DAVIS EXPEDITION FUND

REPORT ON EXPEDITION / PROJECT

Expedition/Project Title: A study of monodominant *Gilbertiodendron dewevrei* forest in the Nouabalé-Ndoki National Park, Republic of Congo.

Location: Nouabalé-Ndoki National Park, Republic of Congo.

Group Members: Ellen Heimpel (accompanied by David Harris, and Josérald Mamboueni)

Aims: To establish transects across the boundary between monodominant *G. dewevrei* and mixed terra firma forest to investigate how species composition changes across the boundary, and ask whether *G. dewevrei* is expanding into mixed forest.

A study of monodominant *Gilbertiodendron dewevrei* forest in the Nouabalé-Ndoki National Park, Republic of Congo.

Ellen Heimpel

July 2022, and November 2022 – January 2023

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Summary

This research involved two field seasons within or in the periphery zones of Nouabalé-Ndoki National Park (NNNP), Republic of Congo. The principal aim was to set up transects across the boundaries between monodominant *Gilbertiodendron dewevrei* forest and mixed *terra firma* forest, examining how tree species composition changes across the boundary, and investigating whether *G. dewevrei* is expanding into mixed forest. The majority of research for this aim was carried out in the second field season (Nov - Jan 2023).

In July 2022, as part of this research, I also assisted on a project to examine the effects of selective logging on tree species composition within the forests of the study area, mostly mixed *terra firma* forest, with some *G. dewevrei* forest. This was part of a long-term study to investigate how road development and multiple cycles of selective logging change forest structure and species composition.

Background

Large areas of the Congo Basin are dominated by the tree *Gilbertiodendron dewevrei* (Connell & Lowman, 1989; Gérard, 1960; Hart, 1990; Hart et al., 1989; Letouzey, 1985). Such dominance is exceptional in tropical forests, which contain the Earth's highest level of biodiversity. Overturning every stereotype of plant diversity in the tropics, *Gilbertiodendron dewevrei* forms stands in which up to 90% of the tree stems belong to just this one species (Djuikouo et al., 2014; Hart, 1995; Makana et al., 2011; Torti et al., 2001; Van der Burgt et al., 2021). For the past 60 years, scientists have been trying to determine how *G. dewevrei* achieves this dominance. The most recent research suggests a suite of traits of *G. dewevrei* combine to create an environment where it can dominate in stands and achieve a stable monodominant state (Peh et al., 2011; Torti et al., 2001). These include EM fungi, large shade-tolerant seedlings, mast fruiting, and light plasticity of seedlings (Hall et al., 2020; Peh et al., 2011; Tovar et al., 2019). Two recent publications on *G. dewevrei* monodominant forests have further increased our understanding of this forest type. Both these publications were based on research carried out in the Sangha Trinational, where this study took place. Tovar et al., (2019) used a pollen core from a yanga in the Goualougo Triangle to show that a small patch of *G. dewevrei* has been in continuous existence for at least 3000 years with low levels of forest disturbance and almost no change in species composition. Hall et al., (2020) showed that in the Sangha Trinational *G. dewevrei* is associated with moist and infertile soils and competes well under a variety of light conditions. However little research has been done into the distribution of these monodominant forest patches, and whether they are expanding, contracting or remaining stable.

This research aimed to study the boundaries between monodominant and mixed forest and investigate whether or not *G. dewevrei* is expanding into mixed forest. This was also the first study looking at detail at the boundaries of *G. dewevrei* forest, characterising them in terms of woody plant species and forest structure.

This specific project fits into a wider research context of trying to understand changing dynamics of species composition in the Sangha Trinational. In the first stages of this research, I assisted on a project examining the effects of selective logging on forest structure and tree species composition in the periphery zones of the NNNP, including *G. dewevrei* forest. In 2013-2014, twenty 50 x 50m plots were set up to start a long-term study looking at the impacts of selective logging on forest structure and tree diversity. Within these 20 plots, every tree ≥10cm in diameter at breast height (DBH), and a subset of trees ≥2cm in diameter was identified and measured. These plots were remeasured in 2016, with new recruits recorded. In 2017/2018 this forest area was selectively logged by Congolais Industrielle des Bois (CIB). This process involves a secondary logging road being made into the forest every 2km where the logging truck drives down. A bulldozer then goes into the forest from these secondary roads, building skidder trails to access the trees. After logging is complete, the roads are then blocked off to remove access. In July 2022, we returned to the plots and began the processing of recusing following this period of selective logging.

Aims:

Recensusing of permanent plots following a period of selective logging:

1. To recensus established plots following a period of logging, as part of a long-term study to understand the impact of selective logging on tree species composition and forest structure.
2. To assess the feasibility of data collection, and train the team to return and complete the measurements of the plots.

Examining the boundaries between monodominant *G. dewevrei* and mixed *terra firma* forest:

1. To set up transects across the boundary between monodominant *G. dewevrei* forest and adjacent mixed *terra firma* forest.
2. To investigate whether *G.dewevrei* forest is expanding, contracting or remaining stable.
3. To investigate how the species composition changes across the boundary from mixed to monodominant forest.

Materials and methods

Team:

July 2022: A team of 13 including David Harris, Josérald Mamboueni, Christopha Atikani, Davy Koni, and Ellen Heimpel.

