the species' distribution range, it is regarded as the bearer of death and the bird is therefore to be avoided and should not be killed. It is often referred to as the thunder bird, because it is used traditionally to protect against lightning spells in South Africa. The bird is believed to bring rain during drought season.

A family group was observed on a daily basis on the pivot irrigation agricultural fields adjacent to the Mara Training Centre. Since they eat snakes, their presence is beneficial to the day workers in this area. The presence of this large terrestrial predator is an indicator of good ecosystem health, and the Enonkishu hornbill family should be monitored and protected as necessary. This includes the protection of large tree species used as nesting sites.

Saddle-billed stork *Ephippiorhynchus senegalensis* Least Concern

While this distinctive stork with its multi-coloured beak is currently listed as Least Concern by the IUCN, a recent paper highlights that the species should now be classified as Vulnerable as it is now all but restricted to protected areas, even though potential habitat (dams) is increasing (Gula et al. 2019). A single encounter with a pair at the Memusi dam was recorded during February 2020, but this species is worthy of further monitoring, as is the black stork *Ciconia nigra*.

Large raptors: Martial, crowned and Verreaux's eagles

As apex predators, raptors are always rare in the broader landscape, and a special occasion when sighted. Generally, Africa's top raptors are in decline (Garbett et al. 2018). Martial eagle *Polemaetus bellicosus* is classified as Vulnerable; crowned eagle *Stephanoaetus coronatus* and bateleur *Terathopius ecaudatus* are Near Threatened, while Verreaux's eagle *Aquila verreauxii* (also commonly known as black eagle) is Least Concern. These four eagles were only recorded in the vicinity of Kileleoni Hill, while tawny eagle *Aquila rapax* was recorded in the savannah areas. Verreaux's eagle were recorded regularly, with a known nest on the southern side of the hill. Martial and crowned eagles were recorded only once. Together with the host of other raptor species encountered, the presence of these species indicates a healthy avian ecosystem, which is reliant on small mammal species. Surveys should continue to monitor these species as part of the set of target animals.

Vulture species

Vulture populations across Africa are in severe decline, with most now threatened with extinction (Ogada and Buij 2011, Rushworth and Krüger 2014, Mullié et al. 2017, Thorley and Clutton-Brock 2017, Garbett et al. 2018). No vulture species were recorded within the boundaries of the Enonkishu Conservancy or the agricultural lands further north. Of the 20 pentads surveyed, only two vultures were recorded (with two species recorded: white-backed vulture and lappet-faced vulture, out of a potential six species) and both of these were in the southern region of the survey area beyond Aitong town, towards the Maasai Mara Game Reserve. Vultures are especially vulnerable to Diclofenec, a veterinary drug which was used to treat cattle and still available for treatment of people, which is lethal to all species of vultures (Bowden 2017). In addition, poisoning of carcasses aimed to control animals known to predate small livestock (hyaena, jackal, leopard, etc) also result in vulture mortality: at least one such event was reported to rangers during this expedition (not on the conservancy).

For wildlife to coexist as a fully functioning ecosystem in the conservancy areas, problems with poisoning of 'problem animals' (predators that have learnt to predate on livestock) will need to be addressed in the future.

This is an issue of which the Enonkishu rangers and managers are already acutely aware. While a comprehensive synthesis of this complicated issue is beyond the scope of this research and report, a broad spectrum of livestock owner education is the simplest solution. Alternative strategies that can be considered include incentive schemes (livestock compensation, poison event reporting) and (in certain cases) the law needs to be involved and there should be community agreements upon solutions for identified problem animals. The extent of the crisis that vultures face cannot be overstated and significant actions will be required if vultures are to return to the skies over Enonkishu on a permanent basis.

The role of atlassing to record bird abundance and species richness

'Birding' – the act of recording bird species – is a rewarding pastime due the variety and challenges inherent in bird identification. The use of the BirdMap citizen science protocol provides useful information on ranges, population trends and patterns of land-use and management. Visitors and residents of Enonkishu should be encouraged to atlas and play a part: participation is easy with the BirdLasser app. As wildlife of all kinds, including birds, face a challenging time during the Anthropocene era, records of wildlife are now more important than ever before. Without them, we will not know if vultures have returned due to conservation efforts, or when and why they disappeared from the African skies forever.

4.5. Acknowledgements

Thanks to Peter Thoem, Margaret Simpson, Gabriele Koßmann and Matthias Herold for their birding and bird mapping efforts.

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5. Waterhole monitoring at Memusi Dam, Enonkishu

Alan Lee
Blue Hill Escape

Rebekah Karimi
Enonkishu Conservancy

5.1. Introduction

As Enonkishu falls in a tropical region with relatively high associated rainfall, it is unsurprising that most mammals recorded at Enonkishu are water-dependent to some degree: waterbuck and buffalo are considered fully water-dependent (Okello et al. 2015), while giraffe are considered relatively water-independent, but do drink when water is available (De Leeuw et al. 2001). Wildlife and livestock distribution patterns in relation to water availability have received much attention in the scientific literature (Gereta and Wolanski 1998, Gaylard et al. 2003, Ogutu et al. 2010 & 2014).

Climate change affects the amount of rainfall and mostly causes higher temperatures and greater climate variability (Hansen et al. 2008). In East Africa, climate change will make rangelands warmer, increase rainfall unpredictability, reduce moisture and increase the frequency and severity of extreme climatic events such as droughts and flooding (Lankester and Davis 2016). Climate change has also disrupted the ecosystem base in new ways. Habitats where migrations are necessary for survival are at serious risk as corridors are increasingly fragmented by human settlement (Sala et al. 2000, Mooney et al. 2009).

As rainfall variability increases, during certain parts of the year, water availability will become a commodity. Interference competition over water resources will become more apparent in the form of aggressive interactions between and among wildlife species (Valeix 2011, Crosmary et al. 2012). Such competition may be amplified by the presence of livestock (Young et al. 2005, Butt and Turner 2012). However, many protected areas provide artificial waterholes in safe areas, preserve natural water sources by reducing wildlife traffic and ensure the survival of wildlife species during drought (Epaphras et al. 2008).

Waterhole observations, either directly or remotely using camera traps, have been implemented as part of monitoring regimes to record visitation to, and use of, water sources (Hayward and Hayward 2012, Abdu et al. 2018a & b). As part of the long-term monitoring at Enonkishu, initiated through Biosphere Expeditions in 2019, waterhole observations are conducted at Enonkishu every month in the morning and afternoon. These periods were selected because two 72 hour monitoring periods during February 2019 indicated that most visitation was recorded during the daytime periods (Karimi and Hammer 2019).

During 2020, Biosphere Expeditions conducted standard waterhole monitoring at the Memusi Dam, but also extended monitoring hours into the evening to validate patterns seen in 2019.

5.2. Methods

Citizen scientists were tasked with observing animals that came to drink at the waterhole called Memusi Dam. Memusi Dam is located at the base of Kileleoni Hill, surrounded on one side by trees and vegetation. A hide was constructed in February 2019 using the branches from the area and some binding wire, and a tarpaulin was installed to protect observers from sun and rain, as well as minimise shadows and visibility of obvious movements. Citizen scientists used chairs so that they observed the waterhole and surrounding area with only their heads visible above the hide wall. They used binoculars, a spotting scope, and for night-time observations torches with red beams and night vision binoculars. No white light torches were permitted to minimise disturbance. The vehicle was parked adjacent to the hide for security purposes, as this activity was often performed without a ranger.

During regular Enonkishu bi-monthly monitoring outside expedition periods in 2019 by rangers, observations were taken every 15 minutes during two shift periods, morning (06:00 – 09:00) and afternoon (16:00 – 18:00). However, instead of records every 15 minutes, during February 2020, observations were taken every 5 minutes. In addition, as the field of observation extended to 500 m, many of the animals observed were simply passing through rather than visiting the waterhole. As such, distance from water sources to groups of animals was recorded (including the stream to the south of the dam), together with a selection of behavioural activities, which included whether or not animals were drinking. Throughout the observation period, when an animal was observed, recorders noted the species, number of animals, as well as age and sex demographics, if possible, and any interesting observations. Key behaviours that were recorded included: drinking, eating salt or dirt (the waterhole is adjacent to a salt lick), feeding (e.g. for herbivores eating grass), vigilant, resting, passing through. Other options included: aggression (intra-species), aggression (inter-species), fleeing (from human or predator), shade-seeking, panting or calling. The following weather variables were recorded: cloud (five categories: clear, cloud <50%, cloudy, overcast, raining), wind (four categories: still, slight breeze, windy, very windy), and temperature (in degrees Celsius recorded from a thermometer in a Silva compass kept in a shady position). Observations were recorded using a smartphone app designed with the CyberTracker software, which automatically recorded date and time.

