EARTHWATCH INSTITUTE

INVESTIGATING THREATS TO CHIMPS IN UGANDA

2014

FIELD REPORT

Investigating Threats to Chimps in Uganda

2014 FIELD REPORT

Background Information

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CHANGES TO:

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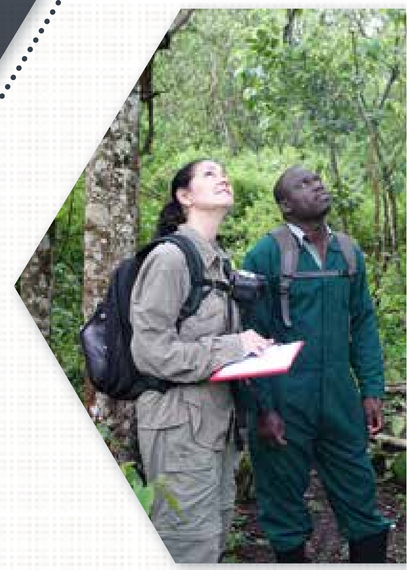

Dear Friends of Budongo,

Greetings from an unusually sunny and hot Budongo Forest. First and foremost, on behalf of the field team I would like to thank all of you for supporting and being a part of our research team. Your participation in the data collection has edged us closer to understanding the mystery of why trees are no longer fruiting as much as they used to. During this fielding year we were able to complete all the monthly phenology observations (every single tree was visited once every month). We were able to record additional primate foraging observations to match the data collected in the early 1990s. We are now confident that analysis of the data sets provides reasonable comparisons of the current primate diet and the diet in the early 1990s. There is no doubt that fruits no longer constitute the bulk of frugivorous primates' diet. Instead, primates are opting for leaves and other plant parts such as herbaceous stems, bark and flowers. The implications of this dietary change are yet to be known. In addition, we observed that there is no indication that primates intensify their raids on agricultural crops during periods of fruit scarcity in the forest. It appears that primates crop raid because of a preference for agricultural crops but not a scarcity of food in the forest.

The quest to understand why trees no longer fruit, has identified changes in forest structure as a potential driver of tree fruiting. A pilot assessment of the effect of canopy openness on tree flowering showed that trees that flowered were in more open habitats than trees that did not flower. Consequently, it is plausible that past management practices that affect temporal variations in canopy structure of tropical rain forests may affect tree fruiting. This may be good news for the primates given that the current cycle of reduced tree fruiting could be a temporary phase that may change with time.

Understanding these trends would not have been possible without your support. We are truly grateful. We have only made preliminary analyses of our data sets and we are looking forward to making comprehensive analyses of our data. We look forward to a continued collaboration with Earthwatch.

Asante saana.

SECTION ONE: Scientific research achievements

TOP HIGHLIGHT FROM THE PAST SEASON

The reduction in the proportion of fruiting trees in Budongo continues to be a mystery. Over the past two years, we have confirmed that indeed the reduction in tree fruiting is not a localized incident but indeed a forest wide occurrence. To understand why this was happening, we set out to investigate two possible causes, namely, climate change and changes in insect pollinator assemblages. The data collected so far does not seem to provide a link to these factors. This year, we examined the effects of changes in forest structure, particularly, canopy openness on tree flowering. The preliminary results indicate that canopy openness above conspecific trees that flowered was significantly higher than the canopy openness above trees that did not flower. This may imply that changes in the forest structure that may cause closure of the canopy may cause a temporal variation in tree flowering, consequently tree fruiting. There is need to assess canopy openness over a larger sample of trees to generate data that is more conclusive

REPORTING AGAINST RESEARCH OBJECTIVES

Objective 1: Patterns of tree phenology (fruiting and flowering) in different forest types of Budongo

We conducted monthly phenology monitoring within seven forest compartments N3, N15, B1, B4, W21, W36 and KP representing different forest types as a result of the past management practices. These habitats have contrasting vegetation structure, plant species composition and levels of anthropogenic disturbances. Along these transects we monitored flowering and fruiting patterns of over 7,300 individual trees in 700 plots. The proportion of fruiting trees is still lower than what was recorded in the early 1990s.The decline in the proportion of fruiting trees observed across the seven forest compartments is consistent with the decline earlier reported in all the forest compartments. This probably confirms the prediction that decline in tree fruiting is not localized in a few compartments previously studied but could be a reflection of a decline in the number of fruiting trees across the entire forest.

