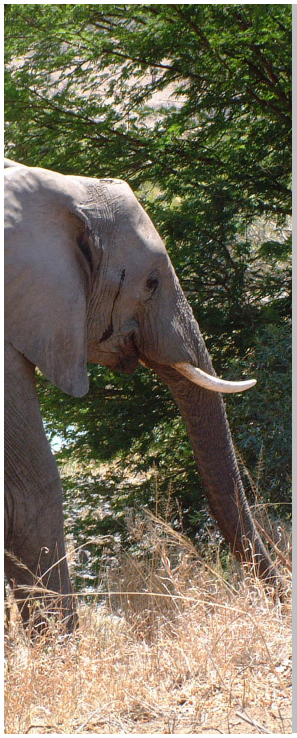

USE OF GEOTRACKER AND KOBOCOLLECT IN MONITORING PATROL EFFORT AND ILLEGAL ACTIVITIES IN OMO FOREST RESERVE, NIGERIA

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ABSTRACT

The study reports the use of GeoTracker and KoBoCollect as law enforcement monitoring tools in the elephant sanctuary of Omo Forest Reserve, southwest Nigeria. Illegal activities in and around the sanctuary were monitored from November 2019 to January 2021 through data collection by rangers while on patrol using the GeoTracker and KoBoCollect system. A total of 267 days of patrol were undertaken during the period. The patrol effort covered 1,081 km (Average = 83 km/month). The mean patrol effort of the rangers was 0.3. About 338 illegal activities that included hunting/gunshots/detection of spent cartridges, setting of wire snare/iron trap, encroachment, logging and farming were recorded. There was a significant difference in the frequencies of encounters of illegal activities across the months. There was also a weak but positive correlation between patrol effort and encounter rate of illegal activities. Spatial distribution of ranger patrols shows that patrols were largely concentrated in the south/mid-eastern part of the sanctuary. The area covered by patrols was relatively small compared to the total area of the sanctuary. The monitoring system provided useful feedback that can help improve the management of the elephant sanctuary.

Key words: anti-poaching patrol, illegal activities, Elephants

INTRODUCTION

The future of many high-value charismatic species and the ecosystems they inhabit across Africa are severely threatened as a result of various anthropogenic activities, including high levels of poaching and habitat destruction (Amusa et al., 2017; Henson et al., 2016). Protected areas have been viewed as the remedy to this malaise (Bruner et al., 2001; Terborgh & van Schaik, 2002), with two major approaches often used: one, being the implementation of a robust exclusionary punitive law enforcement inside core protected areas and the other, being collaborative community-based conservation in areas outside the core protected areas (Nyirenda & Chomba, 2012). The former (law enforcement within and around protected areas) is at the frontline of any site's conservation efforts as its effectiveness is one of the most important factors in providing an operative deterrent to illegal activities in an area (Henson et al., 2016).

Effectiveness of protected areas has been found to be significantly correlated with the level of deterrents to illegal activities (Bruner et al., 2001). Improved law enforcement efforts are associated with a reduction in illegal activities (Jachmann, 2008; Martin, 2010; Leader -Williams et al., 1990). In contrast, poor law enforcement efforts for addressing illegal activities in protected areas have been linked to declines in wildlife populations (Bassett, 2005; Ogutu et al., 2011). Gandiwa et al. (2013) in their study of illegal hunting and law enforcement in northern Gonarezhou National Park and adjacent areas in Zimbabwe reported that the number of illegal hunters arrested declined with increased law enforcement efforts, thereby supporting the hypothesis

that illegal activities would vary with level of law enforcement efforts.

Given the importance of law enforcement to conservation efforts, a number of initiatives have emerged to support management decisions on monitoring and patrol activities in and around protected areas. These range from GIS spatial analysis of illegal activities, use of CyberTracker and SMART as well as deployment of ICT, including the use of tablets and smartphones. All of these have opened up increasing opportunities in the field of forest monitoring, law enforcement and biodiversity conservation. For instance, Mubalama (2010) examined the spatial distribution of wildlife crime incidents in both the Kahuzi-Biega and Virunga National Parks using ArcGIS software with a view to showing how to best direct wildlife crime prevention and mitigation resources. Similarly, the Wildlife Conservation Society (WCS) introduced a CyberTracker-based law enforcement and monitoring system in the Mbe Mountains, Nigeria in 2009, leading to an increase in patrol effort from 343 patrol days/year in 2009 to 830 patrol days/year in 2013 (Imong et al., 2014). It also led to an overall decrease in hunting pressure and a steady increase in great ape observations reflecting the increased patrol effort.

