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EXPLORING THE ECOLOGICAL IMPLICATIONS OF LANDSCAPING PRACTICES ON ECOSYSTEM AND BIODIVERSITY RESTORATION: CASE STUDY OF THE RICA CAMPUS, BUGESERA

A thesis submitted in partial fulfillment of the requirements for the degree of Master in Biodiversity Conservation and Natural Resources Management.

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KIGALI, September 20th,2024

DECLARATION

I, **Digne Brigitte KAMUGIRE**, hereby declare that this thesis is the product of my independent research and has not been submitted previously for any degree at the University of Rwanda, the University of Koblenz, or any other institution.

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Signature:

Date:

Supervisor:

Dr. Myriam MUJAWAMARIYA

Signature:

Date:

DEDICATION

To my beloved son, CYOGERE MATEKA S. Adlai, your vibrant energy, amidst the chaos of my academic pursuits, fuels my determination.

To you, this thesis is dedicated with heartfelt love and appreciation.

ACKNOWLEDGEMENTS

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LIST OF ACRONYMS

ANOVA: Analysis of Variance

BA: Basal Area

DBH: Diameter at Breast Height

DRC: Democratic Republic of Congo

EIA: Environmental Impact Assessment

GI: Green Infrastructure

IUCN: The International Union for Conservation of Nature

LC: Least Concern

NE: Not Evaluated

NT: Near Threatened

RICA: Rwanda Institute for Conservation Agriculture

UN: United Nations

UNDER: United Nations Decade of Ecosystem Restoration

ABSTRACT

The global loss of biodiversity has raised concerns, especially in developing countries where the effects are severe. Biodiversity restoration, using multidisciplinary approaches, is crucial to counteract this loss. Ecological restoration now includes strategies like Green Infrastructure (GI), promoting sustainable human well-being and ecosystem services. The Rwanda Institute for Conservation Agriculture (RICA) demonstrates this commitment by integrating native species into its landscape plan to restore its central campus ecosystem. This study analyzes the outcomes of RICA's restoration efforts, inventorying woody plants over two meters tall to compute diversity indices. It compares the establishment of replanted woody plants in the campus ecosystem by measuring DBH and BA and assesses foliage arthropods from four abundant tree species using the beating method. Arthopods were sorted, identified, counted, and analyzed for distribution, abundance, and diversity across the campus and forest ecosystems. Data were analyzed using various package of RStudio, with statistical comparisons made using the student t-test. The inventory recorded 41 woody plant species from 23 families in the RICA forest, with Sapindaceae being the most abundant. Four endemic species—*Abutilon angulatum, Blighia unijugata, Erythrina abyssinica*, and *Ziziphus mucronata*—were identified.The diversity assessment showed high species diversity (Simpson index of 0.9) and a moderately even distribution (Pielou's evenness index of 0.73). There were no significant differences in DBH and BA between the natural forest and Rica campus ecosystems. Foliage arthropod assessment showed high representation of insects, also represented by Coleoptera, Hemiptera, and Hymenoptera. Insect abundance was similar between ecosystems, though diversity indices indicated higher insect diversity in the natural forest. These findings provide a baseline for conservation planning and management, highlighting the successful establishment of restored woody species and effective landscape practices on campus. Long-term monitoring is needed for sustainable ecosystem management.

1. INTRODUCTION

1.1. BACKGROUND AND PROBLEM STATEMENT

Rwanda, as a rapidly developing country, is experiencing significant biodiversity loss, occurring at a rate estimated to be 1,000 times faster than the natural background rate (Roe, Seddon & Elliott, 2019). This loss is primarily driven by habitat alteration and destruction due to infrastructure development, agriculture, mining, and other activities that threaten biodiversity (USAID, 2019; Hussein, 2021).

To mitigate these impacts, project developers are requested to utilize the Environmental Impact Assessments (EIA). EIA is a multidisciplinary process designed to evaluate the potential impacts of development projects. It provides decision-makers with the information needed to maximize positive outcomes and mitigate negative effects on the economy, society, and the environment (Ortiz et al., 2018). A crucial component of EIA is the assessment of a project's impact on site biodiversity and the development of a mitigation plan. This plan includes measures to limit or neutralize biodiversity loss (Bigard, Pioch & Thompson, 2017).

The Rwanda Institute for Conservation Agriculture (RICA) has demonstrated its commitment to the One Health principle by incorporating biodiversity mitigation into its construction plan. A key mitigation strategy at RICA involved integrating indigenous tree and shrub species from the surrounding RICA forest into the campus landscape to initiate ecosystem restoration. This study aims to evaluate the effectiveness of this approach in restoring the site’s original ecosystem. The RICA restoration project focuses on enhancing biodiversity by reintroducing native species and promoting ecological balance.

This research aims to compare the restored campus ecosystem at RICA with the natural forest by assessing woody plant and insect diversity. The study provides insights into the functional outcomes

of RICA's restoration efforts and their impact on biodiversity conservation. To achieve this, woody plants in the RICA forest and the restored campus landscape were inventoried and analyzed, examining plant diversity indices and the establishment of replanted woody species. Additionally, foliage insects were collected, identified, and analyzed to assess and compare arthropod diversity and abundance between the natural forest and the landscaped area of the RICA campus.

The findings from this research will contribute to a better understanding of the effectiveness of restoration practices at RICA and provide valuable data for future conservation planning. By highlighting successful strategies and identifying areas for improvement, this study aims to support sustainable ecosystem management and biodiversity conservation in rapidly developing regions like Rwanda.

The loss of biodiversity has emerged as a critical issue among conservationists and project developers in recent years. This concern is driven by the recognition that biodiversity is essential for the health and stability of ecosystems, which in turn supports human well-being and the planet's resilience to environmental changes (Roe et al., 2019). One of the most important strategies for addressing biodiversity loss is the restoration of damaged ecosystems. This process involves rehabilitating degraded environments to their former states, aiming to reestablish the ecological services and enhance biodiversity (Wilson & Primack, 2019).

Ecological restoration is acknowledged as a vital nature-based solution (Waylen et al., 2024). Although it can be expensive and resource-intensive, its benefits often justify the investment (Bullock et al., 2011). However, effective restoration requires ongoing monitoring and evaluation to determine its success. By systematically assessing restored areas, practitioners can measure progress, identify successful practices, and pinpoint areas needing improvement or additional resources (Buckingham et al., 2019). This continuous feedback loop is essential for ensuring that restoration efforts are both efficient and impactful.

This study contributes significantly to the field by evaluating the restoration efforts at the RICA campus ecosystem. It provides a detailed analysis of the functional outcomes of the restoration activities undertaken. Through an attentive assessment, this research helps to highlight the effectiveness of specific restoration strategies, offering insights into best practices and areas for further attention. Consequently, the findings from this study not only enhance our understanding of ecosystem restoration on the RICA campus but also serve as a valuable reference for similar projects elsewhere, guiding future efforts in biodiversity conservation and ecosystem management.

1.2. RESEARCH OBJECTIVES, QUESTIONS AND HYPOTHESES

Overall objective: This study aims to assess the ecological impact of landscaping practices applied on the RICA Campus on its biodiversity and restoration of the initial ecosystem conditions.

Specific objectives:

(i) To provide an inventory of woody plant species, growing up to a height of two meters and above in the RICA Natural Forest.

(ii) To assess the establishment and growth performance of trees/shrubs planted in the landscaped areas of RICA Campus.

(iii) To compare the diversity of foliage arthropod communities between five selected tree species found in both the RICA Natural Forest and the campus landscape.

Research questions

Q1. What woody plant species of two meters high or above can be found in the RICA Forest?

Q2. How are the establishment and growth rates of trees and shrubs that have been replanted in the landscaped areas of the RICA campus?

Q3. What arthropod can be found on the foliage of selected tree species present both in the landscaped areas of the RICA campus and the natural RICA Forest?

Research hypotheses

Hypothesis 1: The RICA Forest contains a diverse range of woody plant species of two meters high or above, with a dominance of native species that are well-adapted to the local environment.

Hypothesis 2: The trees and shrubs replanted in the landscaped areas of the RICA campus exhibit high establishment and growth rates, comparable to those in the natural RICA Forest, indicating successful restoration practices.

Hypothesis 3: The diversity and abundance of arthropods found on the foliage of selected tree species is similar between the landscaped areas of the RICA campus and the natural RICA Forest, reflecting the effectiveness of the restoration efforts in recreating a functional ecosystem.

1.3. LITERATURE REVIEW

Humankind causes alterations all over the world and in all types of ecosystems, through its various activities, leading us to a geological era that Eugene F. Stoermer, a freshwater biologist, named Anthropocene in the 1980s (Tickner et *al*., 2020). One of the major consequences caused by these activities is the decline in biodiversity, at the point that a sixth mass extinction is being observed, in which 200 species of vertebrates are known to have disappeared in the last 100 years i.e., 2 species per years; several species that, compared to other historical extinction eras, took 100 times longer to extinct (Ceballos et *al*., 2017).

Africa is an extremely biodiverse continent counting an estimation of 50,000-73,000 plants, 1,100 mammals, 2,500 birds, 3,000-5,500 freshwater fishes, 950 amphibians and 1,600-2,100 reptile species (O'Connell et *al*., 2019); these species find home in distinct habitat types found on the continent, both terrestrial and aquatic ecosystems. The increase in African population, and therefore the increase in their needs, result in an increased habitat degradation, for infrastructure and other

development projects; all together leading to more biodiversity loss due to alteration and loss of the natural aspects of habitats (Chapman et *al*., 2022).

One of the very much discussed impact of the biodiversity loss is the relationship that it has with infectious diseases that are naturally hosted by other organisms than human being by increasing the abundance of vector-borne parasites (Civitello et *al*., 2015) even though scientific findings were contradictory on the fact that more biodiversity exposes human being to a multitude of pathologic diseases. More recent research showed that the loss of biodiversity, resulted in an increase in abundance and diversity of what is called "zoonotic host species" because of the alteration of habitats and the ecosystem in general (Keesing & Ostfeld, 2021).

Environmental scientists have identified multiple factors contributing to the accelerated rate of biodiversity loss, including human-induced habitat degradation and fragmentation, overexploitation of natural resources, pollution, introduction of invasive species, and climate change (Prakash & Verma, 2022). More concerningly, the loss is observed across all groups of living beings, as one extinction can lead to more species becoming extinct through an extinction cascade. This phenomenon is primarily due to the complex network of interactions between species within their communities (Kehoe et al., 2021). A study conducted in protected areas in Germany reported a 76% loss of insect biodiversity over 27 years. Such a loss can led to declines in other forms of biodiversity, as 80% of plants depend on insects for pollination and 60% of birds rely on insects for food (Hallmann et al., 2017). This unequivocally underscores the significant impact of human activities on natural processes, thereby highlighting the importance of incorporating sociological perspectives into discussions concerning the causes, consequences, and mitigation strategies for biodiversity loss (Besek & York, 2019).

The evolving social dynamics introduce a complex challenge to restoration efforts, demanding that goals extend beyond ecological and biodiversity achievements to encompass their impacts on human

well-being, landscape diversification, and sustainability. Yet, notable concerns persist, including the evaluation of the social benefits of ecosystem restoration, determination of recommendable species combinations, prioritization of species and services, and identification of appropriate sources of guidance. These considerations underscore the necessity for ecological restoration to adopt a multidisciplinary and transdisciplinary approach, integrating insights from diverse fields to effectively address the intricate interactions between ecological and social systems (Fischer et *al*., 2021).

