ECOLOGY, DENSITY AND DISTRIBUTION OF SITATUNGA IN CENTRAL UGANDA

UNIVERSITY OF ALBERTA

QUAECUMQUE VERA

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Contributors and Cooperators

Uganda Wildlife Safaris
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Uganda Wildlife Authority
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Researchers

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Highlights

• Second field season was May – August 2016 along the Mayanja River near Ngoma, Uganda

• Camille Warbington passed her PhD Candidacy Examination in December

• We recruited an undergraduate researcher in 2016 for assistance in photographic identification of sitatunga to individual and to perform preliminary analysis of observation data

Mark – resight study:

• During field work, we used 15 viewing platforms as primary image capture locations and 28 motion-triggered trail cameras for secondary data collection

• In 2016, we recorded 65 encounters with sitatunga from viewing platforms, and 98 from trail cameras

• From 2015 data, we identified 80 unique bulls and 39 unique ewes and lambs

• From 2016 data, we identified 23 "new" bulls and 15 "new" bulls and lambs, meaning that these 38 individuals were identified for the first time in 2016.

• Using individuals identified in 2015, we used a Spatially Explicit Capture Recapture (SECR) program to estimate the density of sitatunga along the Mayanja River to be 10.6 (95% confidence interval 6.0 – 18.6) per square kilometer.

• We are recruiting an undergraduate researcher for Fall Term 2017 to verify the identification of individual sitatunga




Telemetry Study:

• We attempted capture of adult sitatunga for 11 days in August 2016 with the cooperation and supervision of the Uganda Wildlife Authority

• We were unsuccessful in capture during 2016, however, we identified methods to aid in capture for 2017 efforts

Genetic Diversity Study:

• We imported 41 sitatunga hide samples from Uganda to the University of Alberta for genotyping via single nucleotide polymorphisms (SNPs)

• Camille Warbington completed courses on genetic laboratory techniques to analyze the genetic data

• DNA extraction and analysis is scheduled to begin in Fall Term 2017

Highlights *con't*

Background

Trophy hunting is controversial, prompting questions of sustainability, equitable treatment of user groups, and ethics (1,2). For the developing world, however, trophy hunting can provide crucial funds for conservation of wildlife and habitats, especially in places with limited tourism (3-5). One reason for skepticism of trophy hunting are sparse data and limited monitoring to form the basis for harvest quotas for target species (1, 2, 6). Sitatunga (Tragelaphus spekii) is a spiral-horned antelope endemic to sub-Saharan Africa that is a highly valued trophy animal (7, 8). In 2010, the Uganda Wildlife Authority authorized trophy hunting for sitatunga (9). Unfortunately, it has done so without complete data on population size or distribution. This is especially concerning because as recently as 2008, sitatunga was thought to be highly endangered in portions of its Ugandan range (10,11). Establishing baseline data on the status of the sitatunga populations within hunting areas and expanding existing knowledge about sitatunga ecology must be a main priority to maintain a responsible trophy hunt in Uganda (3,6).

Image 1: Trail camera picture of sitatunga at night.

Sitatunga have a wide distribution across sub-Saharan Africa, yet there is little scientific information about the species (11). One major reason for the lack of data appears to be the difficulty of working in the wetlands where they live. Sitatunga are adapted for life in dense vegetation in swamps and papyrus marshes, making traditional population survey techniques problematic (12 - 19). Uncertainties about sitatunga are not limited to population density, but extend to basic ecology of the species. For example, there are conflicting reports about the preferred habitats for sitatunga, with some accounts asserting that

Image 2: Trail camera picture of sitatunga.