Monitoring was conducted in four shifts of 4 hours (06:00 – 10:00, 10:00 – 14:00, 14:00 – 18:00, 18:00 – 22:00). This time period was used as previous monitoring suggested that diurnal activity was highest at this water source. In addition, while during the 2019 expedition periods of 72-hour continuous monitoring were conducted, this proved to be logistically challenging and with the wet and muddy conditions of the 2020 expedition combined with low recording rates, this activity was not undertaken. Each of the shifts above was repeated four times during February 2020, but with each shift time-slot occurring on different days. A smoothed pattern of visitation (total number of each species recorded every hour) is provided across the monitoring period.

Three camera traps were set up on a salt lick to the south west of the dam location after the author observed impala feeding on crystallized salt on exposed areas of dirt near the dam. An additional behaviour category (eating salt or dirt) was added to the behavioural monitoring choices.

5.3. Results

Temporal patterns of visitation

Most waterhole observations were conducted in favourable weather conditions (clear and slight breeze, see also appendix V). Temperatures ranged from 10 to 33 °C, but were mild overall (mean ± SD = 21 ± 5 °C, Figure 5.3a). Most numbers of groups were recorded around the middle of the day, roughly correlating with the warmest part of the day (Figure 5.3a).

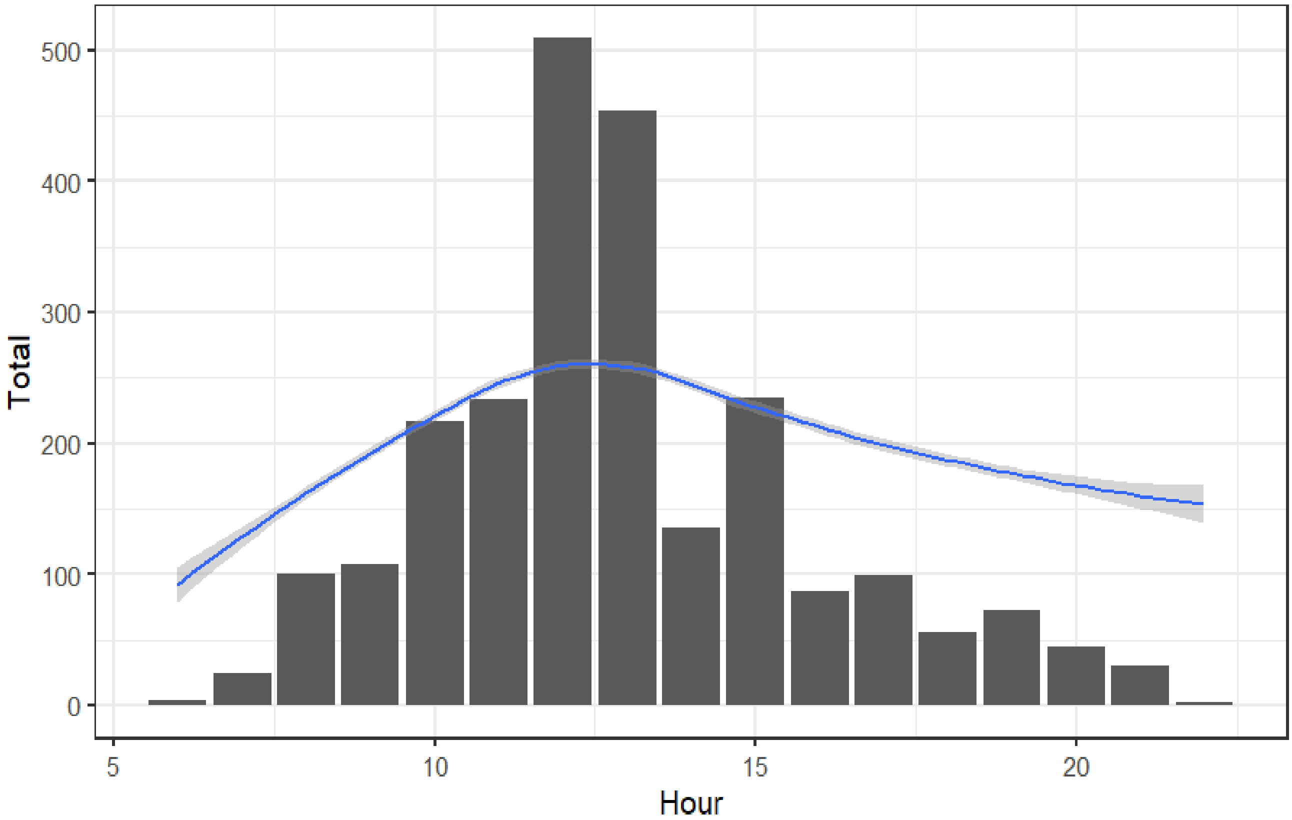

Figure 5.3a. A temperature trace (blue line) from the mean of temperature recorded every 5 minutes at the Memusi Dam: each hour was sampled four times. A cumulative bar chart indicates that most mammal counts occurred during the middle of the day (12:00 – 13:00).

Species richness patterns

While a range of wildlife was recorded from the observation point (Figure 5.3b), very few of these animals (30%) were within 50 m of water (Figure 5.3c) or recorded drinking, as was expected given the wet conditions. 17 species were recorded over the cumulative four-day observation period during February 2020. However, few observations of groups were close to the water (<50 m) compared to further away. Following on from this, during the 64 hours of observation, drinking was only recorded by six species during February 2020: impala (20 counts), warthog (14), giraffe (8), Thomson's gazelle (2), elephant (1) and zebra (1). By contrast, bi-monthly waterhole monitoring during 2019 by Enonkishu rangers suggests that zebras were most frequently encountered and that their behaviour was most commonly associated with drinking (Table 5.3a).

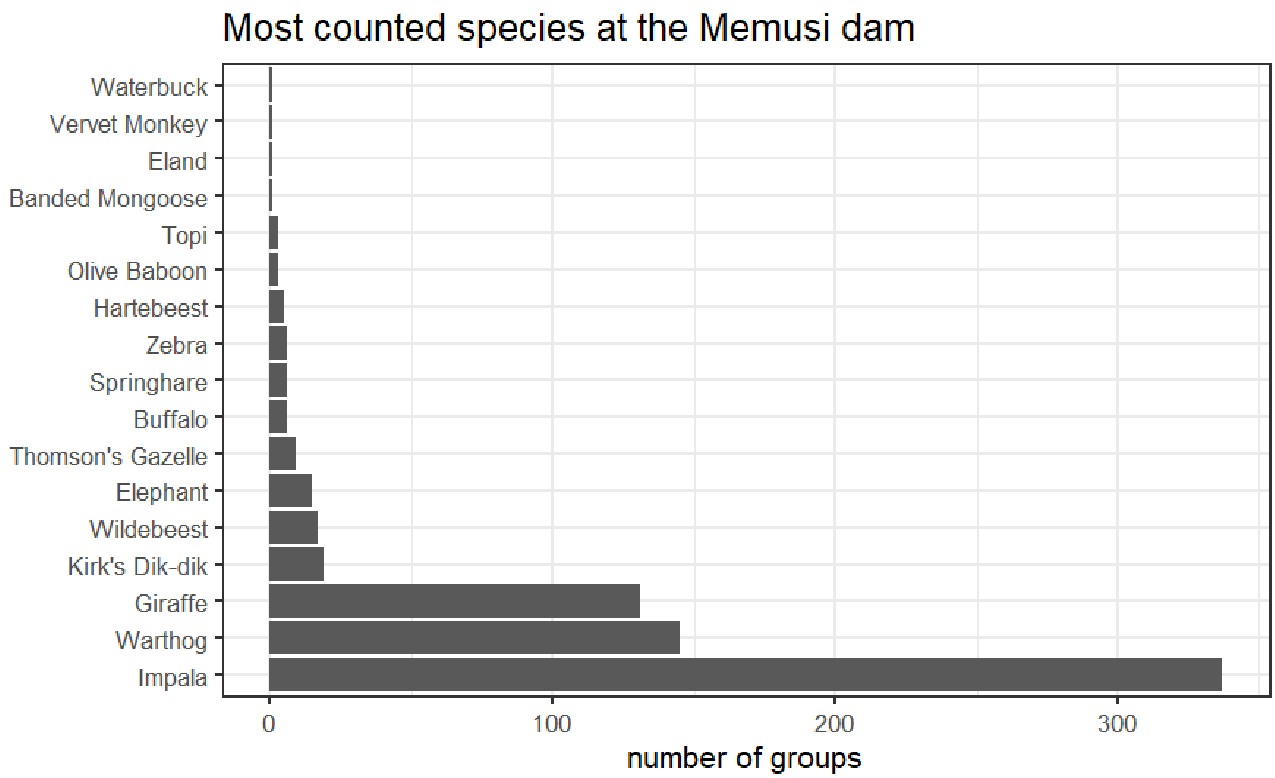

Figure 5.3b. Groups of impala were most frequently counted in the vicinity of the Memusi Dam, followed by warthog and giraffe, but these species were rarely recorded drinking.