In the last years, this highly elevated rate of species extinction has caused scientific discussions to focus on finding ways to mitigate biodiversity loss (Mace et *al*., 2018) while reducing the risks of climate change and ensuring wellbeing of the human population that does not cease to increase (Tickner et *al*., 2020). Governments, health organizations, aid agencies, and more recently, conservation organizations, have set goals to improve the lives of people through development that include the preservation of the ecosystems. Simultaneously achieving these goals is challenging and all countries have approached this dilemma by creating legal and policy requirements for mitigating the environmental impacts of development (Morgan, 2012). A consistent mitigation framework applied by governments and institutions, globally, involve the evaluation of possibilities to avoid or minimize the loss, then taking actions to offset or compensate the effect in the cases where the loss cannot be avoided (McKenney & Kiesecker, 2010).

Ecological restoration is a global practice responding directly to the ecosystem degradation and biodiversity loss. In addition to its ecological impact, it is potentially a measure to improve population health, socioeconomic well-being, and the integrity of diverse national and ethnic cultures. Due to this noticeable role of the ecological restoration, the Unite Nations (UN) declared 2021-2030 as the United Nations Decade on Ecosystem Restoration (UNDER) (Aronson et *al*., 2020). In most restoration project plans, the primary motivation is to restore ecosystem services

such as carbon sequestration, soil stabilization, water provision, and wood production. Since these services do not inherently depend on specific plant communities, developers often overlook the importance of restoring native species and communities. However, the absence of native species, in these restoration efforts, raises concerns regarding the potential for further loss of native biodiversity and degradation of ecosystems due to the introduction of non-native species (Hua et al., 2022).

In the global context, nations are urged to submit their restoration plans to international conventions, initiatives, and forums, including the Rio Convention and the Bonn Challenge, as a demonstration of their dedication to restoring degraded ecosystems. The cumulative commitments for the UN-launched Restoration Decade are estimated to encompass between 765 million and 1 billion hectares across various countries by 2030 (Sewell, van der Esch & Löwenhardt, 2020). Half of these commitments are in Sub-Saharan Africa, primarily because Sub-Saharan countries are the most dedicated to this cause (Sewell & Esch, 2020). In fact, 80% of the population in these countries relies directly on the productivity of their land, yet 65% of these lands are severely degraded. This situation has led to the initiation of the African Great Green Wall, which aims to restore approximately one hundred million hectares in this region and has achieved at least 18% of completion (United Nations Convention to Combat Desertification, 2020). More recently, the biodiversity restoration idea rose a new strategy that is referenced at as “Green-Infrastructure”, GI in short, consisting of linking biodiversity preservation and development project by creating an ecosystem that simultaneously improve environmental conditions and provide sustainable development opportunities for human being and maintain some level of ecosystem services despite the disturbance that may have been caused by the projects (Capotorti et *al*., 2019).

Like elsewhere in the world, Rwanda has integrated GI in its biodiversity restoration strategies, by (i) initiating the Environmental Impact Assessment (EIA), serving to include environmental

preservation and recovering in development project plan, (ii) developing a Green Space Index (GSI), to compute the ratio of green space in urban areas (Nshimiyimana et *al*., 2023).

Through this legal framework, RICA enhanced biodiversity restoration by integrating native tree and shrub species into its landscape. This study provides an initial assessment of the success of RICA's ecosystem restoration efforts.

2. MATERIAL & METHODS

2.1. Study area.

RICA is a higher learning institution located in the Eastern Province of Rwanda. This campus is situated in the middle of a natural savannah forest known as Karama Forest, now named RICA Forest. RICA Forest is a unique savannah forest comprising rare, indigenous savannah tree and shrub species; and has one of the highest forest coverages as indigenous savannah forest in the Eastern Province of the country (MoE, 2019).

The RICA Forest is a 1,346 ha savannah forest, located in the East-South part of Rwanda, in Bugesera District, Gashora Sector (***Figures 1***). This forest was divided into patches for different land uses, fruit trees plantation, agriculture farms, pasture as well as the construction of housing and enterprises buildings for the RICA campus (***Figure 2***). Despite different land uses, the study area still consists of undisturbed patches of the initial natural forest. The remaining natural forest are dispatched fragment estimated to measure a total of 634 ha.

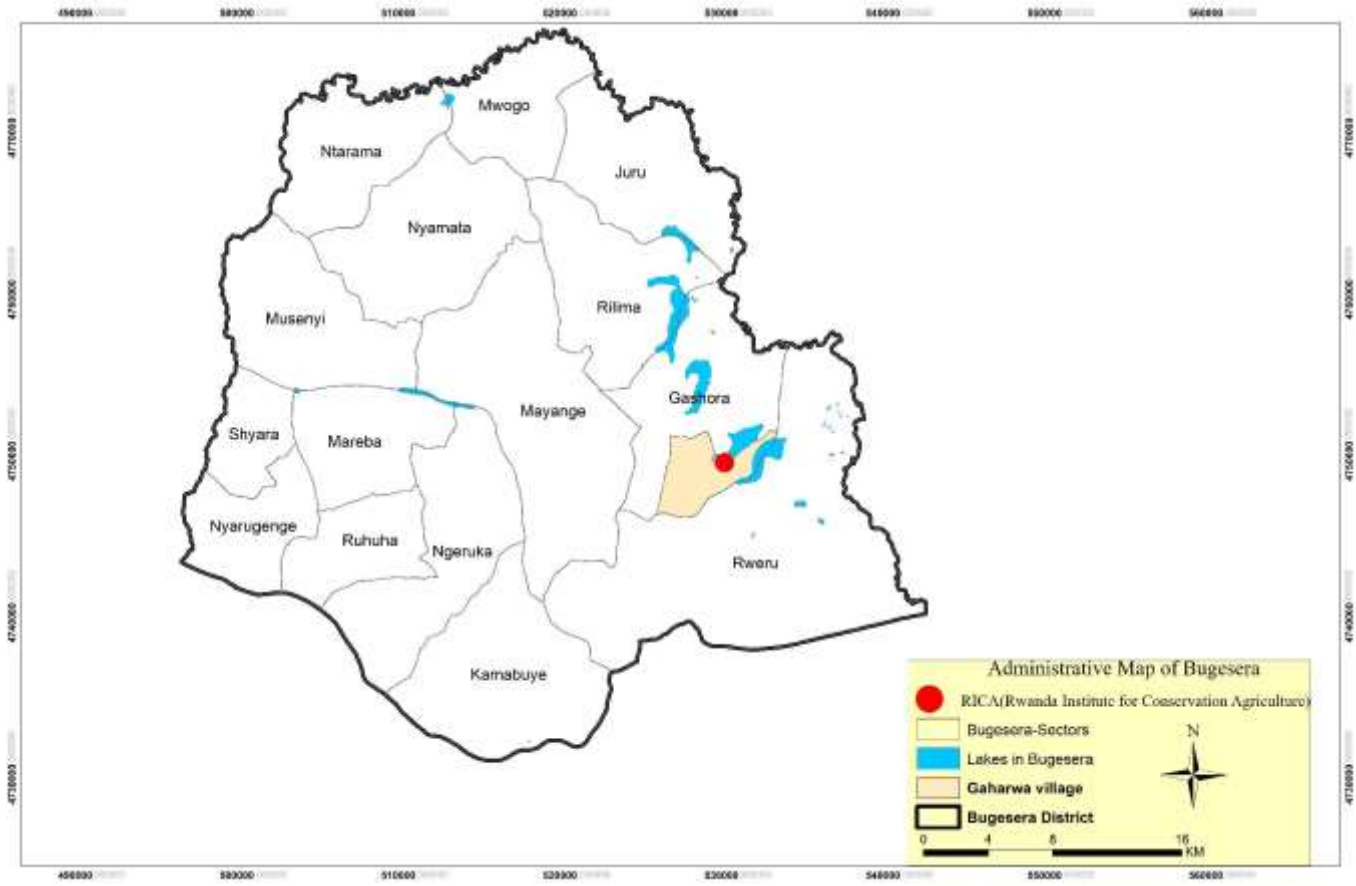

Figure 1: Bugesera district, Gashora sector, Gaharwa village

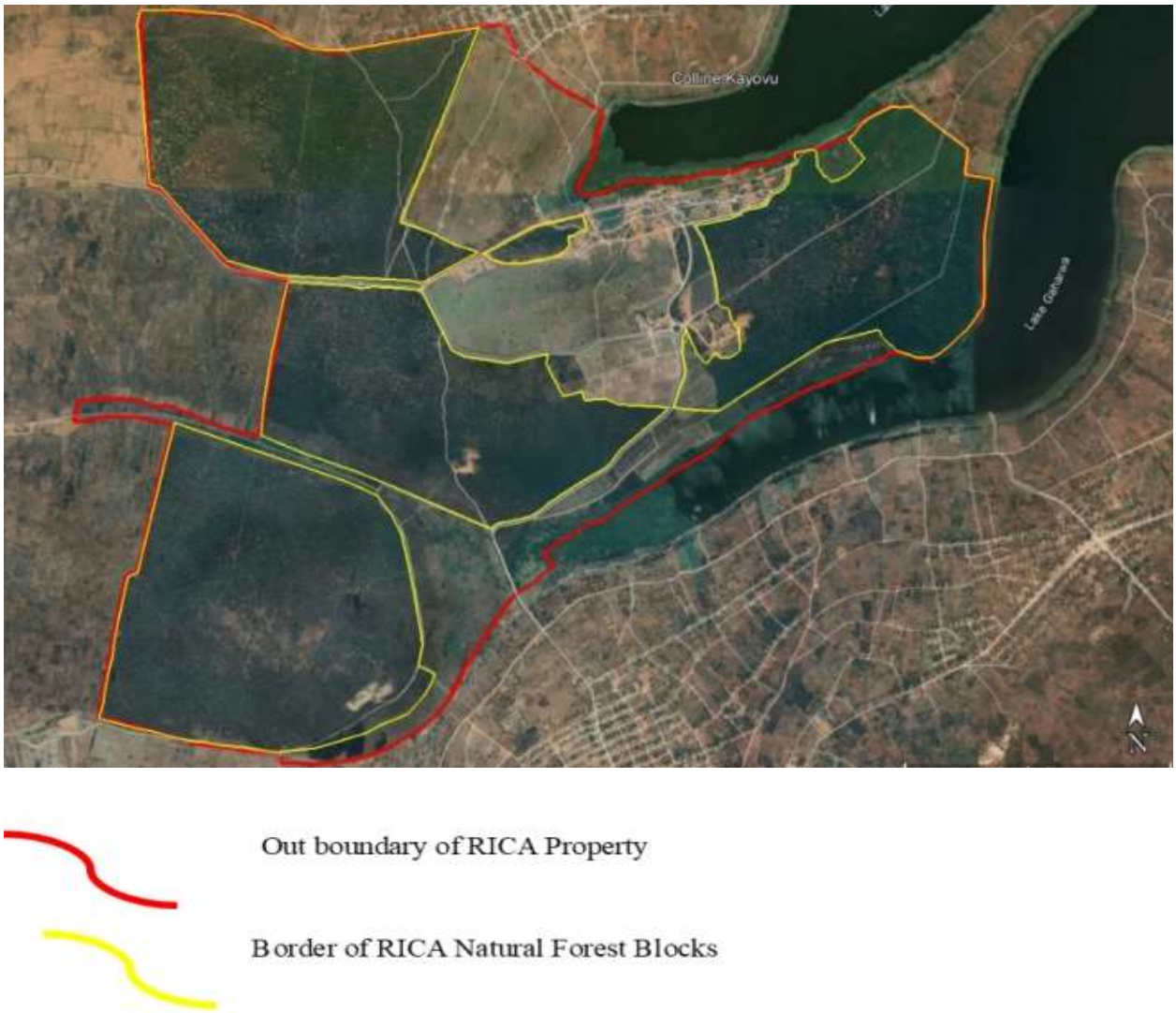

Figure 2: RICA site map (Google Earth pro, 2024)

2.2. Data collection

- **Forest inventory**

The inventory was conducted along five transects randomly located within each stratified site of the RICA Natural Forest. Where applicable, existing trails were utilized instead of creating new transects. Prior to establishing the transects, one hundred meters was measured from a defined and georeferenced starting point into the sample site to ensure that the sampling was conducted away from the forest edge, thereby minimizing edge effects.

