

Understanding the Status and Ecology of Nubian Giraffe in Kidepo Valley National Park, Uganda

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The vast savannahs and striking mountainous terrain of Kidepo Valley National Park (NP) provides a stunning backdrop for a historically significant population of Nubian giraffe. This rugged landscape is home to one of only two remaining naturally occurring populations of giraffe in Uganda. The current Kidepo Valley NP population, however, is only a small remnant of its prior size. What was once the historical stronghold of giraffe in Uganda was decimated by a period of civil unrest and intense poaching, bringing this important population to the brink of local extinction. Despite stabilisation in the region and positive conservation efforts of the Ugandan Wildlife Authority (UWA), giraffe in Kidepo Valley NP have not returned to their previous population size. Recognising the need for reliable ecological data to inform the draft National Giraffe Conservation Strategy, the Giraffe Conservation Foundation (GCF) and partners developed a conservation monitoring programme in 2015. This programme has grown from its early foundations in establishing baseline data on population size, structure and distribution to including a comprehensive population genetics study and a cutting-edge GPS satellite tracking effort to better understand the movement ecology of these giraffe. In April 2018, our team again traveled to Uganda's frontier region to continue this study to deepen insights into the ecology of giraffe in Kidepo Valley NP and identify threats to this critical population of Nubian giraffe.



Brief History of Giraffe in Kidepo Valley National Park

Study Area

Located in north-eastern Uganda, and bordering South Sudan and Kenya, Kidepo Valley NP is comprised of the Narus River Valley in the south and west, and the Kidepo River Valley in the north and east (Harrington & Ross 1974) (Fig 1). The Park's rivers are seasonal, with the Narus River Valley being the only water source during the dry season (Aleper & Moe 2006). Ranging in altitude from approximately 1,000-2,750 m above sea level (Aleper & Moe 2006) an array of habitat is found within the Park, from arid plains and open savannas, to hills, rocky outcroppings, and mountain ranges. The Park itself is an especially biodiverse region, with over 80 species of mammals found within its borders (Aleper & Moe 2006).

In 1962, the year of Uganda's Independence, 1,259 km² were initially gazette as Kidepo Valley NP and an additional 181 km² were added in 1967. During the time leading up to the Park's official designation, poaching was relatively small scale and localised with traditional weapons. From the late 1970s,

however, the severity of these threats changed as Idi Amin's army was overthrown by the Tanzanian army and Obote forces, resulting in a proliferation of firearms among the local Karamajong people. This development led to increased violence in the region, including poaching and cattle raiding. In 1986, Museveni became President of Uganda, but this change in leadership had limited impact on the region. Since travel to the Park was limited to air, few people ventured there and tourism remained largely underdeveloped. Interestingly, even the Lord's Resistance Army (LRA) avoided the region. Under-resourced park staff could do little throughout this period to mitigate the threats which included grazing in the Park and transhumance activities between Kenya, Uganda and South Sudan. Unfortunately, several wildlife species became locally extinct, including rhino, roan antelope and African wild dog, while giraffe numbers were reduced to an estimated three individuals.

In 2001 various voluntary and forced disarmament programmes were instituted to reduce the estimated 40,000 guns in the Karamajong Region. However, this policy led to a virtual state of war between the local people and the Ugandan army. By 2006 the last remnants of the LRA were forced out of northern Uganda which opened the route into the region and for the first time in twenty years the Park was safely accessible by vehicle (Uganda Wildlife Foundation 2014).

Population Trends of Nubian Giraffe Populations in Kidepo Valley NP

The historic distribution of Uganda's Nubian giraffe ranged from the Rift Valley of central-west Kenya across Uganda to the Nile River and northwards into (South) Sudan (Dagg & Foster 1976). In the early 1960s, Dagg (1962) estimated Rothschild's giraffe in Uganda at 1,130 individuals. In contrast, Rwetsiba (2005) reported that