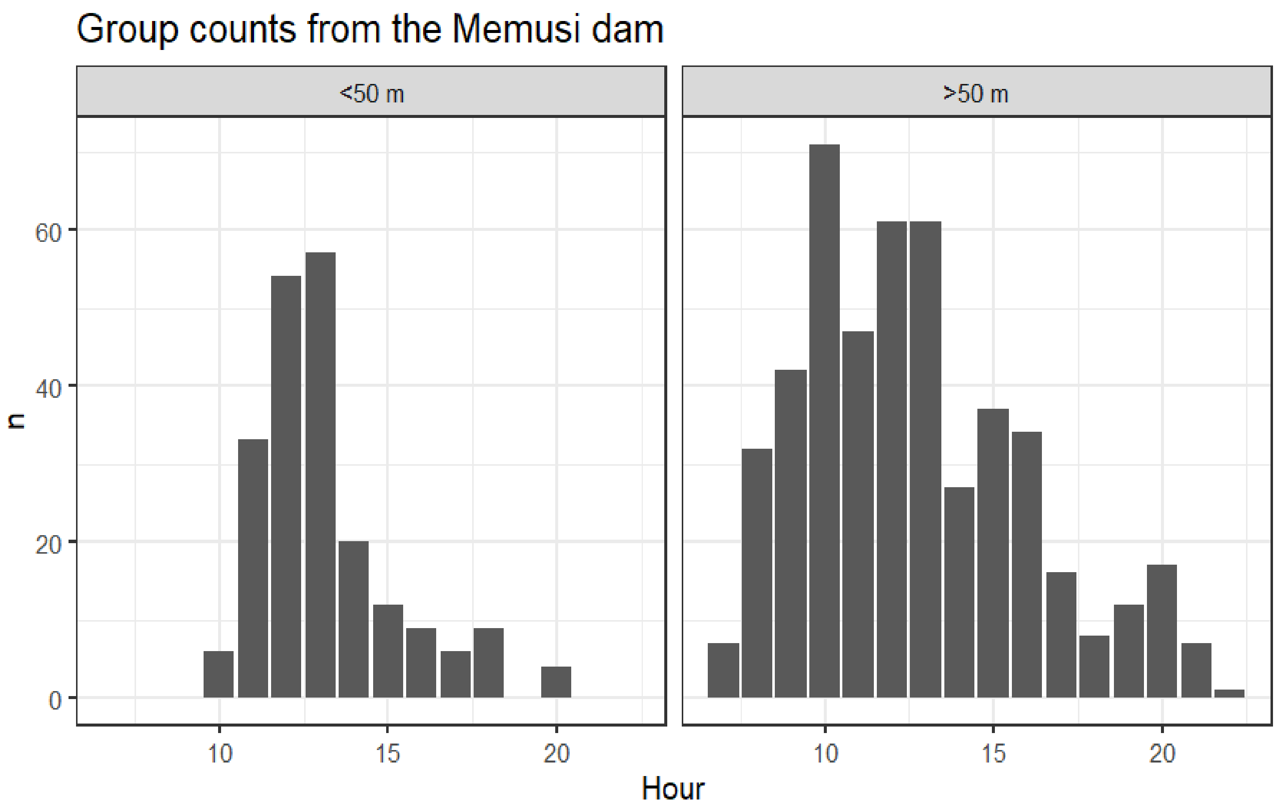

Figure 5.3c. Groups of mammals recorded in the vicinity of Memusi Dam, broken down into the total numbers of groups per hour recorded within 50 m of water, and those beyond 50 m of water, for February 2020.

Table 5.3a. Waterhole monitoring results from Enonkishu team rangers, conducted twice a month from April 2019 to January 2020. Groups is number of groups encountered, Total is the total number of individuals recorded, while Drinking is the number of groups where at least one individual was recorded drinking. The table is arranged by the total number of animals recorded during 15-minute counts.

Species	Scientific name	Groups	Total	Drinking
Olive Baboon	*Papio anubis*	5	124	2
Elephant	*Loxodonta africana*	10	90	3
Zebra	*Equus quagga*	17	73	11
Buffalo	*Syncerus caffer*	6	64	1
Impala	*Aepyceros melampus*	10	63	1
Giraffe	*Giraffa tippelskirchi*	6	36	5
Wildebeest	*Connochaetes taurinus*	8	30	1
Thomson's gazelle	*Eudorcas thomsonii*	3	13	0
Spotted hyaena	*Crocuta crocuta*	7	8	0
Waterbuck	*Kobus ellipsiprymnus*	2	4	0
Hippo	*Hippopotamus amphibious*	4	3	2
Lion	*Panthera leo*	1	2	0
Warthog	*Phacochoerus africanus*	3	2	0
Bat-eared fox	*Otocyon megalotis*	1	1	0
Blacked-back jackal	*Canis mesomelas*	1	1	0
Bushbaby	*Galago* sp	1	1	0

Behaviour of mammals at Memusi Dam

Only one species, impala, was observed licking salt or eating clay (Figure 2.3.5c). This behaviour was recorded during 14 counts. Feeding by herbivores was the most frequently recorded behaviour (13 species, 361 counts), followed by ‘passing through’ (14 species, 122 counts). Vigilance was recorded most frequently for giraffe (49), impala (48) and warthog (3). Most other behaviour categories were rarely recorded (<5 observations for aggression, fleeing, calling, panting, shade seeking).

5.4. Discussion

Given the extraordinarily high rainfalls and abundance of water sources in all locations of the conservancy, it was unsurprising that very low activity levels were observed in the vicinity of the waterhole. That impalas were so commonly observed in the vicinity of the waterhole was more a function of impala being common generally: the most frequently recorded mammal both in the mapping, camera trapping and transect monitoring (chapters 2 and 3). They were also actively observed consuming soil (see below). The lack of zebra drinking is noticeable between the long-term monitoring and monitoring over this wet period. A herd of zebra was regularly observed in the plains across from the water hole, so a lack of observed drinking was certainly not due to a lack of zebra. It will be interesting to compare these ‘wet’ monitoring results to visitation during dry periods in the future.

Monitoring should continue at Memusi Dam, but also at other watering points. The activity offers interesting insights into which species will be most impacted by a drying climate or droughts, as well as yielding interesting records of a variety of wildlife species.

The presence of a salt lick (also known as clay or mineral lick), visible from the hide, adds an extra interesting dynamic to monitoring at Memusi Dam. The consumption of salt and soil by mammals and birds is a well-documented behaviour (Johns and Duquette 1991, Abrahams and Parsons 1996, Downs et al. 2019). Reasons are mostly related to the properties of the soil to bind dietary toxins, as well as for the supplementation of dietary sodium, which is generally lacking in herbivorous diets (Johns and Duquette 1991). The soil may also serve as a source of micro-nutrients (Mills and Milewski 2007). The soil at the Memusi salt lick has a well-defined salt crust, making salt consumption the more likely reason for visitation at this site, although reasons for consumption are often hard to disentangle (Brightsmith et al. 2008).

Salt licks are normally referred to as claylicks or clay licks in South America, and are visited by a range of wildlife, but notably also large numbers of birds, dominated by parrot species (Lee et al. 2010 & 2017). By contrast the lack of regular bird visitation to this salt lick in Kenya was a surprise. Yellow-throated sandgrouse were observed casually in one section of the lick on one day, and a species of turaco on another, but camera traps picked up no other bird activity. At least two parrot species occur on or around Enonkishu, but both are rare, and neither was observed anywhere near the salt lick.

The presence of this salt lick provides a wealth of further monitoring opportunities. Of interest would be the spatial mapping of this important resource to wildlife and cattle throughout this conservancy region, together with the identification of the seasonal visitation patterns to the salt lick together with an identification of the species most reliant upon them, which could be done through continued camera trap monitoring of selected sites.

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6. Biodiversity mapping and inventory at Enonkishu using iNaturalist

Alan Lee
Blue Hill Escape

6.1. Introduction

Manpower is often the limiting factor in how intensively a landscape can be monitored (Dickinson et al. 2012). Citizen scientists offer an opportunity to have boots on the ground in conservation areas where resources are limited, building a valuable database (Bonney et al. 2014). Data collection by citizen scientists on this expedition was simple and straightforward, for example species identification and counting, and data entry was supervised to ensure quality and transparency between the field team and scientists (Foster-Smith and Evans 2003). In addition to collecting valuable data, citizen science engages a larger community in environmental education, scientific literacy, conservation initiatives and natural history observation (Evans et al. 2005). In fact, involving citizen scientists with a fresh perspective offers new insights, which may lead to new and improved testable hypotheses (Foster-Smith and Evans 2003).