During this year we also observed that fruiting patterns differed among forest types with more fruiting observed in the more pristine forest compartment (N15, N3 and W21) compared to secondary forest types (B4 and B1). Compartments B4 and B1 are heavily affected by illegal pit sawying communities. Therefore illegal logging (leading to forest disturbance) might have had an impact on the forest structure which eventually affects phenology of trees in these compartments.

To gain a deeper understanding of the causes of reduced tree fruiting, we considered an assessment of the effects of changes in forest structure on tree fruiting. We selected five common tree species (*Funtumia elastica, Rinorea Ilicifolia, Lasiodiscus mildbraedii, Croton sylvaticus* and *Uvariopsis congensis*) and sampled individual tree species that flowered and others that did not flower during 2013/2014. We then took measurements of canopy openness above the flowering and non-flowering individual trees of the same size (diameter at breast height). The results indicated that canopy openness above conspecific trees that flowered was significantly higher than the canopy openness above trees that did not flower. This may imply that changes in the forest structure that may cause closure of the canopy may cause a temporal variation in tree flowering, consequently tree fruiting. There is need to assess canopy openness over a larger sample of trees to generate data that is more conclusive.

Furthermore, to assess the effects of rainfall patterns on tree fruiting, we found a positive correlation between tree fruiting phenology and rainfall amount. Tree fruiting peaked with increased rainfall and minimum temperatures. Analysis revealed two fruiting peaks between April-May and December-January. Tree fruiting in a given base month was directly correlated to an increase in both rainfall and minimum temperatures in the previous months.

Objective 2: Carbon Cycling and its implication on tree growth and reproduction in Budongo Forest

As we explore the reasons behind the reduced fruiting of trees in Budongo, there are several hypotheses. Initially, we were exploring the effect of climate change and insect pollinator assemblages on tree fruiting patterns. Data collected so far shows no direct linkage between tree fruiting, climate change and/or pollinator assemblage. Consequently, we started investigating the effects of changes in forest structure on tree fruiting patterns. In addition, we are investigating a fourth possible hypothesis that increased carbon dioxide levels are driving trees to invest more in tree growth and less in reproduction. Consequently, by measuring carbon dioxide exchange in relation to tree growth we will be able to deduce whether indeed trees are investing more in tree growth.

To determine how carbon cycling impacts tree growth and reproduction, two intensive carbon monitoring plots, where all components of the forest carbon pool are regularly monitored, were established in Budongo Forest. The intention for establishing these plots is to provide long term data of trends in forests carbon pools. Methods used are based on the protocol of the Global Environment Monitoring (GEM) Network of quantifying forest carbon pools and fluxes. This will allow comparison of results with other sites across the pan-tropics. The data collected will is stored and shared in the GEM network application where data from different other sites is collected.

The objectives of the plots are to quantify the forest carbon pools, comparing the two forest structures and how these vary spatially, within and among sites; to quantify carbon fluxes in forest, comparing the two forest structures and how these vary temporally among years in relation to climate; to relate carbon fluxes to tree growth and phenology. The data will contribute to understanding the key environmental factors influencing key ecological processes in the forest ecosystem, with implications for future climate scenarios. The data collected will provides essential baseline estimates of current forest carbon storage/stocks, and allows tracking ongoing changes in forest carbon cycling; integrating data generated with that of other sites could be useful in the development of the next generation of coupled atmosphere-biosphere models that will play a key role in shaping international climate policy.