the species stays in dense wetland vegetation, while other studies report crop-raiding from dry land adjacent to rivers (10,18). Further, there are inconsistent reports regarding territoriality, movement patterns, and sex ratio (13-19). To ensure sound management of a trophy hunt for sitatunga in Uganda, it is critical to evaluate local information about the species and its population. Due to the inaccessibility of sitatunga habitats, and the difficulties in distance sampling for population estimation, alternate techniques to monitor and estimate population density are warranted. Camera traps are emerging as a useful method identifying activity patterns, species presence, and estimating the abundance of antelope (20-22). If animals are individually identifiable, estimating population from camera traps or a mark-resight population design is feasible (21,23). From previous work in Kenya and the Republic of Congo, sitatunga are identifiable based upon coat markings and horn shape in males (17, 19). By incorporating spatial information, a spatially explicit capture-recapture (SECR) study design allows for estimation of density, even if not all animals in the population are equally exposed to "capture" sites or if the effective sampling area is unknown (24). In addition, SECR models estimated using Bayesian statistical methods allow for i mperfect identification and sparseness of data (25). Recent research indicates that multiple sources of data improve understanding of populations, especially for cryptic or elusive species (20, 26, 27).

To ensure responsible and sustainable sitatunga hunting, our research will provide crucial baseline information in three key areas: habitat use, population size, and genetic diversity. Results from our study, which will be undertaken with support from teams based in Uganda and Canada, will provide information to enhance the management of sitatunga in Uganda and has potential to influence wildlife management for other cryptic and elusive species occupying dense habitats.

Objectives and Methods

Objective 1 – Estimate home range and composition of vegetation within the home range of adult sitatunga. We will capture 12 sitatunga and track with GPS radiocollars. We will supplement telemetry relocations with data from a mark-resight study design (21, 26). Observers at machans over open lanes in papyrus will be equipped with still photography cameras and telephoto lenses, and will serve as additional "capture" locations for inclusion in analysis. Trail cameras will be placed in areas used by sitatunga, to serve as "capture" locations and source of temporal activity data (23, 28). Camera data in conjunction with movement data provide a temporal and spatial record of habitat use for individual sitatunga, which will allow for modelling of habitat selection and population density similar to those being tracked via GPS telemetry (26, 29-31). Images will be compiled into a library for use as a reference in identification to individual, using coat markings and horn features as identifiers (23). Cameras will be located not only in wetlands but at varying distances from the edge of the wetland into forested habitats to document sitatunga use of dry land. We will identify habitat use by projecting GPS radiocollar relocations onto GIS maps with delineated habitat types (31). We will estimate home range using minimum convex polygons and autocorrelated kernel density estimators (AKDE) (32-34).

Image 1: Photo from Machan of sitatunga.

Image 2: Photo from Machan of sitatunga.

Objective 2 –
Estimate density of sitatunga in the Mayanja River of Uganda. Building upon movement data from the mark-resight portion of Objective 1, we will use both telemetry and camera data to develop a spatially explicit capture-recapture (SECR) model of population density (26). Home range information from telemetry data will be incorporated into SECR analysis (27). We will use SECR in a Bayesian framework using SPACECAP in program R (25). This program and design has been successfully implemented in Africa for elusive and cryptic species such as leopard (35).

Objective 3 –
Document dispersal and large-scale population structure. We will collect genetic material from harvested individuals (males only) and individuals captured as part of the radiotelemetry effort (which includes males and females). We will process sampled material for single nucleotide polymorphisms (SNPs). SNPs are a cost-effective way to record thousands of variable sites in non-model organisms, and is now the preferred marker for population-based diversity studies (36).

Image 3: Photo from Machan of sitatunga.

Image 4 Photo from Machan of a Lane.

Image 5 Photo from Machan of sitatunga.

Image 6 Photo from Trail Camera of sitatunga lamb.