November 2023: Josérald Mamboueni, Ellen Heimpel and David Harris. Each day we were accompanied by 2-3 trackers, which changed depending on the day, but included Kati, Kali, Bokili, Mokata, Lembe, Engo, Jali-Leon, Mosingala, Ndombo Rock and Ndzera Aeritier.

Figure 1. *The research team with a Diospyros crassiflora tree in Gilbertiodendron dewevrei forest. Left to right: E.Heimpel, Mokata, J.Mamboueni, Bokili. November 2022.*

Study area:

The Nouabale-Ndoki National Park (NNNP) is located in northern Republic of Congo (Fig. 2), covering more than 4,000 km^2 of contiguous lowland rainforest. It forms part of the larger Sangha Trinational, a network of protected areas in the north-west of the Congo River Basin, where Cameroon, the Central African Republic and the Republic of Congo meet at the Sangha River. The region has never been logged, contains no roads within its borders, and is an important stronghold for populations of large mammals including western gorillas, chimpanzees, and forest elephants. The vegetation types within this region include monodominant forest, which is characterised by high abundance of *Gilbertiodendron dewevrei*. This species occurs mostly alongside streams and rivers, but also occurs in extensive areas up to 10km from streams across the study site. Other vegetation types in the study include mixed species *terra firma* forest, riparian forest, open swamp forest and seasonally flooded forest along the Sangha River (Harris, 2002). The work in Nov - Jan 2023, setting up transects across boundaries between monodominant and mixed forest, took place in the surrounding area of Goualougo research camp (point A, Fig.2), within the NNNP. The research in July 2022 examining the effects of selective logging took place in the periphery zones of the NNNP (point B, Fig.2).

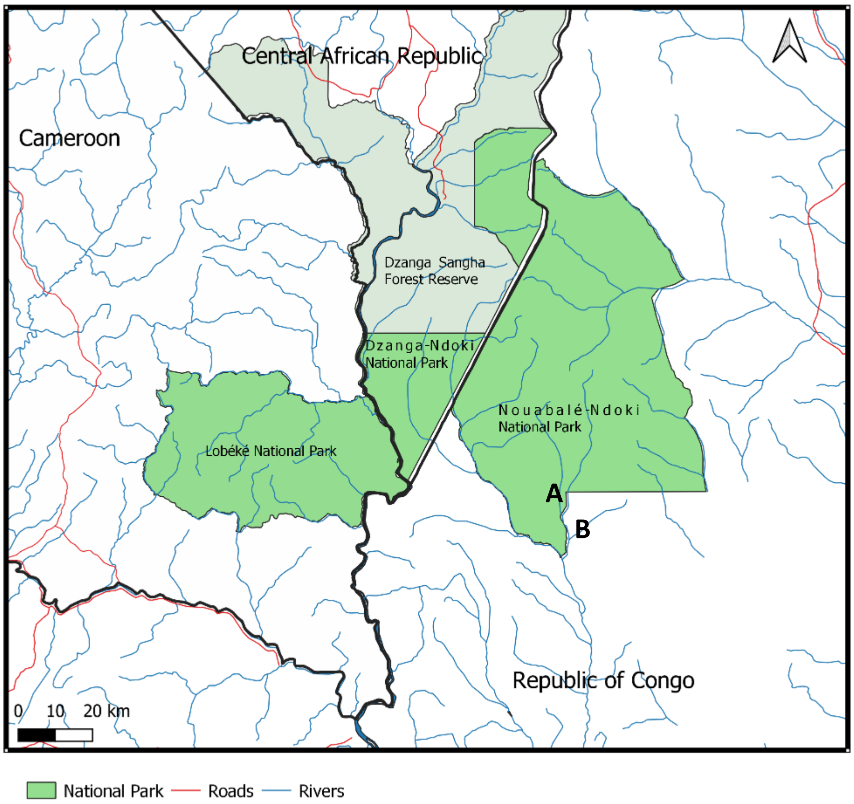

Figure 2: *Map showing the location of study areas. Point A shows the Goualougo Triangle Ape Project, where transects were set up across boundaries between G. dewevrei and mixed terre firme forest. Point B shows the location of Zone C plots in the periphery zone of Nouabalé - Ndoki national park.*

Data collection and analysis

July 2022 - Recensusing of permanent plots following a period of selective logging:

This research activity consisted of the recensusing of forest plots in the periphery zone of the Nouabalé - Ndoki National Park. A team of 13 people spent 2.5 weeks in the forest, during which we recenused three 50m x 50m permanent forest plots.

Plots were reestablished using GPS location and the presence of existing tree tags from previous surveys. These plots were then split into 25 subplots of 10m x 10m. Following standard protocols, each stem ≥10cm in diameter was identified, and the diameter at breast height (DBH) was measured, and a GPS point and X and Y coordinates were recorded. For a subset of the plot (one subplot of 10m x 10m), all trees ≥2cm DBH were measured. Trees from previous censuses were identified using tree tags. New recruits were also recorded. For each stem, we recorded: tag number, species, DBH, X and Y coordinates, and GPS coordinates. Notes were also made on the general condition of each subplot within every plot.