Along these transects, only woody plants with a height of two meters or more were recorded within four-meter blocks extending two meters on both sides of the transect. For each recorded plant species, herbarium information—including scientific and vernacular names, a brief morphological description of the species, and its native distribution and habitats—were documented. Herbarium specimens were also collected and preserved in the RICA Herbarium. Additionally, detailed information on each identified species, including endemism status, conservation status according to the IUCN Red List, and indigenous uses, were recorded.

- **Assessment of trees and shrubs establishment and growth performance on the campus landscape**

While building the RICA campus from month and year to month and year, a variety of tree/shrub species native to the RICA forest were transplanted in the campus landscaping. The establishment and growth performance of these species was assessed by comparing the Diameter at the Breast Height (DBH) and Basal Area (BA) of tree/shrub species installed on the landscaped ecosystem of RICA campus to the one of mature individuals in the RICA natural forest. The DBH of at least five individuals of each recorded species was measured at 1.3 meters (Şahin et al., 2019) in both the RICA Natural Forest and the RICA campus landscape. These measurements were compared and used to compute the BA of each species in both ecosystems.

- **Assessment of foliage arthropod community**

Ecosystem restoration success was also evaluated by analyzing arthropod communities on tree foliage, using them as indicators of restoration effectiveness. Samples were collected using the beating method (Luong *et al*., 2019), which captured a diverse range of foliage-dwelling arthropods, including insects, mites, and spiders. All captured arthropods were included in the assessment. The analysis compared the collected foliage-dwelling arthropod communities from four selected tree

species—*Ficus thonningii*, *Haplocoelum foliolosum*, *Olea europaea subsp. cuspidata*, and *Pappea capensis*—with samples obtained from both the natural RICA Forest and the landscaped areas of the RICA campus. The selection of these tree species was based on their prominence and abundance within the restored campus landscape, reflecting their significance in the replanting efforts guided by the campus landscape designs.

For each selected tree species, three individuals were randomly selected and marked in both the Natural Forest and the campus landscape for foliage arthropod collection. The arthropod collection was conducted in two times, four months apart, to allow for recovery of the arthropod communities between collections. Arthropod specimens were preserved in plastic vials (***Figure 3***) containing 70% ethanol (Medlock et al., 2018).

Figure 3: Plastic vial (Picture by Kamugire, 2023)

2.3. Data processing and analysis

Collected data were processed, cleaned using Microsoft Excel, and statistically analyzed using RStudio software, version 4.2.2 (Bhagarathi, Da Silva & Subramanian, 2024). The Chi-square (χ^2) test of goodness of fit, Student t-test, and Analysis of Variance (ANOVA) were utilized for statistical data analysis. The χ^2 test was applied to determine the distribution of tree species across families in

the forest inventory and the distribution of arthropod orders across the selected tree species. The student t-test was employed to compare and determine statistical differences between the means of DBH (Diameter at Breast Height) and BA (Basal Area) as well as arthropod abundance across both ecosystems. the ANOVA and Kruskal-Wallis H test (a non-parametric equivalence of one-way ANOVA) were computed to get more insight of the effect of families on the tree/shrub DBH and total BA. Prior to ANOVA, the Shapiro Wilk test for normality was performed to determine the distribution of the data. Various packages of RStudio were used. To perform box plots and accumulation plots, the "ggplot2" package was used, for the Analysis of Variance, "ggpubr", "tidyverse", "broom" and "AICcmodavg" packages were used while "vegan" package was used to compute diversity indices.

For all inventoried plants, the following analyses were conducted:

a) Relevant biodiversity indices were calculated to reflect species richness, diversity, and evenness of all woody species of two meter high. Species richness was determined directly by totaling the number of species in each transect. Diversity and evenness were calculated using the following indices:

✓ **Simpson's index** (as in Magurran, 1988): *1-D*

$$D = \sum \quad \frac{n_1(n_1-1)}{N(N-1)}$$

to measure the dominance where n_i= the number of individuals in the i^{th} species, N= the total individuals of all the species in the sample.

✓ **Shannon's index** (as in Magurran, 1988): *H' = -Σpi * ln(pi)* where pi is the proportion of individuals in the i^{th} species.

✓ **Evenness index** (Hill, 1973): $E = \frac{H'}{H'max} = -\frac{\sum_{i=1}^{S} pi \ln(pi)}{\ln(S)}$ to determine how equally abundant are individuals across existing species in the RICA Forest.

b) Total basal area describes the average amount of area occupied by tree stems (based on the sampled DBH) and was calculated by summing basal areas of sampled tree species and dividing by the area of land in which the trees was measured. Basal area was calculated by using the following formula: **$BA=\pi$ x $(DBH/2)^2$**.

The establishment and growth performance were analyzed by comparing the DBH and BA of tree/shrub species among the two ecosystems using the student t-test and displayed on box plot. ANOVA was used to assess the effect of plant families constituting the RICA community has on the tree/shrub DBH and BA.

In addition, foliage arthropods were sorted into taxonomic orders as precisely as possible, counted, pinned, and identified using available literature on Afrotropical insects **(…)**. From the specimen, three major analyses were conducted, to understand arthropod community of both ecosystems: (i) the distribution of the arthropod orders across the four tree species, (ii) comparison of both sites for their arthropod abundance using Student t-test., and (iii) the arthropod diversity indices and their abundance from both ecosystems were compared using the student t-test and displayed on box plots. Additional to these, individual numbers of beetles and spider groups were identified as indicator groups to species or morphotypes, respectively.

3. RESULTS

3.1. Forest inventory

A total of 1,057 tree and shrub individuals, representing 41 species across 23 distinct families, were recorded within the transects during the forest inventory. The families identified include Anacardiaceae, Apocynaceae, Bignoniaceae, Burseraceae, Capparaceae, Celastraceae, Chrysobalanaceae, Combretaceae, Ebenaceae, Euphorbiaceae, Fabaceae, Icacinaceae, Loganiaceae, Malvaceae, Moraceae, Olacaceae, Oleaceae, Rhamnaceae, Rubiaceae, Rutaceae, Santalaceae, Sapindaceae, and Tiliaceae. Among these, the most represented families were Fabaceae with 6 species (14.63%), Sapindaceae with 4 species (9.76%), and both Rubiaceae and Capparaceae with 3 species each (7.32%). While the least represented families, each comprising 1 species (2.44%), were Burseraceae, Celastraceae, Chrysobalanaceae, Combretaceae, Ebenaceae, Euphorbiaceae, Icacinaceae, Loganiaceae, Malvaceae, Moraceae, Olacaceae, Oleaceae, Rhamnaceae, Santalaceae, and Tiliaceae.

The chi-square (χ^2) test of goodness of fit showed that the tree/shrub individuals are not evenly distributed across the families (p-value<0.01). The abundance (number of trees/shrubs) was found to vary between 0 and 65 with a mean of 5.156 and a median of 1. For each recorded tree/shrub species, herbarium information, cited: vernacular (local) name, family (and subfamily where applicable), description of the species and their known uses, were recorded (**Appendix 2).**

Additional information, cited: native range and habitat details, endemism status and IUCN red list conservation status, were also recorded (**Appendix 3).** Within the dataset:

- Only four species, comprising approximately 9.76% of the total recorded species, were identified as endemic to distinct sub-regions of Africa. These endemic species include *Abutilon angulatum*, *Blighia unijugata*, *Erythrina abyssinica*, and *Ziziphus mucronata*,

confined to Sub-Saharan Africa, tropical Africa, Eastern-south Africa, and Sub-Saharan Africa, respectively.

- According to the IUCN Red List criteria, most of the recorded species were classified as Least Concern (LC), with exceptions of Abutilon angulatum, Capparis erythrocarpos, Grewia similis, and Strychnos lucens, for which Red List evaluations have not been conducted/Not Evaluated (NE), as of the present date.

Diversity assessment of RICA Forest

To conduct the biodiversity assessment of RICA forest, the dominance index (D), the Simpson's index (1-D), Shannon Wiener index (H') and the index of Evenness (E) were calculated (***Table 3.***).

Table 1: Tree species biodiversity indices

	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Average
Shannon index	2.819	2.745	2.722	2.674	2.557	**2.704**
Simpson index	0.907	0.912	0.916	0.905	0.874	**0.903**
Inverse Simpson index	10.702	11.356	11.961	10.540	7.963	**10.505**
Pielou evenness index	0.759	0.739	0.733	0.720	0.689	**0.728**

The dominance index, found to be 0.09 is closer to the minimal dominance index (which is in this case 0.2) than it is closer to the maximum dominance index (which is always 1), this implies that the data were diversified, there is no dominance of some species in RICA forest. The Simpson index (represented as 1-D) of 0.9, implies that when two tree/shrub individuals are randomly selected from RICA forest, there is over 90% of chances that they will be from distinct species while there are less than 10% chances that they both belong to the same species. This indicates that this forest has a high diversity in terms of woody species growing up to two meters tall and above.

The Pielou' s evenness index ranges between 0 and 1, where 1 indicates a community in which species are evenly distributed. In the RICA forest community, the Pielou 's evenness index was found to be 0.728, implying that within the RICA forest community, tree/shrub individuals are somewhat evenly distributed across species.

