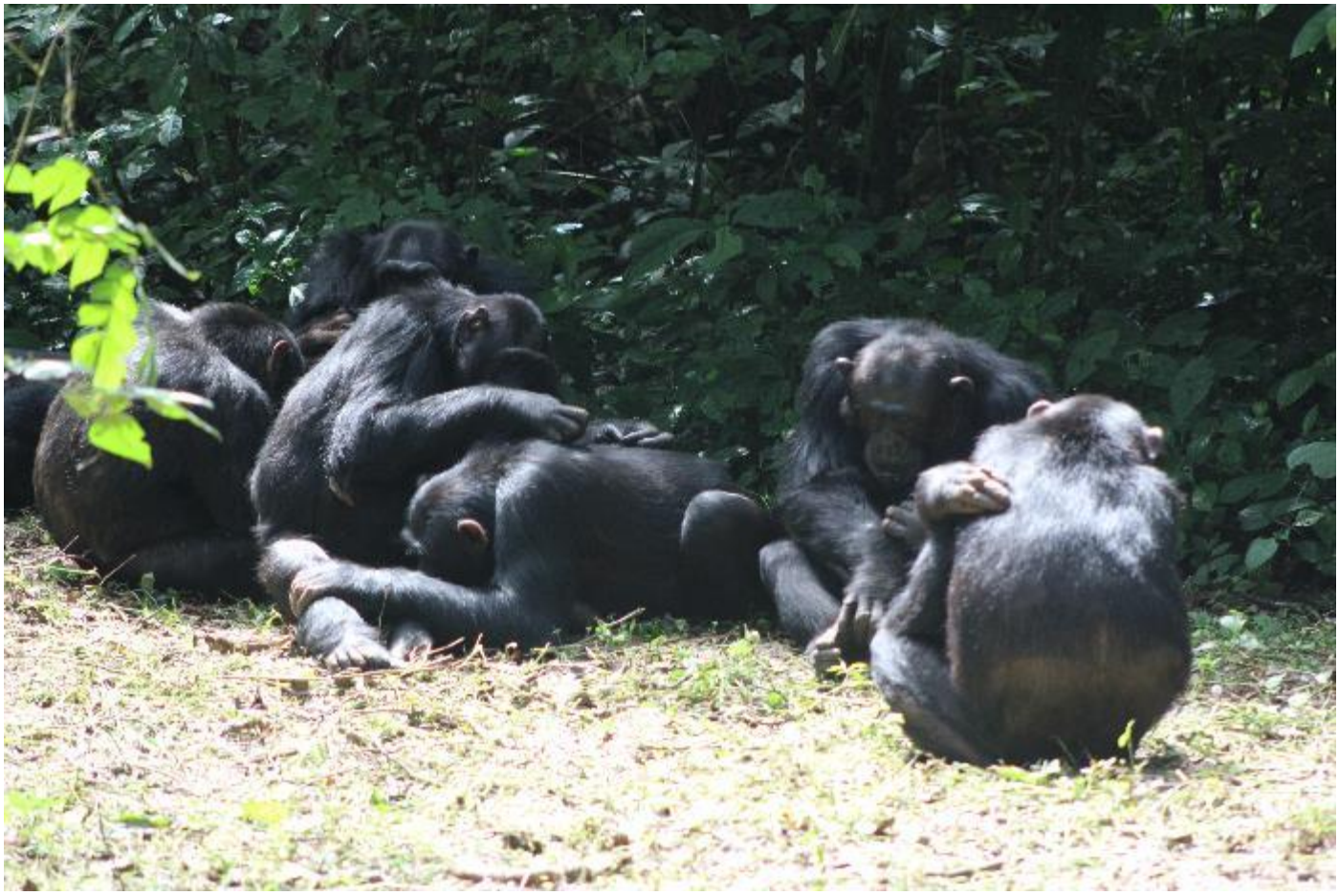

Chimpanzees grooming together. Grooming helps in removing parasites, and strengthens social bonds. Photo credit: Budongo Conservation Field Station

Earthwatch 2019 Annual Field Report

INVESTIGATING THREATS TO CHIMPANZEES IN UGANDA

Changes in tree reproductive phenology: Implications for primate foraging, avifauna abundance and human-wildlife conflict around Budongo Forest Reserve, Uganda

LEAD PI: FRED BABWETEERA
Report completed by: FRED BABWETEERA, DAVID ERYENYU and MOREEN UWIMBABAZI
Affiliation: BUDONGO CONSERVATION FIELD STATION

Period covered by this report: January 2019-December 2019

Dear volunteers

The period we live in, has been referred to us the Anthropocene. The rise in human populations, the consequent demand for resources, and the desire for economic development has resulted in tremendous changes in the composition and functioning of natural systems. Our understanding of the impact of these changes, in the short term and long term, remains poor, yet imperative for the sustainable management, and conservation of species and ecosystems. Budongo Forest is no exception with regards to these challenges. Although blessed with a rich diversity and long history of scientific endeavors and conservation efforts, Budongo Forest, to date, faces challenges from outside and within. A growing human population, expanding commercial agriculture, disappearing patches of forests in its surrounding, and changes in weather and climatic patterns puts new pressures on this ecosystem. In the end, change in one component of the ecosystem potentially has cascading effects on the others. Our long-term goal is to use scientific endeavors and community engagements to ensure a habitable environment for people and wildlife. Using long-term data, we are now aware that there has been a decline in the number of fruiting trees over the years, and forest structural changes and climatic factors contribute to this decline. This project investigates the trend in fruiting, and goes further to understand the dynamics in the population of dependent species. We have expended the geographical and ecological scope of this project over the years, built some insights, and with more data, we anticipate a better understanding of some components, when the data gets analyzed.