Figure 3. *Work in the plot. (A) Taking a DBH measurement with a DBH measurement tape; (B) marking out the plot boundaries following a compass bearing; (C) Replacing an old tree tag; (D) Taking a DBH measurement with electronic callipers.*

Nov 2022 - Jan 2023 - Examining the boundaries between monodominant *G. dewevrei* and mixed *terra firma* forest:

This study involved setting up transects across the boundaries between monodominant *G. dewevrei* and mixed *terra firma* forest in the vicinity of Goualougo research camp. GPS points were selected along boundaries between monodominant and mixed forest, using satellite imagery. The boundary point was determined on the ground as the final *G. dewevrei* seedling. The transects were then laid out at a 90° angle from the boundary: 120m in length (100m in *G. dewevrei* forest and 20m in mixed forest), and 40m in total width. Trees were measured in four different categories, with different transect widths for each category (Fig. 4). Categories were:

- Category 0 – All trees ≥ 70cm dbh. Transect was 40 m wide - 20 m either side of the main transect line.
- Category 1 – All trees ≥ 10cm dbh. Transect was 20 m wide - 10m either side of the transect line
- Category 2 – All trees 1–10 cm dbh. Transect was 4m wide. 2 m either side of the transect line
- Category 3 - Seedlings of *G.dewevrei* with dbh < 1 cm. Transect was 4 m wide. 2 m either side of the transect line.

Each stem was identified, DBH was measured, and position was recorded by measuring the length and width along/from the transect in metres. For category 3 (*Gilbertiodendron* seedlings), the height was measured, as well as the position. For unidentified trees, voucher specimens were taken for identification at RBGE (Fig.5).

In addition, transects were set up in the centre of *G. dewevrei* forest patches, to provide a comparison to test whether different patterns were observed at the boundaries. These were set up following the same procedure, except they were only 100 m in length, as they did not have the 20 m in mixed forest.

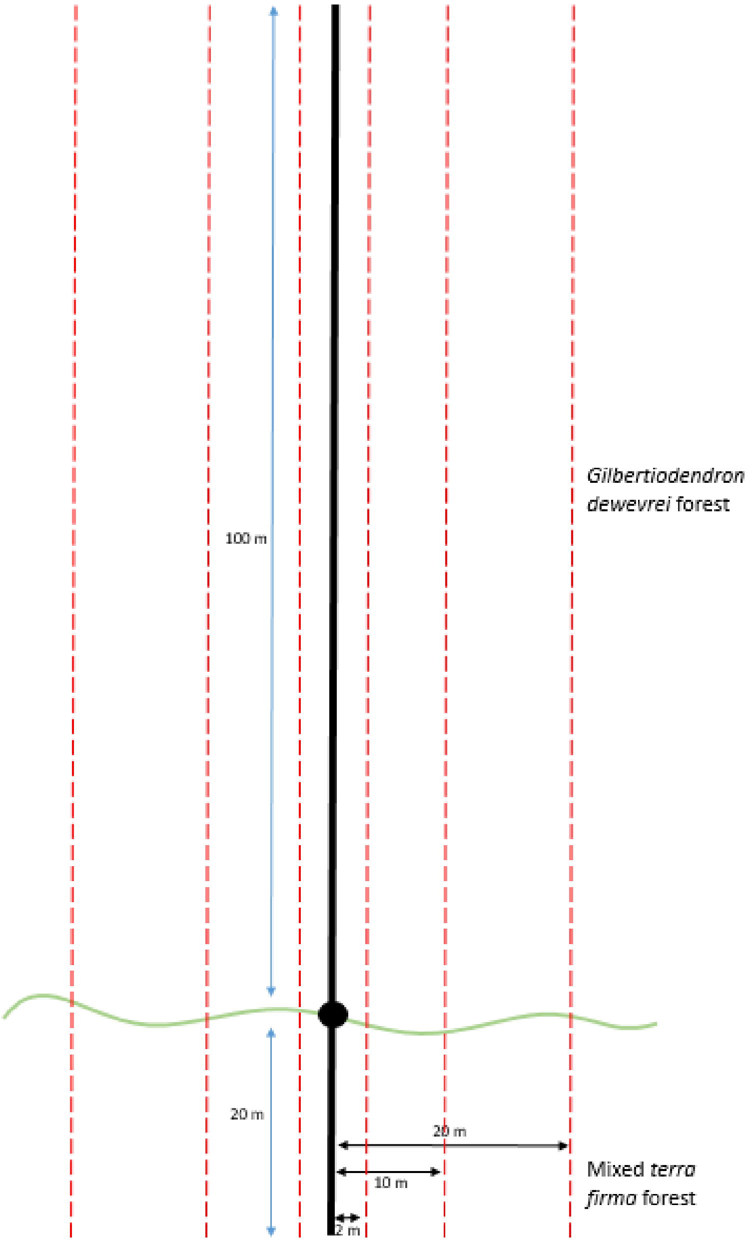

Figure 4. *Layout of transects across the boundaries between monodominant and mixed forest. Black line is the transect, the green line represents the boundary, the black circle is the last G. dewevrei seedling, and the red dotted line represents the different transect widths for different categories of tree.*

Figure 5: *The team making herbarium specimens.*

Preliminary results

July 2022 - Recensusing of permanent plots following a period of selective logging:
Overall, the data collected in this trip consists of the remeasurement of three 50m x 50m plots. This included the measurement of 435 trees - 346 existing and 89 new, and the collection of 31 different plant species as herbarium specimens. Already we are seeing some variation in the influence of logging on the plots depending on their position. Plot 8 was approximately 100m from a logging road, whereas Plot 7 was about 20m from the logging road; and plot 9 had a logging road cutting directly through it.