Study Area

Our research is taking place in central Uganda, in the marshes of the Mayanja River system, which is part of the Nile watershed in the Nakaseke District of Uganda. Central Uganda lies between 900 and 1100 m above sea level, and contains multiple lakes, rivers, and swamps (37). The Equatorial Ugandan climate is described as generally rainy, with two dry seasons, December to February and June to August, although there is local variation in the length, timing, and duration of the dry seasons (38). Reports from people familiar with the study area indicate that both dry seasons are characterized by a decrease in rain, although the December to February dry season is drier, longer, and more reliable (Anon., E. Enyel , P. Symington, R. Okori, pers.comm). On average, little of the land is permanently cultivated (38). Other species present include hippopotamus (Hippopotamus amphibius), Nile bushbuck (Tragelaphus scriptus bor), Defassa waterbuck (Kobus ellipsiprymnus), oribi (Ourebia ourebi), bohor reed buck (Redunca redunca), warthog (Phacochoerus africanus), bushpig (Potamochoerus larvatus), and common duiker (Sylvicapra grimmia). As part of this study, we will use GIS to map the extent of papyrus and other suitable habitats. The most recent estimates of the total area of papyrus and other wetlands occurred in 1999. The estimate at that time was 30,000 km2 (MWE, unpublished data).

__Figure 1.__ Map of Uganda. Black box indicates the study area (image from Wikimedia Commons)

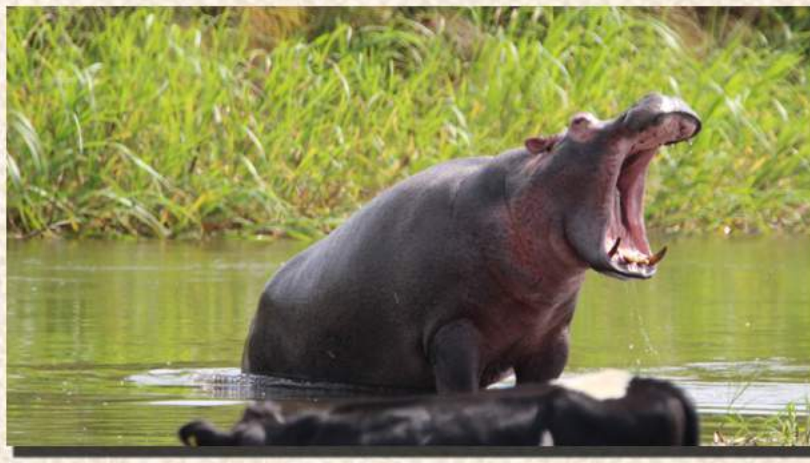

__Image 1.__ Hippo displaying anger at cattle on river bank at the UWS Camp.

Results

Field research occurred from 4 May through 20 August in the Mayanja River near Ngoma, Uganda. We used 15 machans and 28 trail cameras across approximately 10 km of river to record 163 encounters with sitatunga. The papyrus in the study area covers approximately 8.1 km2.

__Figure 2.__ Map of the Mayanja River study area showing the machan locations and extent of the papyrus. Satellite image taken in 2013

We attempted mark-resight at machans a total of 93 times, 50 times in the morning hours around sunrise (approximately 6:30 AM to 9 AM), and 42 times around sunset (approximately 1630 to 1900). Temperature during data collection ranged from 13 to 30 Celsius, and we recorded 11 rain events during these efforts.

We classified an individual as an adult male if horn shape included one full twist. We classified an individual as an immature male if horns were present but did not meet the shape requirement.

Sitatunga were classified as lambs when they displayed very small body size and/or were accompanied by a larger adult female.

We classified a sitatunga as unknown sex and/or age if we could not completely see the head to verify presence of horns, or if the body size was intermediate between lamb and adult female size.

Results con't

Compared to 2015, the water level of the Mayanja River was much higher in 2016, extending up to 50 m further inland. This water level partially or fully submerged papyrus mats in most of the machan lanes, and altered the location of the main channel of the river. The difference in hydrology affected our ability to detect sitatunga between years. As illustrated in figures 3A and 3B, our detections included a higher proportion of adult females in 2016, and comparatively higher proportion of males in 2015. In figure 3C, the pooled proportion of males and females between both years is skewed towards males. We caution against using this result as indication of a male-biased sex ratio of sitatunga in the Mayanja River, because the variation in detection of sexes between 2015 and 2016 indicates that river conditions affect our ability to detect sitatunga, thus further modelling of the year effect and habitat components are warranted.