Fields in which citizen science has been utilised include biological studies of global climate change and in sub-disciplines focused on species (rare and invasive) and ecosystems (Dickinson and Bonney 2012). By engaging non-career scientists, programmes deploying civilians to ecosystems off the beaten path elevate public understanding and support of science, the environment, and earth stewardship (Dickinson et al. 2012).

iNaturalist is a citizen science project and online social network of naturalists, citizen scientists and biologists, built on the concept of mapping and sharing observations of biodiversity across the globe. iNaturalist may be accessed via its website or from its mobile applications. Observations recorded with iNaturalist provide valuable open data to scientific research projects, conservation agencies, other organizations, and the public. With its global coverage, the project has been called "a standard-bearer for natural history mobile applications" (Goldsmith 2015).

In addition to observations being identified by others in the community, iNaturalist includes an automated species identification computer vision tool. Images can be identified via an artificial intelligence model, which has been trained on the large database of the "research grade" observations on iNaturalist. A broader taxon such as a genus or family is typically provided if the model cannot decide what the species is. This is a great learning tool, as contributors need have no prior knowledge about a species or taxon group in order to gain an idea of what their photograph is of. The guesses made by the software are then validated by the community of other participants.

6.2. Methods

The documenting of biodiversity using iNaturalist was a voluntary exercise during the expedition. Those who chose to participate downloaded the app onto their smartphones to then simply take and upload photographs. The iNaturalist platform was used to document a variety of taxa including plants, insects, invertebrates, fungi, mammals and birds.

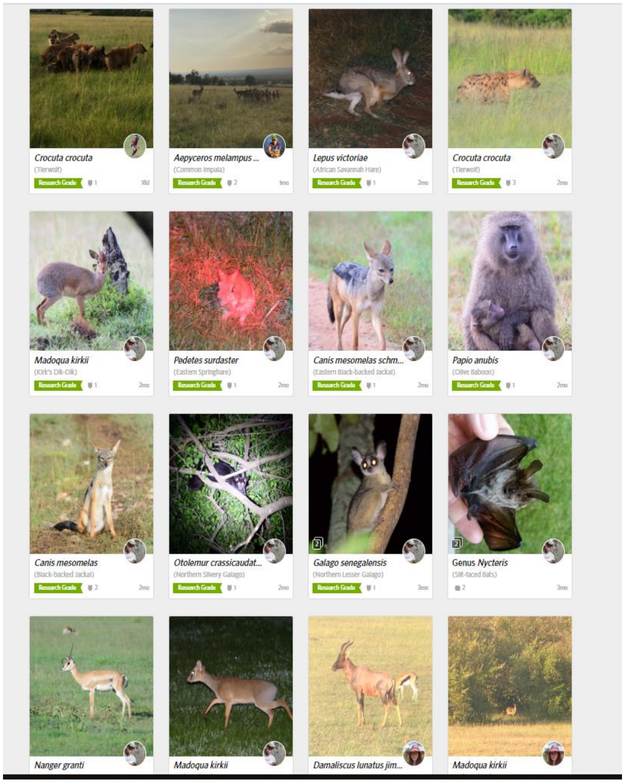
A .kml file of the conservancy was uploaded to create a 'place' in iNaturalist. An iNaturalist project page was then created by the author, which captures all records that had coordinates falling inside the conservancy. This means that records do not have to be manually submitted to the project. The project page shows a summary of leading participating observers in terms of photographs contributed, species recorded, and the most common species. It should be noted that the project is open-ended and records can now be submitted by anyone. The expedition was thus only a starting point.

6.3. Results

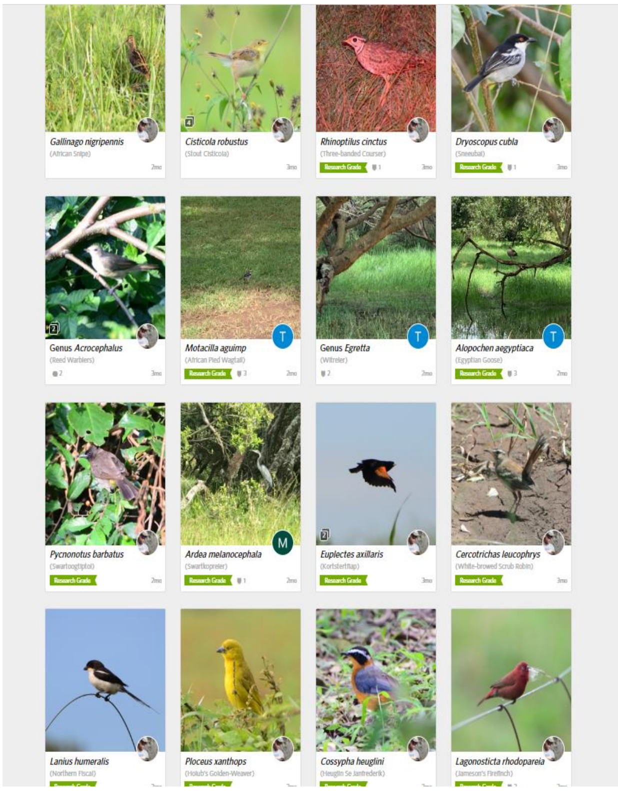
As of 4 May 2020, 325 photographic observations had been captured by the project across the conservancy (Figure 6.3a).

Figure 6.3a. Coverage map of observations captured by the Enonkishu Biodiversity survey on iNaturalist:. Image captured on 4 May 2020.

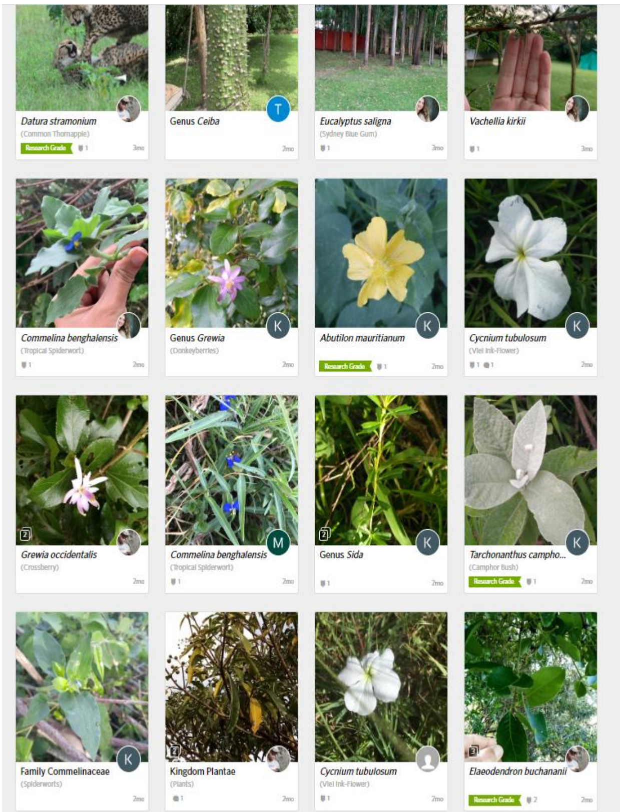
Different groups of taxa can be viewed for plants, insects, reptiles, fungi, etc. by applying the appropriate filter in the 'Observations' tab of the project. For instance, the results of applying the 'mammals' filter is illustrated in Figure 6.3b, top left panel, with other groups in the other panels.



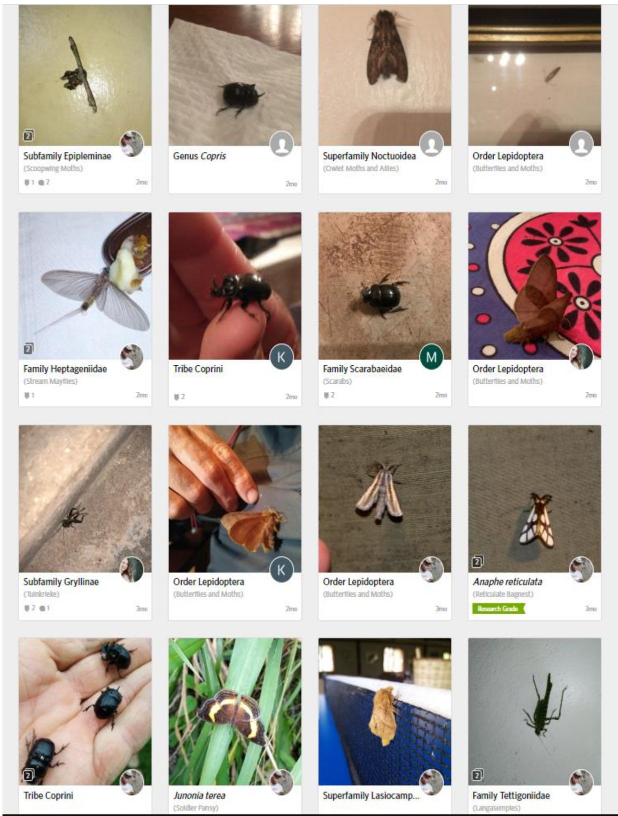
Mammals



Birds



Plants



Insects

Figure 6.3b. Some of the mammals, birds, plants and insects of Enonkishu as recorded in iNaturalist.