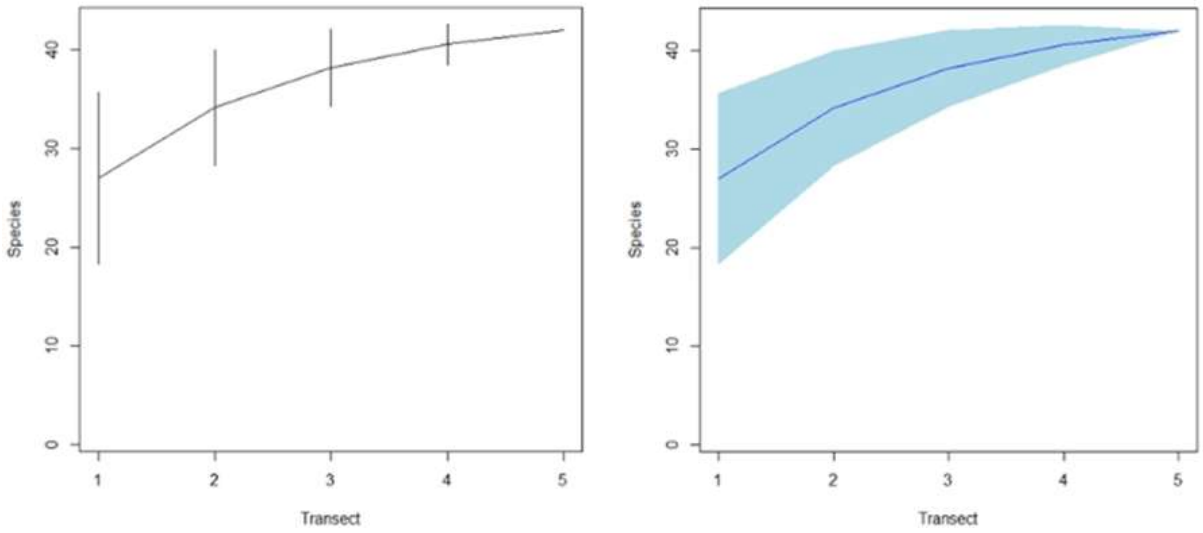

Figure 4: Accumulation with (left panel) and without (right panel) standard deviation of tree species over transects.

3.2. Establishment and growth assessment

To assess the establishment and growth performance of the tree/shrub species replanted in the campus landscape, their DBH and the BA in both ecosystems were compared. The DBH in natural forest varies from 1.9 to 67.1 cm with 18.2 and 20.61 cm as median and mean respectively while in Campus landscape, the DBH varies from 9.7 cm and 55.7 cm with the median of 22.5 cm and the mean of 25.2 cm.

Similarly, the Basal Area in natural forest varies from 2.83 cm^2 and 3,536 cm^2 with the median of 260 cm^2 and the average of 490 cm^2 while the Basal Area in Campus landscape varied from 73.9 to 2,436 cm^2 with their median and mean of 388 cm^2 and 615 cm^2, respectively. The values of

tree/shrub DBH and total BA, from both ecosystems, were compared using the student t-test to find out if or not DBH and BA varies significantly as you move from one site to another.

Table 2: Student t-test for DBH and BA of trees from both sites

	Mean in group Campus landscape	Mean in group Natural Forest	Student t-test	Degree of freedom	p-value	95% Confidence interval
DBH	25.21481	20.6122	1.368	66	0.176	[-2.113,11.318]
BA	614.652	490.524	0.775	66	0.441	[-195.657,443.914]

The student t-test results in ***Table 4.***, shows that there is no statistically significant difference between both DBH and total BA of tree/shrub species from both ecosystems (the natural forest and the campus landscape) as the p-value>0.05 and the 95% Confidence interval of the differences between both sites includes the value zero.

This classical test leads to similar results as the box and whisker plot (sometimes simply called box plots) which shows that in both sites and both factors (DBH and BA), the medians are not far from each other (***Figure 5***), indicating that the differences in DBH and BA, across both ecosystems, are not statistically significantly different.

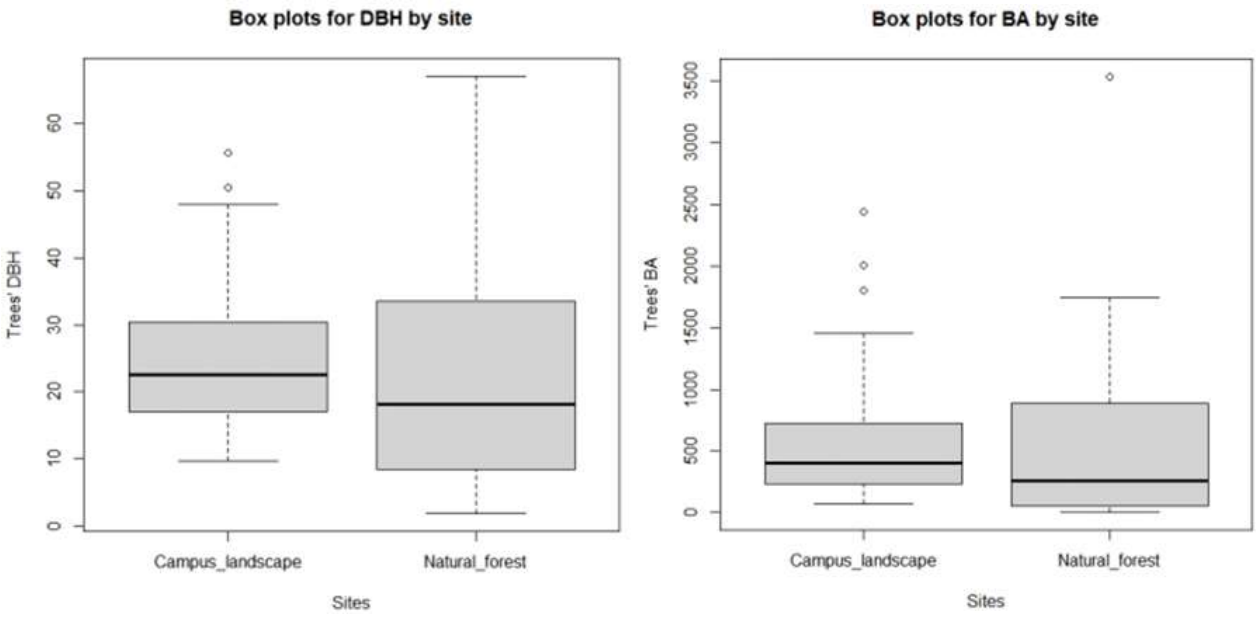

Figure 5: Graphical comparison of tree and shrub DBH and BA comparison in RICA natural forest and RICA campus.

Moreover, one-way Analysis of Variance (ANOVA) was performed to assess the effect of plant families on DBH and total BA in both sites.

Table 3: ANOVA table for DBH and tree/shrub families

	Natural Forest					Campus Landscape				
	Df	Sum Sq	Mean Sq	F value	Pr (>F)	Df	Sum Sq	Mean Sq	F value	Pr (>F)
Family	23	3799	152	0.519	0.929	18	3347	185.9	2.393	0.105
Residuals	15	4388	292.6			8	622	77.7		
Shapiro-Wilk test					0.005					0.018
Kruskal Wallis test					0.656					0.263

Table 5 above shows that for the DBH, both ecosystems, data have a highly significant (given p-value<0.01 for Shapiro Wilk test of normality) and significant (given p-value<0.05 for Shapiro Wilk test of normality) departure from normality respectively, implying that data were not normally distributed. The ANOVA table shows that, for both the natural forest and the campus landscape ecosystems, there is no effect (p-value>0.05) of tree/shrub families on their DBH; and the Kruskal-

Wallis H test showed the similar result as the ANOVA test, implying that the use of this last was the right choice.

Table 4: ANOVA table for total BA and tree/shrub families

	Natural Forest					Campus Landscape				
	Df	Sum Sq	Mean Sq	Fvalue	Pr(>F)	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Family	23	6497483	259899	0.35	0.99	18	8478781	471043	2.605	0.0846
Residuals	15	11140734	742716			8	1446436	180805		
Shapiro-Wilk					<0.0001					<0.0001
Kruskal Wallis test					0.656					0.263

Similarly, for the total BA, ***Table 6*** shows that in both ecosystems, there was a highly significant departure from normality (Shapiro Wilk test of normality, with p-value<0.01). ANOVA tables show no significant effect of tree/shrub families on the total BA, implying that the total BA of tree/shrub species are statistically similar across the families, indicating that (observed) differences are so small that they can be due to chance or sampling error. Furthermore, the Kruskal Wallis H test showed comparable results (p-value>0.05) as ANOVA.

3.3. Foliage arthropod community assessment

The assessment of foliage arthropod orders across the four tree species (***Table 7***) revealed that 53 specimens were collected from the natural forest, while 64 were collected from the campus landscape, representing 45% and 55%, respectively. The χ^2 test of goodness of fit indicated an even distribution of foliage arthropods between the two sites, with a p-value = 0.309.

In the natural forest, 14 specimens were collected from *Haplocoelum foliolosum*, 17 from *Olea europaea subsp. cuspidata*, 12 from *Ficus thonningii*, and 10 from *Pappea capensis*, corresponding to approximately 26%, 32%, 23%, and 19%, respectively. The χ^2 test of goodness of fit showed that the specimens were evenly distributed across the tree

species within the natural forest with a p-value = 0.569. Similarly, in the campus landscape, 14 specimens were collected from *Haplocoelum foliolosum*, 24 from *Olea europaea subsp cuspidata*, 10 from *Ficus thonningii*, and 10 from *Pappea capensis* tree species, accounting for approximately 22%, 38%, 15%, and 25%, respectively. The χ^2 test of goodness of fit indicated an even distribution of insects across the tree species within that site with a p-value = 0.09. $\chi 2$ test of independence showed that there was association between sites and arthropod orders with a p-value=0.0012.

Upon examining the distribution of taxonomic orders among specimens across sites, Hemiptera, Coleoptera, and Hymenoptera were significantly predominant, $\chi 2$ test of goodness of fit with a p-value<0.01 (p-value = 0.0004), comprising approximately 33%, 29%, and 15%, respectively. In contrast, Blattodea, Orthoptera, and Plecoptera were the least represented orders, each accounting for 0.855%. Acari (identified mite order) and Aranea (identified spider order) were represented with 5% and 9%, respectively (***Table 5***).