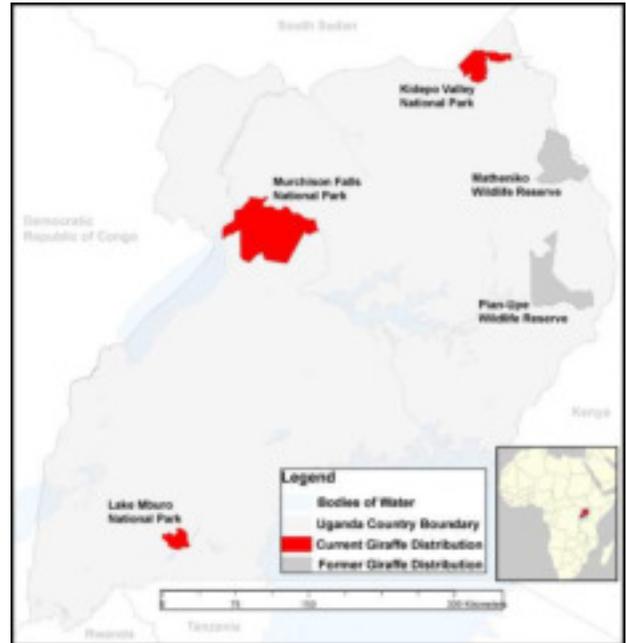


Figure 1: A map of current and historic distribution of giraffe in Uganda



Rothschild's giraffe in Uganda numbered approximately 2,500 in the 1960s. By the early 1980s, the population had decreased to ~350 giraffe (Rwetsiba 2005).

It is important to note, although Dagg (1962) referred to *G. c. cottoni* and *G. c. rothschildi*, *G. c. cottoni* was previously subsumed into *G. c. rothschildi* (Dagg 1971), and more recently *G. c. rothschildi* subsumed into *G. c. camelopardalis* (Fennessy et al. 2016). By the mid to late 1990s, East (1999), who combined Nubian and Rothschild's giraffe, estimated the total number of Nubian giraffe in Uganda at 145 individuals, most of which occurred in Murchison Falls NP. In contrast to this figure, Rwetsiba (2005) estimated Uganda's giraffe population to number 250 individuals during the same timeframe. Currently, giraffe are only found in three national parks: Murchison Falls NP contains the largest population - >1,250 in the north and 37 introduced into the south in 2016-17, Lake Mburo NP recently introduced 15 giraffe in a translocation effort from Murchison Falls NP, and Kidepo Valley NP hosts to an imperiled population of 34 individuals in 2017.

Kidepo Valley NP formerly supported one of the country's largest protected Nubian/Rothschild's giraffe populations (East 1999), with an estimated 400 giraffe in the late 1960s/early 1970s (NEMA 2009; Rwetsiba 2006; Nampindo *et al.* 2005). The population decreased to an estimated 160 giraffe in 1982 (NEMA 2009; Rwetsiba & Wanyama 2005) and by 1995, a mere five individuals were estimated to remain (East 1999). Three Rothschild's giraffe (one male and two females) were successfully translocated from Kenya's Lake Nakuru NP to Kidepo Valley NP in 1997 to promote the recovery of the Park's giraffe population (Uganda Wildlife Foundation 2014; Rwetsiba & Wanyama 2005; East 1999; Lamprey & Michelmore 1996).

In 2002, nine giraffe were estimated to remain in the Kidepo Valley Conservation Area (KVCA) (Rwetsiba & Wanyama 2005). In 2005, the first aerial total count of wildlife in the KVCA counted 14 giraffe, all of which occurred in the southern parts of Kidepo Valley NP (Rwetsiba & Wanyama 2005). Muller (2011) estimated Kidepo Valley NP's giraffe population at <20 individuals. An aerial survey of Kidepo Valley National Park in 2014 identified 20 giraffe within the Park (Wanyama *et al.*, 2014). In 2015 and 2016, GCF vehicle based photographic surveys documented 28 unique individuals and estimated 30 giraffe in the population, respectively. In 2017, 34 Nubian giraffe individuals were estimated by GCF from individual IDs.

Current Research Efforts in Kidepo Valley NP

Nubian giraffe in Uganda are currently estimated to number >1,300 individuals remaining in the wild across Murchison Falls NP, Kidepo Valley NP and Lake Mburo NP. Conservation research on the Nubian giraffe has been identified as a conservation priority by GCF and the IUCN SSC Giraffe & Okapi Specialist Group, and GCF in partnership with UWA, Uganda Wildlife Education Centre (UWEC) and Dartmouth College have worked together in Uganda since 2013.

