

PROJECT TITLE: **Capacity building for preservation of naturally accumulated skeletal collections in Bwindi Impenetrable National Park**

Project Dates: July 15, 2017 – July 14, 2020

Location: Bwindi Impenetrable National Park

Core Partners: The George Washington Univ. (GW); Dr. Shannon McFarlin, Assoc. Professor (**Applicant**)
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Institute of Tropical Forest Conservation (ITFC); Dr. Robert Bitariho, Director

Collaborating Partners: Mountain Gorilla Veterinary Project (MGVP); Dr. Mike Cranfield, Director
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INTRODUCTION

Bwindi Impenetrable National Park in southwestern Uganda spans >32,000 hectares, and contains a variety of habitat types ranging from 1,160 to 2,607 meters in altitude. Located at the intersection of the Albertine Rift, Congo basin and East Africa, Bwindi is understood to have served as a Pleistocene refugium for forest species in the past. Today, Bwindi is known for its exceptional biodiversity within East Africa, and is a designated UNESCO World Heritage Site (UNESCO, 2017). Many species that live within Bwindi are globally threatened or endangered, including many species of butterflies, birds, and mammals, including high profile species such as the African elephant, eastern chimpanzee, l'hoest's monkey, and mountain gorilla (IUCN World Heritage Outlook, 2017; The IUCN Red List of Threatened Species, 2017).

Approximately 400 of the world's ~880 Critically Endangered mountain gorillas live in Bwindi (Roy et al., 2014; The IUCN Red List of Threatened Species, 2017). A developed ecotourism program in Bwindi brings visitors from around the world to see the gorillas, and generates critical revenue to support conservation. Despite being separated from the mountain gorillas of the Virunga Massif by just 30km, Bwindi gorillas are distinctive ecologically, and differ in many aspects of their behavior and life history (e.g., Watts, 1984; McNeilage, 2001; Ganas et al., 2004; Ganas and Robbins, 2005; Robbins et al., 2009; Robbins, 2011; Wright et al., 2015). Continued efforts to better understand the biology, behavior and population dynamics of Bwindi gorillas remains a priority for their effective conservation, as does strengthening ongoing educational programs around the park focused on both local and tourist communities.

We propose to recover naturally accumulated skeletons of mountain gorillas from Bwindi Impenetrable National Park, and of other fauna where possible, and help build local capacity to support their long-term preservation as a scientific and educational resource in Uganda.

MAJOR OBJECTIVES

We propose to work together as a team, with the assistance of other partners/participants as appropriate, towards the following collaborative objectives.

Short-term objectives (with current funding):

Assist UWA and ITFC in the systematic recovery and curation of mountain gorilla skeletons buried in BINP to prevent their degradation, and initiate training of UWA and ITFC staff to establish a foundation for the long-term preservation of BINP skeletal collections as a resource in Uganda. Specific aims include:

1. Excavate naturally accumulated skeletal remains of mountain gorillas from existing burials in BINP.
2. Clean, catalog and inventory existing and recently excavated skeletal specimens, to establish a curated skeletal collection of BINP mountain gorillas and other fauna, housed in temporary space provided by ITFC.

3. Establish protocols for the post-mortem burial and recovery of skeletal remains arising from future mountain gorilla deaths, and from other fauna when discovered in the forest.
4. Engage Ugandan field and research staff of UWA and ITFC, and Ugandan students where possible, in all of the above activities to initiate training and building of expertise in osteology, skeletal excavation, preparation, curation and management practices.

Long-term objectives (pending additional support):

Build local capacity for the sustainable preservation and management of BINP skeletal collections as a resource for science, education and tourism in Uganda. Specific aims include:

1. Establish long-term sites and protocols for the post-mortem burial and recovery of mountain gorilla skeletal remains in/around BINP.
2. Establish long-term housing of curated BINP skeletal collections as a scientific and educational resource in Uganda.
3. Pursue expanded opportunities for training of UWA and ITFC staff, and mentoring of Ugandan students, in osteology, skeletal preservation and management, and skeletal research, to build local capacity for sustainable collections preservation and scientific programs to be carried out by Ugandan scientists.
4. Use resources and knowledge generated from BINP skeletal collections and research to support the education and tourism missions of partner organizations, including outreach to local schools and communities, and development of content for UWA and ITFC conservation education programs.