The activities implemented so far includes plot establishment, tree census, height measurement, sapling census, liana census, and the root growth measurements. Some of the equipment has already been assembled, awaiting installation.

Above ground living biomass measurements: The above ground living biomass is represented by the tree, saplings and seedlings biomass in the forests. Each tree within the plot (Dbh≥10cm) was identified and measured for diameter using a diameter tape either at 1.3 meters above the ground or at a varied distance from the ground depending on the stem structure based on rules of deviation from the measurements point(1.3m from ground). Each tree was given and painted with a number that allows retracing for future measurements, and its location among the twenty five sub-plots noted. Trees were also identified to species level, and where species could not be identified, the closest taxonomical grouping was given, usually the genus name. Two sets of diameter measurements have so far been made in the two plots, which are annual measurements. Dendrometers will be installed on some of the tree soon to allow more regular and more precise measurements of tree diameter growth to detect seasonal growth patterns.

Besides providing measurements for plant biomass and therefore rate of plant growth and carbon capture, information collected in diameter measurement is useful in the long run for monitoring changes in stem density and species composition of the forests. It also helps to monitor rate of death of plants, and therefore detect any unusual pattern of death of plants in the plot in the event of unusual weather patterns.

The total height of all the trees of ten centimeters and above in diameter (Dbh/DPOM) in the two plots were measured using a range finder. This will be useful, together with the tree diameter measurements, in calculating the biomass of the individual trees, and therefore for determining the amount of carbon in each of the trees, and the plot as a whole.

Sapling census: Saplings represent trees of between two and ten centimeters in diameter at breast height. The diameter of saplings was measured within the sapling census plots for forest biomass calculation. Five plots of 10m×10m (sapling census plots) were established at the four corner subplots and one at the centre subplot for this purpose. All the saplings were measured for diameter at 1.3 meters from the ground, and given numbers and their species identified. The points of measurements were painted, and each sapling tagged with numbered ribbons to aid future identification for subsequent measurements. So far, one set of measurement has been made in each of the two plots. The sapling census information is useful for forest biomass calculation, and can show patterns of species recruitment and biomass changes with long term data.

Liana census: Lianas are woody forest climbers. Recent observations show that Lianas may be increasing in their densities/dominance and growth rate with the increasing levels of carbon dioxide levels in the atmosphere, and therefore could be important in carbon sequestration in the face of climate change. The diameter of all the Lianas with any point at least ten centimeters in diameter within two and a half meters from the ground were measured at three points along its stem, using a diameter tape. The three points are: 1.3 meters along its length from the ground, 1.3 meters vertically from the ground, and the largest point along the stem within 2.5 meters vertically from the ground. This measurement will help in monitoring the growth rates and input of lianas into the forest living biomass pools. In addition, lianas can cast shade on tree species thus affecting flowering potential of trees.

Root growth measurement: Roots form an important part of the forest carbon pool, especially the fine roots. Roots absorb moisture and nutrients for plant growth and maintenance. Fine root dynamics are affected by climate and edaphic factors, and the interactions between many of these and the plant physiology. Fine roots can therefore be a good indicator of the tree response to changes in the environment. Two methods of root growth measurement have therefore been deployed. The two sets of equipment used for root growth measurement are in-growth cores, and rhizotrons.

Left: An Earthwatch volunteer and BCFS Field Assistant installing root-growth monitoring equipment in compartment N3, Budongo Forest.

In-growth cores are a way of measuring fine root growth at depth of up to 30 cm. In-growth cores are cores of root free soil surrounded by mesh bags, which allow estimation of root production per unit area per unit time. They are inserted into the soil and removed at regular intervals, for this case every three months, and the roots in the soil core collected, cleaned of soil, and dried to constant mass. This then represents fine root growth within a specified period.

Materials were procured, and the in-growth cores made. Sixteen in-growth cores were installed in each of the plots in a grid of 4×4, and these are visited after every three month, removed out of the ground, roots within each picked, cleaned, and packed in paper for drying to constant mass in an oven, and this mass represents plant root growth within the three month. The in-growth cores for N3 were installed in April, 2014, while those of KP were in June, 2014.