This conservation programme seeks to build on the first three annual comprehensive assessments of Nubian giraffe numbers in Kidepo Valley NP undertaken by GCF, UWA and partners since 2015. The Kidepo Valley NP giraffe population likely faces the hallmark threats of a small, recovering population potentially including inbreeding depression from a genetic bottleneck and top down population regulation. Given the estimated small population size, it is susceptible to demographic and environmental stochasticity, requiring a close monitoring of population dynamics to quickly identify and mitigate potential and emerging threats. This survey provides an



invaluable update on the initial baseline collected to address gaps in knowledge for the IUCN Red List Assessment of the Nubian giraffe, as well as for the implementation of the first-ever draft National Giraffe Conservation Strategy and Action Plan in Uganda 2017-2027.

Project Objectives – April 2018

1. To re-survey the Nubian giraffe population size, distribution and threats in Kidepo Valley NP.
2. To collect additional DNA tissue samples from Nubian giraffe in Kidepo Valley NP to better understand social relationships.
3. To fit five GPS satellite units to Nubian giraffe in Kidepo Valley NP.
4. To provide additional recommendations on suitability for translocating a new founder population of Nubian giraffe to Kidepo Valley NP in August-September 2018.
5. To provide ongoing capacity building and support to UWA monitoring staff in Kidepo Valley NP.
6. To provide valuable data for the 'living' Uganda country-wide status report and Uganda's draft National Giraffe Conservation Strategy and Action Plan 2017-2027.

Population Monitoring

Methods

The primary data collection method for population monitoring was a vehicle-based fixed route photographic survey to obtain a total count of giraffe over the survey period. Since each individual giraffe has a unique pelage pattern, photographs of observed giraffe were compared with previously photographed giraffe to ensure that repeated sightings of an animal did not result in increased population estimates.

We conducted surveys daily between 8-10 April 2018, from approximately 8:00am to 4:00pm during each day. Using survey routes and protocols established in 2015, the southern section of the Park was identified in the Kidepo Valley NP as the preferred habitat for giraffe. We used three survey teams to drive each route during every survey day, ensuring complete coverage of the Park's road network over all survey events; three vehicles during each survey period: (1) North - north of Apoka, (2) South - south of Apoka, and (3) East - east of Apoka. Each survey vehicle had a driver, a research team with survey equipment, and an UWA ranger. The UWA rangers proved invaluable in guiding the survey teams to vantage points within the Park along the various routes. Their knowledge of the Park allowed us to track the giraffe so to get close enough to photograph and/or identify them.

When giraffe were encountered, photographs were taken of all individuals and the location, age class (Calf: 0-1 year; Subadult: 1-5 years; Adult: 5+ years), sex, group composition, injuries and any visible signs of disease were also noted. Using pattern recognition software, the database of unique individual giraffe in the Park was updated to include observations from 2015-17 surveys and was subsequently added online to GiraffeSpotter (giraffespotter.org). As part of long-term monitoring, the capture history records of individual giraffe were generated from repeated photographic surveys which enable the monitoring of both individual space-use and population distribution over time. All individual giraffe encounter and matches were visually confirmed by researchers to ensure positive identifications.



Results

During the survey period, we documented 86 giraffe observations and 17 group observations. From these encounters, we identified **35 unique individual giraffe** in the Park, including three newly identified calves/subadults. Two calves encountered in 2017 were not re-sighted during the 2018 surveys. The current population structure is skewed towards adult, which is consistent with other healthy ungulate populations and the sex ratio is 1.18 males/female, suggesting no sex bias in survival parameters (Table 1). None of the observed giraffe showed any sign of snare wounds or giraffe skin disease.

Table 1: Giraffe population structure in Kidepo Valley National Park

	Calf	Subadult	Adult	Total
Male	2	3	14	19
Female	1	4	11	16
Total	3	7	25	

All giraffe encounters were in the southern part of the Park, along the Narus Valley. This spatial distribution of encounters is consistent with all prior GCF surveys with no giraffe encounters ever documented outside of the Narus Valley.