EXPECTED RELEVANCE

Scientific capacity and knowledge:

Through training opportunities for Ugandan staff in systematic skeletal preservation practices to ensure sustainability of this effort, and research mentoring opportunities for Ugandan students and scholars, this resource will facilitate new research avenues ultimately to be led by Ugandan scientists.

Natural history collections serve as a reservoir of valuable data relevant to understanding biodiversity, species responses to climate change, infectious disease, and other emerging problems (e.g., Rocha et al., 2014; Dieulliis et al., 2016). Less than a handful of Bwindi mountain gorilla skeletal specimens are represented in museums outside Uganda, and more generally, eastern gorilla natural history collections in museums worldwide are limited in scope and/or poorly provenanced. This project will establish an exceptionally rare and invaluable skeletal resource that will contribute to the knowledge of mountain gorillas in Bwindi Impenetrable National Park, Uganda. Opportunistically collected skeletons representing Bwindi's other fauna will further expand the scientific potential of the collection.

The collection will facilitate new avenues of research to generate unique insights into aspects of mountain gorilla morphology, developmental biology, life history, behavior and health, which complement ongoing research and veterinary monitoring efforts focusing on living members of the population. Since existing mountain gorilla burials in BINP comprise individuals whose lives span decades, from the 1980s (if not earlier) to the present day, the collection also has the potential to contribute retrospective knowledge of mountain gorillas living before current monitoring programs were fully established. Finally, as Bwindi mountain gorillas are ecologically distinctive, and differ in many aspects of their behavior and life history from other gorillas, this collection will significantly enhance scientific research to understand factors influencing gorilla diversity.

Education and Tourism:

Knowledge generated from research on skeletal collections can be used in the development of content relevant to mountain gorilla conservation to be employed in conservation education centers, museums, and other public learning spaces. This knowledge can be displayed the form of skeletal 'casts' (or copies) to engage visitors directly in 'hands-on' learning, through three-dimensional imagery (e.g., 'virtual' skulls), or other visual and written content. 'Portable' content can also be developed for outreach programs taken to local schools.

Skeletons (or casts generated from skeletons) can be used to develop foundational knowledge in anatomy and biology, and to engage school children and other visitors in a variety of topics, such as: *the structure of the human body and how it differs from our close primate relatives; features of the skeleton that convey information about what animals eat or how they live; growth and aging of mountain gorillas; reconstructing 'skeletal life histories' of individual Bwindi gorillas; and major threats to the conservation of mountain gorillas and other animals of Bwindi.*

Because the skeleton reveals information not only about how animals live, but also how they die, skeletons can be very powerful tools for teaching visitors about conservation. Through interactions with local schools, local communities and international visitors/tourists, they can play an important role in helping visitors learn about science and increase their interest, understanding and appreciation of the value of biodiversity conservation (Reiss et al., 2016).

We anticipate using knowledge gained from the BINP skeletal collection to assist UWA, ITFC and our other partners in developing content for planned Conservation Education Centers in Buhoma, and elsewhere, and to contribute content for conservation education programs based in local area schools (e.g., Bwindi Apes Conservation Education Partnership). Additionally, as this project proceeds, we look forward to finding other ways to use the BINP skeletal collection to support the education and tourism missions of our partners.

PROVISIONAL SCHEDULE

The proposed efforts in BINP will be concentrated in shorter-term field seasons of approximately 1-2 months in duration each, to occur annually. (Schedule subject to change based on logistics and other constraints).

Pilot Visit: July 17-28, 2017

Goal – To discuss project objectives, catalogue existing skeletons and conduct pilot burial excavations of BINP mountain gorillas, to better understand local conditions so that we may enact a postmortem burial protocol and plan for a larger skeletal excavation effort to begin in 2018.