Rhizotrons, which are chambers inserted into the soil, measure surface root growth (≤30 cm depth) in tropical field sites which allow frequent in situ observation of root growth. The chambers consist of a transparent perspex sheet which is supported by a wooden or metallic framework. The length extension of roots growing adjacent to the perspex sheet is recorded as an indicator of root growth, and they allow more regular readings than in-growth cores. The root growth is traced on transparencies, and analyzed using an image analyzer to derive root length, and therefore the mass.

The materials were procured, and nine rhizotrons were assembled and installed in pits dug for the purpose in each of the two plots. After installing, the equipment were left for two month after which readings are taken from each every month; involving the tracing of the root growth of each screen on to a transparencies, according to their diameter classes. The data collected so far by this method has been scanned, awaiting a computer application for transforming the tracings into root biomass. Installations took place in April and June 2014 for N3 and KP respectively.

Litter trap equipment assembling: Equipment required for fine litter measurement have so far been procured and assembled. Data collection of litter fall will commence as soon as an appropriate gas powered oven is installed at the field station. Litter fall data is collected on weekly basis thus requires on site oven drying.

Carbon dioxide efflux: Equipment for carbon efflux has been procured awaiting installation by the expert collaborators. Carbon dioxide efflux refers to the carbon dioxide released into the forest atmosphere by respiratory activities of organisms in the forests. Carbon dioxide efflux originates from plant respiration, and that of other organism in the soil. Four main measurements of the efflux will be taken: total soil carbon dioxide efflux, stem carbon dioxide efflux, components of soil carbon dioxide efflux (partitioning experiment) and coarse woody debris carbon efflux.

Total soil carbon dioxide efflux represents the carbon dioxide released from activities roots and associated organisms, and due to the decomposition of organic matter in soil and on the soil surface. Stem respiration represents carbon dioxide released by respiratory activities on the tree stem. While coarse woody debris refers to respiration activities due to the decomposition of the forest litter, and therefore the contribution of coarse woody debris to forest carbon dioxide efflux. Components of soil carbon dioxide efflux or partitioning experiment refers to the separation of total soil respiration to the contributing sources which are; root respiration, rhizomicrobial respiration, and the respiration due to the decomposition of soil organic matter. Collars made of plastic, with modification for the partition experiment, will be installed in the forest and tree stems, and the soil respiration chamber (SRC) and the Infra Red Gas Analyzer (IRGA) will be used to measure each of those components of respiration in the forest.

Data collection for some of the forest carbon pools has been done, especially for the above ground living biomass, and the below ground living biomass, and will still continue. Some measurements, especially those that require drying have not been implemented because it is not cost effective to operationalize without an oven with the appropriate temperature adjustment range for sample drying at the field site. As soon as the oven is procured, such data will be collected. The other measurements, especially the carbon efflux measurements, will be implemented as soon as the equipment is installed. While data will continue to be collected, and in some cases data analysis made, the intention of most measurements is to show long term patterns.

Objective 3: Implications of changes in tree fruiting in Budongo on primate foraging

Analysis of three-yearlong (2012-2014) foraging data for Blue and Red-tailed monkeys of Budongo Forest Reserve shows a decline in the contribution of fruits to the diets of these frugivorous monkey species in comparison to their diet in the 1990s . In addition, it appears that while the proportion of fruits has declined in the diets of both species, the proportions of other fall-back diets have increased significantly. These fall-back diets include tree bark and herbaceous stems.

Primates in Budongo Forest appear to switch their diets to whatever food is readily available within their habitant. However, in relation to crop raiding, there is no indication that primates intensify their raids on agricultural crops during periods of fruit scarcity. For instance, although crop raiding by wild animals (especially primates) around Budongo Forest Reserve has increased both in intensity and frequency, raiding of agricultural crops peaked in May - June which corresponds with the peak fruiting season in the forest. Given that the agricultural crop maturity phase starts in May, it is plausible that primates crop raid because of a preference for agricultural crops but not a scarcity of food in the forest.