All the data collected during these surveys will be added to the GCF Uganda Country Profile to help inform future conservation measures and the development of the draft National Giraffe Conservation Strategy and Action Plan. In time, the information will also be incorporated into the IUCN Red List assessment of the Nubian giraffe.

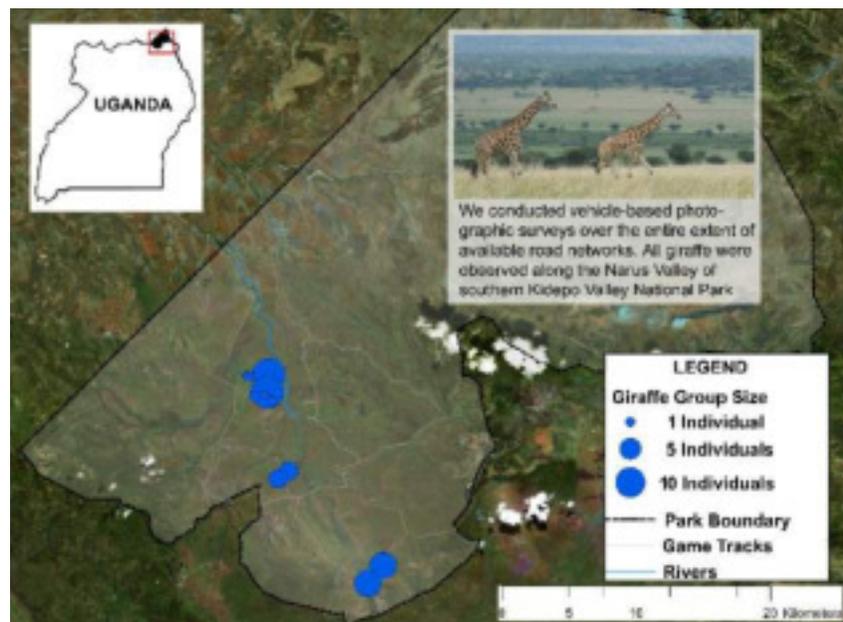


Fig 2. A map of Kidepo Valley NP showing the locations and sizes of all observed groups of giraffe during the 2017 survey.



Spatial Ecology

Methods

To better understand the spatial ecology of giraffe in Kidepo Valley NP and to inform Park-specific management strategies for the conservation of this flagship species, including future giraffe reinforcement translocations, we deployed five newly developed solar-charged GPS satellite tracking units on giraffe. This GPS tracking programme is part of an Africa-wide effort, Twiga Tracker, an initiative spearheaded by GCF working in collaboration with the Smithsonian Conservation Biology Institute, San Diego Zoo Global and Wildlife Conservation Alliance to better understanding spatial ecology of all giraffe species throughout the continent.

GCF and partners undertook the first preliminary study of giraffe movements in Kidepo Valley NP during 2016-17, testing the newly developed GPS satellite units. To build a baseline of understanding giraffe spatial ecology in the Park, we fit five additional giraffe with ossicone mounted GPS satellite tracking units (Fig 3) in April 2018.

These solar charged tracking units were designed by the Kenyan based company Savannah Tracking and programmed to record coordinate fixes at one hour intervals. Spatial data are uploaded to a server via Iridium satellite uplink twice daily to allow for real-time monitoring of tracked individuals.

Collaring operations took place on 11 and 12 April. The immobilisation and collaring team consisted of two UWA veterinarians, one technician, UWA wardens, UWA rangers and UWA drivers, supported by individuals from GCF, Dartmouth College, Chester Zoo, Columbus Zoo, and Cheyenne Mountain Zoo.

All giraffe were immobilised using a combination of Etorphine and Azaperone, with dosages commensurate with the estimated body size. Once the giraffe was secured on the ground, the reversal was immediately administered. Each giraffe was restrained for approximately 15-20 minutes while the GPS unit was fixed. Each GPS unit was attached to the ossicone using two surgical steel bolts and nylon webbing. While the giraffe was restrained, we also collected morphometric data as well as tissue and blood samples.