- **Meet with partners** to discuss short- and long-term project objectives.
- **Clean and catalogue** existing skeletal specimens currently stored at ITFC, and establish a temporary ITFC storage location for these and additional skeletal specimens to be recovered from BINP.
- **Locate and excavate burials** in the Ruhija sector of BINP:
 - Note, we expect Rukina's burial to be the easiest to locate, followed by Zeus and the unnamed Bitkura BB. There is very little information concerning the burial location of Busyingye, Ratona and Kiconcyo

Gorilla burials in/near Ruhija; information provided by Gorilla Doctors.

Group	Age	Sex	Name	Year	Location	GPS	Vet/pathologist(s)
Kya.	SB	M	Zeus	2004	Ruhija	?	Innocent Rwego, Benard Ssebide
Kya.	INF	F	Busingye	2005	ITFC cpd	?	ITFC staff buried without PM
Bit	BB	M	Unnamed	2007	Ruhija	0806823/ 9883894	Benard Ssebide, Eddy Kambale, Gladys Kalema
Kya.	INF	M	Ratona	2007		?	
Kya.	INF	M	Kiconcyo	2009			
Kya.	SB	M	Rukina	2015	Katonvi hill	0808278/ 9882349	Ricky Okwir

- Based on these excavations, draft a **proposed burial protocol** for future mountain gorilla deaths to be discussed by the partners.
- **Capacity Building** - Working with two UWA staff and two ITFC staff in all of the above activities, *initiate introductory training* in the following areas to build local expertise (to be continued and expanded in future years):
 - Skeletal anatomy/identification.
 - Skeletal cleaning, labeling, inventory and cataloguing protocols
 - Skeletal excavation protocols
 - Skeletal collections management practices
 - Introduction to selected research problems and techniques in skeletal biology: linear measurements, dental impressions, and three-dimensional imaging of skeletal specimens

Year 1: 2018

- **Meet with partners** to discuss progress and current protocols, revisit short- and long-term project objectives, and discuss specific objectives for workshop training.
- Hold a **workshop for UWA and ITFC staff** in Ruhija, Buhoma and Nkuringo/Rushaga, to provide introductory training on the following topics:
 - Objectives of the BINP skeletal project; what we can learn from preserving the skeletons of animals from BINP; value of these skeletons as a resource for research and education
 - Skeletal identification; bones of the skeleton; protocols for handling a carcass discovered in the forest; protocols for burying a carcass.

*For the workshop to be held in Ruhija, this can include a visit to the skeletal collection lab.
- **Locate and excavate burials in the Buhoma sector** of BINP:
 - Note: working with UWA, we located the burial sites for Ruhondeza and Mwirima in July, 2016, and are confident these are recoverable. For remaining burials, we will first prioritize GPS-documented burials. We expect it may be difficult or impossible to locate burials without GPS.

Gorilla burials in/near Buhoma; information provided by Gorilla Doctors.

Group	Age	Sex	Name	Year	Location	GPS	Vet/pathologist(s)
Katendegere	INF	M	Ruhara	1996		?	UWA vet ?
Katendegere	SB	M	Mugurusi	1996		?	UWA vet ?
Mubare	JUV	M	Kawere	1998		?	UWA vet ?
Habinyanja B	INF	M	Unnamed	2002	Rangers camp	?	Mike Cranfield, John Bosco Nizeyi
Habinyanja B	INF	M	Unnamed	2002		?	Gladys Kalema
Mubare	INF	M	Bukumu baby	2004		?	Chris Whittier, Benard Ssebide
Habinyanja	INF	M	Unnamed	2004		?	Innocent Rwego, Gladys Kalema
Mubare	INF	M	Bukumu baby	2004		?	
Mubare	INF		Bukumu baby	2005		?	
Habinyanja	INF	F	Binyonko baby	2007		?	Benard Ssebide, Denis Muhangi
Mubare	INF	M	Bukumu baby	2007		?	
Mubare	ADF	F	Kashongo	2009		?	Mike Cranfield, Benard