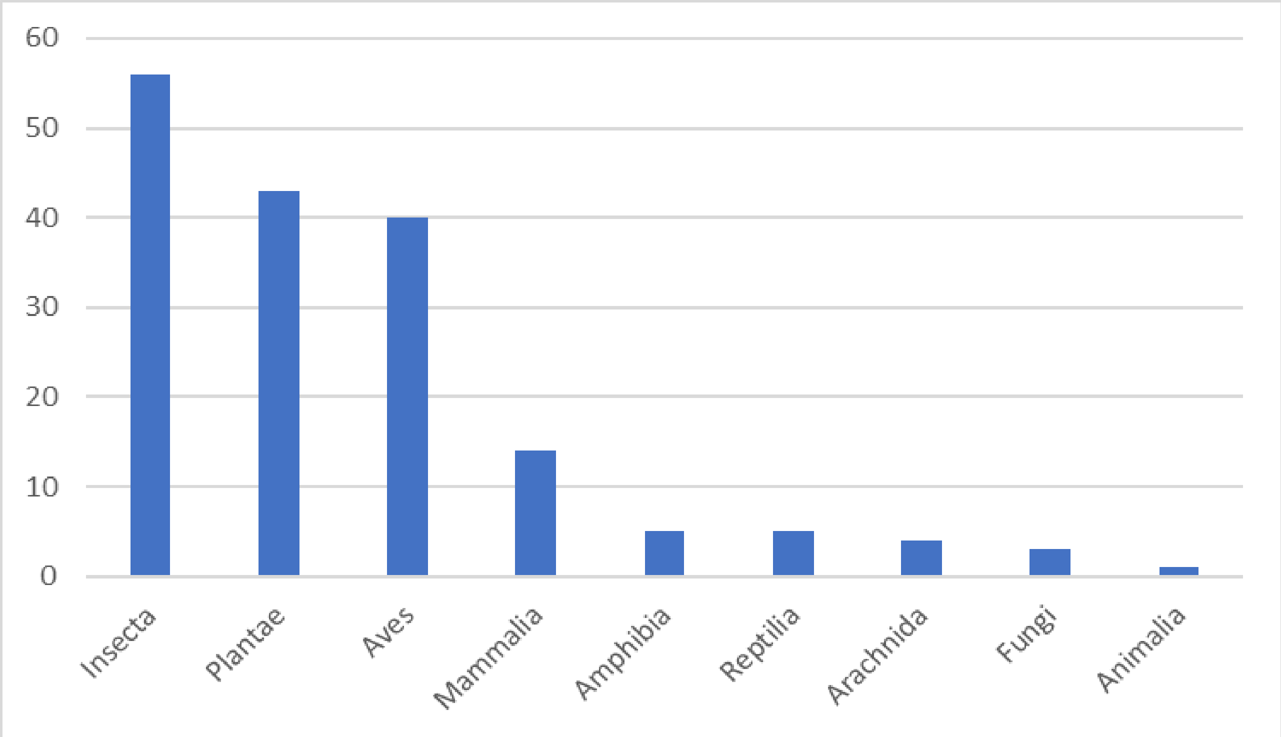


Figure 6.3c. A barchart of the major taxon groups registered through iNaturalist for Enonkishu.

6.4. Discussion

The iNaturalist platform is an easy and convenient way to monitor biodiversity, including within the Enonkishu Conservancy. The platform provides a visual record of biodiversity, which can be useful for researchers and managers, and could even be used to market the conservancy due to the visual impact the biodiversity creates. For instance, it may be possible for the conservancy to generate a guide to the mammals and birds of Enonkishu using the records captured within the conservancy.

The platform forms a good basis for publicly vetting biological records: this can be very useful for documenting the presence of rare or unexpected taxa, which will often be questioned if presented simply as part of a list generated through citizen science. It is hoped that employees and residents of Enonkishu will continue to contribute records to iNaturalist.

Specialist taxon group zoologists (e.g. entomologists, arachnologists and herpetologists) can be hard to come by, and there is often little incentive for citizen scientists to monitor these groups in comparison to the excitement and ease of large mammal, or even bird, monitoring. However, many insect groups and plants are visually interesting and easy photographic targets. Thus, anyone can take photos and upload them for the biodiversity record of the conservancy, which can be used by taxon specialists at a later time. Indeed the project is currently serving to document non-charismatic fauna and flora: at the time of writing most records were for insects and plants (Figure 6.3c).

The use of this platform for monitoring biodiversity should continue with future expeditions in Kenya, and would also be easily integrated into other expeditions in other countries. The use of these data may well form the basis of future research notes.

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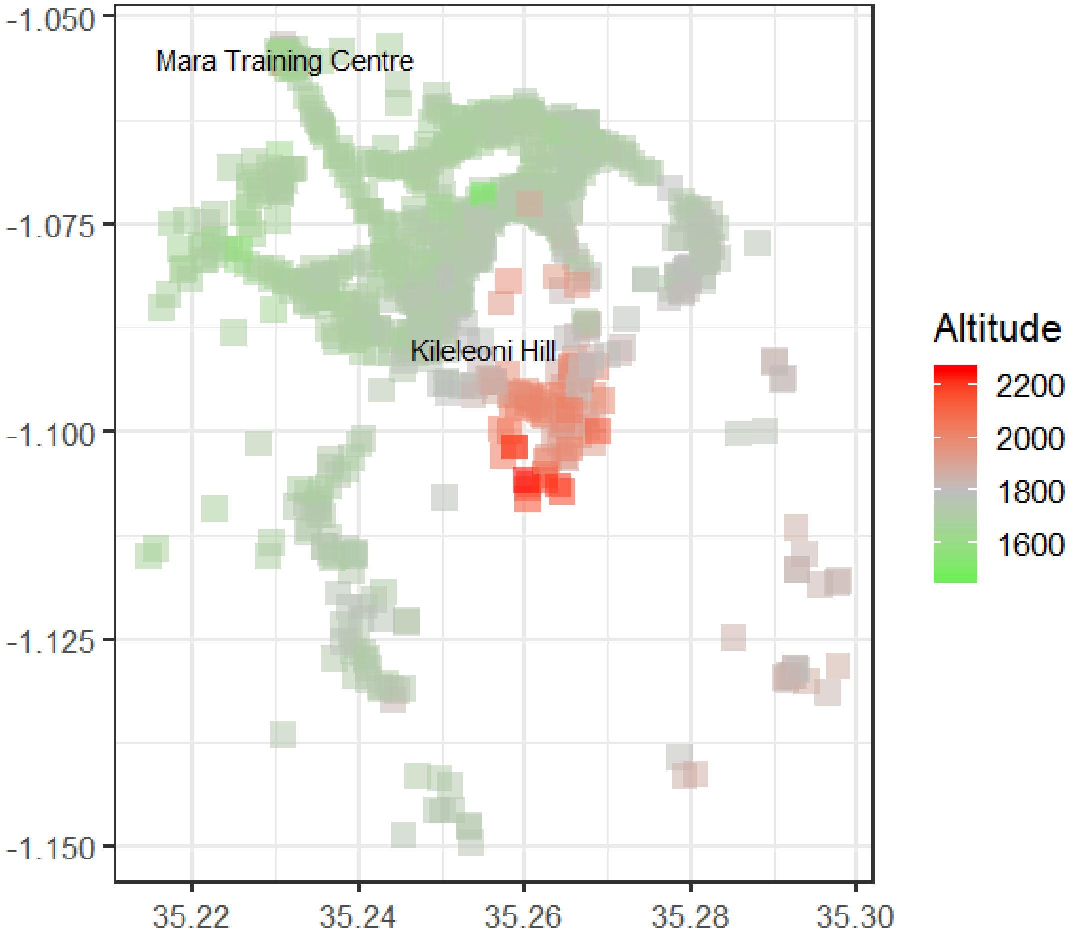
Appendix I: Elevation profile

An elevation profile (altitude in m) captured as secondary information during mammal mapping: smartphones automatically included these data each time a record was saved.



Appendix II: Habitat types

Dense lowland forest

Forests in lowlands and along river, large trees, high canopy. Mainly Euclea, Croton, and Acacia trees.