Your participation in our field research immensely contributes towards achieving the data needs to achieve these ambitions. This year, we met our data collection targets, and briefly share with you some of the results as we know now, but also give an outlook going forward.

This task is demanding, and we are grateful to people like you, who dedicate their time and resources to enable us achieve this goal. The effect of your support is enduring, and you give us joy in sharing what we have learnt, while giving us a challenge to reflect and devise better ways to understand these systems and functioning. Working together with you makes us feel that we have partners, and provides us with energy to continue.

It is always our pleasure to have you in Budongo, and we feel stronger, that together with you, we collectively contribute to the conservation of Budongo, and global biodiversity.

Asante sanna!

Fred Babweteera

Volunteers receive instructions on the setting of mist nets (Photo credit: Budongo Conservation Field Station)

SUMMARY

It is now eight years since Earthwatch Institute offered to support this project. Here, we share with you some of things we have learnt over the year for the different research objectives. Particularly, we share on what we know about the fruiting patterns, the primate foraging patterns, and the patterns we so far discern for the avifauna. We also provide you with an outlook, and what our plans going into the future are. Overall, we were successful with our data collection targets, and data amounts starting to promise to provide opportunity to comprehensive analysis into some of the questions of interest.

GOALS, OBJECTIVES, AND RESULTS

1. **To assess the patterns of tree phenology (fruiting and flowering) in different forest types of Budongo Forest Reserve.**

In Budongo Forest, we have studied phenology patterns from 1993 to date. The motivation for collecting this data was to better understand and create ecological and evolutionary linkages between fruiting levels and frugivore species behavioral aspects. An initial exploration of this data revealed an overall decline in the number of fruiting trees over the years (Babweteera et al., 2012), with a 15% overall decline, and up to 60% decline in fruiting for some keystone species. Keystone species being those species that play an important ecological role, for example that they provide or constitute much of the forage, or that they are used as food trees when food sources are scarce. Thereafter, we expanded on these studies to different forest sections, considering that we had sampled a limited number of forest areas. In 2011, we expanded from 10 transects in two forest sections to 30 transects in six forest compartments. In 2018, we statistically considered the available data from the two forest compartments, and looked at 24 years of fruiting (Babweteera et al., 2018, 2012). From this analysis, we now know that forest conditions and species ecological groups influence the fruiting patterns. Particularly, species group that are adapted to light conditions, and usually at the canopy receiving more light, fruited more regularly. On the other hand, tree species and ecological groups adapted to low light conditions were severely affected by the decline in the number of fruiting trees, and were mainly in low light conditions. These are strong indications that the light environment in the forest, driven by forest structural changes, is changing. Basically, that trees adapted to living under low light conditions, and usually at the lower forest canopy are the most negatively affected, as the forest canopy closes, leaving them to access less light; and light is nevertheless essential for especially reproductive functions. We also know that some previously logged sections of the forest have a relatively high stem density and average tree height (Eryenyu, 2018), all indicators of competition, and light is known to be one of the limiting resources in tropical forests (van Schaik, Terborgh, & Wright, 1993), for which there is competition among plants. We also know that

climatic changes have an effect. Particularly, we know that species groups that showed the most decline also showed a correlation with the minimum temperature, yet there has been a rise in minimum temperature in Budongo Forest and surrounding landscapes (Babweteera et al., 2012). This has implications for the functioning of the forest, considering that extremes of temperature are predicted to occur at a global level (Doughty et al., 2015; IPCC, 2014), but equally localized for the Budongo landscape (Babweteera et al., 2012).

These results are, however, from a limited area of the forest. Phenological patterns and cycles are better appreciated with long-term data, considering that they are very complex, with site, species and individual differences. We have nonetheless progressed in building the data base for four additional forest areas, and currently approaching a stage where the data should be sufficient for some statistical considerations, from where we should be able to better explore the patterns across different forest areas, and improve our understanding, especially if what we know currently is abroad pattern across the structural and species diversity of the Budongo Forest.

On the other hand, a lot of questions still remain unexplored, and could be useful in better appreciating phenological patterns. For example, edaphic and nutrient characteristics of the soil remains unexplored, yet potentially important for understanding these patterns. We also motivated to continue to make these studies to the future, as recent studies have shown that tropical forests are extremely dynamic (Anderson-Teixeira et al., 2015; Malhi, Gardner, Goldsmith, Silman, & Zelazowski, 2014), but particularly, we suspect the Budongo Forest may experience long-term cyclic changes, resulting in opening and closure of the forest, and cascading changes in forest functioning, which hypothesis can only be explored with long-term data.