Nov 2022 - Jan 2023 - Examining the boundaries between monodominant *G. dewevrei* and mixed *terra firma* forest:
In total 11 transects were set up, nine across the boundaries of monodominant and mixed forest, and two within the centre of *G. dewevrei* forest. Location of transects are shown in Fig.6. A total of 745 trees ≥ 10cm and 1,891 trees 1-10 cm were measured and identified. In addition, 1,289 seedlings of *Gilbertiodendron dewevrei* (dbh < 1 cm) were measured; recording height and position along transect (length and width). Some herbarium specimens have yet to be identified, but currently the transect data spans across 40 families, 136 genera and 211 species. Fig.7 shows an initial plot of one of the transects.

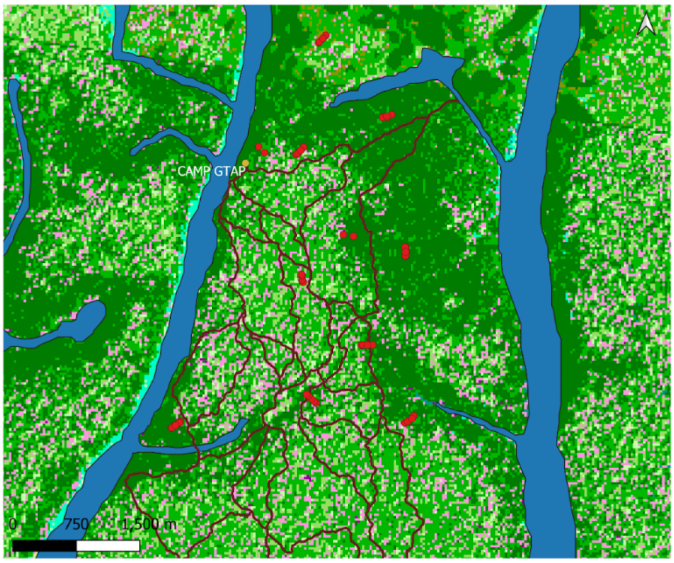

Figure 6. *Location of transects in the Goualougo Triangle. Red points show transects. Each point represents a GPS point taken at -20, 0, 50 and 100 for each transect. Yellow point represents Goualougo research camp. Background is a vegetation map from Nadine La Porte (unpublished). Dark green represents Gilbertiodendron dewevrei forest, blue represents watercourses, and brown lines show paths from Goualougo camp.*

The data from this trip has yet to be analysed in detail, but initial impressions suggest a number of interesting results. In all transects there were fewer juvenile *Gilbertiodendron* trees than expected. A range of 1- 16 category 2 trees were *Gilbertiodendron*, out of an average of 187 category 2 trees in each boundary transect. This suggests that perhaps less regeneration is needed than expected in order to maintain monodominance. Additionally, a higher dominance of *Gilbertiodendron* was found in transects away from the boundaries with mixed *terra firma* forest. This suggests that perhaps the boundaries are 'transitional zones' between monodominant and mixed forest.

Initial impressions from the size distribution of *G.dewevrei* along the boundary transects is that it is expanding, but slowly. The boundary of larger trees is behind, but not too far from, the boundary of seedlings. From observations in the field, *Gilbertiodendron* trees were only producing seeds once they reach a size of approximately 40 cm dbh. Therefore, any movement of the boundary towards mixed forest would be happening over relatively long time frames. For example if the 40cm trees produce seedlings outside of the boundary which they establish successfully it will take many years for these to reach 40 cm and produce their own seedlings outside of the boundary. One transect was positioned in a small patch of *Gilbertiodendron* forest, spanning the entirety of this "island" of *Gilbertiodendron*. This transect showed a different pattern to the others, with not a single seedling recorded in the transect line. This could suggest that there is limited regeneration in small patches of *G. dewevrei* forest.

Another conclusion that we drew from our results, was that in order to draw substantial conclusions from the size of trees about what is happening at the boundary, it would be helpful to core some *G. dewevrei* trees and investigate the relationship between size and age in *G. dewevrei.*

Results on how tree species composition changes as you go across the boundary supports previous research I have carried out in my PhD which finds that there are certain species associated with *G. dewevrei* forest, being found there exclusively, or in higher frequency than in mixed forest. These species were consistently found in *G. dewevrei* forest along the transects.

