

Understanding the Status and Ecology of Nubian/Rothschild's Giraffe in Uganda's Kidepo Valley National Park

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In the rugged wilderness of Uganda's northeastern Karamoja Region, nestled in the striking valleys along the mountainous borders with South Sudan and Kenya, Kidepo Valley National Park (NP) hosts a diverse assemblage of unique wildlife. Historically, Kidepo Valley NP was home to one of the largest populations of giraffe in Uganda, but years of civil unrest decimated the region's wildlife, including the rare Nubian giraffe *Giraffa camelopardalis camelopardalis* (formerly Rothschild's giraffe *G. c. rothschildi*). Despite the ensuing political stability, the giraffe population of Kidepo Valley NP has yet to recover to a level beyond jeopardy. Since 2015, the Giraffe Conservation Foundation (GCF) and partners have been working to develop a systematic population monitoring programme and implement a series of associated scientific studies to better understand the population status and the unique nature of the threats that this small and imperiled population faces in Uganda's frontier region.

Brief History of Giraffe in Kidepo Valley NP

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

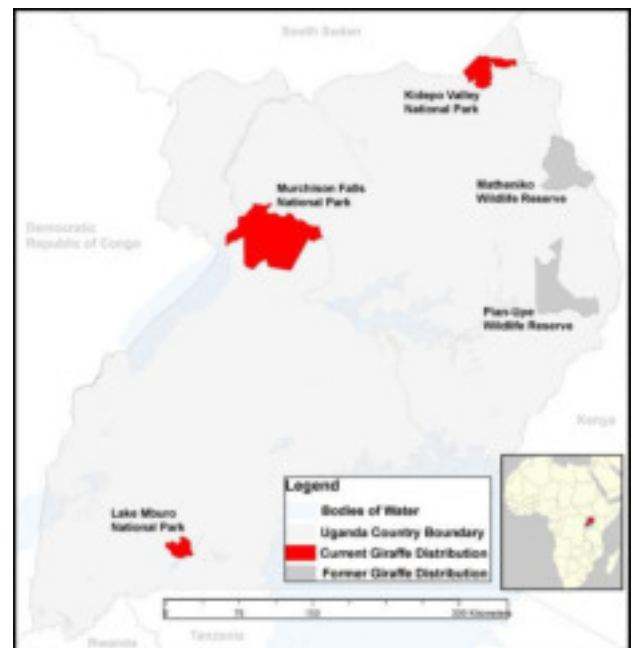


Figure 1: A map of current and historic distribution of giraffe in Uganda

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 by 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/Rothschild's Giraffe Populations in Kidepo Valley NP

The historic distribution of Uganda's 'Endangered' Nubian giraffe *G. c. camelopardalis* (formerly *G. c. rothschildi*) 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 Rothschild's giraffe in Uganda numbered approximately 2,500 in the 1960s. By the early 1980s, the population had decreased to an estimated 350 giraffe (Rwetsiba 2005).

It is important to note, although Dagg (1962) referred to *G. c. cottoni* and *G. c. rothschildi*, *G. c. cottoni* has been subsumed into *G. c. rothschildi* (Dagg 1971) and referred to as such. By the mid to late 1990s, East (1999), who combined the two subspecies, estimated the total number of Nubian/Rothschild's 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, Lake Mburo NP recently received 15 giraffe in a translocation effort, and Kidepo Valley NP hosts to an imperiled population.

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 & Michelmores 1996).

In 2002, nine giraffe were estimated to remain in the Kidepo Valley Conservation Area (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.

Current Research Efforts in Kidepo Valley NP

Nubian giraffe in Uganda are currently estimated to number <1,300 individuals remaining in the wild and ~1,250, 30 and 15 in their native range in Uganda (Murchison Falls NP, Kidepo Valley NP and Lake Mburo NP, respectively) (Marais *et al.* 2013; 2017; M. Brown pers. comm.). 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 Uganda Wildlife Authority (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 two comprehensive assessments of Nubian giraffe numbers in Kidepo Valley NP undertaken by GCF, UWA and partners in 2015 and 2016. 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 development of the first-ever National Giraffe Conservation Strategy and Action Plan in Uganda.