CHANGES TO RESEARCH PLAN OR OBJECTIVES

Initially, this study aimed at gaining a better understanding of the causes and implications of the changes in tree phenology. Two hypotheses were investigated namely effect of climate change and insect pollinator assemblages on tree fruiting patterns. Data collected so far has not shown a direct linkage between tree fruiting, climate change and/or pollinator assemblage. However, it is too early to rule out the effect of the two parameters. Consequently, we started investigating the effects of changes in forest structure on tree fruiting patterns. In addition, we are investigating a fourth possible hypothesis that increased carbon dioxide levels are compelling trees to invest more in tree growth and less in reproduction. Consequently, by measuring carbon dioxide exchange in relation to tree growth we will be able to deduce whether indeed trees are investing more in tree growth

SECTION TWO: Impacts

PARTNERSHIPS

- **Masindi District Local Government:** The local government has partnered with us to disseminate findings relating to the patterns of human-wildlife conflict in relation to changes in tree fruiting phenology
- **Global Environment Monitoring (GEM) Network:** Have assisted in the establishment of the carbon cycling monitoring programme.
- **Makerere University**: Provided laboratory space for drying materials; In addition, the project recruited two students to participate in data collection on this project
- **Wildlife Conservation Society(WCS):** We are working with scientists from WCS to develop a regional peer reviewed publication about changes in tree fruiting phenology across the tropics

DEVELOPING ENVIRONMENTAL LEADERS

One of our graduate students (Herbert Nyombi) successfully completed his MSc degree. He has been involved in teaching undergraduate students at Makerere University. Another graduate student (Nancy Akumu) is soon completing her studies as well and is currently working with an Environmental NGO based in Northern Uganda. We have recruited a third MSc student (David Eryenyu) to join the field research team.

The project has also provided a training platform for graduate and undergraduate students from two local universities (Makerere and Gulu) to train in applied tropical rain forest ecology and conservation.

IMPACTING LOCAL LIVELIHOODS

Most field assistants and support staff on this project are recruited locally.

LOCAL COMMUNITY ACTIVITIES

Local communities have been involved inthe on-farm studies to assess the frequency and intensity of crop raiding by forest dwelling animals. Most community members have registered appreciation for this study that seeks to develop pragmatic research based solutions for the chronic human-wildlife conflict. To this effect, we have established on farm demonstration/trial plots to assess the effectiveness of non-traditional crops that are less palatable to frugivorous forest dwelling animals.

DISSEMINATION OF RESEARCH RESULTS

Draft Manuscripts

- Relationship between wildlife crop-raiding patterns and tree fruiting patterns around Budongo Forest. (Submitted in February 2015)
- Effects of canopy openness on flowering and fruiting tree phenology in Budongo Forest. (Submitted January 2015)

Grey literature and other dissemination of your results

Academic theses

- Kisegu, D. (2014): Canopy openness in relation to flowering and fruiting tree phenology within Budongo Forest Reserve. BSc. dissertation, Makerere University
- Nyombi, H. (2014): Tree reproductive phenology under changing climatic conditions. MSc. thesis, Makerere University

Annual reports:

- Annual report to the Royal Zoological Field Station.

SECTION THREE: Acknowledgements, Funding and Appendices

PROJECT FUNDING

The project is co-funded by the Royal Zoological Society of Scotland who are the core donors of the Budongo Conservation Field Station.

ACKNOWLEDGEMENTS

I am grateful to all volunteers who joined us during the 2014 fielding season. You all made our work much easier and it was a joy working with you. I would also like to thank the field staff for the excellent field work during this year. The local communities and leaders have been a great partner in implementing this project. Last but not least, I would like to thank Earthwatch for the support in organizing the fielding and for the financial support in implementing this project.

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