2. **To determine the abundance and/or current foraging patterns of primates and birds in relation to foraging patterns and/or abundances observed in the early 1990s**

a) ***Current foraging patterns of primates in relation to foraging patterns observed in the 1990s, and implications of changes in tree fruiting in Budongo on crop raiding by primates around the reserve***

The interest in this objective is to understand how primates are responding to the observed decline in the number of fruiting trees over the years, but particularly by comparing old data with that from current observations. From previous considerations, we know that there is a diet shift,

with fruits becoming less in the diet of frugivorous primates (Nyombi, 2015). We also observed that the proportion of trees contributing to the diet of monkeys has changed (Eryenyu et al., 2019) (Table 1), especially that few tree species now contribute more to the diet than in the past, and primates relying heavily on a few species than previously (Table 2a, 2b). These results indicate changes in the diet priorities of species. However, a preference for ripe fruits and young leaves, considering fruit stage and leave stage persists, showing preference for high sugar content in fruits and proteins in young leaves respectively. The priority of species, defined by the proportion of time they have been seen feeding on them also seems to change, with new species, compared to the 1990s, becoming more dominant in the diet. The implications of these can be fully understood by a nutritional analysis of the food content of individual species.

Table 1: Number of tree species contributing to the diet of chimpanzees in the 1990s and 2010s

Monkey species	Number of tree species fed on	
	2012-2017	1994-1995
Black and white colobus	35	57
Blue monkey	54	85
Red tailed monkey	40	75
All species	64	103

On the implications of decline in fruiting on crop raiding patterns, we have previously collected and analyzed data on the crop raiding patterns (Nyombi, 2015). The most outstanding outcome of this analysis is the realization that primates chose to visit villages during the peak period of availability of fruits in the forest, and in the months of April to June. Coincidentally, this period also overlaps with the maturity and ripening of food crops and fruit trees in human settlements. It seems therefore that primate and general crop raiding patterns is an opportunistic behavior, and showing preference for crops grown by humans. This is not surprising, considering that humans over the centuries have either selected the best food crops, or have bred these crops to optimize their nutrient content and palatability. Similar results were previously reported for the Budongo Forest in an earlier study (Tweheyo, Hill, & Obua, 2005), with a correlation between incidences of crop raiding and fruit availability in the forest. These results are not surprising, considering that foraging theory predicts that animals opt for those species that provide optimal reward for any energy invested.

Volunteers with teachers of Karongo Primary School-a school at the forest edge, sharing teaching experiences. This group of volunteers had a number of teachers.

We have suspended data collection with regards to crop raiding, to avoid interview fatigue in the communities. However, over the years, we have worked with communities to address challenges related to crop raiding. Several interventions, including experimentation with non-traditional crops and those potentially less vulnerable to crop raiding, to enterprise development and vocational skill development, have been tried as alternative approaches with different levels of success. The search for alternative crops and models of how to grow them remains an option we remain open to explore, as we find it pertinent to help farmers cope with the problem of crop raiding and its impacts on livelihoods.

Volunteers receive briefing on the techniques used by poachers to relocate the snares. Snares indiscriminately target species, including the chimpanzees. Snare injuries have a long-term effect on the lives of chimpanzees, including negatively affecting their health, ability to access food resources, maneuver social aggressions, and for females, reduce their ability to take of infants.

Table 2a: Proportional contribution of tree species to the diet of different monkey species in the 1990

	Plant species	B Monkey	Plant species	BWC monkey	Plant species	RT monkey
1	*Celtis durandii*	0.09	*Celtis durandii*	0.15	*Celtis durandii*	0.10
2	*Cynometra alexandrii*	0.09	*Celtis mildbraedii*	0.07	*Cynometra alexandrii*	0.06
3	*Maesopsis eminii*	0.08	*Alstonia boonei*	0.06	*Maesopsis eminii*	0.06
4	*Celtis zenkeri*	0.08	*Maesopsis eminii*	0.06	*Celtis zenkeri*	0.06
5	*Celtis mildbraedii*	0.06	*Cynometra alexandrii*	0.05	*Celtis mildbraedii*	0.06
6	*Climber spp*	0.04	*Celtis zenkeri*	0.03	*Climber spp*	0.04
7	*Croton macrostachys*	0.03	*Climber spp*	0.03	*Croton macrostachys*	0.04
8	*Ficus sur (capensis)*	0.03	*Khaya anthotheca*	0.02	*Ficus sur (capensis)*	0.03
9	*Broussonetia papyrifera*	0.03	*Bosqueia phoberos*	0.02	*Khaya anthotheca*	0.03
10	*Khaya anthotheca*	0.03	*Broussonetia papyrifera*	0.01	*Funtumia elastica*	0.03
		0.56		**0.50**		**0.52**

Table 2b: Proportional contribution of tree species to the diet of different monkey species in the 2010s