Dense forest in valleys of hills

Large trees of the Ficus, Euclea, Rhus and other groups. High canopy, in the valleys of steep hills.

Dense shrub

Tarchonanthus camphoratus shrub, mainly on rocky soil on hillslopes. Very dense and low canopy.

Disturbed areas

Bare soil, medium bare soil or invasions of herbaceous pioneer species (*Solanum*, *Lantana*, *Ricinus*, *Opuntia* spp.)

Open shrub / grass or forest edges

Patchy *Croton dichogamus* or other shrubs. Open grassy areas between shrub stands, low canopy, young plants.

Grassland / glades

Open areas with just grass or very occasional, single trees (*Acacia, Balanites*).

Wetland

Waterlogged, vegetated areas, river-like branching forms, water-dependent reeds and grasses.

Appendix III: Camera trap highlights from Enonkishu

These are photos from hotspot cameras as well as the camera grid at Enonkishu. Included are also other examples of common wildlife observed during the expedition.

White-tailed mongoose

Large-spotted genet

Mongoose sp

Striped polecat (Zorilla)

Olive baboon

Olive baboon in a fig tree

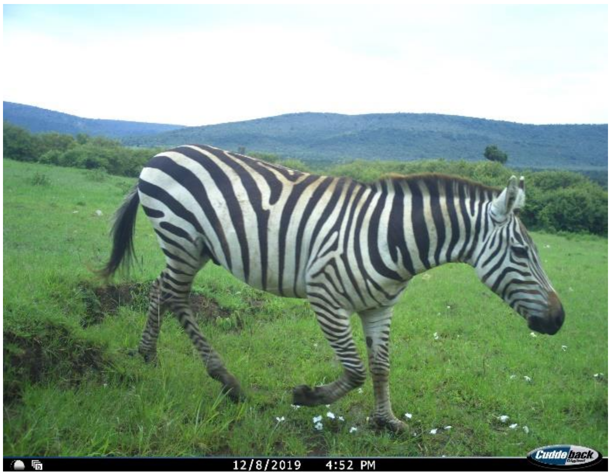
Defassa waterbuck

Coke’s hartebeest

Impala

Wildebeest

Ground hornbill



Plains zebra

Maasai giraffe

Water buffalo

Spotted hyaena

Black-backed jackal

Hippopotamus

African porcupine

Domestic cattle

Kirk's dik-dik

Bushbuck (female)

Warthog

Elephant

Elephant eating soil at mineral lick


Eland (courtesy of Christiane Flechtner)


Topi (courtesy of Malika Fettak)


Thomson's gazelle, female and young


Thomson's gazelle, male


Grant's gazelle (with deformed horn)

Appendix IV: Bird species list compiled during February 2020 for Enonkishu and surrounding area. Records indicates the number of times the species was recorded, and is an index of relative abundance.

English name (IOC)	Scientific name	Records
Northern Fiscal	*Lanius humeralis*	25
Superb Starling	*Lamprotornis superbus*	23
Cape Turtle Dove	*Streptopelia capicola*	22
Northern Grey-headed Sparrow	*Passer griseus*	21
Tawny-flanked Prinia	*Prinia subflava*	21
Yellow-fronted Canary	*Crithagra mozambica*	21
Dark-capped Bulbul	*Pycnonotus tricolor*	20
European Bee-eater	*Merops apiaster*	18
Purple Grenadier	*Uraeginthus ianthinogaster*	18
Rattling Cisticola	*Cisticola chiniana*	18
Speckled Mousebird	*Colius striatus*	17
Tropical Boubou	*Laniarius major*	17
Emerald-spotted Wood Dove	*Turtur chalcospilos*	16
Hadeda Ibis	*Bostrychia hagedash*	16
Pied Crow	*Corvus albus*	16
Red-billed Oxpecker	*Buphagus erythrorhynchus*	16
Red-eyed Dove	*Streptopelia semitorquata*	16
Yellow Bishop	*Euplectes capensis*	16
Black-backed Puffback	*Dryoscopus cubla*	14
Red-rumped Swallow	*Cecropis daurica*	14
Rufous-naped Lark	*Mirafra africana*	14
Bronzy Sunbird	*Nectarinia kilimensis*	13
Slate-coloured Boubou	*Laniarius funebris*	13
White-browed Robin-Chat	*Cossypha heuglini*	13
African Paradise Flycatcher	*Terpsiphone viridis*	12
African Pied Wagtail	*Motacilla aguimp*	12
Baglafecht Weaver	*Ploceus baglafecht*	12
Fan-tailed Widowbird	*Euplectes axillaris*	12
Greater Blue-eared Starling	*Lamprotornis chalybaeus*	12
Grey Crowned Crane	*Balearica regulorum*	12
Speckled Pigeon	*Columba guinea*	12
Village Weaver	*Ploceus cucullatus*	12
Wire-tailed Swallow	*Hirundo smithii*	12
Arrow-marked Babbler	*Turdoides jardineii*	11
Black-headed Oriole	*Oriolus larvatus*	11
Grey-backed Camaroptera	*Camaroptera brevicaudata*	11
Klaas's Cuckoo	*Chrysococcyx klaas*	11
Northern Wheatear	*Oenanthe oenanthe*	11
Western Citril	*Crithagra frontalis*	11
African Firefinch	*Lagonosticta rubricata*	10
Hildebrandt's Starling	*Lamprotornis hildebrandti*	10
Pin-tailed Whydah	*Vidua macroura*	10

English name (IOC)	Scientific name	Records
Scarlet-chested Sunbird	*Chalcomitra senegalensis*	10
Black Saw-wing	*Psalidoprocne pristoptera*	9
Crowned Lapwing	*Vanellus coronatus*	9
Egyptian Goose	*Alopochen aegyptiaca*	9
Northern Black Flycatcher	*Melaenornis edolioides*	9
Red-chested Cuckoo	*Cuculus solitarius*	9
White-browed Coucal	*Centropus superciliosus*	9
African Grey Flycatcher	*Melaenornis microrhynchus*	8
Amethyst Sunbird	*Chalcomitra amethystina*	8
Brown-crowned Tchagra	*Tchagra australis*	8
Yellow-breasted Apalis	*Apalis flavida*	8
African Pipit	*Anthus cinnamomeus*	7
Ant-eating Chat	*Myrmecocichla formicivora*	7
Augur Buzzard	*Buteo augur*	7
Black-headed Heron	*Ardea melanocephala*	7
Kenya Sparrow	*Passer rufocinctus*	7
Village Indigobird	*Vidua chalybeata*	7
White-fronted Bee-eater	*Merops bullockoides*	7
Brubru	*Nilaus afer*	6
Diederik Cuckoo	*Chrysococcyx caprius*	6
Hamerkop	*Scopus umbretta*	6
Helmeted Guineafowl	*Numida meleagris*	6
Knob-billed Duck	*Sarkidiornis melanotos*	6
Northern Yellow White-eye	*Zosterops senegalensis*	6
Red-capped Lark	*Calandrella cinerea*	6
Red-collared Widowbird	*Euplectes ardens*	6
Red-fronted Tinkerbird	*Pogoniulus pusillus*	6
African Dusky Flycatcher	*Muscicapa adusta*	5
African Harrier-Hawk	*Polyboroides typus*	5
Common Buzzard	*Buteo buteo*	5
D'Arnaud's Barbet (ssp)	*Trachyphonus darnaudii usambiro*	5
Greater Honeyguide	*Indicator indicator*	5
Grey-headed Bushshrike	*Malaconotus blanchoti*	5
Orange-breasted Bushshrike	*Chlorophoneus sulfureopectus*	5
Ruppell's Starling	*Lamprotornis purpuroptera*	5
Three-banded Plover	*Charadrius tricollaris*	5
Yellow-throated Longclaw	*Macronyx croceus*	5
African Marsh Harrier	*Circus ranivorus*	4
African Pygmy Kingfisher	*Ispidina picta*	4
Bare-faced Go-away-bird	*Corythaixoides personatus*	4
Black Kite	*Milvus migrans*	4
Bronze Mannikin	*Lonchura cucullata*	4
Chinspot Batis	*Batis molitor*	4
Cinnamon-chested Bee-eater	*Merops oreobates*	4
Collared Sunbird	*Hedydipna collaris*	4
Fork-tailed Drongo	*Dicrurus adsimilis*	4