May 2015 May 2016 June 2016 July 2016

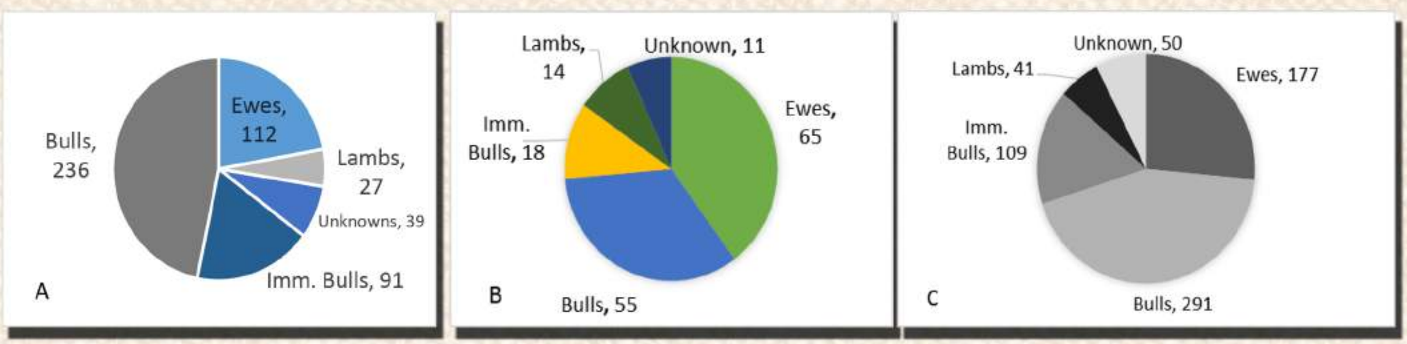

Figure 3A-C. *Sitatunga encounters in (A) 2015, (B) 2016, and (C) pooled between years, classified by age and sex. Numbers shown are the number of encounters from trail cameras and from machan visits..*

Trail cameras allow monitoring of temporal sitatunga activity patterns, as they are triggered by motion in front of the detection zone. Pooling trail camera detections from 2015 and 2016, we see that sitatunga do not appear to be restricted to activity around sunrise and sunset, but are active throughout the day and night (Figure 4). Yet, there are crepuscular peaks in activity from approximately 0700-1000 and 1800-2100hr. The early peak coincides with the timing of morning mark-resight efforts, but the late peak occurs after sunset. These results reinforce the utility of multiple data sources to detect cryptic and elusive species, because using machan visits only would miss detection of sitatunga after sunset. Future analysis of these data will be helpful in directing mark-resight effort to periods of high sitatunga activity.