In their study, Bassey et al. (2018) evaluating the use of CyberTracker (cybertracker.org/) and SMART (smartconservationtools.org/) for effective law enforcement monitoring in the Cross River Gorilla Landscape in Nigeria, also reported that total encounter rate of hunting signs per kilometre walked decreased from 2.57 in 2012 to 1.11 in 2017 in Afi Mountain Wildlife Sanctuary. A similar decrease in the total encounter rate of hunting signs was also recorded for the Okwangwo Division of Cross River National Park between 2011 and 2017. In the same vein, Brofeldt et al. (2018) studied community-based monitoring of tropical forest crimes and forest resources using ICT in Prey Lang, Cambodia. The study revealed that local communities with little formal education are able to monitor forest crimes and forest resources cost-effectively using ICT.

In this study, we report on the use of GeoTracker (geo-tracker.org/) and KoBoCollect (www.kobotoolbox.org/) as law enforcement monitoring tools to assess threats, adaptively manage ranger programmes, and improve effectiveness of anti-poaching patrols in the elephant sanctuary of Omo Forest Reserve, southwest Nigeria. GeoTracker alongside KoBoCollect has the capacity to improve the quality of ranger-based patrol data by avoiding errors previously encountered when using GPS units and notebooks only, and also by collecting standardised and comparable data across sites. It also has the potential to reduce the amount of time spent entering data by directly downloading patrol data from input devices to a database for analysis and reporting. In addition to fostering an improved communication between field personnel and managers through faster data analysis and reporting, this initiative can also help in improving the monitoring of ranger performance through the automated tracking function of GeoTracker, thereby increasing transparency and accountability.

MATERIALS AND METHODS

Study area

Omo Forest Reserve (OFR) is located between longitudes 40 19' – 40 40' E and latitudes 60 35' – 70 05' N in the Ijebu East and North Local Government Areas of Ogun State. It was gazetted in 1925 as part of the old Shasha forest reserve of southwestern Nigeria. It covers an area of about 1,305 km^2 forming common boundaries with Osun, Ago-owu and Shasha forest reserves in Osun State and Oluwa forest reserve in Ondo State, all of which also share some common natural endowments (Amusa, 2015). It is a mixed, moist, semi-evergreen rainforest in the Congolian sub-unit of the Guinea-Congolian Centre of Endemism or Phytochorion (Ola-Adams, 2014). The altitude ranges between 15 m and 150 m above sea level, mainly dominated by an undulating topography of up to 15 per cent slope. The rainy season in OFR usually commences in March. The mean annual rainfall in the area ranges from about 1600 to 2000 mm with two annual peaks in June and September, with November and February being the driest months (Isichei, 1995).

The forest reserve is inhabited by people of several ethnic groups, the dominant one being the Yoruba of Ijebu origin. Most parts of the forest are disturbed with a substantial area converted to monoculture plantations of the fast growing exotic *Gmelina arborea* tree. The Nigerian government in 1946 established a 460 ha Strict Nature Reserve (SNR) within the reserve. It was upgraded to a Biosphere Reserve (BR) in 1977 by UNESCO owing to its richness in biological diversity (Obioho, 2005). It is an IUCN category IV reserve. It was, therefore, expected to be a managed nature reserve/wildlife sanctuary with several objectives that are aimed at protecting biodiversity but permitting human use where this is compatible with forest conservation. Nevertheless, the ecological integrity of the reserve is threatened by increasing numbers of migrant farmers and a high rate of logging operations among other anthropogenic activities. In spite of this

situation, OFR still harbours one of the last remaining populations of Elephant, Chimpanzee and White-throated Monkeys in the southwestern part of Nigeria.