English name (IOC)	Scientific name	Records
Grey-capped Warbler	*Eminia lepida*	4
Holub's Golden Weaver	*Ploceus xanthops*	4
Lesser Striped Swallow	*Cecropis abyssinica*	4
Little Swift	*Apus affinis*	4
Lynes's Cisticola	*Cisticola distinctus*	4
Red-cheeked Cordon-bleu	*Uraeginthus bengalus*	4
Red-fronted Barbet	*Tricholaema diademata*	4
Red-headed Weaver	*Anaplectes rubriceps*	4
Scaly Francolin	*Pternistis squamatus*	4
Southern Ground Hornbill	*Bucorvus leadbeateri*	4
Spur-winged Goose	*Plectropterus gambensis*	4
Tawny Eagle	*Aquila rapax*	4
Thick-billed Weaver	*Amblyospiza albifrons*	4
Western Yellow Wagtail	*Motacilla flava*	4
Yellow-rumped Seedeater	*Crithagra xanthopygia*	4
African Green Pigeon	*Treron calvus*	3
Athi Short-toed Lark	*Alaudala athensis*	3
Barn Swallow	*Hirundo rustica*	3
Capped Wheatear	*Oenanthe pileata*	3
Green Sandpiper	*Tringa ochropus*	3
Laughing Dove	*Spilopelia senegalensis*	3
Lilac-breasted Roller	*Coracias caudatus*	3
Pied Kingfisher	*Ceryle rudis*	3
Red-faced Crombec	*Sylvietta whytii*	3
Schalow's Turaco	*Tauraco schalowi*	3
Spectacled Weaver	*Ploceus ocularis*	3
Straw-tailed Whydah	*Vidua fischeri*	3
Tambourine Dove	*Turtur tympanistria*	3
Violet-backed Starling	*Cinnyricinclus leucogaster*	3
Western Cattle Egret	*Bubulcus ibis*	3
White-backed Vulture	*Gyps africanus*	3
White-bellied Canary	*Crithagra dorsostriata*	3
Yellow-billed Kite	*Milvus aegyptius*	3
Yellow-throated Sandgrouse	*Pterocles gutturalis*	3
Zitting Cisticola	*Cisticola juncidis*	3
Abdim's Stork	*Ciconia abdimii*	2
African Blue Flycatcher	*Elminia longicauda*	2
African Hawk-Eagle	*Aquila spilogaster*	2
African Wattled Lapwing	*Vanellus senegallus*	2
Bateleur	*Terathopius ecaudatus*	2
Black-chested Snake Eagle	*Circaetus pectoralis*	2
Black-winged Kite	*Elanus caeruleus*	2
Black Sparrowhawk	*Accipiter melanoleucus*	2
Brimstone Canary	*Crithagra sulphurata*	2
Brown-throated Martin	*Riparia paludicola*	2
Cardinal Woodpecker	*Dendropicos fuscescens*	2

English name (IOC)	Scientific name	Records
Cinnamon-breasted Bunting	*Emberiza tahapisi*	2
Common Ostrich	*Struthio camelus*	2
Common Sandpiper	*Actitis hypoleucos*	2
Crested Francolin	*Dendroperdix sephaena*	2
Double-toothed Barbet	*Lybius bidentatus*	2
Golden-breasted Bunting	*Emberiza flaviventris*	2
Green Wood Hoopoe	*Phoeniculus purpureus*	2
Grey-backed Fiscal	*Lanius excubitoroides*	2
House Sparrow	*Passer domesticus*	2
Long-tailed Widowbird	*Euplectes progne*	2
Malachite Kingfisher	*Corythornis cristatus*	2
Narina Trogon	*Apaloderma narina*	2
Pallid Harrier	*Circus macrourus*	2
Rosy-throated Longclaw	*Macronyx ameliae*	2
Secretarybird	*Sagittarius serpentarius*	2
Speckle-fronted Weaver	*Sporopipes frontalis*	2
Spotted Thick-knee	*Burhinus capensis*	2
Streaky-headed Seedeater	*Crithagra gularis*	2
Verreaux's Eagle	*Aquila verreauxii*	2
White-eyed Slaty Flycatcher	*Melaenornis fischeri*	2
White-faced Whistling Duck	*Dendrocygna viduata*	2
White-rumped Swift	*Apus caffer*	2
Woolly-necked Stork	*Ciconia episcopus*	2
African Fish Eagle	*Haliaeetus vocifer*	1
African Grey Woodpecker	*Dendropicos goertae*	1
African Palm Swift	*Cypsiurus parvus*	1
African Sacred Ibis	*Threskiornis aethiopicus*	1
African Snipe	*Gallinago nigripennis*	1
African Thrush	*Turdus pelios*	1
Black-and-white Mannikin	*Lonchura bicolor*	1
Black-bellied Bustard	*Lissotis melanogaster*	1
Black-lored Babbler	*Turdoides sharpei*	1
Black-rumped Waxbill	*Estrilda troglodytes*	1
Black Crake	*Amaurornis flavirostra*	1
Black Stork	*Ciconia nigra*	1
Common Bulbul	*Pycnonotus barbatus*	1
Common Scimitarbill	*Rhinopomastus cyanomelas*	1
Common Waxbill	*Estrilda astrild*	1
Crimson-rumped Waxbill	*Estrilda rhodopyga*	1
Crowned Eagle	*Stephanoaetus coronatus*	1
D'Arnaud's Barbet	*Trachyphonus darnaudii*	1
Dusky Indigobird	*Vidua funerea*	1
Fischer's Sparrow-Lark	*Eremopterix leucopareia*	1
Fulvous Whistling Duck	*Dendrocygna bicolor*	1
Giant Kingfisher	*Megaceryle maxima*	1
Great Egret	*Ardea alba*	1

English name (IOC)	Scientific name	Records
Grey Heron	*Ardea cinerea*	1
Hartlaub's Turaco	*Tauraco hartlaubi*	1
Kittlitz's Plover	*Charadrius pecuarius*	1
Kori Bustard	*Ardeotis kori*	1
Lanner Falcon	*Falco biarmicus*	1
Lappet-faced Vulture	*Torgos tracheliotos*	1
Lesser Honeyguide	*Indicator minor*	1
Lesser Spotted Eagle	*Clanga pomarina*	1
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	1
Little Bee-eater	*Merops pusillus*	1
Long-billed Pipit	*Anthus similis*	1
Marabou Stork	*Leptoptilos crumenifer*	1
Martial Eagle	*Polemaetus bellicosus*	1
Meves's Starling	*Lamprotornis mevesii*	1
Meyer's Parrot	*Poicephalus meyeri*	1
Montagu's Harrier	*Circus pygargus*	1
Nubian Woodpecker	*Campethera nubica*	1
Pectoral-patch Cisticola	*Cisticola brunnescens*	1
Placid Greenbul	*Phyllastrephus placidus*	1
Plain-backed Pipit	*Anthus leucophrys*	1
Purple-banded Sunbird	*Cinnyris bifasciatus*	1
Red-breasted Swallow	*Cecropis semirufa*	1
Red-necked Spurfowl	*Pternistis afer*	1
Rock Dove	*Columba livia*	1
Rock Martin	*Ptyonoprogne fuligula*	1
Scaly-feathered Weaver	*Sporopipes squamifrons*	1
Southern Grosbeak-Canary	*Crithagra buchanani*	1
Speke's Weaver	*Ploceus spekei*	1
Spot-flanked Barbet	*Tricholaema lacrymosa*	1
Spotted Eagle-Owl	*Bubo africanus*	1
Spur-winged Lapwing	*Vanellus spinosus*	1
Stout Cisticola	*Cisticola robustus*	1
Streaky Seedeater	*Crithagra striolata*	1
Temminck's Courser	*Cursorius temminckii*	1
Three-banded Courser	*Rhinoptilus cinctus*	1
White-bellied Tit	*Melaniparus albiventris*	1
White-browed Scrub Robin	*Cercotrichas leucophrys*	1
White-headed Saw-wing	*Psalidoprocne albiceps*	1
White-throated Bee-eater	*Merops albicollis*	1
White Stork	*Ciconia ciconia*	1
Winding Cisticola	*Cisticola marginatus*	1
Wing-snapping Cisticola	*Cisticola ayresii*	1
Woodland Kingfisher	*Halcyon senegalensis*	1
Yellow-billed Oxpecker	*Buphagus africanus*	1
Yellow-billed Stork	*Mycteria ibis*	1
Yellow-rumped Tinkerbird	*Pogoniulus bilineatus*	1