	Plant species	B monkey	Plant species	BWC monkey	Plant species	RT monkey
1	*Broussonetia papyrifera*	0.15	*Celtis durandii*	0.20	*Khaya anthotheca*	0.19
2	*Khaya anthotheca*	0.14	*Khaya anthotheca*	0.18	*Broussonetia papyrifera*	0.10
3	*Maesopsis eminii*	0.11	*Ficus exasperata*	0.10	*Ficus exasperata*	0.09
4	*Ficus exasperata*	0.10	*Maesopsis eminii*	0.09	*Albizia glaberrima*	0.06
5	*Funtumia elastica*	0.06	*Broussonetia papyrifera*	0.08	*Funtumia elastica*	0.05
6	*Celtis durandii*	0.04	*Celtis mildbraedii*	0.05	*Climber spp*	0.05
7	*Albizia glaberrima*	0.04	*Cynometra alexandrii*	0.04	*Celtis mildbraedii*	0.04
8	*Cynometra alexandrii*	0.03	*Cola gigantea*	0.04	*Maesopsis eminii*	0.04
9	*Climber spp*	0.03	*Albizia glaberrima*	0.03	*Celtis durandii*	0.04
10	*Ficus sur (capensis/vogelana)*	0.03	*Climber spp*	0.03	*Morus lactea*	0.03
		0.74		**0.84**		**0.70**

b) Abundance of frugivores in relation to abundances observed in the 1990s

During 2019, a total of 64 and 160 bird species were recorded using mist nets and point counts respectively. However, we now have data for three years (2017-2019), a cross six forest compartments, representing different management histories and plant species composition of the Budongo Forest. We provide a preliminary insight into this data, especially considering the different bird feeding guilds (de Graaf, Tilgman, & Anderson, 1985): frugivores, insectivores and nectarivores. Feeding guilds (representing different species assemblages and ecological groups) can alert us to changes driven by environmental changes, since they share common resources and can respond similarly to changes affecting the resource. A cross different forest compartments, we see variation in species assemblages (Figure 1a and 1b). Frugivores were more species diverse compared to insectivores (Figure 1a) whereas insectivores accounted for the highest number of bird individuals in many compartments (Figure 1b).

Above: *Volunteers observe demonstration on the taking of bird morphometrics*

Left: *Volunteers participates in mist net setting.*

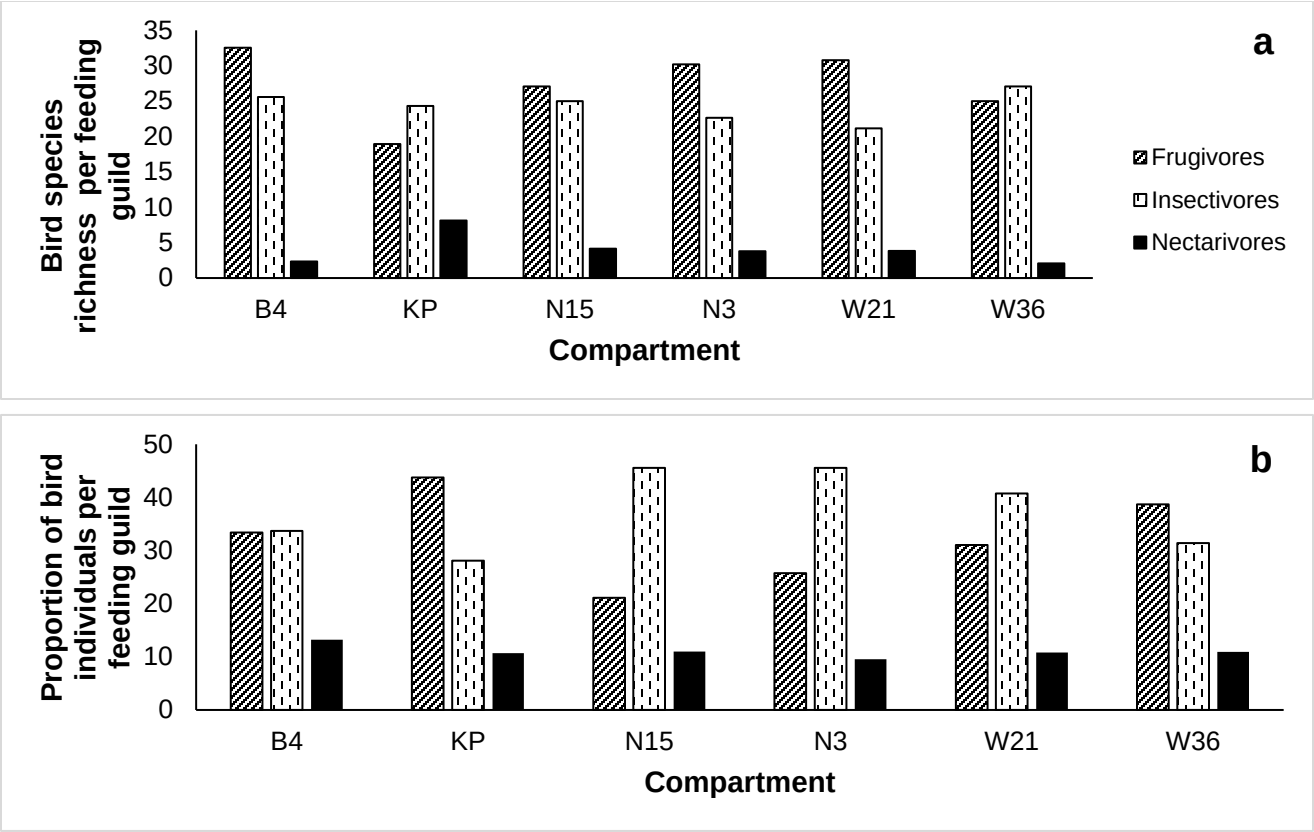

Figure 1: (a) Bird species richness and **(b)** abundance per feeding guild across the compartments for the period 2017 to 2019.