Table 6: Distribution and association of foliage arthropod community (at order level) on selected tree species

Site	Tree species	Acari	Aranea	Blattodea	Coleoptera	Hemiptera	Hymenoptera	Lepidoptera	Orthoptera	Plecoptera	Psocoptera	Row total	Total %	Site %
Natural forest	***Haplocoelum foliolosum***	3	3	0	3	1	0	2	1	0	1	14	11.966	26.415
	Olea europaea cuspidata	3	3	0	1	9	1	0	0	0	0	17	14.530	32.075
	Ficus thonningii	0	0	1	3	0	5	0	0	0	3	12	10.256	22.642
	Pappea capensis	0	0	0	2	2	5	0	0	1	0	10	8.547	18.868
Site 1 total		6	6	1	9	12	11	2	1	1	4	53	45.299	
Campus landscape	***Pappea capensis***	0	2	0	9	5	0	0	0	0	0	16	13.675	25.000
	Haplocoelum foliolosum	0	1	0	8	2	2	1	0	0	0	14	11.966	21.875
	Olea europaea cuspidata	0	2	0	4	18	0	0	0	0	0	24	20.513	37.500
	Ficus thonningii	0	0	0	4	2	4	0	0	0	0	10	8.547	15.625
Site 2 total		0	5	0	25	27	6	1	0	0	0	64	54.701	
Overall total		6	11	1	34	39	17	3	1	1	4	117		
Percent		5.128	9.402	0.855	29.060	33.333	14.530	2.564	0.855	0.855	3.419	100		

Identified arthropod orders were represented by the following families:

- **Acari Order**: Family of Trombidiidae
- **Aranea Order**: Family of Salticidae and Araneidae
- **Blattodea Order**: Family of Ectobiidae
- **Coleoptera Order**: Family of Tenebrionidae, Culculionidae, Noteridae, Scaraboidea, Chrysomelidae, Melyridae, Coccinelidae, Dermestidae, Scydmaenidae, Meloidae and Scydmaenidae
- **Hemiptera Order**: Family of Pentatomidae, Reduviidae, Tingidae, Cercopidae, Meridae, Lygaeidae and Miridae
- **Hymenoptera Order**: Family of Formicidae, Ichnemonidae and Pyrrchocoriidae
- **Lepidoptera Order**: Family of Erebidae, Notodontidae and Erebidae
- **Orthoptera Order**: Family of Gryllidae
- **Plecoptera Order**: Family of Perlidae
- **Psocoptera Order**: Family of Ectopsocidae

Table 7: Student test for arthropod abundance in both sites

Mean in group Campus landscape	Mean in group Natural Forest	Student	Degree of freedom	p-value	95% Confidence interval
1.829	1.71	0.263	64	0.794	[-0.785,1.023]

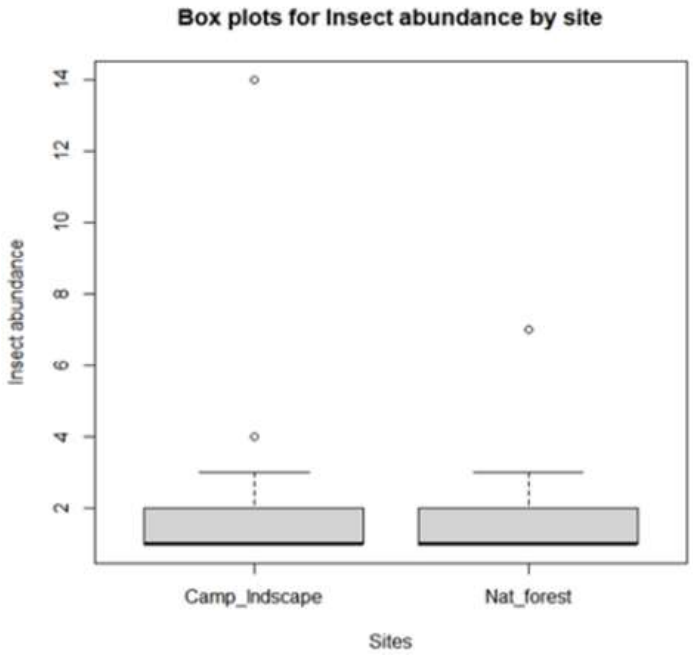

Figure 6: Graphical presentation of arthropod abundance in RICA natural Forest and RICA campus.

The exploration of arthropod abundance shows that the first quartiles are indistinguishable from the medians, and they are almost similar (far below 2) for both ecosystems as shown by ***Figure 6***. The student t-test confirmed this trend since it has shown that no ecosystem had the larger arthropod abundance than another (p=0.794) and the confidence interval of the difference among the sites contains the value zero as illustrated by ***Table 8.***

Table 8: Foliage arthropod diversity indices of both RICA natural forest and RICA landscape

		Haplocoelum foliolosum	*Olea europaea subsp cuspidata*	*Ficus thonningii*	*Pappea capensis*	Average
Shannon index	Natural forest	2.303	1.735	1.807	1.569	1.948
	Campus landscape	2.154	1.570	1.672	2.441	1.799
Simpson index	Natural forest	0.889	0.787	0.818	0.755	0.831
	Campus landscape	0.862	0.678	0.793	0.900	0.778
Inverse Simpson index	Natural forest	9.000	4.688	5.488	4.083	6.392
	Campus landscape	7.258	3.101	4.829	10.000	5.063
Pielou evenness index	Natural forest	0.769	0.579	0.603	0.524	0.650
	Campus landscape	0.731	0.533	0.568	0.829	0.611

However, results in ***Table 9*** above shows that the natural forest is more diverse that the Campus landscape as the computed diversity indices' averages in the natural forest are greater than the averaged indices in the campus landscape. Furthermore, the arthropod data in campus landscape were more spread around the group mean (larger confidence interval) as illustrated by ***Figure 7***.

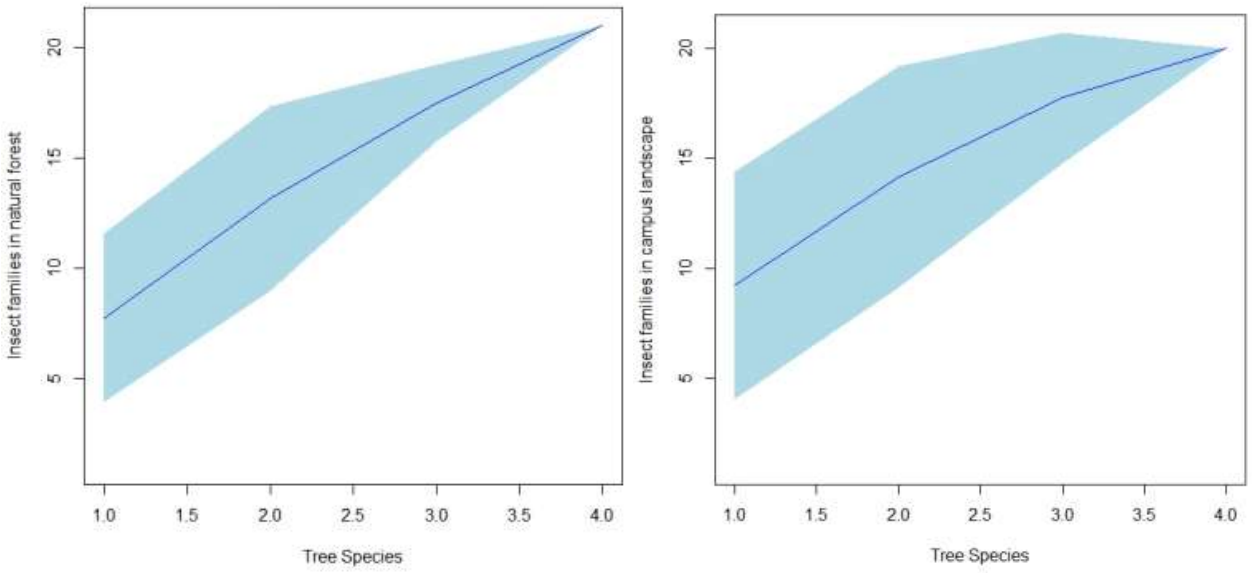

Figure 7: Accumulation of arthropod orders over tree species in natural forest (left panel) and in the campus landscape (right panel)

4. DISCUSSION

Forest inventory

These findings provide a valuable insight of the diversity composition and structure of the RICA forest, aiding the assessment of biodiversity and ecosystem health. Quantifying the abundance of trees and shrubs across families gives an understanding of the ecological dynamics and functioning of the forest. The understanding of the biodiversity composition within the RICA Forest, as revealed by this study, provides a crucial baseline for developing conservation planning and sustainable management strategies. These strategies aim to preserve the biodiversity and ecosystem services of the RICA Forest, aligning with the findings of Dau and Chukwu (2018), emphasizing the role of forest inventory as a tool to gain knowledge that will lead to sustainable management and planning for the forest as it provides understanding on the flora and fauna biodiversity within ecosystems. The biodiversity indices derived from our data indicate an even distribution of plant species across families for woody species reaching two meters or more in height. This implies that in this forest there is no tree/shrub species dominating RICA forest. The rich and diverse flora composition of the RICA Forest significantly enhances its value in terms of biodiversity, as supported by Lakićević and Srđević (2018).

At the transect level, transect 3 exhibited higher biodiversity indices compared to the other transects, while Transect 5 showed lower indices (**Table 3**). The elevated biodiversity in Transect 3 can be attributed to its location within the core of the RICA forest, which supports a richer variety of tree and shrub species and a higher number of individuals. In contrast, transect 5 is located nearer to the local human community and their agricultural plots surrounding the forest, leading to a decline in biodiversity. This finding aligns with a study by Tripathi *et al.* (2021), which reported a decrease in native tree species abundance with agricultural expansion in Mozambique. The same study, also, noted an increase in exotic species in areas close to human activities, mirroring our field observations in transect 5, where several exotic species were present, though not recorded in the inventory, highlighting the significant impact of human proximity on biodiversity composition of the forest.

The inventory and available literature on Afrotropical studies revealed the presence of endemic species restricted in various African sub-regions, it also highlighted species that have not been

evaluated by the IUCN Red List (**Appendix 3**). This underscores the importance of conserving the RICA Forest, as it supports unique flora that contributes to its biodiversity. The need to prioritize the protection of this forest is reinforced by other studies that advocate for the conservation of ecosystems with any level of endemism (Carrasco *et al*., 2020).

Establishment and growth performance

The findings show no significant difference in tree/shrub DBH and BA when the natural forest ecosystem and the campus landscape were compared indicating a successful establishment of restored indigenous species. This result can be attributed to landscaping practices applied in the campus landscape such as regular watering, seasonal mulching, use of fertilizers and pesticides, and pruning for maintenance that optimize the growth of these tree/shrub species despite disturbances faced outside of their native communities. These findings contradict previous studies on the reestablishment of indigenous woody species, elsewhere, that have reported a death of seedlings months after the replantation followed by a decline in growth rate of the survivals (Sakai et *al*., 2011). The landscape practices applied on the replanted trees and shrubs are used to mitigate as much stressing factors as possible that typically affect urban vegetation, allowing the plant individuals in RICA campus landscape to develop similarly to the ones in their natural conditions, contrary to the declaration by Kamo *et al.* (as cited in Sakai et *al*., 2011) that declared a decline in growth performance of certain indigenous species in exposed areas of tropical regions.

Moreover, our results suggest the absence of a detectable effect of families on the tree/shrub DBH and BA in both ecosystems. This absence can be attributed to the fact that these two tree growth metrics are more strongly influenced by environmental factors and management than by taxonomic families. Environmental conditions such as soil quality, water availability, light exposure and microclimatic conditions play crucial roles in the growth of trees and shrubs irrespectively to the taxonomic families they belong to. The genetic differences of trees and shrubs was reported to have a minor impact on the year-to-year growth as noted by Housset et *al*. (2021). Both research findings highlight the impact of sustainable management and preservation plans in the health and establishment of restored ecosystems.