Interventions from the government and various conservation agencies (Nigeria Conservation Foundation, Paignton Zoo, UK and Pro-Natura International Nigeria) in order to mitigate threats to the rich biodiversity of the reserve have been implemented. These include establishing a wildlife sanctuary covering an area of about 37,500 ha ≈ 29 per cent of the forest reserve. The wildlife sanctuary is made up of Elephant (30,000 ha ≈ 23 per cent) and Chimpanzee (7,500 ha ≈ 6 per cent) areas or camps. However, the management of the area until recently has been haphazard owing to ineffective institutionalisation and poor law enforcement that has failed to halt most of the anthropogenic activities affecting biodiversity conservation.

Description of the GeoTracker and KoBoCollect system

Elephants in OFR are being protected under the Omo-Oluwa-Shasha Forest Elephant Protection Initiative/ Project. The project has ten rangers actively working in the field with two managers and one rangers' supervisor. The rangers operate in shifts of two teams of five rangers. Patrol activities are carried out by the rangers on foot and motorbikes. The rangers make use of intelligence reports, road blocks, stop and search, ambush and at times joint patrol with the government's Safety Corps in some locations within the project area. Field reporting of daily events and activities are captured in field notebooks, by camera, video recording and recording GPS coordinates of incidence locations. Rangers are empowered to stop and prevent all forms of encroachments into the elephant sanctuary. These encroachments can be in the form of farming, hunting, logging and trespassing.

To improve patrol efforts and activities, we introduced the GeoTracker and KoBoCollect system. Training sessions were conducted on how to use this system. The focus was on field data collection with intensive practical sessions in field testing. The training was tailored to ensure that rangers have the capacity to collect accurate and reliable information and are able to carry out preliminary analysis to provide decision support to meet conservation needs. Prior to the beginning of each training session, various software and databases were installed (GPS Coordinates, GPX Viewer and Google Earth) which are synchronised on different handheld smartphones and laptop computers.

GeoTracker is a database and geographic information system (GIS) that provides online access to environmental data. It is a software application program that was developed around 2013 to record data on GPS points and tracks. The innovation of GeoTracker lies in its ability to record, even when offline. It can be used on a handheld personal digital assistant (PDA), laptop or tablet personal computer and can take data on speed, duration and distance covered. All the data recorded can be geo-referenced and stored in a user-friendly way that allows easy access, display and analysis. It can record very long tracks without problems. Recorded tracks are saved in GPX, KML or KMZ format, so they can be used in certain applications such as OziExplorer or Google Earth. KoBoCollect is data collection app used on mobile devices in the field.

Data collection on illegal activities in the elephant sanctuary and adjoining areas using the GeoTracker and KoBoCollect system

Illegal activities and Elephant sightings in and around the elephant sanctuary of OFR were monitored from November 2019 to January 2021 through data recorded by rangers while on patrol activities using the GeoTracker and KoBoCollect system. Patrol routes were taken as transects with unfixed width. They were used to collect information on indicators of illegal activities and animal observations. During the patrol activities, data were recorded on the numbers of rangers on patrol; the duration of the patrol; the area travelled; the types, quantity and locations of illegal activities encountered; and the numbers of Elephants or their indices encountered.

Given that patrol movements should be unpredictable by nature, the rangers were trained to randomise patrol movements as much as practically feasible, both to optimise the impact of law enforcement, and to enable statistical inference from monitoring data. The patrol routes and the location of all encounters were marked using the GeoTracker and GPS Coordinates on enabled android phones. These were later overlaid on a base map of the project area and subsequent plotting of GPS coordinates. Also, GPX Viewer and Google Earth applications were used to plot and locate the areas covered by the rangers during the patrol activities. The GPS Coordinates application is configured to take pictures with the coordinate imprinted on the picture taken.

For Elephant sightings/indices, the location and signs detected during patrol were recorded. In the case of illegal activities, these were categorised according to

those offences which directly relate to hunting, gunshots, detection of spent cartridges, setting of wire snare/iron trap, encroachment, logging and farming.