All giraffe were monitored following fitting the units to ensure they were behaving normally and did not exhibit any signs of injury or distress. All giraffe safely returned to their respective herds after they were released. The UWA monitoring team in Kidepo Valley NP continue monitoring of the giraffe as part of their field programme.

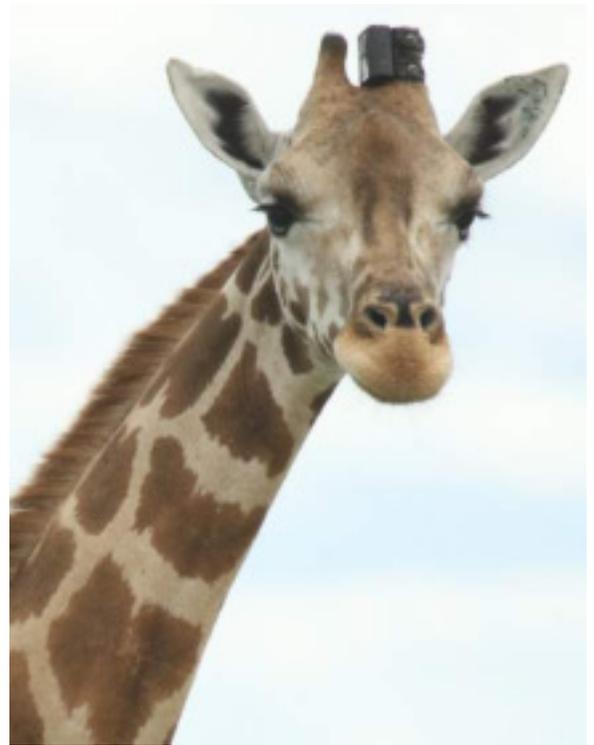


Fig 3. A solar charged GPS tracking unit attached to the ossicone of an adult female Nubian giraffe



Results

Preliminary data from the GPS satellite units has been mapped and presented below (Fig 4.) The exhibited movement behaviours from tracked giraffe are consistent with the spatial distribution of giraffe herds exhibited during surveys in that movement appears to be restricted to within the Narus Valley of the southern half of the Park. Most giraffe have exhibited tortuous movement in the densely vegetated areas along the eastern and western edges of the Park with more linear movements along the river valley. Additionally, movement behaviours have begun to reveal insights into fission/fusion dynamics of giraffe social behaviour. Although the collared giraffe were in three distinct herds during the collaring operations, tracked individuals regularly converged and separated over the duration of the tracking period.

DNA Data Sampling

During the immobilisation and collaring, we collected tissue samples from all giraffe for future DNA analysis. Over the span of the collaring exercise, we collected tissue samples from two additional individual giraffe that were not previously sampled. Throughout all survey and sampling efforts we have collectively sampled tissue from 22 individuals – 59.5% of the current total documented population. The identity of all individuals from which DNA biopsy tissue samples were collected was noted and we plan to continue genetic sampling for all individuals in the population to have a full record of their population dynamics.

Following the submission of relevant agreements and paper work to the relevant Uganda Authorities, the 2016 samples were sent to GCF's partner genetics laboratory in Germany, the Senckenberg Biodiversity and Climate Research Centre, to develop dedicated microsatellite analyses to assess pedigrees and genetic diversity.