Foliage community of selected tree species

The Chi-square test assessment of arthropod orders suggested no association between the identified orders and the selected tree species for foliage arthropod collection, namely *Ficus thonningii*, *Haplocoelum foliolosum*, *Olea europaea subsp. cuspidata*, and *Pappea capensis*, in both the natural forest and the campus landscape. This finding could be explained by the fact that many of the foliage arthropods, especially ones found in diversified ecosystems, tend to be polyphagous rather than specialized, as reported by Andow, 1991; Hamba¨ck, Agren &Ericson 2000; Massey et *al*. 2006; Unsicker et *al*. 2006; Jactel & Brockerhoff 2007; Sobek et *al*. 2009 (referenced by Schuldt et *al*., 2010). This fact was reported, by the same study, to apply also on the abundance, in forests and any other ecosystem. However, **Table 7** shows a higher percentage of specimen on *Olea europaea subsp cuspidata* trees in both ecosystems,

However, the computation of arthropod diversity indices indicated that the natural forest hosts a greater variety of foliage arthropods compared to the campus landscape. This difference can be due to the more complex and stable environment providing more diverse plant-animal interactions in the natural forest and therefore a variety of niches and microhabitats than the campus landscapes, in contrast with the landscape management practices that can disrupt niches and resources needed by various arthropods. Moreover, the presence of artificial lights, pollution, and higher human activity levels in the campus, can further negatively impact arthropod populations and their diversity. This was also reported in a study done by Straka et *al*. (2021), suggesting that even though the presence of trees can offer some shelter to several arthropods, most specifically insects, the presence of nocturnal lights still significantly negatively impact their richness and abundance. Furthermore, the presence of families such as Salticidae of the Araneae order, Curculionidae of the Coleoptera order, and Formicidae of the Hymenoptera order in both ecosystems serves as indicators of the effects of human activities, such as habitat fragmentation and pollution, as noted in a study by Ghannem et al. (2018).

5. CONCLUSION & RECOMMENDATION

This study aimed to evaluate the establishment of the initial ecosystem prior to the construction of the RICA campus, following the implementation of selected landscape practices. The evaluation confirmed that restoring plant biodiversity is feasible, although it requires careful attention due to the species being grown outside their native communities. This highlights the potential for successful biodiversity restoration with intentional landscape management, but it also underscores the need for ongoing monitoring and adaptation to ensure these replanted native species can thrive and integrate effectively.

Additionally, the study observed that certain ecological services might be inhibited or limited by landscape practices such as the use of pesticides and fertilizers. These practices can reduce the availability of habitats for associated organisms, particularly insect biodiversity. This finding is crucial as it points to the unintended consequences of common landscape management techniques, suggesting that more sustainable practices are necessary to support a wider range of ecological functions and maintain overall ecosystem health.

Despite providing valuable insights, this study is not conclusive due to limitations in time and resources. The constraints impacted the depth and breadth of the research, indicating that further studies are necessary to fully understand the changes occurring within the ecosystem and to identify areas requiring immediate attention. Future research should focus on long-term monitoring and a comprehensive assessment of the impacts of landscape practices on ecosystem services and biodiversity, offering clearer guidance for effective and sustainable ecosystem management.

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APPENDICES

Appendix 1: List of tree/shrub species inventoried in RICA Forest (both natural forest)

Nº	Tree/Shrub species
1	Abutilon_angulatum_(Guill._&_Perr.)_Mast.
2	Acacia_gerrardi_(Benth.)/_Vachellia_gerrardi_(Benth.)P.J.H.Hurter
3	Acacia_hockii_De_Wild./_Vachellia_hockii_(De_Wild.)_Seigler_&_Ebinger
4	Acacia_polyacantha_Willd./_Senegalia_polyacantha_(Willd.)_Seigler_&_Ebinger
5	Acokanthera_schimperi_(A.DC.)_Schweinf.
6	Afrocanthium_lactescens_(Hiern)_Lantz
7	Albizia_gummifera_(J.F.Gmel.)_C.A.Sm.
8	Allophylus_rubifolius_(Hochst,_ex._A._Rich.)_Engl.
9	Apodytes_dimidiata_E.Mey._ex_Arn.
10	Blighia_unijugata_Baker/_Phialodiscus_unijugatus_(Baker)_Radlk.
11	Cadaba_farinosa_Forssk.
12	Capparis_erythrocarpos_Isert
13	Capparis_spinosa_L.
14	Carissa_spinarum_L._/_Carissa_edulis_(Forssk.)_Vahl
15	Combretum_molle_R.Br._ex_G.Don
16	Commiphora_africana_(A.Rich.)_Engl.
17	Dichrostachys_cinerea_(L.)_Wight_&_Arn.
18	Erythrina_abyssinica_Lam.
19	Euclea_racemosa_subsp._schimperi_(A.DC.)_F.White
20	Euphorbia_candelabrum_Welw.
21	Ficus_thonningii_Blume
22	Gardenia_ternifolia_Schumach._&_Thonn.
23	Grewia_bicolor_Juss.
24	Grewia_similis_K.Schum.
25	Haplocoelum_foliolosum_(Hiern)_Bullock

26	Lannea_humilis_(Oliv.)_Engl.
27	Markhamia_lutea_(Benth.)_K.Schum.
28	Markhamia_obtusifolia_(Baker)_Sprague
29	Maytenus_senegalensis_(Lam.)_Exell/_Gymnosporia_senegalensis_(Lam.)_Loes.
30	Olea_europaea_subsp._cuspidata_(Wall._&_G.Don)_Cif.
31	Osyris_lanceolata_Hochst._&_Steud.
32	Pappea_capensis_Eckl._&_Zeyh.
33	Parinari_curatellifolia_Planch._ex_Benth.
34	Psydrax_schimperianus_(A.Rich.)_Bridson/_Canthium_schimperianum_A.Rich.
35	Rhus_natalensis_Bernh./_Searsia_natalensis_(Bernh._ex_C.Krauss)_F.A.Barkley
36	Strychnos_lucens_Baker
37	Trema_orientale_(L.)_Blume
38	Vepris_nobilis_(Delile)_Mziray/_Teclea_nobilis_Delile
39	Ximenia_caffra_Sond.
40	Zanthoxylum_chalybeum_Engl.
41	Ziziphus_mucronata_Willd.

Appendix 2: Inventoried tree species names, families, descriptions and uses

Scientific names **Vernacular names** **Family**	**Description**	**Uses**	**References**
Abutilon angulatum **(Guill. & Perr.) Mast.** Umukungeri Malvaceae	**An erect perennial shrub**: 1-3 m, occasionally taller than that. **Bark on stem and branches**: dull greyish-green color, velvety, fibrous, and noticeably angled. **Leves**: simple, alternate with sub-falcate stipules, **the blade** is roundish to broadly ovate, with a cordate base and acute to acuminate apex, dark grey-green color at the upper surface and the lower	Edible (leaves and flowers as vegetables); medicinal (leaves, flowers, roots); bee forage; fibers (to make cloths, strings, and cordage); tinder to start as fire; ornamental.	(Nduwayezu *et al.*, 2009) https://www.botswanaflora.com/speciesdata/species.php?species_id=138810#:~:text=Description%3A,from%20the%20base%3B%20margins%20serrate.

	surface paler and veined from the base, **the margin** is serrate. **Inflorescence**: a large, terminal, and lateral panicle, loose, much branched and ultimately leafless. **Flowers**: bisexual, regular, yellow to apricot-orange color, and opening in the afternoon; fruits are sub-globose schizocarp of a dark-brown color, smooth or with fine papillae.		https://www.worldfloraonline.org/taxon/wfo-0000511722 https://prota.prota4u.org/protav8.asp?g=pe&p=Abutilon%20angulatum
Acacia gerrardi **(Benth.)**/ *Vachellia gerrardi* **(Benth.) P.J.H.Hurter** Umugunga Fabaceae	**A shrub or small tree**: 15m in height, with a dispersed irregular crown. **Bark**: rough and longitudinally furrowed with a grey-brown color; branchlets are densely hairy; thorns are noticeably short either straight or hooked with brown tips. **Leaves**: alternate, hairy and bipinnate with 5-12 pairs of pinnae. **Leaflets:** numerous, small, and hairy; flowers are bisexual, and in axillary clusters, round, of creamy white to white colored heads that have a sweet smell. **Fruits**: slightly curved pods of a brown to grey-brown color with darker dots, narrow, rounded and not woody but covered in velvet grey hairs when young. **Seeds**: compressed oblong with a hard testa, and an olive-brown color.	Firewood, charcoals, timber, construction, medicine (bark), fodder, bee forage, nitrogen fixation.	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009a) https://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=125920 https://prota.prota4u.org/protav8.asp?g=pe&p=Acacia+gerrardii https://www.worldfloraonline.org/taxon/wfo-0000196431
Acacia hockii **De Wild.** / *Vachellia hockii* **(De Wild.) Seigler & Ebinger** Umugenge Fabaceae	**A shrub or small tree**: 5-11m high with a round crown. **Bark:** tends to be yellow and is peeling. **Leaves:** compound with 20-25 pairs of small leaflets; stipular-paired-short and straight spines. **Flowers:** bright yellow, **forming** small round heads **Fruits**: curved dehiscent **pods** of around 15cm long with a reddish to purplish brown color **Seeds:** free olive-brown, hanging on threads-like stalk.	Firewood, charcoal, agroforestry, bee forage, and the bark can be used as ropes.	(Orwa *et al.*, 2009b) (Nduwayezu *et al.*, 2009) https://www.mozambiqueflora.com/speciesdata/species.php?species_id=186030 https://www.zambiaflora.com/speciesdata/species.php?species_id=186030 https://tropical.theferns.info/viewtropical.php

			?id=Vachellia+hockii &redir=Acacia+hockii
Acacia polyacantha **Willd.** / *Senegalia polyacantha* **(Willd.) Seigler & Ebinger** Umuharata Fabaceae	A **large, deciduous tree:** usually 10-15m tall but can reach 25m, the whole plant bears dark brown to black hooked and paired thorns. **Crown**: flat-topped and shallow. **Bark:** yellow-brown color, papery and have persisting prickles, as the tree matures, the bark turns smoother and whitish grey, sometimes with flakes; **young branches** are covered by silvery hairs. **Leaves:** bipinnately compound with 14-35 pairs of pinnae and 20-60 leaflets to every pinna. **Leaflets**: a dark green color above while the below is lighter, the margin and stalk are covered by hair. **Flowers:** light yellow to cream color and are produced in spikes, they have a sweet smell. **Fruits** are flat and shiny green seedpods turning a light brown color as they mature. **Seeds**: flattened and dark brown, of a number between 3-10 per pod.	Timber, firewood, charcoals, tool handles, farm tools, medicine (leaves, roots, bark), agroforestry, fodder (pods, leaves, and seeds), ornamental, shade, source of gum, tannin and dyestuffs, live fence, and bee forage.	(Orwa *et al.*, 2009c) (Nduwayezu *et al.*, 2009) https://www.malawiflora.com/speciesdata/species.php?species_id=126120 https://tropical.theferns.info/viewtropical.php?id=Senegalia+polyacantha&redir=Acacia+polyacantha https://www.worldfloraonline.org/taxon/wfo-0000209605
Acokanthera schimperi **(A.DC.) Schweinf.** Umusagwe Apocynaceae	An **evergreen shrub or small tree**: branches and dense round crown, growing to 2-10m long. **Bark**: dark brown and hallowed with age. **Leaves**: opposite, dark green, shiny at the top and paler at the bottom with cuneate or rounded at the base and pointed and sharp apex. **Flowers**: white with pink tubes with a sweet smell and developed in clusters. **Fruits:** small green or red berries that become purple when ripen.	Ornamental plant; edible fruits; medicine; shade; roots, offshoots, leaves, and the bark are used to prepare arrow poison.	(Orwa *et al.*, 2009d) (Nduwayezu *et al.*, 2009) https://tropical.theferns.info/viewtropical.php?id=Acokanthera+schimperi https://plants.jstor.org/compilation/acokanthera.schimperi https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:60447729-2/general-information
Afrocanthium lactescens **(Hiern) Lantz**	A **deciduous shrub or small tree:** resistant to both draught and termites growing 3-12m tall with hairy young branches.	Firewood, edible fruits, medicinal (poison antidote),	(Nduwayezu et al., 2009)