Project Objectives – March/April 2017

1. To re-survey the Nubian giraffe population size, distribution and threats in Kidepo Valley NP
2. To collect and analyse DNA tissue samples from Nubian giraffe in Kidepo Valley NP to assess inbreeding depression
3. To fit a minimum of two GPS satellite collars to Nubian giraffe in Kidepo Valley NP
4. (As appropriate,) to provide recommendations on suitability for translocating a new founder population of Nubian giraffe to Kidepo Valley NP
5. To train and support UWA monitoring staff in Kidepo Valley NP
6. To provide valuable data for the Uganda country-wide status report and Uganda's National Giraffe Conservation Strategy and Action Plan

Population Monitoring

Methods

The primary data collection method for population monitoring consisted of vehicle based fixed route photographic surveys and photographic documenting of incidental encounters, seeking 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.



Fig 2. Researchers visually confirm giraffe identities from pelage patterns and unique markings.

Surveys were conducted between 27 March and 3 April 2017, from approximately 8:00am to 4:00pm. 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. Surveys were driven by one of three vehicles during each survey period: (1) North - north of Apoka, (2) South - south of Apoka, and East- east of Apoka. The north section of the Park, extending into the Kidepo Valley, was also surveyed to better assess potential habitats where giraffe may seasonally move. Each survey vehicle had a driver, a researcher familiar with the area, survey equipment, an UWA ranger and additional spotters. The UWA rangers proved invaluable in guiding the survey teams to great vantage points within the Park along the various routes. Their knowledge of the Park allowed us to track the giraffe so that we could get close enough to photograph and/or identify them.

When encountered, as a minimum the right side of each giraffe was photographed, 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 noted. Using pattern recognition software (HotSpotter), a database of unique individual giraffe in the Park was updated from to include observations from 2015 and 2016 surveys. As part of long-term monitoring, the capture history records of individual giraffe were generated from repeated photographic surveys which will 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 (Fig 2).

To assess potential genetic diversity and pedigrees of this small population, we collected tissue samples from selected giraffe. Tissue biopsies provide the greatest quantity of high quality nuclear DNA of any biological samples that can be secured readily from free-ranging individuals. Samples for genetic (DNA) analysis were collected from the remnant Kidepo Valley NP giraffe population using a remote biopsy dart delivery system. Skin biopsies were collected from the giraffe in the population using a Dan-Inject rifle and biopsy dart.

Using pelage patterns of the targeted giraffe, we associated all samples with a unique identification and ensured no sample duplication. Once collected, all DNA tissue were stored in 95% ethanol and labelled. All permits for the export of the samples to the lab partner in Germany will be finalised in collaboration with UWA.

RESULTS

Population Survey

During the survey period (6 days in total), we documented 93 giraffe observations and 18 group observations. The mean size of each group of giraffe was 5.17 individuals (stdev = 3.29). From these observations, we identified **34 unique individual giraffe** in the Park, including six new calves. All giraffe previously identified during the 2015 and 2016 surveys were observed during the 2017, including previous calves. None of the giraffe seen showed any sign of snare wounds or giraffe skin disease.

The South (108 km) and North Route (119 km) were traversed a minimum of three times, and together with opportunistic observation undertaken during collaring and DNA sampling activities, greater than 1,000 km were driven during the survey timeframe. No giraffe were observed outside of the Narus Valley (Fig 3).

All the data collected during these surveys will be added to the GCF Uganda giraffe Country Profile to help inform future conservation measures and the proposed development of a 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.