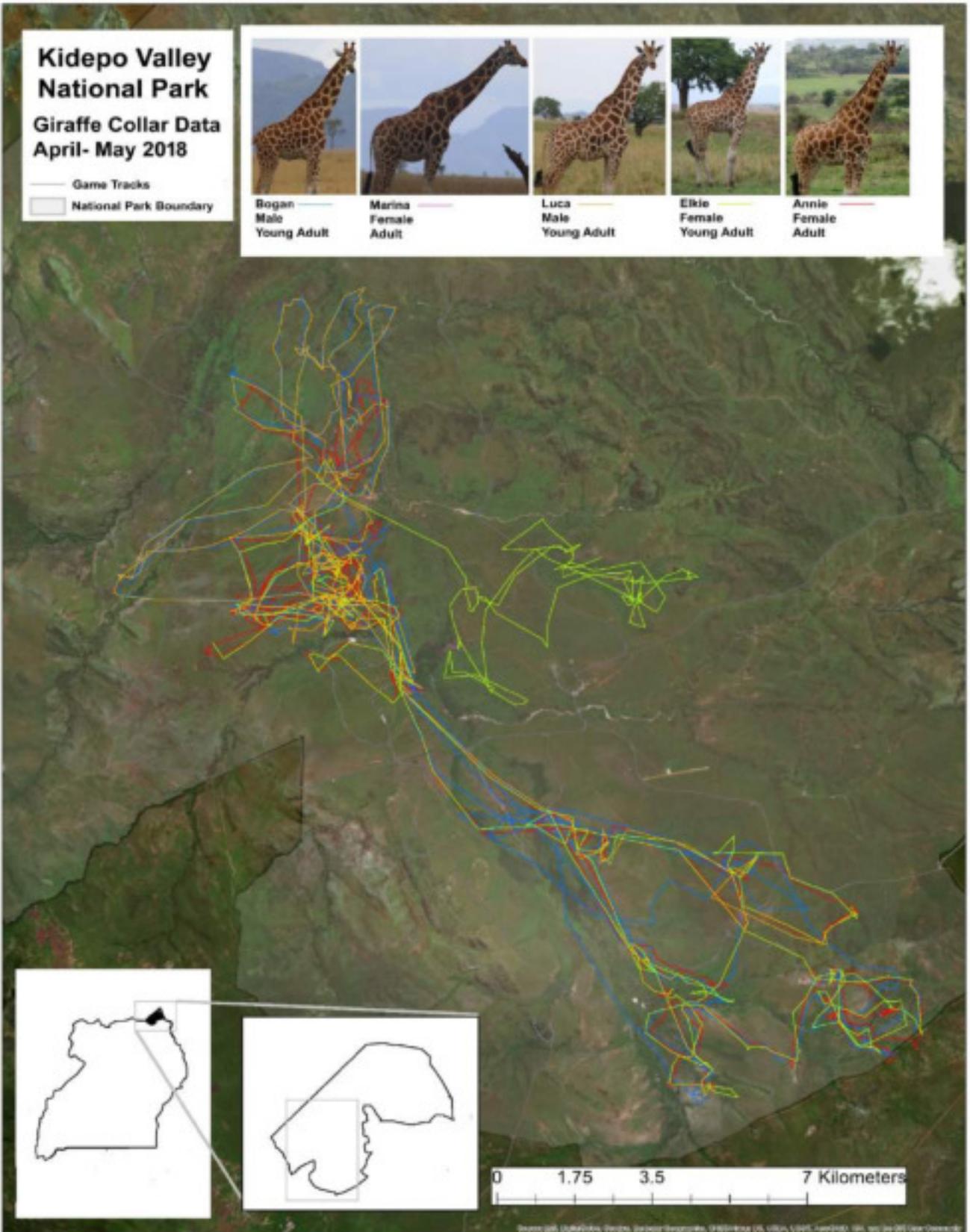


Fig. 4: A map of preliminary telemetry data from 5 recently deployed ossicone-mounted GPS units



Goals	Specific	Measurable	Assgnable	Relevant	Time-bound	Outputs
<i>Uganda</i>						
1. To collect and analyse DNA tissue samples from Nubian giraffe in Kidepo Valley NP to assess social relationships.	Develop key giraffe conservation outputs to support Nubian giraffe long-term conservation and management	Five individual DNA tissue samples collected from giraffe in Kidepo Valley NP	GCF with partners including UWA, Chester Zoo, Dartmouth College	Ongoing DNA tissue sampling of giraffe in Kidepo Valley NP to assess social relationships	Project preparation – January 2018	2 additional DNA tissue samples collected (cumulatively 59% of the population)
2. To re-survey the Nubian giraffe population size, distribution and threats in Kidepo Valley NP		Updated report submitted highlighting current population numbers, distribution and threats of giraffe in Kidepo Valley NP		Field work – April 2018	Survey report completed	
3. To fit five GPS satellite units to Nubian giraffe in Kidepo Valley NP		Five GPS satellite units fitted to giraffe in Kidepo Valley NP and provide regular reports on their movements.		Initial reporting – June 2018	Five giraffe collared	
4. To provide additional recommendations on suitability for translocating a new founder population of Nubian giraffe to Kidepo Valley NP in 2018		UWA staff capacity built for ongoing monitoring of the Kidepo Valley NP giraffe population		Ongoing reporting thereafter	Training of UWA staff undertaken on giraffe monitoring.	
5. To provide capacity support to UWA monitoring team in Kidepo Valley NP		Build on draft translocation proposal highlighting the potential of new founder giraffe introduced into Kidepo Valley NP in August-September 2018			Giraffe translocation planning underway with UWA.	
6. To provide valuable data for the 'living' Uganda country-wide status report and draft Uganda's National Giraffe Conservation Strategy and Action Plan		New data added to the Uganda Country Profile and National Strategy and Action Plan			New data to be added to Uganda Country Profile and conservation status report.	