Umukondokondo Rubiaceae	**Bark:** dark grey or grey-red**,** smooth but turns rough with time. **Leaves:** simple, opposite, dark green, oval to broadly elliptic and wide with 6-16cm long and 4-14cm wide. The bark and leaves secrete a gum-like sap when wounded. **Flowers**: whitish to cream-yellow with a very sweet smell. **Fruits**: small with 7-12mm diameter, heart to square shaped and two distinct lobes, yellow when young ripping to be brown-purple and edible.	building material and tool making, bee forage.	https://www.zambiaflora.com/speciesdata/species.php?species_id=155890#:~:text=Description%3A,hairless%20or%20slightly%20velvet%20below. https://tropical.thefern s.info/viewtropical.php ?id=Afrocanthium+lac tescens&redir=Canthiu m+lactescens
Albizia gummifera **(J.F. Gmel.) C.A.Sm.** Umusebeya Fabaceae-Mimosoideae	A **large deciduous tree:** 4.5-30 m tall. **Branches**: ascending forming a flat and open crown at the top. **Bark**: smooth and grey. **Leaves**: bipinnate counting 5-7pairs of pinnae and 9-16 pairs of leaflets per pinna. **Leaflets:** almost rectangular, of glossy dark green above and the beneath surface is covered in short hair on the midrib and margins. **Flowers**: white-pink clusters with long stamens hanging out in tubes and tips of deep red color. **Fruits**: papery dehiscent and flat pods, of a shiny brown color turning reddish or purplish.	Timber, firewood, building materials, grain mortars, beehives, medicine (pods, roots, and bark), agroforestry and soil conservation, shade, fodder, bee forage.	(Orwa *et al.*, 2009e) (Nduwayezu et al., 2009) https://tropical.thefern s.info/viewtropical.php ?id=Albizia+gummifer a https://www.malawiflora.com/speciesdata/species.php?species_id=125660 https://prota.prota4u.org/protav8.asp?g=pe&p=Albizia+gummifera+(J.F.Gmel.)+C.A.Sm.
Allophyllus rubifolius **(Hochst, ex. A. Rich.) Engl.** Isheshe Sapindaceae	A **shrub or small tree**: 3-12m and is sometimes described as a creeper. **Bark**: smooth with a grey to green color; **branchlets** have short soft hair or are hairless. **Leaves**: trifoliate with 2 lateral a half smaller than the terminal leaflet emitting a sweet smell when crushed, **leaflets** are obovate to elliptic of 3-9 cm long, they can have either smooth or densely hairy margin and blade, the **blade** is of a glossy green on the top side and paler at the bottom side and the **margin** is irregularly dented.	Firewood, medicine, soil conservation and erosion control, forage, bee forage, thin stems are used to construct granaries.	(Nduwayezu et al., 2009) https://www.mozambiqueflora.com/speciesdata/species.php?species_id=137390#:~:text=Description%3A,unbranched%2C%20catkin%2Dlike%20racemes. https://www.worldfloraonline.org/taxon/wfo-0000526853

	Inflorescences: axillary developing in clusters, around 10 cm long and can be either branched or unbranched. **Flowers**: small with cream or yellowish-green color. **Fruits**: small berries, round or elliptic and of red to orange color ripping to a purplish-black color.		https://prota.prota4u.org/protav8.asp?g=pe&p=Allophylus%20rubifolius https://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=203110
Apodytes dimidiata **E.Mey. ex-Arn.** Umusibya Icacinaceae	**Small to medium evergreen tree**: 4-25m tall with a dense crown. **Bark**: grey to pale grey-brown, smooth when young but grows to become peeled and cracked in older trees. **Leaves**: ovate-elliptic, simple, and alternate, 2-15cm long and 1.5-8cm wide, shiny dark green on top while paler and dull green at the bottom, petiole and midrib of younger leaves are red to pink. **Flowers**: small, white and have a sweet smell, produced in axillary or terminal panicles of around 8cm long. **Fruits**: berry-like, small, flattened, 8mm long, green but turn black when ripe with a fleshy appendage covering the fruit on one side giving it a kidney-shape.	Timber (building and furniture), firewood, charcoal, tool manufacturing, medicine (leaves, bark, and roots), bee forage.	(Razafiniary, 2020a) https://www.mozambiqueflora.com/speciesdata/species.php?species_id=137260 https://pza.sanbi.org/apodytes-dimidiata-subspdimidiata
Blighia unijugata **Baker** / *Phialodiscus unijugatus* **(Baker) Radlk.** Umuturamugina Sapindaceae	An **evergreen, medium to large tree**: 20m tall but can reach 30-35m in a forest; with a rounded, dense, and shady **crown**. **Bark:** thin, grey to dark green, smooth with wart-like outgrowths. **Leaves**: compound, alternate with 2-3 pairs of leaflets; **leaflets** are of a dramatic pink red at first turning a shiny dark green later at the above and dull green below, they are opposite pairs, with the uppermost pair larger than the others; the **margin** is entire and often wavy. **Flowers**: unisexual, male, and female flowers are usually on different trees, of white color and have a sweet smell.	Firewood, charcoal, timber, construction materials, shade.	(Razafiniary, 2020b) https://prota.prota4u.org/protav8.asp?g=pe&p=Blighia%20unijugata https://pza.sanbi.org/blighia-unijugata#:~:text=Evergreen%2C%20medium%20to%20large%20tree,80%20to%20300%20mm%20long. https://www.malawiflora.com/speciesdata/species.php?species_id=137480

	Fruits: in cluster, have 3 lobes and pear-shaped, they have ridge-like wings, of bright pink to red color, splitting to release 3 glossy dark brown to black **seeds**.		https://tropical.theferns.info/viewtropical.php?id=Blighia+unijugata
Cadaba farinosa **Forssk.** Umuvutavuta/ Umuryanka Capparaceae	**A slender, much branched, evergreen shrub:** 5m tall, rarely growing as a tree up to 8m. **Bark**: yellowish grey color and strongly furrowed. **Leaves**: numerous, small, alternate on young shoots while clustered on older wood, its blade is oblong-ovate or elliptic-oblong shaped, rounded, mucronate or retuse at the apex while the base is rounded or cuneate, both sides of the leaf and the petiole are hairless but covered with a white mealy powder. **Flowers**: yellowish-green and developed in racemes with their axis covered with the same white mealy powder as the leaves. **Fruits:** oblong, cylindrical, and densely covered in white powder, the interior of the fruit is orange-red when mature with multiple seeds. **Seeds:** the size of a millet grain, comma-shaped, shiny, and brown, arranged in a single layer within the fruit.	Edible (flowers and young twigs and leaves); medicinal (leaves, woods, bark); fodder (flowers, leaves, fruits); firewood; wind and water erosion control; stabilization of sand dunes; shade and shelter, live fence; cleansing ceremonies (in Sudan).	(Orwa *et al.*, 2009f) https://tropical.theferns.info/viewtropical.php?id=Cadaba+farinosa
Capparis erythrocarpos **Isert.** Munyegereze/ Umukorokombe Capparaceae	A **very thorny, much branched shrub**: 6m tall, usually climbing but was observed to also be erect in some cases. **Branches**: slightly zigzag, a greyish-velvety color when young. **Leaves**: elliptic to ovate, blunt and mucronate at the apex, greyish and velvety when young, losing the velvet when older. **Margin**: often wavy. **Flowers**: solitary, axillary, greenish white. **Fruits**: ellipsoid, green turning deep pink or red when ripe.	Medicinal (root bark), edible (fruits).	https://www.mozambiqueflora.com/speciesdata/species.php?species_id=124430 https://www.worldfloraonline.org/taxon/wfo-0000584688

Capparis spinosa **L.** Umutugunguru/ Umukorokombe Capparaceae	A **shrub, small plant, or a robust woody climber:** 5-10 m high, with an upright trunk, strongly branched, spiny and climbing; **branches** have yellowish hairs. **Bark:** a grey to grey-brown color; **spines** are paired under the petiole. **Leaves**: simple and alternate with elliptic to oval shape, slightly hairy with a greyish green color. **Inflorescence:** umbel shaped and terminal, around 3 m long, hairy, and consisting of up to 15 flowers. **Flowers:** bisexual and zygomorphic with sweet smell; **petals** are of a pale yellowish green surrounding a set of slender white or pink stamens of around 30mm long. **Fruits:** cherry size to a golf ball, when ripe they are pink to pale orange and have a dark brown **seed** adhered to the fruit by a flesh and are in great number in one fruit.	Edible fruits, firewood, medicinal, cultural beliefs, poisons (leaves).	https://tropical.theferns.info/viewtropical.php?id=Capparis+spinosa https://www.gardenia.net/plant/capparis-spinosa https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/capparis-spinosa https://hort.extension.wisc.edu/articles/capers-capparis-spinosa/
Carissa spinarum **L./** *Carissa edulis* **(Forssk.) Vahl** Umunyonza Apocynaceae	**Evergreen small tree, shrub, or scrambler:** 5m or 6m. **Bark:** grey and smooth; very much branched to form a dense canopy; and young **branchlets** are with or without hair; **spines** are woody, simple, straight and most of the time single of 2-7 cm in height. **Leaves:** simple, opposite with a shiny dark green above and a paler green below, an entire **margin**, a round base and pointed tips; the **petiole** is short of around 5mm long. **Flowers:** red, pink, or purple on the outside while the inside is white with a sweet smell. **Fruits:** rounded and/or ovoid berries, green when unripe turning dark red or purplish color when ripe.	Edible fruits; firewood; fodders (leaves and fruits); roots are used for medicinal purpose; ornamentals; live fence and bee forage.	(Nduwayezu *et al.*, 2009) (Linn, 1994) https://www.worldfloraonline.org/taxon/wfo-0000803913 https://tropical.theferns.info/viewtropical.php?id=Carissa+spinarum https://www.malawiflora.com/speciesdata/species.php?species_id=144940
Combretum molle **R.Br. ex G. Don** Umurama Combretaceae	**Small to medium-sized tree:** 3-13m, occasionally reaching 16m high, **deciduous** with rounded crown; it can be **evergreen** when the moisture is sufficient. **Bark**: grey and smooth when young becoming grey-brown or almost black; rough and flaking when older; with reddish hairs. **Leaves:** opposite, simple, covered by velvety hair	Medicine, fodder, firewood, timber, bee forage, soil improvement and mulches (leaves).	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009a) https://tropical.theferns.info/viewtropical.php?id=Combretum+molle