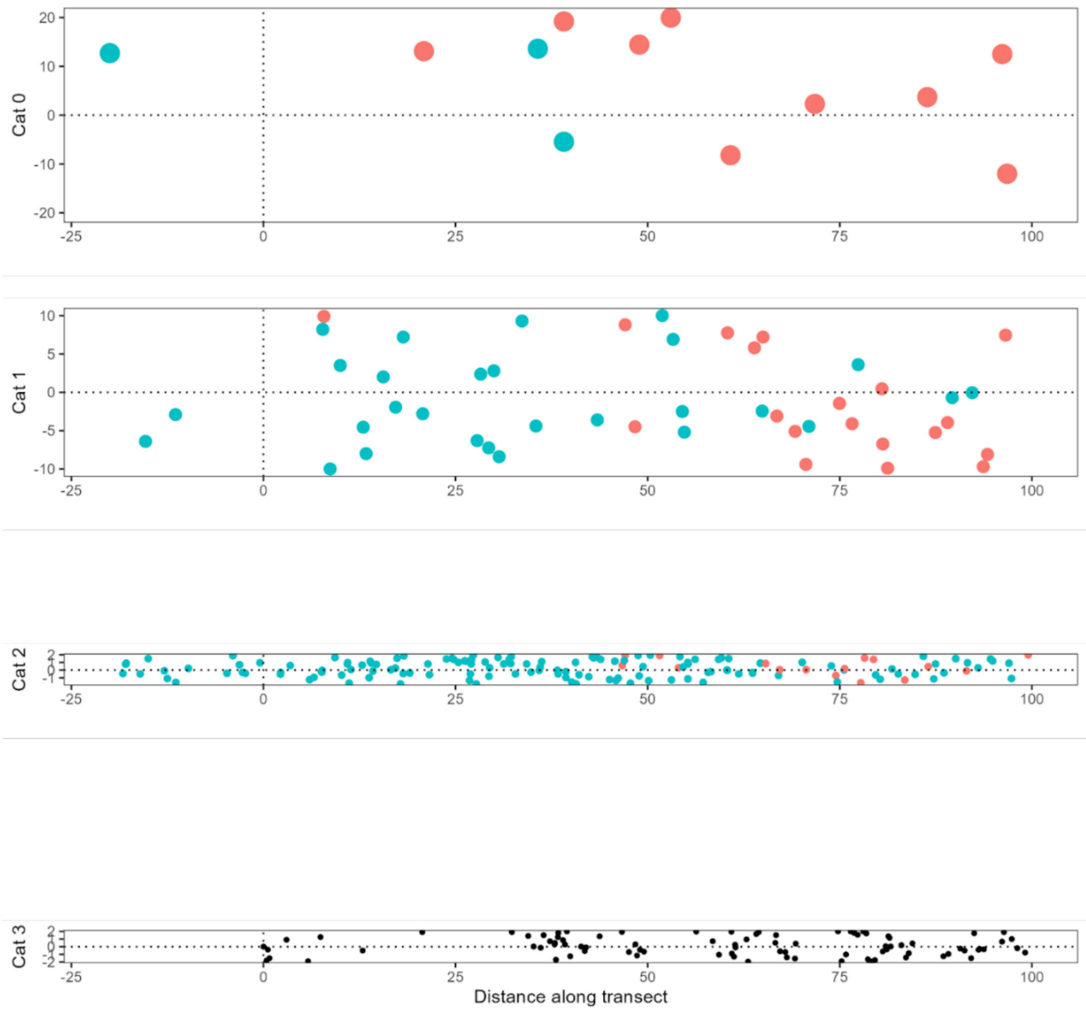

Figure 7: *Data from transect 11 plotted by category. Cat 0 = trees ≥ 70 cm dbh. Cat 1 = trees ≥ 10 cm dbh. Cat 2 = trees 1-10 cm. Red points are G. dewevrei trees and blue points are all other species. Cat 3 = G. dewevrei seedlings < 1 cm dbh. Black dots represent G. dewevrei seedlings.*

Specimens

115 specimens were collected over the two trips (Table S2). Duplicates of these specimens have been deposited in the national herbarium at IRSEN. The rest have been exported to the herbarium at the Royal Botanic Garden Edinburgh where they are in the process of being identified.

<u>Collaboration and capacity building</u>

In July 2022, students Mr. Mamboueni and Mr. Atikani received training on data collection, plant identification and the establishment and inventory of permanent plots from Dr David Harris. They also received training on the use of mapping software from Dr David Harris and myself. In November Mr Mamboueni received further training in plant identification, GPS, R and QGIS software, and plot/transect sampling techniques.

Discussion and further projects

July 2022 - Recensusing of permanent plots following a period of selective logging:

Some of the team will return in April 2023 to recenus the remaining 17 plots. Following this period of data collection, the data will be analysed, looking for short-term influences of selective logging on tree species composition and forest structure. This dataset will form part of a long-term study, so these plots will be recencused every few years. This will provide a valuable long-term dataset that will inform forestry certification standards, and provide information about changes in above ground biomass and carbon sequestration potentials.

Nov 2022 - Jan 2023 - Examining the boundaries between monodominant *G. dewevrei* and mixed *terra firma* forest:

Currently we are in the process of identifying the herbarium specimens from this trip. Analysis will be carried out on whether tree species composition changes across the boundary. This will relate to previous work I have done which shows that monodominant *G. dewevrei* forest has a unique species composition compared to mixed *terra firma* forest, with plant species associated with this forest type. The size class distribution of *G. dewevrei* trees, and the spatial distribution of seedlings, will provide insight into whether *G. dewevrei* is expanding into mixed forest.

As part of my research into monodominant *G. dewevrei* forest, I will also use remote sensing data to detect and map the occurrence of *Gilbertiodendron dewevrei* forest across the Sangha Trinational, and the wider Congo Basin. This will be important for quantifying accurate estimates for carbon stocks across the basin, designing effective conservation initiatives, and understanding the vegetation of the area. It will also give context to this work looking at whether *G. dewevrei* forest is expanding.