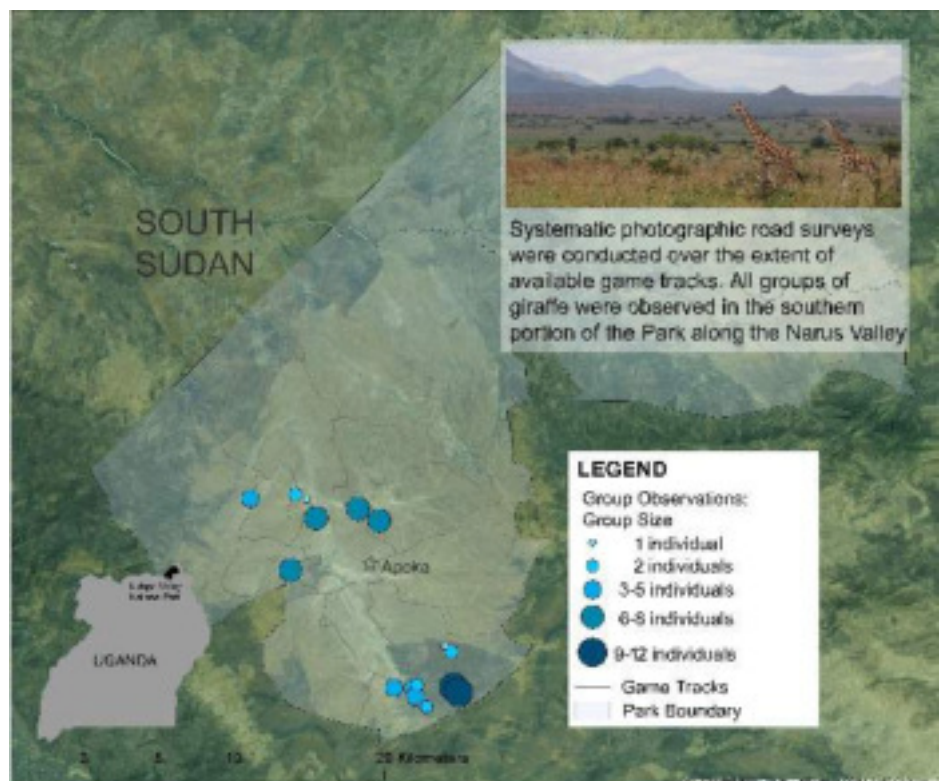


Fig 3. A map of Kidepo Valley NP showing the locations and sizes of all observed groups of giraffe during the 2017 survey.

DNA Data Sampling

During the field work, an additional six biopsy tissue samples were taken from giraffe in the Park for future DNA analysis. In addition to the 14 giraffe sampled during the 2016 field season, we have collected tissues from 20 individuals (59% of the current total documented population). The identity of all individuals from which DNA biopsy tissue samples were collected were noted and in future visits it is envisaged to complete the 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, Bik-F, Senckenberg Museum, Frankfurt, to develop dedicated microsatellite analyses to assess pedigrees and genetic diversity.

Movement Ecology

Methods

To better understand the spatial ecology of giraffe in the system and to inform Park-specific management strategies for the conservation of this flagship species, we deployed two newly developed GPS satellite tracking units on giraffe. GCF and partners undertook the first preliminary study of giraffe movements in Kidepo Valley NP during the April 2016 field survey. Although this 2016 study yielded new understandings of giraffe movements in the Park, further efforts were required to better understand giraffe space use in this system. As such, we sought to expand on this growing body of knowledge by outfitting two giraffe with newly designed ossicone mounted GPS satellite tracking units (Fig 4).

These solar charged tracking units were designed by the Kenyan based company, [Savannah Tracking](#), and were programmed to record coordinate fixes at 30 minute intervals. Data were uploaded to a server via Iridium satellite uplink to allow for real-time monitoring of tracked individuals.

On the afternoon of 1 April 2017, an adult female giraffe was collared by UWA with support of GCF and team. The team consisted of two veterinarians, one technician, wardens, rangers and drivers from UWA, supported by individuals from GCF, Dartmouth College, Chester Zoo, St. Louis Zoo, Nashville Zoo, Taronga Zoo and independent wildlife photographers.

The female giraffe was darted using a cocktail of drugs (8 mg Etorphine / 40 mg Azaperone). The giraffe was down for approximately 15 minutes during the fitting of the unit during which time we collected morphometric data as well as tissue and blood samples. An attempt to tag a large adult bull was also made on the same afternoon, however, for animal welfare issues we released the animal soon after capturing. On the morning of 2 April 2017 a smaller bull giraffe was successfully fitted with a unit using similar protocols to the female.

All giraffe were monitored following fitting the units to ensure they were behaving normally and any health concerns were allayed. As anticipated they rejoined their herds. The UWA monitoring team in Kidepo Valley NP will continue monitoring of the giraffe as part of their field programme.

Preliminary data from the GPS satellite units has been mapped and presented below. The data indicate that both giraffe showed very different movements during the first month after collaring. The female did not travel far from her initial collaring site, while the male travelled a fair distance towards the border of Kidepo Valley