The different compartments were further categorized into different forest types according to the logging intensity (with intensity based on the amount of timber removed per hectare) as: heavily logged, slightly logged and unlogged. Species diversity in the three main feeding guilds varied across these forest types, whereby frugivorous birds were abundant (Figure 2a) in the heavily logged forests but represented by less frugivorous species (Figure 2b) and the reverse was true for the slightly logged forests. Primary (unlogged) forests are richer in insectivorous birds than frugivorous birds (Figure 2).

The variation in the assemblages of birds for the different feeding guilds between compartments and forest types may be due to the differences in vegetation structure, phenology patterns, logging intensity and time since logging of the study sites.

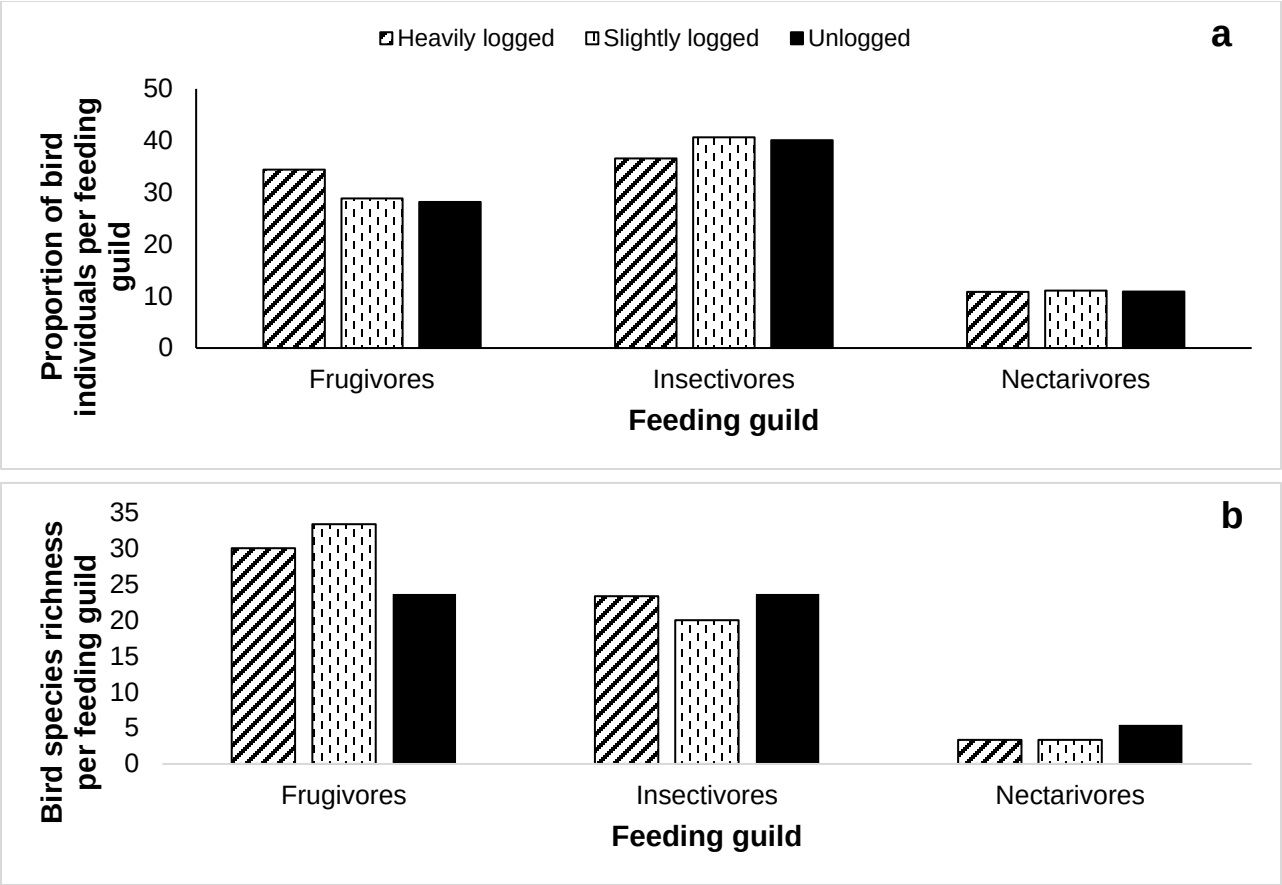

Figure 2: **(a)** Proportion of bird individuals and **(b)** species recorded per feeding guild for the different forest types for the years 2017-2019.

3. **To explore the patterns of insect pollinator assemblages (abundance, species richness and diversity) and pollination services in different forest types of Budongo**

DATA COLLECTION ON THIS MODULE SUSPENDED TILL THE RESEARCH STUDENT RESUMES.