Data analysis

Data analyses were conducted using monthly patrol man-days as the measure of effort (Jachmann, 2008). As described by Jachmann (2008), this index has been used in management of protected areas in Ghana due to its ease of interpretation, and the fact that minimum monthly standards for patrols in the country's protected areas are set using effective patrol man-days. One patrol day is designated to be 8 hours in length; the unit "patrol man-days" is then equivalent to the number of staff on patrol, multiplied by the number of days patrolled. In other words, for each patrol, independent of the duration, the number of patrol hours was divided by 8, and multiplied by patrol size (number of staff on patrol), to give the measure of effective patrol man-days, with these summed for the period of the study. An index, referred to as the "kilometric index of abundance" (KIA), based on the number of kilometres walked by patrols (Groupe, 1991), was used to compute encounter rates. This is the number of encounters with illegal activities or with Elephant/elephant indices in a given month divided by the distance in kilometres walked by patrols in that month. Additional data analysis was based on descriptive, parametric and non-parametric statistics, including t-test, Kruskal-Wallis tests and Spearman's rank correlations. All analyses were carried out at $p < 0.05$ in assessing significance. Qualitative and quantitative data were analysed using SPSS 20.0 and MS Excel 2016 and presented in tables and line charts. Spatial presentations were made for relevant data using shapefiles in mapping software directly from the GeoTracker.

RESULTS

Patrol effort

Table 1 and Figure 1 show the patrol effort and spatial distribution of rangers within the period under review (November 2019 – January 2021). A total of 267 days of patrol were undertaken during the period (range = 2–56 man-days/month, average = 20 man-days/month, SD = 14.72, CV = 0.07). Patrols were not made in May and October 2020 owing to severe restrictions in lockdowns occasioned by the COVID-19 pandemic. Generally, permits were obtained for rangers to carry out patrols as part of essential activities exempted from the lockdown. The highest number of days spent on patrol was in September 2020 (56 man-days), while the lowest was in December 2020 due to a new wave of lockdown and its severity in movement restriction for workers. On average, a total of 20 man-days/month was spent on

Forest Elephant © Equilibrium Consultants

Table 1. Rangers' patrol effort in the elephant sanctuary of Omo Forest Reserve

Month	Days spent on patrol	Distance covered (km)	Patrol effort
Nov-19	28	93.30	0.3
Dec-19	24	48.00	0.5
Jan-20	22	73.30	0.3
Feb-20	28	140.00	0.2
Mar-20	9	90.00	0.1
Apr-20	4	40.00	0.1
Jun-20	16	80.00	0.4
Jul-20	30	84.04	0.4
Aug-20	27	179.21	0.2
Sep-20	56	143.69	0.4
Nov-20	18	90.00	0.2
Dec-20	2	4.00	0.5
Jan-21	3	15.00	0.2