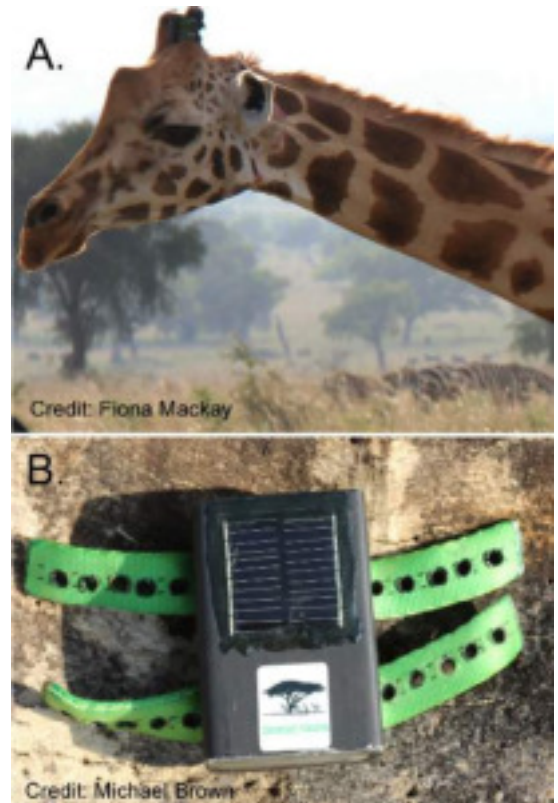


Fig 4: A. Ossicone GPS unit mounted to a female giraffe; B. Close-up of the GPS tracking unit

NP along both ends of the Narus Valley (Fig 5). Both tracking units have subsequently been removed from the giraffe as this was an initial trial and a large effort to collar more giraffe will be conducted in early 2018.