4. **To investigate the relationship between tree growth patterns and tree phenology**

On this objective, we continue to collect data on forest productivity, particularly on stem and root productivity. We shared results from this effort in the previous report, but continue towards building a long-term perspective on patterns of productivity, and how past management and environmental factors interact to determine carbon storage (Eryenyu, 2018).

On the other hand, working with George-August University, Gottingen, and Makerere University, Kampala, we have set up a nutrient manipulation experiment intended to understand if nutrient

additions can improve on forest productivity, and consequently if nutrient(s) limit the productivity of Budongo Forest. We therefore aim at, in 2020, incorporating phenological observations, to understand the role of nutrients in forest productivity and phenology, and what role nutrients may have in the observed decline in number of fruiting trees. We hope that this study will facilitate us in teasing apart the role of nutrients in the observed decline in fruiting, but also provide a more complete picture of the interaction between productivity and reproductive phenology.

PROJECT IMPACTS

1. Increasing Scientific Knowledge

a) Total citizen science research hours

On average, volunteers spend eight hours working, being trained, or moving to areas of field work. In 2019, we received a total of 40 volunteers, contributing approximately 3200 work hours to our field work.

b) Peer-reviewed publications

Babweteera, F., Plumptre, A. J., Adamescu, G. S., Shoo, L. P., Beale, C. M., Reynolds, V., … Muhanguzi, G. (2018). The ecology of tree reproduction in an African medium altitude rain forest. Biotropica, 50(3), 405–417. https://doi.org/10.1111/btp.12563

Babweteera, F., Sheil, D., Reynolds, V., Plumptre, A. J., Zuberbuhler, K., Hill, C. M., … Tweheyo, M. (2012). Environmental and anthropogenic changes in and around the Budongo Forest Reserve. In J. A. Plumptre (Ed.), *The ecological impact of long-term changes in Africa's Rift Valley* (pp. 31–53). Nova Science Publishers, Inc.

c) Non-peer reviewed publications:

Technical reports, white papers, articles, sponsored or personal blogs

Eryenyu, D. (2018). *Belowground Carbon Allocation in an African Tropical Forest with a History of Different Management Practices*. An *Msc Thesis*, Makerere University, Kampala.

Nyombi, H. 2015. *Tree fruiting phenology: Implications on primate foraging patterns in and around Budongo Forest Reserve, Uganda*. Unpublished MSc Thesis, Makerere University. 106 pp

d) Books and book chapters

Babweteera, F., Mawa, C., Asiimwe, C., Okwir, E., Muhanguzi, G., Okimat, J. P., & Robinson, S. (2018). Budongo Forest: A paradigm shift in conservation? In *Conservation and Development in Uganda* (pp. 104-122). Routledge.

e) Presentations:

David Eryenyu, Herbert Nyombi, Caroline Asiimwe, Moses Businge, Geoffrey Muhanguzi, Fred Babweteera, 2019. Implications of change in fruiting phenology on primate foraging behavior. A paper presented at the Second African Primatological Society Conference, Entebbe, Uganda. Earthwatch was acknowledged.

2. Outreach and Mentoring

a) Graduate students

List graduate students doing thesis work on the project and include student CVs and their research proposal on file with the university as an attachment when you submit your annual report

Student Name	Graduate Degree	Project Title	Anticipated Year of Completion
David Eryenyu	PhD	The effect of nutrient manipulation on allocation to productivity and phenology in the Budongo Forest	2023
Mercy Bwire	MSc	Assessment of temporal changes in diet of Budongo Forest Reserve chimpanzees	2020

b) Community outreach

Provide details on how you have supported the development of environmental leaders in the community in which you work.

Name of school, organization, or group	Education level	Participants local or non-local	Estimated number of participants	Details on contributions/ activities
Makerere University	Undergraduate, Graduate	Local	100	Providing training and Research facilities
Masindi District Local government	All levels	Local	30	Conservation education and forest field exposure
Kinyara Sugar Works	All levels	Local and non-local	15	Forest exposure and conservation education

3. Partnerships

List your current active professional partnerships that contribute to your project and indicate the type of support these partners provide

Partner	Support Type(s)[1]	Years of Association (e.g. 2006-present)
Masindi District Local Government	Dissemination of results on patterns of human-wildlife conflicts in relation to tree fruiting phenology.	2012-to-date
Makerere University, Kampala	Technical support, collaboration, academic support	2012-to-date
Wildlife Conservation Society (WCS)	Technical support, Collaboration	2015-to-date
Royal Zoological Society of Scotland	Funding (provides the core funding for BCFS activities)	2006-to-date

[1]. Support type options: funding, data, logistics, permits, technical support, collaboration, academic support, cultural support, other (define)

4. Contributions to management plans or policies

List the management plans/policies to which your project contributed this year

Plan/Policy Name	Type[2]	Level of Impact[3]	New or Existing?	Primary goal of plan/policy[4]	Stage of plan/policy[5]	Description of Contribution
N/A	N/A	N/A	N/A	N/A	N/A	N/A