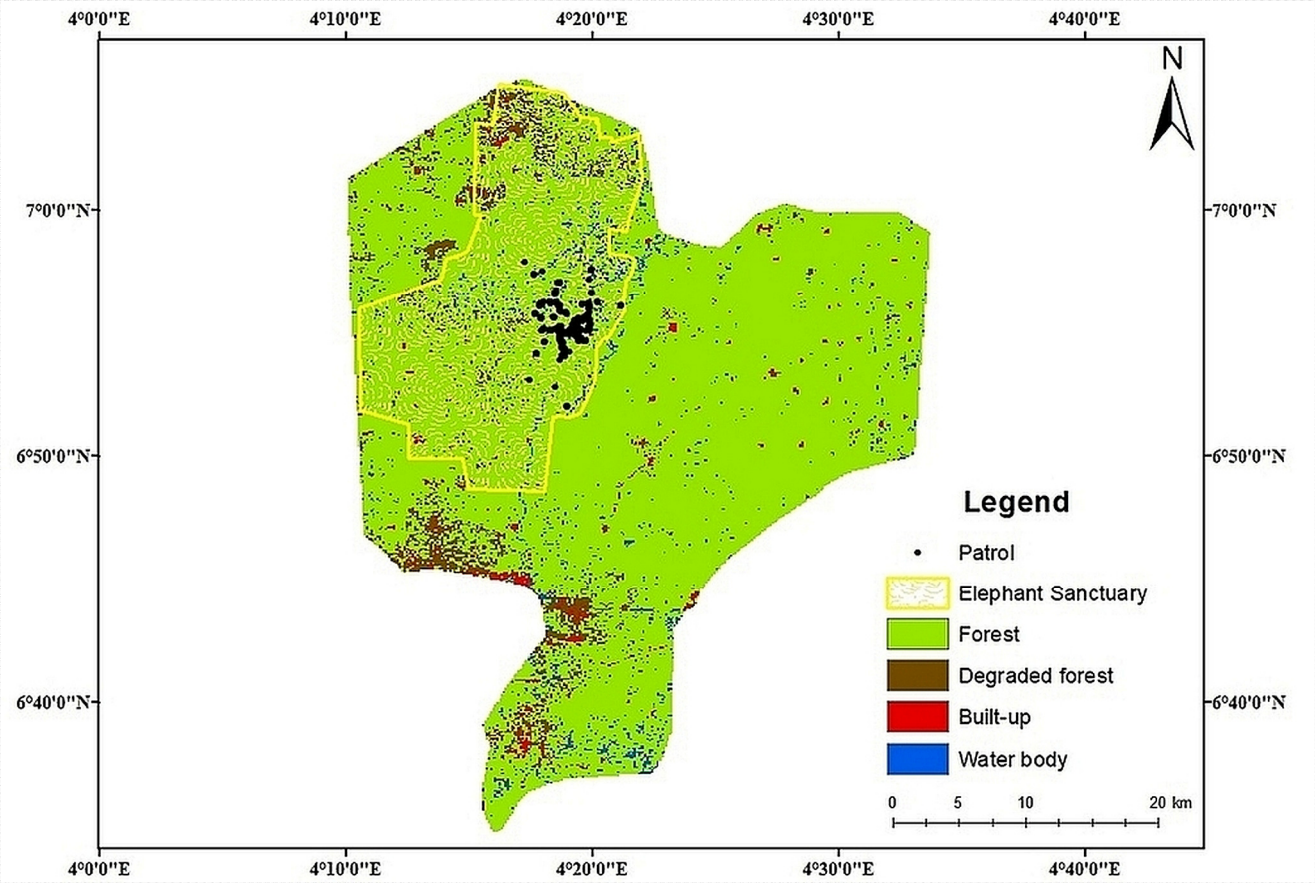

Figure 1. Locations of rangers' patrol effort over the study period

patrol by the rangers. The coefficient of variation (0.07) shows a low disparity across the months. The patrol effort covered a total of 1,081 km during the period under review (range = 4 – 179 km/month, average = 83 km/month, SD = 50.36, CV = 0.61). The maximum distance covered was 179 km/month, while the minimum was 4 km/month. The mean distance covered was 83.12 km/month with little variation across the months. The mean patrol effort of the rangers was 0.3. There is no significant difference in patrol efforts between the dry and rainy season in the study area ($t = 0.60$, $p > 0.05$). Overall, in the period under review, patrol in man-days per month was positively correlated with number of kilometres walked in those months ($rs = 0.72$, $p < 0.05$). Observations on the spatial distribution of ranger patrols show that patrols were largely concentrated in the south/mid-eastern part of the elephant sanctuary with occasional forays into the north -eastern area. The south-western, north-western and larger parts of the central areas of the sanctuary were not covered within the period under review. The area covered by patrols was relatively small compared to the total area of the elephant sanctuary.

Illegal activities encountered

The illegal activities encountered by rangers while on patrol include: hunting, gunshots, detection of spent cartridges, setting of wire snare and iron trap, encroachment, logging and farming activities. These activities were categorised based on prevalence into hunting/gunshots/detection of spent cartridges, setting of wire snare/iron trap, encroachment, logging and farming. A total of 179 hunting/gunshots/detection of spent cartridges were recorded within the period, while 53 setting of wire snare/iron trap were detected. There were four (4) cases of encroachment, eight (8) logging and 94 farming activities respectively. The highest rate of hunting/gunshots/detection of spent cartridges (36) was in August 2020, while the highest rate of setting of wire snare/iron trap (17) was in December 2019. Most of the encroachment (3) and logging activities (3) detected were in March 2020, while the most farming activities (24) detected was in September 2020. In aggregate terms, the highest number of illegal activities (56) of all categories was recorded in December 2019. The highest mean number of illegal activities encountered per kilometre walked was in December 2020 (0.40

encounter/km; Table 2). Kruskal-Wallis One-way Analysis of Variance shows a significant difference in the frequencies of encounters of illegal activities across the months ($H = 25.26$, $p < 0.05$), but not between dry and rainy seasons ($t = -1.185$, $p > 0.05$). There is also a weak but positive correlation between patrol effort and encounter rate of illegal activities ($rs = 0.27$, $p<.001$) in the study area.