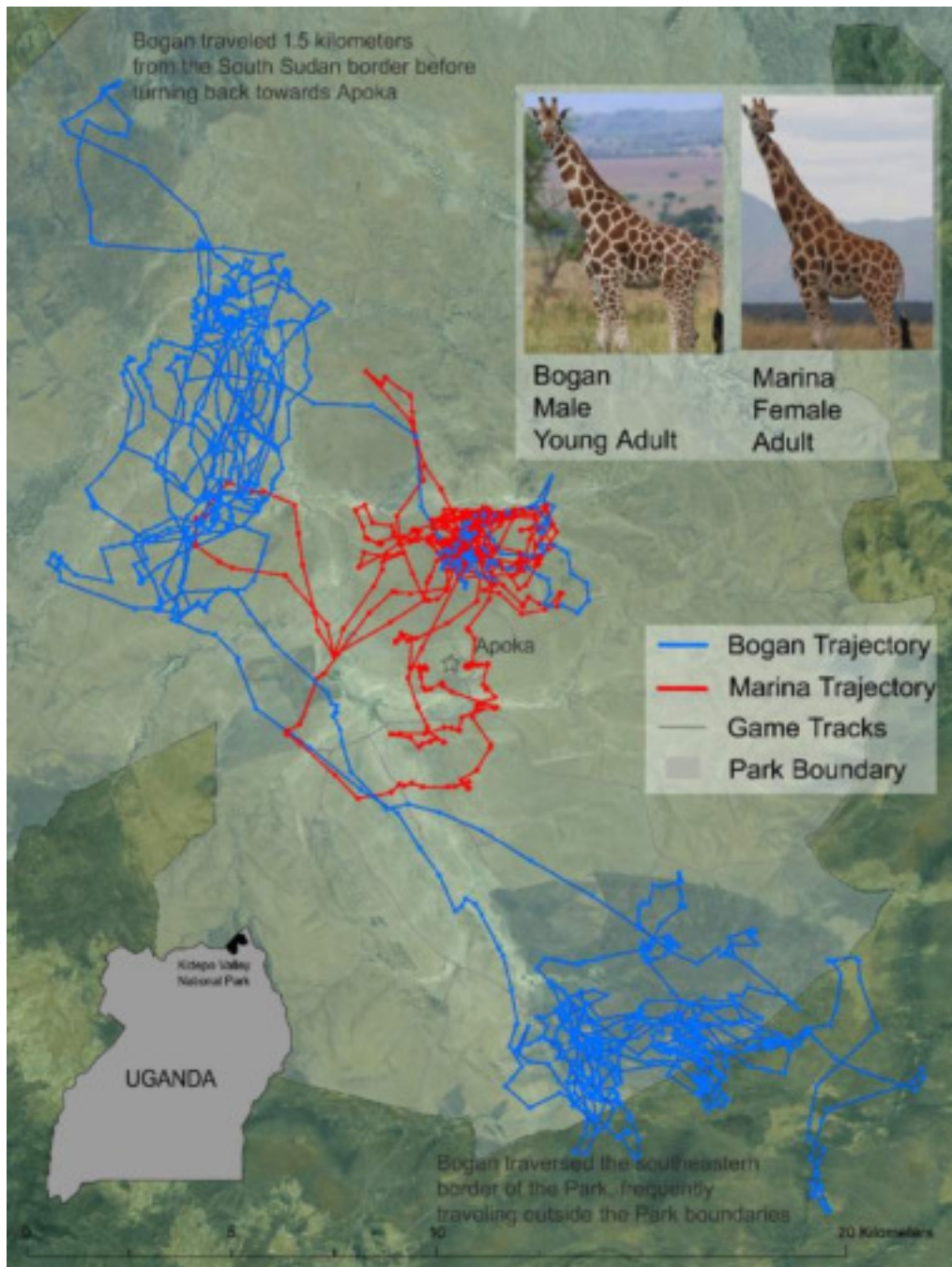


Fig 5: Map of collared giraffes' trajectories

Goals	Specific	Measurable	Assignable	Relevant	Time-bound	Outputs
<i>Uganda</i>						
1. To collect and analyse DNA tissue samples from Rothschild's giraffe in Kidepo Valley NP to assess inbreeding depression	Develop key giraffe conservation outputs to support Rothschild's giraffe long-term conservation and management	Five individual DNA tissue samples collected from giraffe in Kidepo Valley NP	GCF with partners including UWA, Dartmouth College, Chester Zoo	First-ever DNA tissue sampling of current giraffe in Kidepo Valley NP	Project preparation – January 2017	6 additional DNA tissue samples collected (cumulatively 59% of the population)
2. To re-survey the Rothschild's 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		to assess inbreeding depression	Field work – March/April 2017	Survey report completed and submitted (April 2016)
3. To fit a minimum of two GPS satellite collars to Rothschild's giraffe in Kidepo Valley NP		Two collars (one GPS satellite collar and one camera collar) fitted to giraffe in Kidepo Valley NP and provide regular reports on their movements.		Ongoing survey of population numbers, distribution and threats of giraffe in Kidepo Valley NP	Initial reporting – July 2017	Two giraffe collared
4. (As appropriate,) to provide recommendations on suitability for translocating a new founder population of Rothschild's giraffe to Kidepo Valley NP		UWA staff train and implement new Citizen Science initiative to help ongoing monitoring of the Kidepo Valley NP giraffe population		GPS collaring of three Rothschild's giraffe in Kidepo Valley NP	Ongoing reporting thereafter	Training of UWA staff undertaken on giraffe monitoring (April 2016) Citizen Science flyer printed and distributed.
5. To train and implement new Citizen Science Rothschild's Giraffe Monitoring Project in Kidepo Valley NP		Based on genetics findings, develop a report highlighting the translocation potential of new founder giraffe into Kidepo Valley NP		Training of UWA rangers in giraffe monitoring		Report on potential translocation options to be developed after analysis of DNA tissue samples
6. To provide valuable data for the Uganda country-wide status report and Uganda's National Giraffe Conservation Strategy		New data added to the Uganda Country Profile and the Africa-wide Giraffe Conservation Status Report		Giraffe conservation translocation assessment for Kidepo Valley NP using IUCN guidelines		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 supported by Dartmouth College (USA) has to date provided valuable outputs, including the translocation of 15 giraffe to Lake Mburo NP, 18 giraffe to the south side of Murchison Falls NP, 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 is currently drafting a translocation viability assessment using the IUCN guidelines to help better inform UWA about this potential activity. 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 current development and future monitoring of the National Giraffe Conservation Strategy for Uganda. This Strategy will highlight future targeted efforts in the broader interest of giraffe conservation, and in particular of the threatened Nubian giraffe.

What are the next steps? 2017-18

A series of recommendations for future giraffe conservation and management in Kidepo Valley NP are outlined below, based on the efforts and findings described above. As a priority, the following has been highlighted to follow up by UWA, GCF and partners:

- Finalise biopsy tissue sampling of remaining 14 individuals for assessing inbreeding and pedigree of entire Kidepo Valley NP giraffe population; samples to be sent to laboratory for analysis alongside the others.
- Fitting 4-6 GPS satellite solar units to assess movements in and around Kidepo Valley NP for ongoing conservation monitoring and management.
- Regular annual survey (2018) and further training and capacity building of UWA staff and others interested (e.g. tour operators).
- Undertaking an assessment of the viability of future giraffe translocations into Kidepo Valley NP based on IUCN guidelines including the genetic findings.

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 Uganda Wildlife Education Centre 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 for March/April 2017 was undertaken collaboratively with partners from GCF, UWA, Dartmouth College, Canada Bay Club, Chester Zoo, Nashville Zoo and St. Louis Zoo.

We would further like to thank the following organisations:



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