[2]. Type options: agenda, convention, development plan, management plan, policy, or other (define)

[3]. Level of impact options: local, regional, national, international

[4]. Primary goal options: cultural conservation, land conservation, species conservation, natural resource conservation, other (define)

[5]. Stage of plan/policy options: proposed, in progress, adopted, other (define)

5. Conserving natural and sociocultural capital

a) Conservation of taxa

i. List any focal study species that you did not list in your most recent proposal

Species	Common name	IUCN Red List category	Local/regional conservation status	Local/regional conservation status source
N/A	N/A	N/A	N/A	N/A

ii. *In the past year, has your project helped conserve or restore populations of species of conservation significance? If so, please describe below.*

Species	IUCN Red List category	Local/regional conservation status	Local/regional conservation status source	Description of contribution	Resulting effect[6]
Pan troglodytes schweinfurthii	Endangered	Threatened by population growth and	IUCN	Protection of species from snares injuries habitat destruction and loss, by presence of research staff in the species home range, who make hunters shy to sets nares, but also remove snares upon encounter	Reduced numbers of snare injuries and death Reduced prevalence of opportunistic diseases
Cordia millenii	Least Concern Globally, Endangered in Uganda	Illegal logging targets mature "mother" trees, restricting recruitment	IUCN, National Red List for Uganda	The research area has majority of the remaining mother trees, with presence of researchers and field assistants deterring illegal activities.	Mature (mother) trees protected, protecting chance of recruitment; mature trees may be used for seed collection for restoration purposes

6. Resulting effect options: decreased competition, improved habitat for species, range increased, population increase, improved population structure, increased breeding success, maintained/enhanced genetic diversity, other

b) Conservation of ecosystems

In the past year, has your project helped conserve or restore habitats? If so, please describe below.

Habitat type	Habitat significance[7]	Description of contribution	Resulting effect[8]
Forest	Feeding site, breeding ground, home range of the Sonso and Waibira Chimpanzees communities	Presence of researchers make illegal forest users shy to access research areas hence minimize illegal activities that impact on species and ecosystem integrity.	Reduced numbers of snare injuries and death of the chimpanzees Reduced prevalence of Opportunistic diseases for primates arising from vulnerably due to stress from snare injuries Mature timber species protected in the research area compared to non-research area.

7. Habitat significance options: nursery, breeding ground, feeding site, corridor, migration path, refuge, winter range, summer range, spring range, fall range or other (define)

8. Resulting effect options: extent maintained, condition achieved, restored, expanded, improved connectivity or resilience

c) Ecosystem services

*Indicate which ecosystem service categories you are **directly studying** in your Earthwatch research and provide further details in the box below as needed.*

Provisioning Services

☐Fisheries (Fresh & Marine)
☐Energy (Fuelwood/hydropower)
☐Livestock grazing
☐Material extraction (e.g. resin, grass)
☐Timber
☐Water supply
☐Other food (crops, wild foods, spices)
☐Pharmaceuticals

Regulating & Support Services

☒Carbon sequestration/storage/"blue"
☐Coastal protection
☐Erosion control
☐Flood regulation/protection
☐Pest and disease control
☐Pollination
☐Seed dispersal
☐ Water purification/quality
☒ Nutrient cycling

Cultural Services

☐Cultural/historical values
☐Health (mental & physical)
☐Research & knowledge
☐Recreational
☐Spiritual/aesthetic values

Other Services

☒Biodiversity
☐Employment/Livelihoods

Details:

We are studying carbon allocation in Budongo Central Forest Reserve. This has a relationship with nutrient recycling, since some elements directly measure nutrient cycling while growth and reproductive patterns (phenophases) imply use of nutrients and/or resource allocation.

The experiment on nutrient manipulation directly measures carbon sequestration, while giving an account of how these changes with levels of nutrients (though currently not an Earthwatch funded project, are similar to current other studies carried out, and answers broadly similar questions).

d) Conservation of cultural heritage

Provide details on intangible or tangible cultural heritage components that your project has conserved or restored in the past year.

Cultural heritage component[9]	Description of contribution	Resulting effect
Traditional hunting route	The route to the field station passes through the "Royal mile" which was a traditionally royal hunting route, and one of the best bird watching site in Uganda, helping to maintain this route	The hunting route is maintained, and the cost of maintaining it is reduced since there is regular usage of the road. This route could get covered up by forest growth if not for the regular usage
Former sawmill site	The research station is located at, and using building which were for the sawmill for saw logs from this forest. This was one of the largest sawmills in Uganda's forest harvesting history.	The station uses buildings formerly for the sawmill, besides maintaining the site previously for the sawmill.

[9] Cultural heritage component options: traditional agriculture, artifacts, building(s), hunting ground or kill site, traditional ecological knowledge and practices, monument(s), oral traditions and history, spiritual site, traditional subsistence living

e) Impacting local livelihoods

Provide details on how livelihoods were impacted by your project. This includes persons hired to assist Earthwatch teams (field assistants, guides, cooks, drivers, etc.) and any economically applicable training provided to local community stakeholders.