Future work could also involve putting in more transects, including in other areas to see if the same patterns are being observed elsewhere within the range of *G. dewevrei.* We would also like to establish a long-term monitoring study of *G. dewevrei* forest, by setting up permanent plots fully in *G. dewevrei* forest.

Importance of this work

G. dewevrei forest is an important forest type in the study area, making up approximately 11% of the vegetation in the Sangha Trinational and up to 25% of the vegetation in the NNNP (Blake & Fay, 1997; Hall et al., 2020; Laporte, 2002). It has largely been ignored in conservation discourse, due in part to its lower tree species diversity. However, this forest type contains a unique subset of vascular plant species, and initial research suggests it stores more carbon than mixed *terra firma* forest (Cassart et al., 2017; Makana et al., 2011). This study will improve understanding of how the species composition differs from mixed forest, and how the distribution of *G. dewevrei* forest may be changing. Given the amount of G. dewevrei forest across the second largest, continuous tropical forest block in the world, this highlights the global importance of the differences between *G. dewevrei* and mixed *terra firma* forest.

The first stage of this research project looking at the influence of selective logging, is also extremely relevant to current hotspots of research and policy. The rapidly growing population in the Congo Basin has led to an acceleration of forest disturbance rates over the past few decades. Tyukavina et al., (2018) used time-series satellite data to estimate that 16 million hectares of forest have been cleared across the Congo Basin between 2000 and 2014. An estimated 84% of the forest disturbance in the region is attributed to small-scale, non-mechanized forest clearing for agriculture, with other major drivers of forest loss including artisanal and industrial logging (10% of total forest disturbance), selective logging, mining and road expansion. Tyukavina et al., (2018) also highlights that maintaining natural forest cover in the Congo Basin in the future will be further challenged by population growth and increased agricultural development and timber harvesting inside remaining old growth forests. Research has found that human activity within forests can influence tree species composition (e.g. Maicher et al., 2021). The work carried out as part of this project to examine the impact of logging on tree species composition and forest structure in the periphery of the NNNP will help us to understand the impacts of logging in this area, helping us to develop conservation and management plans.

Limited research has been carried out regarding the influence of forest loss and disturbance on monodominant forest stands. It is hypothesised that low frequency of disturbances in monodominant forests is an important factor explaining the prolonged dominance of a single species (e.g. Tovar et al., 2019). Forest clearance could interrupt the system maintaining monodominance in *G. dewevrei* forest and allow other species to establish. An interesting further avenue of discussion connecting these two research projects would be to investigate the impact of deforestation on *G. dewevrei* forest, for example by surveying areas where *G. dewevrei* forest has been cleared by human activity, to see if regeneration is happening.

In summary, this research gave a valuable contribution to the wider context of understanding the forests of the Sangha Trinational, and how they are affected by anthropogenic change. We collected data as part of a long-term study monitoring the effects of selective logging on forest structure and species composition in the forests in the periphery zones of the NNNP, and collected new data that which will help us to understand a unique forest type in this area, *G. dewevrei* forest. The author would like to thank the Davis Expedition fund for their generous support with this project, as well as WCS-Congo and the Goualougo Triangle Ape Research project for their assistance throughout the field excursions.

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Appendices

Appendix 1: Breakdown of costs

From the Davis Expedition fund at the University of Edinburgh, I received £6,080 towards the cost of this research. The breakdown of costs is listed below. Table S1 lists costs already paid for, which sums to £4,929.49. Table S2 lists estimates of costs for which I have yet to receive the bill. The remaining £1,150.51 from the Davis Fund will be put towards these costs once the bill is received from WCS – Congo.

Item	**Cost (£)**
Flights (July 2022)	£2098.26
Vaccinations	£251
Visa (July 2022)	£161
Equipment	£459.23
Malaria medication	£38
Cash for transport / accommodation in Brazzaville	£69.12
Flights (Nov 2022)	£947.35
Visa (Nov 2022)	£186.85
Malaria medication (Nov 2022)	£47
Equipment (Rope, flagging tape, secateurs, waterproof notebooks, memory cards, batteries, black cloth)	£211.24
Laptop for collaborator	£341.27
Accommodation in Brazzaville (Nov 2022)	£40.45
Total	**£4,929.49**

Table S1. Breakdown of costs already paid.

Item	Cost (£)
Park entry fee	£35
Letter of invitation from WCS – Congo (for Visa)	£100
Travel from Brazzaville to Bomassa (for J. Mamboueni and E. Heimpel)	£500
Base camp lodging (3 nights for J. Mamboueni and E. Heimpel)	£125
Travel from Bomassa to Goualougo (for J. Mamboueni and E. Heimpel)	£40
Field camp lodging (36 nights for J. Mamboueni and E. Heimpel)	£3000
Food at field camp (for J. Mamboueni and E. Heimpel)	£360
Labour (2 x Porters/trackers)	£500
Travel from Goualougo to Bomassa (for J. Mamboueni and E. Heimpel)	£40
Base camp lodging (1 night for J. Mamboueni and E. Heimpel)	£50
Travel from Bomassa to Brazzaville (for J. Mamboueni and E. Heimpel)	£500
Accommodation in Brazzaville (4 nights for E. Heimpel)	£130
Total	**£5,380**

Table S1. *Estimates of costs still to be billed. Remaining money from Davis Fund will be used to contribute towards these costs.*