							Ssebide
Mubare	INF	M	Kashongo baby	2009		?	Mike Cranfield, Benard Ssebide
Mubare	INF	M	Kashundwe baby	2009	Muzabagiro loop	0790033/9890948	Gladys Kalema
Habinyanja	BB	M	Mizano	2011	Mugamizano in Bwindi 'neck'	?	Abdulhameed Kateregga
Rushegura	AD F	F	Nyamunwa	2011	Hakondo	0792873/9890588	Fred Nizeyimana
Mubare	SB	M	Ruhondeza	2012	Buhoma HQ near old offices	0793430/9893918*	Fred Nizeyimana
Oruzogo	INF	M	Kakobe twin baby	2012	Buhoma HQ near gorilla doctors	?	Mike Cranfield, Benard Ssebide, Abdulhameed Kateregga
Rushegura	SB	M	Mwirima	2014	Near Buhoma Park HQ.	0791040/9890445	Fred Nizeyimana, Jan Ramer
Solitary	SB	M	Mutesi	2014	Kancherere	0793870/9892092	Fred Nizeyimana
Mubare	INF	F	Mitunu's Inf	2015	Gorilla Doctors Cpd	Exact site known	Ricky Okwir, Benard Ssebide

- **Clean, catalogue and inventory** newly recovered skeletal specimens.
- **Capacity Building** - Working with two UWA staff and two ITFC staff in all of the above activities, *continue* more targeted training in the following areas to build local expertise:
 - Training on skeletal anatomy/identification. Develop more detailed expertise of skeletal anatomy and biology through a more comprehensive *short course in osteology*.
 - Review the following protocols developed in Year 1, and target new knowledge development as needed:
 - Skeletal cleaning, labeling, inventory and cataloguing
 - Skeletal excavation protocols
 - Skeletal collections management practices
 - Continue introductions to selected research problems and techniques in skeletal biology.

Year 2: 2019

- **Meet with partners** to discuss progress and current protocols, plan Year 2 field efforts, and discuss longer-term objectives.
- Where possible, **locate and excavate burials in the Nkuringo and Rushaga sectors** of BINP. (Note, given the number of burials, we expect these excavations may continue in Year 3.)

Gorilla burials in/near Nkuringo and Rushaga; information provided by Gorilla Doctors.

Group	Age	Sex	Gorilla name	Year	Burial area	GPS	Vet/ pathologist(s)
Nkuringo	SB	M	Unnamed	2002		?	Mike Cranfield, Benard Ssebide
Nkuringo	INF		Wageni baby	2002		?	
Nkuringo	ADF	F	Wageni	2004		?	
Nkuringo	INF		Twin baby	2005		?	
Nkuringo	SB	M	Nkuringo	2008	Mulore, buffer zone	0791726/9884142	Jean Felix Kinani, Benard Ssebide, Denis Muhangi
Nkuringo	INF	F	Katungi	2010	Rangers camp	0793070/9880993	Jean Felix Kinani, Fred Nizeyimana