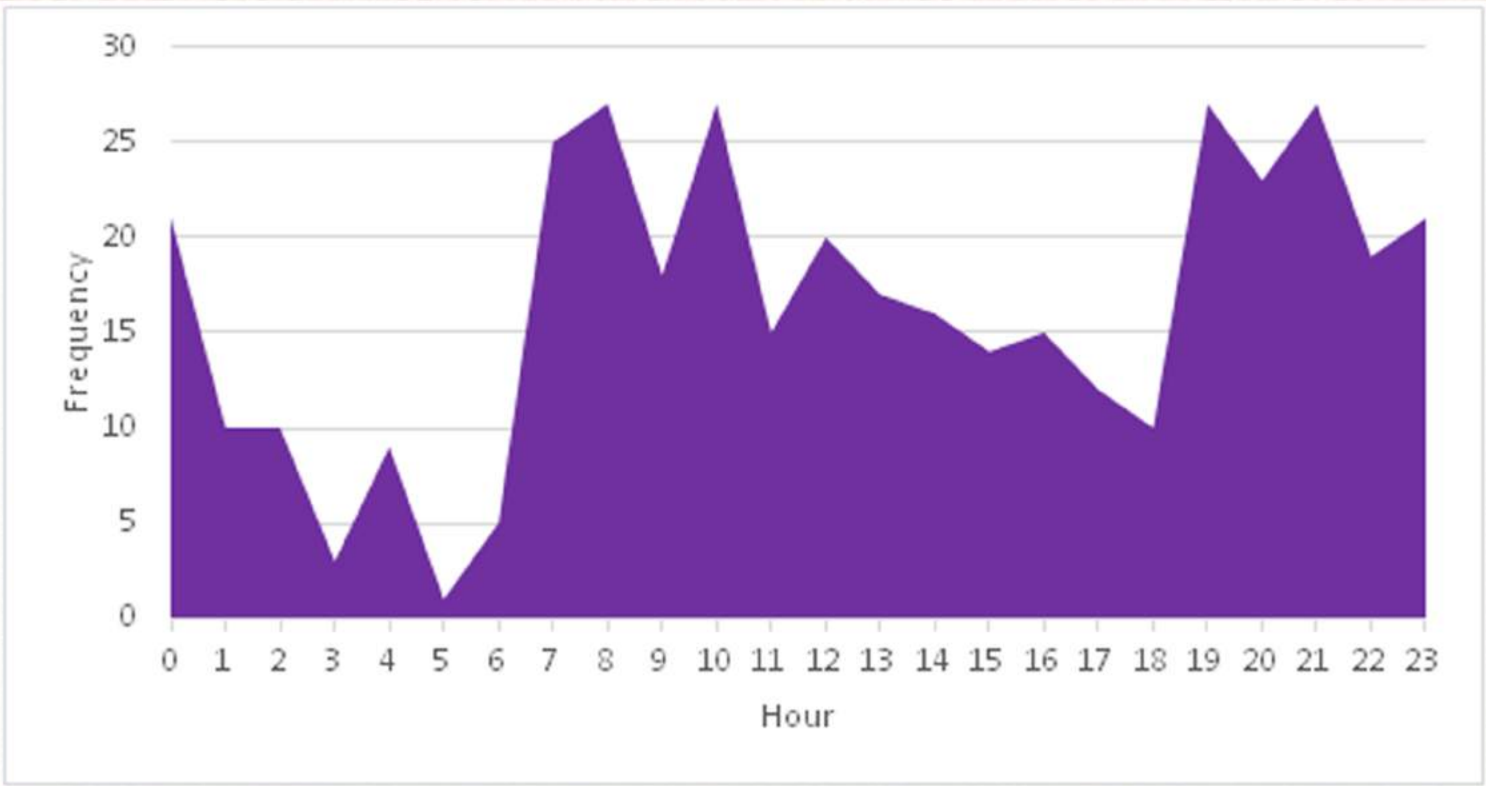

Figure 4. *Trail camera detections of sitatunga classified by time of day, April – August 2015-2016.*