Appendix 2: List of Specimens

Collector	**Collector Number**	**Family**	**Species**
Heimpel, E; Mamboueni, J	6	Fabaceae	*Erythrophleum suaveolens*
Heimpel, E; Mamboueni, J	7	Sapindaceae	*Pancovia harmsiana*
Heimpel, E; Mamboueni, J	8	Sapindaceae	*Chytranthus macrobotrys*
Heimpel, E; Mamboueni, J	9	Putranjivaceae	*Drypetes umbricola*
Heimpel, E; Mamboueni, J	10	Sapindaceae	*Laccodiscus pseudostipularis*
Heimpel, E; Mamboueni, J	11	Sapindaceae	*Lecaniodiscus cupanioides*
Heimpel, E; Mamboueni, J	12	Phyllanthaceae	*Margaritaria discoidea*
Heimpel, E; Mamboueni, J	13	Rubiaceae	*Corynanthe macroceras*
Heimpel, E; Mamboueni, J	14	Ebenaceae	*Diospyros mannii*
Heimpel, E; Mamboueni, J	15	Sapindaceae	*Deinbollia molliuscula*
Heimpel, E; Mamboueni, J	16	Malvaceae	*Microcos oligoneura*
Heimpel, E; Mamboueni, J	17	Achariaceae	*Scottellia klaineana*
Heimpel, E; Mamboueni, J	18	Putranjivaceae	*Drypetes cinnabarina*
Heimpel, E; Mamb oueni, J	19	Annonaceae	*Uvariastrum germainii*
Heimpel, E; Mamboueni, J	20	Rubiaceae	*Pausinystalia macroceras*
Heimpel, E; Mamboueni, J	21	Rubiaceae	*Rothmannia lateriflora*
Heimpel, E; Mamboueni, J	22	Rubiaceae	*Rothmannia hispida*
Heimpel, E; Mamboueni, J	23	Fabaceae	*Dialium pachyphyllum*
Heimpel, E; Mamboueni, J	24	Rhamnaceae	*Lasiodiscus*
Heimpel, E; Mamboueni, J	25	Putranjivaceae	*Drypetes capillipes*
Heimpel, E; Mamboueni, J	26	Putranjivaceae	*Drypetes principum*
Heimpel, E; Mamboueni, J	27	Putranjivaceae	*Drypetes occidentalis*
Heimpel, E; Mamboueni, J	28	Putranjivaceae	*Drypetes urophylla*
Heimpel, E; Mamboueni, J	29	Putranjivaceae	*Drypetes principium*
Heimpel, E; Mamboueni, J	30	Putranjivaceae	*Drypetes fallax*

Heimpel, E; Mamboueni, J	31	Meliaceae	*Leplaea cedrata*
Heimpel, E; Mamboueni, J	32	Achariaceae	*Camptostylus mannii*
Heimpel, E; Mamboueni, J	33	Putranjivaceae	*Drypetes principum*
Heimpel, E; Mamboueni, J	34	Meliaceae	*Trichilia tessmannii*
Heimpel, E; Mamboueni, J	35	Putranjivaceae	*Drypetes angustifolia*
Heimpel, E; Mamboueni, J	36	Rubiaceae	*Aidia micrantha var. micrantha*
Heimpel, E; Mamboueni, J	37	Annonaceae	*Xylopia*
Heimpel, E; Mamboueni, J	38	Rubiaceae	*Pavetta calothyrsa*
Heimpel, E; Mamboueni, J	39	Rubiaceae	*Apocynaceae*
Heimpel, E; Mamboueni, J	40	Rubiaceae	*Rothmannia*
Heimpel, E; Mamboueni, J	41	Sapindaceae	*Pancovia harmsiana*
Heimpel, E; Mamboueni, J	42	Putranjivaceae	*Drypetes polyantha*
Heimpel, E; Mamboueni, J	43	Putranjivaceae	*Drypetes principum*
Heimpel, E; Mamboueni, J	44	Sapindaceae	*Lecaniodiscus cupanioides*
Heimpel, E; Mamboueni, J	45	Irvingiaceae	*Irvingia wombolu*
Heimpel, E; Mamboueni, J	46	Achariaceae	*Caloncoba flagelliflora*
Heimpel, E; Mamboueni, J	47	Malvaceae	*Malvaceae*
Heimpel, E; Mamboueni, J	48	Malvaceae	*Cola*
Heimpel, E; Mamboueni, J	49	Malvaceae	*Grewia pinnatifida*
Heimpel, E; Mamboueni, J	50	Meliaceae	*Trichilia prieuriana subsp. vermoesenii*
Heimpel, E; Mamboueni, J	51	Annonaceae	*Isolona hexaloba*
Heimpel, E; Mamboueni, J	52	Burseraceae	*Santiria trimera*
Heimpel, E; Mamboueni, J	53	Fabaceae	*Dialium polyanthum*
Heimpel, E; Mamboueni, J	54	Putranjivaceae	*Drypetes paxii*
Heimpel, E; Mamboueni, J	55	Putranjivaceae	*Drypetes polyantha*
Heimpel, E; Mamboueni, J	56	Putranjivaceae	*Drypetes principum*
Heimpel, E; Mamboueni, J	57	Euphorbiaceae	*Grossera macrantha Pax*