Elephant and other animal sightings

Table 3 shows the various observations made on Elephant (*Loxodonta cyclotis*) ranging activities in the study area. These observations were classified as footprints, tracks, feeding site, dung, playing ground, scratching site and call. A total of 115 Elephant footprints were recorded within the period, but no actual sightings were made during the patrols. This was followed by detection of 30 Elephant feeding sites, 28 sites of fresh dung, 18 tracks and playing grounds, nine (9) scratching sites as well as one (1) call. The highest number of Elephant activities recorded was in January 2021 while mean encounter rate was 0.29 signs per kilometre. Meanwhile, several species of key animals other than Elephants were also sighted by rangers while on patrol. A total of 288 sightings involving 19 different species were recorded. The animals encountered include: *Anomalurus beecrofti* (Beecroft's Flying Squirrel), *Atherurus africanus* (Brush-tailed Porcupine)

Table 2. Encounter rate of illegal activities in the elephant sanctuary and adjoining areas across months

Illegal activities	Encounter rate of illegal activities/Km/Month												
	Nov 19	Dec 19	Jan 20	Feb 20	Mar 20	Apr 20	Jun 20	Jul 20	Aug 20	Sep 20	Nov 20	Dec 20	Jan 21
Gunshot/Hunting/ Detection of Cartridges	0.03	0.70	0.10	0.12	0.29	0.60	0.00	0.04	0.20	0.08	0.00	1.50	0.93
Wire Snare/Iron Trap	0.00	0.40	0.03	0.00	0.01	0.00	0.00	0.12	0.08	0.05	0.00	0.00	0.07
Encroachment	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Logging	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.01	0.00	0.50	0.00
Farming	0.00	0.13	0.00	0.03	0.09	0.20	0.01	0.27	0.02	0.18	0.06	0.00	0.73
Total	0.03	1.23	0.13	0.15	0.45	0.80	0.01	0.44	0.30	0.32	0.06	2.00	1.80
Average	0.01	0.25	0.03	0.03	0.09	0.16	0.00	0.09	0.06	0.06	0.01	0.40	0.36

Table 3. Observations of Elephants/Elephant activities in the elephant sanctuary and adjoining areas

Elephant activities	Months													
	Nov 19	Dec 19	Jan 20	Feb 20	Mar 20	Apr 20	Jun 20	Jul 20	Aug 20	Sep 20	Nov 20	Dec 20	Jan 21	Total
Footprints	4	7	4	17	10	6	-	12	5	9	7	18	16	115
Tracks	-	-	3	1	2	4	-	-	7	-	1	-	-	18
Feeding site	-	-	2	1	1	1	-	4	3	2	5	1	10	30
Dung	-	-	4	-	1	1	-	4	3	5	1	5	4	28
Playing ground	-	-	-	1	-	-	-	1	9	1	2	-	4	18
Scratching site	-	-	-	-	-	-	-	2	3	-	1	-	3	9
Call	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Total	4	7	13	20	14	12		23	30	17	17	24	38	219