Nkuringo	ADF	F	Samehe	2011	Muryamirembe in buffer zone	0790500/ 9884754	Fred Nizeyimana, Jean Bosco Noheri
Nkuringo	SB	M	Karibu	2014	Bushaho in buffer zone	0793263/ 9881717	Fred Nizeyimana, Mike Cranfield, Methode Bahizi, Jean Bosco Noheri
Solitary	ADF	F	Unnamed	2015	Nyarugaragara in buffer zone	0792786/ 9883113	Fred Nizeyimana, Ricky Okwir
Bushaho	ADF	F	Unnamed	2016	Kyangara	0795180, 9879912	Ricky Okwir
Bushaho	INF		Kafupi	2016	Nkuringo Hill	0794392, 9881758	Fred Nizeyimana
Nshongi	ADF	F	Nkuhene	2010	Mulukore	0801619/ 9879441	Fred Nizeyimana, Jan Ramer
Nshongi	ADF	F	Un-identified chimp	2010	Mpororo central	0800471/ 9878212	Fred Nizeyimana, Jan Ramer
Kahunge	INF	F	Un-named	2011	Byabitukuru	0798835/ 9878772	Fred Nizeyimana, Jean Bosco Noheri
Nshongi	ADF	F	Bwiruka	2012	Nyundo hill	0807073/ 9877083	Fred Nizeyimana
Kahunge	SB	M	Ruhamuka	2013	Kahunge hill	0798492/ 9880613	Fred Nizeyimana
Solitary	SB	M	Unnamed	2013	Hakondo	0792686/ 9891064	Fred Nizeyimana
Mishaya	SB	M	Mishaya	2014	Bubare	0799747/ 9876878	Fred Nizeyimana, Jean Bosco Noheri, Jan Ramer
Bweza	INF	M	Unnamed	2015	Byabitukuru	0798857/ 9877821	Fred Nizeyimana, Ricky Okwir
Bikingi	INF	M	Unnamed	2015	Mucungo	0797525, 9880894	Fred Nizeyimana
Busingye	INF	F	Czerina's baby	2015		Known burial site	Fred Nizeyimana

- **Clean, catalogue and inventory** newly recovered skeletal specimens.
- **Capacity Building** - Working with two UWA staff and two ITFC staff in all of the above activities, *continue* more targeted training in the following areas to build local expertise.
 - Training on skeletal anatomy and biology. Review knowledge developed in Year 1, and target continued learning where needed.
 - Review the following protocols and assess progress in attaining proficiency.
 - Skeletal cleaning, labeling, inventory and cataloguing
 - Skeletal excavation protocols
 - Skeletal collections management practices
 - Continue introductions to selected research problems and techniques in skeletal biology.
 - As the collection is anticipated to have grown by Year 2, it will be a valuable resource for research. Thus, in addition to working with UWA/ITFC staff in all of the above activities, we will also pursue opportunities to mentor a Ugandan Masters student for their thesis research.
 - With UWA, ITFC and other partners, pursue opportunities to developing content for planned Conservation Education Centers in Buhoma and elsewhere, and to contribute content for conservation education programs based in local area schools.

Year 3: 2020

- Meet with partners to discuss progress and current protocols, plan Year 3 field efforts, **discuss progress towards project sustainability**, and develop **plans for pursuing long-term scientific and**

educational objectives.

- Complete any **remaining excavations of burials** not recovered in Years 1 and 2, as well as excavations of recent burials accumulated since 2017. Clean, catalogue and inventory these skeletal specimens.
- **Capacity Building** - Working with UWA staff and ITFC staff in all of the above activities, continue more targeted training in the following areas to build local expertise. *Goal: To develop proficiency in the following areas by the end of Year 3.*
 - Review knowledge developed in Years 1 and 2, and assess progress in attaining proficiency. Target continued learning where needed in the following areas.
 - Skeletal anatomy and biology.
 - Skeletal cleaning, labeling, inventory and cataloguing
 - Skeletal excavation protocols
 - Skeletal collections management practices
 - In addition to working with UWA/ITFC staff in all of the above activities, we will also pursue opportunities to mentor a Ugandan Masters student for their thesis research.
 - Continue to strengthen the educational/tourism impact of the project, through interactions with the UWA and ITFC Conservation Education Centers and conservation education programs based in local area schools.

LIST OF DATA INSTRUMENTS

- Standard skeletal excavation equipment (shovels, trowels, basins for cleaning bones)
- Portable osteometric board for collecting skeletal measurements
- Digital camera and laptop for collecting data (FOR SCIENTIFIC PURPOSES ONLY: NOT FOR COMMERCIAL PURPOSES)
- 3D laser scanner for collecting three-dimensional images of bones (FOR SCIENTIFIC PURPOSES ONLY: NOT FOR COMMERCIAL PURPOSES)
- Other small consumable supplies (e.g., masks, gloves, polyvinylsiloxane molding material, cleaning detergent)

BUDGET

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