Heimpel, E; Mamboueni, J	58	Salicaceae	*Homalium stipulaceum*
Heimpel, E; Mamboueni, J	59	Sapindaceae	*Allophylus*
Heimpel, E; Mamboueni, J	60	Rubiaceae	*Rothmannia lateriflora*
Heimpel, E; Mamboueni, J	61	Rubiaceae	*Pauridiantha dewevrei*
Heimpel, E; Mamboueni, J	62	Sapindaceae	*Chytranthus gilletii*
Heimpel, E; Mamboueni, J	63	Putranjivaceae	*Drypetes urophylla*
Heimpel, E; Mamboueni, J	64	Sapindaceae	*Radlkofera calodendron*
Heimpel, E; Mamboueni, J	65	Sapindaceae	*Lecaniodiscus cupanioides*
Heimpel, E; Mamboueni, J	66	Rubiaceae	*Pavetta calothyrsa*
Heimpel, E; Mamboueni, J	67	Rubiaceae	*Rothmannia libisa*
Heimpel, E; Mamboueni, J	68	Rubiaceae	*Tricalysia crepiniana*
Heimpel, E; Mamboueni, J	69	Lauraceae	*Beilschmiedia*
Heimpel, E; Mamboueni, J	70	Labiatae	*Vitex welwitschii*
Heimpel, E; Mamboueni, J	71	Sapindaceae	*Lovoa trichilioides*
Heimpel, E; Mamboueni, J	72	Rubiaceae	*Tricalysia pallens*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10297	Rubiaceae	*Rubiaceae sp.*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10298	Putranjivaceae	*Drypetes occidentalis*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10299	Putranjivaceae	*Drypetes occidentalis*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10300	Zingiberaceae	*Renealmia*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10301	Annonaceae	*Xylopia*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10302	Bignoniaceae	*Bignoniaceae*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10303	Putranjivaceae	*Drypetes*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10304	Putranjivaceae	*Drypetes ituriensis*

Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10305	Putranjivaceae	*Drypetes occidentalis*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10306	Sapotaceae	*Omphalocarpum*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10307	Euphorbiaceae	*Euphorbiaceae*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10308	Putranjivaceae	*Drypetes laciniata*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10309	Sapotaceae	*Sclerocroton sp.*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10310	Rubiaceae	*Bertiera*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10311	indet	*indet indet*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10312	Passifloraceae	*Adenia*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10313	Vitaceae	*Cissus*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10314	Vitaceae	*Cissus*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10315	Malvaceae	*Malvaceae*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10316	Rubiaceae	*Sabicea*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10317	Rubiaceae	*Sabicea dinklagei*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10318	Cucurbitaceae	*Cucurbitaceae*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10319	Combretaceae	*Combretum latialatum*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10320	Annonaceae	*Uvaria*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10321	Rubiaceae	*Leptactina arnoldiana*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10322	Combretaceae	*Connaraceae*

Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10323	Fabaceae	*Dalhousiea africana*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10324	Vitaceae	*Vitaceae*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10325	Vitaceae	*Vitaceae*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10326	Rubiaceae	*Pauridiantha*
Harris, DJ; Koni, D; Mamboueni, JC; Atikani, C; Heimpel, E	10327	Hypericaceae	*Harungana madagascariensis*
Harris, DJ; Mamboueni, JC; Heimpel, E	10329	Phyllanthaceae	*Antidesma*
Harris, DJ; Mamboueni, JC; Heimpel, E	10330	Rubiaceae	*Schumanniophyton*
Harris, DJ; Mamboueni, JC; Heimpel, E	10331	Rubiaceae	*Tarenna*
Harris, DJ; Mamboueni, JC; Heimpel, E	10332	Putranjivaceae	*Drypetes umbricola*
Harris, DJ; Mamboueni, JC; Heimpel, E	10333	Putranjivaceae	*Drypetes fallax*
Harris, DJ; Mamboueni, JC; Heimpel, E	10334	Rubiaceae	*Bertiera*
Harris, DJ; Mamboueni, JC; Heimpel, E	10335	Meliaceae	*Leplaea*
Harris, DJ; Mamboueni, JC; Heimpel, E	10336	Euphorbiaceae	*Crotonogyne*
Harris, DJ; Mamboueni, JC; Heimpel, E	10337	Rubiaceae	*Bertiera*
Harris, DJ; Mamboueni, JC; Heimpel, E	10339	Euphorbiaceae	*Crotonogyne*
Harris, DJ; Mamboueni, JC; Heimpel, E	10340	Putranjivaceae	*Drypetes*
Harris, DJ; Mamboueni, JC; Heimpel, E	10341	Putranjivaceae	*Drypetes*
Harris, DJ; Mamboueni, JC; Heimpel, E	10342	Putranjivaceae	*Drypetes*
Harris, DJ; Mamboueni, JC; Heimpel, E	10343	Putranjivaceae	*Drypetes*
Harris, DJ; Mamboueni, JC; Heimpel, E	10344	Zingiberaceae	*Renealmia sp.*
Harris, DJ; Mamboueni, JC; Heimpel, E	10345	Guttiferae	*Garcinia sp.*
Harris, DJ; Mamboueni, JC; Heimpel, E	10346	Meliaceae	*Leplaea laurentii*
Harris, DJ; Mamboueni, JC; Heimpel, E	10347	Putranjivaceae	*Drypetes ituriensis*