We have completed initial identification of individual sitatunga based upon spot patterns and horn shape. None of the available spot-detection software packages are suitable for sitatunga; thus all identifications are made manually. We have preliminarily identified all individuals in 2015 and 2016, and we are currently in the midst of the verification process. Based upon our preliminary identification there were 103 unique bulls (of any age) and 54 females and lambs (hornless individuals) in the Mayanja River study area in 2015-2016. A total of 80 bulls and 39 hornless individuals were identified for the first time in 2015, and 23 bulls and 15 hornless sitatunga were identified for the first time in 2016. Using data from 2015 only, we performed a preliminary SECR analysis in program R, assuming that individuals did not vary in their exposure to detection areas, and that detection areas did not differ between sites. Our preliminary estimate is that there are 10.6 sitatunga per square kilometer (95% confidence interval: 6.0 – 18.6). We caution against extrapolation of this estimate to the Mayanja River or outside our study area, because we have yet to determine if detection areas differ substantially to affect density estimates. Further modelling and analysis will clarify these results.We will recruit another undergraduate researcher to verify the identification of individual sitatunga from these images, and to explore the data further during Fall Term 2017. In conjunction with the Uganda Wildlife Authority's veterinarian, we attempted capture of adult sitatunga during August 2016. While we were unsuccessful in capture, we did formulate alternative capture strategies to use during capture attempts in 2017. Capture and fitting of GPS radiocollars to adult sitatunga remains a field research priority in 2017. Data provided by these collars will be instrumental in calculating the home range and habitat use of sitatunga. We successfully obtained an export permit to bring sitatunga hide samples from Uganda to Canada in 2016. We imported 41 hide samples from harvested adult males. Renewal of the import permit is pending. We hope to collect further samples during the 2017 field season. Camille has completed training in genetic laboratory techniques and analysis during Winter term 2016. DNA extraction and analysis will begin in Fall Term 2017. We presented a poster highlighting the objectives and methods of the project, and an oral presentation on preliminary results at the 2016 Alberta Chapter of The Wildlife Society Annual Meeting. For these presentations, Camille Warbington won third place for Best Graduate Student Presentation and third place for Best Graduate Student Poster at this event. Camille Warbington also won a place at the 3-Minute Thesis finals for her talk on the basics of the project. In December 2016, Camille passed her comprehensive examination to become a Doctoral Candidate at the University of Alberta.

Timeline

January 2017 – August 2017: perform field capture of adult sitatunga, record demographic information, take genetic samples, and capture animals and affix GPS radiocollars; position trail cameras; maintain camera trap grid, including downloading images, troubleshooting malfunctions, and relocating cameras as necessary; continue photographing of sitatunga from machans; obtain genetic materials from harvested sitatunga in Uganda; compile data from GPS collars; complete importation of hide samples;
September – December 2017: Obtain satellite imagery of study area and begin assignment of habitat types; complete identification of individuals from images taken in 2017; begin DNA extraction and analysis of genetic diversity; perform and compile population genetic analysis; troubleshoot any problems detected in the primers and DNA testing methods; begin estimation of home range size; continue identification of individuals from mark-resight and camera-trap data; prepare manuscripts for publication.



Images 1,2,3- *Photographed from Machans of Situnga Immature Bulls and Ewe*

Significance and Deliverables

In the developing world, trophy hunting offers incentive to landowners to preserve hunted species and their habitats (1,3-6). Even if local communities are supportive of hunting, wildlife managers need data about the hunted species to ensure sustainability (1). To date, there have been few studies of sitatunga, and these studies offer conflicting reports (12-19). Local information about sitatunga ecology and population is therefore imperative to ensure sound management of this species and any harvest. Information about population density, home range, and habitat connectivity will improve not only local management, but also will add to the body of knowledge about sitatunga that could aid in conservation of this species across its range. After completion of this project, we will have estimates of population size, genetic structure, and habitat use of the sitatunga population in the Mayanja River, Uganda. This research builds upon existing population density estimation techniques for cryptic and elusive species, and capitalizes on multiple data sources to enhance accuracy and precision of estimates (26). In this manner, the results of this research can benefit conservation strategies for other species facing deficient data.

Images 4- *Waterlilies on the Majanya River Basin*

Future Research Priorities

We were able to collect substantial mark-resight data during both field seasons. We have established that sitatunga are individually identifiable based upon coat markings and horn shape, and preliminary analyses verify that our study design is suitable to generate a density estimate. Our analyses will be vastly improved with GPS telemetry data, thus capture of adult sitatunga is a research priority. Assessing the effects of habitat and location on detection will be valuable for SECR density estimates, thus obtaining adequate GIS information is another priority for 2017.

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