Table 4. Observations of other animals/animal activities across months

Animals	Frequency of observations per month													
	Nov 19	Dec 19	Jan 20	Feb 20	Mar 20	Apr 20	Jun 20	Jul 20	Aug 20	Sep 20	Nov 20	Dec 20	Jan 21	Total
Anomalurus beecrofti (Squirrel)	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Atherurus africanus (Brush-tailed Porcupine)	-	1	-	2	-	-	-	3	-	2	7	1	5	21
Cephalophus maxwelli (Maxwell's Duiker)	-	3	-	-	1	-	-	-	-	-	-	-	-	4
Cephalophus niger (Black Duiker)	-	-	-	14	7	3	-	6	4	2	5	17	7	65
Cephalophus sylvicultor (Yellow-backed Duiker)	-	-	-	-	-	-	-	-	1	-	-	-	1	2
Cercocebus torquatus (Red-crowned Mangabey)	-	-	-	4	-	-	-	-	-	-	-	-	-	4
Cercopithecus mona (Mona Monkey)	-	-	-	-	-	-	-	-	-	3	-	-	5	8
Chamaeleo africanus (Chameleon)	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Civettictis civetta (African Civet)	2	6	-	-	1	-	-	2	2	1	2	2	4	22
*Cricetomys gambianus (*Gambian Giant-rat)	-	-	-	-	-	-	-	-	1	1	-	-	1	3
Crossarchus obscurus (Cusimanse Mongoose)	1	4	-	-	1	-	-	2	23	4	7	7	7	56
Dendrohyrax dorsalis (Tree Hyrax)	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Epomophorus gambianus (Fruit Bat)	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Manis spp. (Pangolin)	-	-	-	-	-	-	-	2	1	3	-	-	-	6
Naja nigricollis (Cobra)	-	-	-	-	1	-	-	-	-	2	-	-	-	3
Numida meleagris (Helmeted Guineafowl)	-	-	1	2	-	1	-	1	5	-	1	-	4	15
Potamochoerus porcus (Red River Hog)	-	-	1	19	4	-	10	1	8	2	-	1	3	49
Python regius (Rock Python)	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Tragelaphus scriptus (Bushbuck)	-	-	-	6	-	-	-	2	5	-	8	-	4	25
Total	3	15	2	47	15	5	10	20	51	21	30	28	41	288

and *Cephalophus maxwelli* (Maxwell's Duiker) among others (Table 4). *Cephalophus niger* (Black Duiker) was the most frequently encountered animal (65). This was followed by *Crossarchus obscurus* (Cusimanse Mongoose; 56) and *Potamochoerus porcus* (Red River-hog; 49). More animals were encountered in August 2020 (51) than in other months. The mean encounter rate of key animals other than Elephant was also 0.29 signs per kilometre.

DISCUSSION

The work of rangers in protecting flagship species like Elephants and their habitats is not an easy task. Training in new technologies, methods and strategies to achieve better results lightens the load somewhat. The key aspect of this study is the use of GeoTracker and KoBoCollect as law enforcement monitoring tools. Collecting law enforcement and wildlife monitoring data using a notebook and GPS is time consuming and prone to errors (Bassey et al., 2018). In contrast, by using the GeoTracker and KoBoCollect system, we have shown that it is possible for rangers to collect large amounts of geo-referenced data that is downloaded directly from an input device to a desktop computer for analysis and reporting. This has helped to significantly improve ranger motivation and performance in the field.

The study has shown that current patrol efforts in the elephant sanctuary of Omo Forest Reserve may be suboptimal. The mean patrol effort and mean distance covered by rangers as recorded are in contrast with the findings of Wiafe and Amoah (2012) who reported a mean of 381 monthly man-days of patrol effort and average distance covered of 643 km in Kakum Conservation Area, Ghana. The reason for this observation could be attributed to differences in the numbers of rangers carrying out patrols in the areas as well as limitations posed by the COVID-19 pandemic. Further, patrol activities in the study area are currently on a pilot scale and yet to take full shape. This may also explain why the spatial distribution of ranger patrol activities is largely concentrated in certain areas of the elephant sanctuary.

While there is no significant difference in the frequencies of encounters of illegal activities between the dry and rainy seasons in the study area, there is a perceived decline in illegal activities in the landscape even though the decline was not steady over the whole study period. The observation of a significant difference across months suggests that patrol activities may have to be stepped up during certain periods of the year. This is even more important given that farming and hunting are widely practised in the study area with incessant encroachment into the elephant sanctuary. This offers opportunity for scaling up the potential benefits of the GeoTracker system in comparing the detection of illegal activities and patrol efforts in the future.

Meanwhile, observations on Elephant activities and other animals have also shown that the elephant sanctuary is very rich in biodiversity and efforts should be sustained to continuously protect the area. This is underscored by the current conservation status of some of the animals. The Elephants and other animals are generally threatened by habitat loss due to farming and logging in the study area.