Local livelihood impact(s)	Description of contribution	Number of people impacted
Field assistants	This project has continuously employed field assistants since 2011 to collect data on the different aspects, including that of phenology and ornithology	Four persons
Support staff	We usually hire additional staff to support the stay of volunteers	Two support staff

RESEARCH PLAN UPDATES

Report any changes in your research since your last proposal/annual report. For any 'yes' answers, provide details on the change in the 'Details' box. This section will not be published online.

1) Have you added a new research site or has your research site location changed? ☐**Yes** ☒**No**
2) Has the protected area status of your research site changed? ☐**Yes** ☒**No**
3) Has the conservation status of a species you study changed? ☐**Yes** ☒**No**
4) Have there been any changes in project scientists or field crew? ☐**Yes** ☒**No**

Details – provide more information for any 'yes' answers

5) Provide details on any changes to your objectives, volunteer tasks, or methods, include reason for the change.

ACKNOWLEDGEMENTS

Earthwatch Institute makes a commendable effort in organizing the volunteers' trips and resources, and this effort is much appreciated. The volunteers who accept this project, contribute their resources and time are equally much appreciated, and your efforts makes a difference to this project. Your participation does not only allow us to collect data in the amount planned, but also make us realize the partnerships we enjoy, and boost our morale in doing sometimes difficult field work. This project benefits from the dedication and knowledge of the different field staff, and their effort is equally appreciated. Our local partners include the National Forestry Authority, the Uganda Wildlife Authority, the National Council for Science and Technology, and the President's office that approve and allow our research to continue in the protected areas. Masindi District Local Government give us support in communication, education and dissemination of research findings to local communities. Makerere University has always supported students on this project, by contributing to capacity building, and enabling them accomplish their research goals. The Royal Zoological Society of Scotland provides core funding to BCFS, enabling the running of day to day activities at the research station.

LITERATURE CITED

Anderson-Teixeira, K. J., Davies, S. J., Bennett, A. C., Gonzalez-Akre, E. B., Muller-Landau, H. C., Joseph Wright, S., … Zimmerman, J. (2015). CTFS-ForestGEO: A worldwide network monitoring forests in an era of global change. *Global Change Biology*, *21*(2), 528–549. https://doi.org/10.1111/gcb.12712

Babweteera, F., Plumptre, A. J., Adamescu, G. S., Shoo, L. P., Beale, C. M., Reynolds, V., … Muhanguzi, G. (2018). The ecology of tree reproduction in an African medium altitude rain forest. *Biotropica*, *50*(3), 405–417. https://doi.org/10.1111/btp.12563

Babweteera, F., Sheil, D., Reynolds, V., Plumptre, A. J., Zuberbuhler, K., Hill, C. M., … Tweheyo, M. (2012). Environmental and anthropogenic changes in and around the Budongo Forest Reserve. In J. A. Plumptre (Ed.), *The ecological impact of long-term changes in Africa's Rift Valley* (pp. 31–53). Nova Science Publishers, Inc.

de Graaf, M. R., Tilgman, G. N., & Anderson, H. S. (1985). Foraging Guilds of North American Birds. *Environmental Management*, *9*(6), 493–536.

Doughty, C. E., Metcalfe, D. B., Girardin, C. A. J., Huasco, W. H., Silva-Espejo, J. E., Murakami, A., … Malhi, Y. (2015). Drought impact on forest carbon dynamics and fluxes in Amazonia ´. *Nature*, *519*(79), 78–94. https://doi.org/10.1038/nature14213

Eryenyu, D. (2018). *Belowground Carbon Allocation in an African Tropical Forest with a History of Different Management Practices*. Makerere University, Kampala.

Eryenyu, D., Nyombi, H., Asiimwe, C., Businge, M., Muhanguzi, G., & Babweteera, F. (2019). Implications of change in fruiting phenology on primate foraging behavior. In *Second Afeican Primatological Conference*. Entebbe: African Primatological Society.

IPCC. (2014). *Climate change 2014: a synthesis report. Contribution of the working groups I, II, and III to the Fifth Assessment report of the Intergovrenmental Panel on Climate Change*. (R. K. Pachauri & L. A. Meyers, Eds.) (Vol. 108). Geneve, Switzerland: IPCC. https://doi.org/10.1073/pnas.1116437108

Malhi, Y., Gardner, T. A., Goldsmith, G. R., Silman, M. R., & Zelazowski, P. (2014). Tropical Forests in the Anthropocene. *Annual Review of Environment and Resources*, *39*, 125–159. https://doi.org/10.1146/annurev-environ-030713-155141

Nyombi, H. (2015). *Tree fruiting phenology: Implications on primate foraging patterns in and around Budongo Forest Reserve, Uganda*. Makerere University.

Tweheyo, M., Hill, C. M., & Obua, J. (2005). Patterns of crop raiding by primates around the Budongo Forest Reserve, Uganda. *Wildlife Biology*, *11*(3), 237–247. https://doi.org/10.2981/0909-6396(2005)11[237:POCRBP]2.0.CO;2

van Schaik, C. P., Terborgh, J. W., & Wright, S. J. (1993). The Phenology of Tropical Forests : Adaptive Significance and Consequences for Primary Consumers. *Annual Review of Ecology and Systematics*, *24*(1993), 353–377.