Appendix V: Wind and cloud condition counts at Memusi Dam

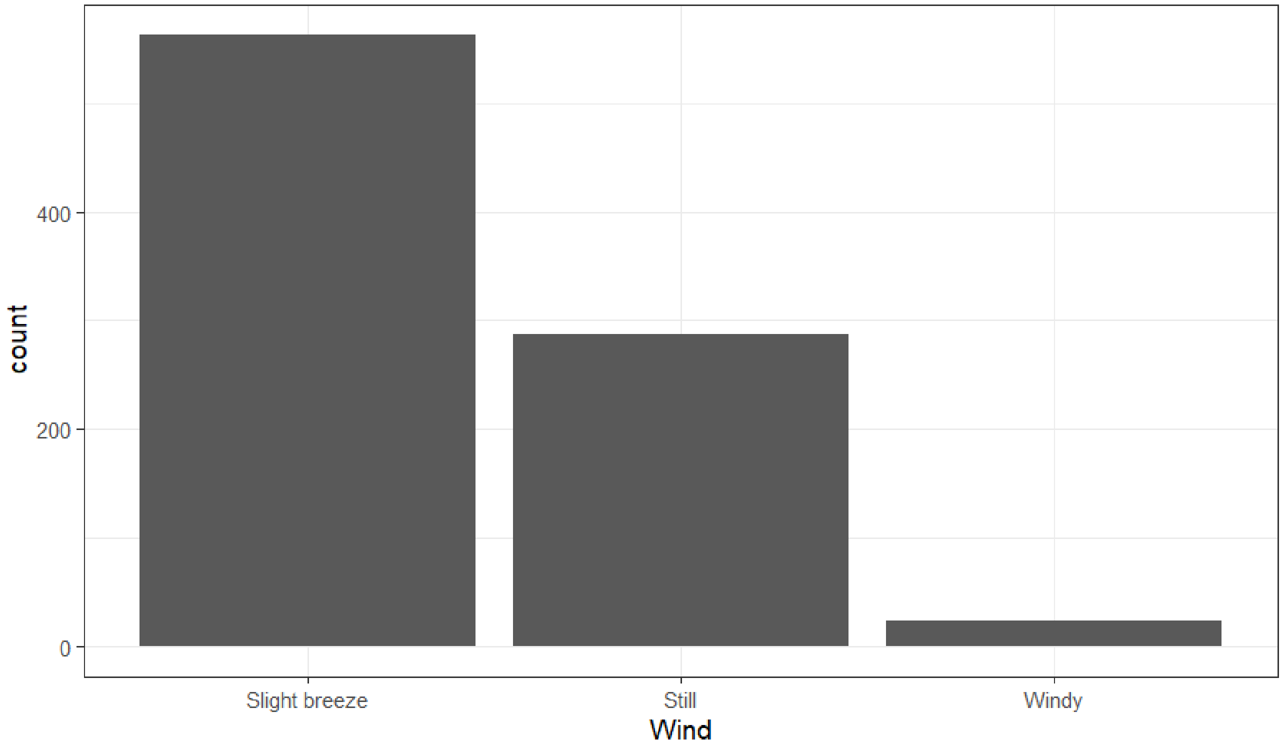


Figure Va. Count of wind condition categories at Memusi Dam during February 2020. Conditions were never recorded as 'Very Windy'. Counts are totals from a cumulative 4 days of monitoring during the 06:00 – 08:00 period.

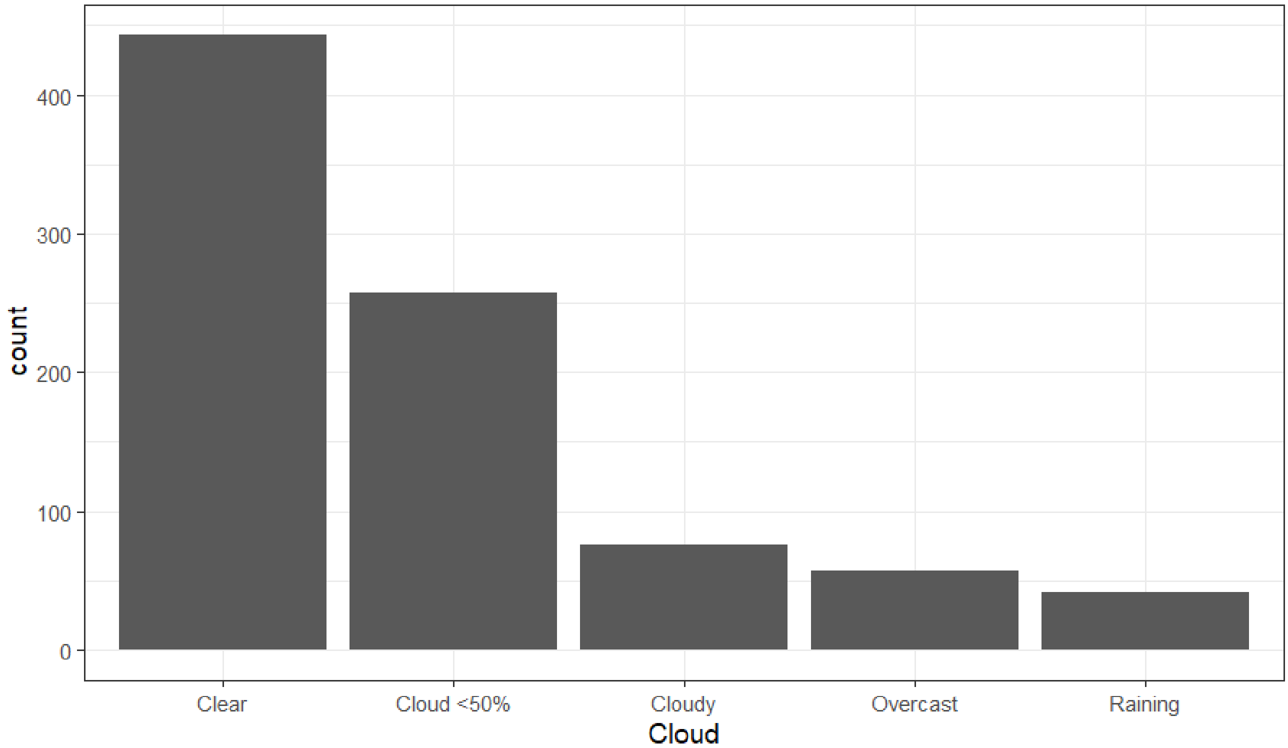


Figure Vb. Count of cloud condition categories at Memusi Dam during February 2020. Counts are totals from a cumulative 4 days of monitoring during the 06:00 – 08:00 period.

Appendix VI: Community outreach with Emarti community

The way to make real changes in society is by influencing people, especially children, through awareness and education to be advocates for the environment (Hadzigeorgiou & Skoumios 2013). In Kenya, higher-educated adults often migrate to larger cities to pursue their careers (Agesa & Sunwoong 2001). However, rural students are able to influence their families and establish their behaviour and priorities for when they are making environmental decisions as adults (Ballantyne et al. 1998).

During each expedition group, members of the school 'wildlife club' and other students from Emarti Secondary School, located close to the border of Enonkishu Conservancy, were invited to the conservancy and hosted there for the day as part of an outreach activity.

Expedition participants discussed and created various activities in an afternoon planning session the day before. The day itself then followed a set pattern: collection from school and a game drive in the morning, followed by a joint lunch and then an afternoon of presentations and activities around the expedition base. The afternoon activities varied and ranged from presentations and/or slide shows of camera trap pictures to preparing expedition equipment for demonstration, or a learning game or exercise, all depending on the skills and areas of interests of participating citizen scientists.

During the morning game drives, it was apparent that despite the students living in close proximity to the Mara, many of them had not seen wildlife in that context before. The students were fascinated with getting close to and identifying animals they by and large only knew from books, as well as trying out some of the research equipment such as binoculars, compass, GPS, rangefinder and smartphones for data collection.

After lunch at the Mara Training Centre, citizen scientists shared their reasons for coming to Kenya to instill a sense of pride in the students, who were also encouraged to take small actions, such as not littering, to appreciate their local environment, etc. Ranger Albert then gave a talk about the conservancy, the ranger's daily tasks, their aims and motivation. Next, the students heard MTC employee Musa talking about grass as the most important factor for the well-being of local people and their livestock, but also for conservation. Finally, citizen scientists then led on a learning task in small groups and results were presented back to the whole group, before the children were taken back to their school.

Literature cited

Agesa, R. and Sunwoong, K. (2001) Rural to Urban Migration as a Household Decision: Evidence from Kenya. Review of Development Economics 5(1): 60-75.

Ballantyne, R., Connell, S. and Fien, J. (1998) Students as Catalysts of Environmental Change: a framework for researching intergenerational influence through environmental education. Environmental Education Research 4(3): 285-298.

Hadzigeorgiou, Y. and Skoumios, M. (2013) The Development of Environmental Awareness through School Science: Problems and Possibilities. International Journal of Environmental and Science Education, v8: 405-426.

Below are some photos of community outreach activities.


KENYA
itions.org
Bushnell
02-09-2020 14:48:31


MARA

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Appendix VII: Expedition diary and reports

A multimedia expedition diary is available on https://blog.biosphere-expeditions.org/category/expedition-blogs/kenya-2020/.

All expedition reports, including this and previous expedition reports, are available on www.biosphere-expeditions.org/reports.

More pictures, videos, media coverage of the expedition are available via www.biosphere-expeditions.org/kenya.