CONCLUSION

The monitoring system described in this study has provided useful feedback that can help improve the management of the elephant sanctuary in Omo Forest Reserve, southwest Nigeria. The patrol activities and law enforcement efforts at the elephant sanctuary need to be strengthened and made more effective in reducing all forms of illegal activities in the area. There is a need for more investment in this conservation strategy. The protection activities of the rangers should be intensified across the seasons of the year and into the different parts of the elephant sanctuary. The current size of the ranger force needs to be increased in order to ensure that most areas of the elephant sanctuary are effectively patrolled. The rangers should be motivated, continuously trained and respond to data on the different incidence of illegal activities encountered in order to adapt management strategies for the elephant sanctuary. It is also important and pertinent to provide up-to-date technology such as that used in this study in a sustainable and standardised system to collect patrol information so as to enhance the effectiveness of protection efforts. This should be combined with continuous sensitisation of farmers, hunters and local people in the area.

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River Omo in Omo forest reserve, south west of Nigeria © Fela Sanu/Shutterstock.com

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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RESUMEN

El estudio informa sobre el uso de GeoTracker y KoBoCollect como instrumentos de monitoreo para la aplicación de la ley en el santuario de elefantes de la Reserva Forestal Omo, en el suroeste de Nigeria. Las actividades ilegales en el santuario y sus alrededores fueron monitoreadas desde noviembre de 2019 hasta enero de 2021 mediante la recolección de datos durante los patrullajes de los guardaparques utilizando el sistema GeoTracker y KoBoCollect. Durante dicho período se realizó un total de 267 días de patrullaje. Los esfuerzos de patrullaje abarcaron 1.081 km (un promedio de 83 km/mes). El esfuerzo medio de patrullaje de los guardaparques fue de 0,3. Se registraron alrededor de 338 actividades ilícitas que incluían la caza/disparos/detección de cartuchos gastados, colocación de trampas de alambre/hierro, invasión, tala y agricultura. Hubo una diferencia significativa en la frecuencia de los hallazgos de actividades ilícitas en los diferentes meses ($H = 25,26$, $p < 0,05$). También se registró una correlación débil pero positiva entre el esfuerzo de las patrullas y la tasa de hallazgos de actividades ilícitas ($rs = 0,27$, $P < 0,001$). La distribución espacial de los patrullajes muestra que las patrullas se concentraron en gran medida en la parte meridional y centro-oriental del santuario. La zona cubierta por las patrullas era relativamente pequeña en comparación con el área total del santuario. El sistema de monitoreo proporcionó información que podría ser de utilidad para ayudar a mejorar la gestión del santuario de elefantes.

RÉSUMÉ

L'étude examine l'utilisation du GeoTracker et du KoBoCollect en tant qu'outils de surveillance de l'application de la loi dans le sanctuaire des éléphants de la réserve forestière d'Omo, au sud-ouest du Nigeria. Les activités illégales à l'intérieur et autour du sanctuaire ont été surveillées de novembre 2019 à janvier 2021 grâce à la collecte de données à l'aide du système GeoTracker et KoBoCollect lors de patrouilles des rangers. Au total, 267 jours de patrouille ont été effectués au cours de la période. L'effort de patrouille a couvert un total de 1 081 km (en moyenne 83 km/mois), la patrouille moyenne étant de 0,3 km. Environ 338 activités illégales ont été enregistrées dont la chasse, les coups de feu, la détection de cartouches épuisées, la pose de collets métalliques ou de pièges en fer, l'empiètement, l'exploitation forestière et agricole. Le nombre de constats d'activité illégale variait de manière significative au cours des mois ($H = 25.26$, $p < 0.05$). Il y avait aussi une corrélation faible mais positive entre l'effort de patrouille et le taux des constats d'activité illégale (rs 0,27, P \u003c 0,001). La distribution spatiale des patrouilles des rangers montre que ces patrouilles étaient largement concentrées dans la partie sud/centre-est du sanctuaire. La zone couverte par les patrouilles était relativement petite par rapport à la superficie totale du sanctuaire. Ce système de suivi a fourni des informations utiles qui pourront aider à améliorer la gestion du sanctuaire des éléphants.