Conservation Outcomes

Kidepo Valley NP is home to the second largest Nubian giraffe population in Uganda, and as such, conservation strategies for this unique taxon hinge on a detailed understanding of their population dynamics and ecology. Our broader and ongoing evaluation of their numbers and current threats to the population in Uganda in collaboration with UWA and UWEC, and technically supported by Dartmouth College has to date provided valuable outputs, including the translocation of 15 giraffe to Lake Mburo NP (new calves have been born), 37 giraffe to the south side of Murchison Falls NP (new calves have been born), population surveys and monitoring in all Parks, and the development of a draft National Giraffe Conservation Strategy and Action Plan. The findings from this project have already provided a critical baseline to help with future conservation efforts for Nubian giraffe in the Park, as well as the country at large.

Importantly, conservation translocation has been identified as a key tool to further secure Nubian giraffe numbers and range in Uganda. As an example, a detailed understanding of the population structure in Murchison Falls NP as a potential source population to supplement genetic diversity within the small Kidepo Valley NP is an essential component of safely removing individuals and using them to propagate viable populations in other areas of Uganda. GCF drafted a translocation viability assessment using the IUCN guidelines to help better inform UWA about this potential activity – as such UWA is key to undertake the operation in late 2018. Additionally, our current conservation research efforts in Murchison Falls NP and knowledge of group structure, preferred associations and social dynamics, coupled with detailed understanding of giraffe skin disease issues, should provide for a social consideration when selecting individuals for translocations in the future. All this work has been initiated through this project and in future findings will help us to make informed recommendations and decisions.

With the ongoing monitoring of the Kidepo Valley NP giraffe population, a better understanding of giraffe by all stakeholders can help to further develop their long-term conservation and management. Our work will continue to inform the implementation of the current draft National Giraffe Conservation Strategy and Action Plan for Uganda.

Next Steps: 2018-19

A series of recommendations for future giraffe conservation and management in Kidepo Valley NP are outlined below and relate directly to the draft National Giraffe Conservation Strategy and Action Plan for Uganda. As a priority, the following has been highlighted to follow up by UWA, GCF and partners:

- Finalise biopsy tissue sampling of remaining individuals for creating pedigree of entire Kidepo Valley NP giraffe population; samples to be sent to laboratory for analysis alongside the others.
- Fitting additional GPS satellite solar units to assess movements in and around Kidepo Valley NP for ongoing conservation monitoring and management.
- Regular annual survey (2019) and further training and capacity building of UWA staff and others interested (e.g. tour operators).
- Assess viability and practicality of establishing a student programme to monitor the giraffe full-time in Kidepo Valley NP.



- Implement proposed giraffe translocation from Murchison Falls NP into Kidepo Valley NP in August 2018 to augment the current population.

Permits

All necessary permits have been approved by the UWA and Uganda Council of Science and Technology. Additionally, a signed MoU between UWA, GCF and UWEC exists, which guides all giraffe conservation support in the country.

Project Partners

The project is part of a larger collaboration underpinned by a Memorandum of Understanding (MoU) between the UWA, GCF and UWEC. Additionally, technical support from Dartmouth College was invaluable and all fieldwork in April 2018 was undertaken collaboratively with partners from GCF, UWA, Chester Zoo and Cheyenne Mountain Zoo, Cleveland Metroparks Zoo, Dartmouth College, and friends of GCF.



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