	when young becoming smoother as they get older, they are pinkish-orange color. **Flowers:** small, of pale cream or greenish-yellow color sometimes with small tint of red; growing in a dense axillary spike forming an inflorescence; with a strong sweet smell attracting bees and other insects. **Fruits:** have 4-wings of a light yellowish-green color with red shades turning red-brown when dry.		https://www.zambiaflora.com/speciesdata/species.php?species_id=141970
Commiphora africana **(A. Rich.) Engl.** Umudahwera Burseraceae	**Deciduous shrub or small tree**: 3-5m, occasionally individuals can reach 10m, the tree is bare of leaves for several months in dry season; the **crown** is round, **branches** are ascending then bending downwards, **branchlets** end in spines. **Leaves:** trifoliate, soft, hairy, have a bright green color and have a sweet scent. **Leaflets**: obovate, irregularly, and roundly toothed and the terminal leaflet is at least twice the size of lateral ones. **Flowers:** in axillary clusters of 4-10 flowers, petals are 4 in reddish green color, not fused forming a tube. **Fruits**: almost spherical or ellipsoidal, red colored when ripe, made of two outer cotyledons splitting to reveal a red fresh embedding a hard stony seed.	Edible (roots, gum, bark, fruits...); fodder; timber; medicine; gum or resin extracted from the stem is used to make arrows; live fences and hedges.	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009g) https://tropical.theferns.info/viewtropical.php?id=Commiphora+africana https://www.worldfloraonline.org/taxon/wfo-0000617158
Dichrostachys cinerea subsp. africana **Brenan & Brummitt** Umukamba/ Umuyebe Fabaceae-Mimosoideae	A **semi-deciduous to deciduous tree**: 7m tall with an open, umbrella-shaped crown. **Bark**: green, hairy, and woody on young branches while it turns dark grey-brown and longitudinally fissured as branches mature and on the stem; **thorns** are green, alternate and in single with a curved tip. **Leaves**: hairy, bipinnate and have 5-10 pairs of pinnae bearing 2-21 pairs of leaflets; leaflets are olive-green colored, small, obovate, or lanceolate shaped, they are slightly glossy on the above while dull below. **Flowers**: bisexual, developed in pendulous, cylindrical, and bicolored spikes, of a pinkish-	Edible (fruits and seeds), medicine (bark, roots, leaves), fodder, bee forage, firewood, charcoals, timber, erosion control, nitrogen fixation and soil improvement, ornamental, live fence, fibres for utensil making.	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009h) https://www.mozambiqueflora.com/speciesdata/species.php?species_id=126320 https://tropical.theferns.info/viewtropical.php?id=Dichrostachys+cinerea

	mauve or white color and the color may vary even on the same tree individual. **Fruits**: curled, twisted, sickle-shaped and leathery tough, and indehiscent pods, they are developed in a mass from the spike, of a green color at first, turning deep brown as they mature. **Seeds**: shiny, black, smooth, compressed, ovoidal to ellipsoidal shaped, produced in four per pod.		
Erythrina abyssinica **Lam.** Umuko/Umurinzi Papilionoideae	**Deciduous medium-sized tree**: to 5-10m; the **crown** very well branched, rounded and spreading; the **trunk** is short. **Bark:** of a brownish yellow color when young growing to turn grey brown to creamy brown, scratched and often with spines, when damaged, it secretes a brownish gummy sap. **Leaves:** trifoliate and alternate with a petiole of 6-20cm; **leaflets** are broad, hairy when young losing the hair with maturity, with ovate, cordate and/or almost circular with a round base and an obtuse or angular apex; terminal leaflet is slightly larger than lateral ones; the **main veins** have scattered spine at the undersurface. **Flowers:** grow in dense, pyramidal racemes that can be either terminal or axial with a peduncle of 20cm, bisexual, densely hairy of orange-red color. **Fruits**: hairy woody pods of a brown to black color, dehiscing to a set of free bright red ellipsoid seeds.	Fodder, apiculture, firewood, timber, dyestuff (roots and bark), medicine (bark, roots, and flowers), erosion control, agroforestry, live fence, ornamental, soil conservation, cultural ceremonies, and myths.	(Nduwayezu *et al*., 2009) (Orwa *et al.*, 2008) https://tropical.theferns.info/viewtropical.php?id=Erythrina+abyssinica https://www.mozambiqueflora.com/speciesdata/species.php?species_id=133260 https://treesa.org/erythrina-abyssinica/

Euclea racemosa subsp. schimperi **(A.DC.) F.White** Umushikiri Ebenaceae	An **evergreen shrub or a small tree**: 3-12m long, densely branched. **Bark**: grey or grey-black colored and smooth. **Leaves:** opposite, shiny, of a dark green color above and a dull pale green below, the tip is round while the base is narrow, and the edge curls in the inside. **Flowers:** small, of cream-white color and a sweet smell, the male flower bears several stamens. **Fruits:** small and round, green ripening to purple-black color, the thin flesh is edible and surrounds seeds	Firewood, medicine (roots), edible, tool making, soil conservation, shade, antidote for poisons, boundary marking, black dye (roots).	(Nduwayezu et al., 2009) (Orwa *et al.*, 2009i) https://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=143910 https://tropical.theferns.info/viewtropical.php?id=Euclea+racemosa https://www.worldfloraonline.org/taxon/wfo-0000681125
Euphorbia candelabrum **Welw.** Umuduha/ Ikiha Euphorbiaceae	A **succulent tree**: 3-15m high (can reach 20m). **Trunk:** thick and erect; **branches** are erect and spread to form a large round crown. **Bark:** green-grey produce food by photosynthesis as mature trees do not have **leaves**, and white latex when ripped; seedlings have small, simple, oblong, and alternate **leaves** changing into scales as the tree matures **Flowers:** small, unisexual, of green-yellow color, fleshy and developed in groups of 4-6 next to paired spines. **Fruits:** green-red and pea-size capsules, and **seeds** are of a dirty white color.	Medicinal (latex), ornamental, shade, live fences, timber, firewood, insect repellent, beehives.	(Nduwayezu et al., 2009) (Razafiniary, 2020c) https://tropical.theferns.info/viewtropical.php?id=Euphorbia+candelabrum
Ficus thonningii **Blume** Umuvumu/Umutaba Moraceae	An **evergreen or briefly deciduous tree:** dense, rounded to spreading crown, growing to 6-21m and multi-stemmed, sometimes epiphytic. **Bark:** hairy on young branches while it is smooth and grey in older branches and stem, often with aerial hanging roots. **Leaves:** simple, alternate, shiny, obovate, or elliptic, of a dark green color, thin and papery with a smooth **margin**. **Flowers**: small, greenish-yellow, and inconspicuous.	Edible (fruits and leaves), medicine (leaves and latex), ornamental, timber, firewood, fodder, ceremonial and cultural, fiber and glue, soil, and water conservation.	(Orwa *et al.*, 2009a) (Nduwayezu et al., 2009) https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:853830-1/general-information https://www.worldfloraonline.org/taxon/wfo-0000690599;jsessionid=62345998FB613D87FF53A062D172A91A

	Fruits: small figs, green but ripping to yellow or orange, clustered at the end of branchlets.		https://tropical.theferns.info/viewtropical.php?id=Ficus+thonningii
Gardenia ternifolia **Schumach. & Thonn.** Umutarama Rubiaceae	An **evergreen shrub or small tree:** 3-6m high. **Bark:** grayish white and smooth. **Leaves:** in whorls of 3, oblanceolate to obovate, roughly hairy on both sides; **margin** is entire, the base is cuneate while the tip is rounded, the **midrib** is grayish white and protruding on both sides. **Flowers:** creamy or white, maturing to yellow color, and have a sweet smell. **Fruits:** ovoid, velvety and terminal, green when young and ripe to be yellowish brown, comprising several **seeds**.	Food, firewood, medicine, ornamental, magic charm.	(Nduwayezu et al., 2009) (Razafiniary, 2020d) https://www.zambiaflora.com/speciesdata/species.php?species_id=155370 https://www.worldfloraonline.org/taxon/wfo-0000971206;jsessionid=4B4EA1B45020CF118C51FD9D96BC9383 https://tropical.theferns.info/viewtropical.php?id=Gardenia+ternifolia
Grewia bicolor **Juss.** Umukomagabo Tiliaceae	A **shrub or small tree**: multibranched, growing up to 7m high. **Bark:** smooth and grey in young tree maturing to become dark grey and highly cracked, the **trunk** peels in grey to reddish-grey straps. **Leaves:** simple, alternate, elliptic to slightly ovate or lanceolate, of dark and dull green color above and whitish below with silvery hair, **margin**: finely toothed sometimes almost entire. **Flowers:** small of bright yellow color, produced in axillary clusters at the end of branches. **Fruits**: sweet but astringent, single, round, and fleshy drupes of reddish-brown or orange when ripen.	Firewood and charcoal, timber and building materials, food, and alcoholic drink production (fruits), medicine, bark fibers used as ropes, fodders.	(Orwa *et al*., 2009) (Nduwayezu et al., 2009) https://www.africa.upenn.edu/famine food/category3/cat3_Grewia_bicolor.htm https://www.botswanaflora.com/speciesdata/species.php?species_id=138390 https://pza.sanbi.org/grewia-bicolor
Grewia similis **K.Schum.** Umukomagore Tiliaceae	A **shrub:** 2-3m, sometimes a climber. **Bark:** grey or grey-brown, smooth at early age but aging to become rough, flaking, and fibrous. **Leaves:** simple, of a shiny dark green color above and hairy below, they are small, oval to rounded	Edible (fruits, leaves), medicinal (leaves, roots, stems, bark), building materials, tool making, fodder, bee forage.	(Orwa *et al.*, 2009b) (Nduwayezu et al., 2009) https://plants.jstor.org/compilation/grewia.similis

	shape, with a round or notched tip while the base is round, the **margin** is finely toothed. **Flowers:** bright purple or pink (sometimes white), produced at terminal shoots between leaves and branchlets. **Fruits:** small fleshy berries, of a bright red color or orange when ripe with a sweet flavor.		https://www.worldfloraonline.org/taxon/wfo-0000710313;jsessionid=744560E4453941D0B6A86DC9C2AA6403 https://tropical.theferns.info/viewtropical.php?id=Grewia+similis
Haplocoelum foliolosum **(Hiern) Bullock** Umujwiri Sapindaceae	A **shrub or small tree:** 15-25m tall. **Bark:** grey and smooth but usually showing folding, the **wood** is reddish; **branchlets** are dark greyish brown to black and with short hair. **Leaves:** alternate and paripinnate with 2-16 pairs of leaflets; **leaflets** are opposite, oblong to elliptical, smooth or have dispersed hair on the midrib, their base is cuneate to obtuse and asymmetrical while the apex is notched. **Flowers**: unisexual, regular, and white, cream, or yellowish, developed in axillary clusters. **Fruits:** orange to red, ovoid capsule, indehiscent or irregularly splitting; **seeds** are ellipsoid, brown, and covered by a thin fleshy aril.	Building materials, timber, tool handles, edible (fruits), bee forage, leaf decoctions used like lotion, toothbrushes (twigs).	https://www.zambiaflora.com/speciesdata/species.php?species_id=137440 https://prota.prota4u.org/protav8.asp?g=pe&p=Haplocoelum+foliolosum https://plants.jstor.org/stable/10.5555/al.ap.flora.ftea004221
Lannea humilis **(Oliv.) Engl.** Umukundambazo/ Ikiryoheramuhoro Anacardiaceae	A **deciduous shrub or a small tree:** 6m tall, with a thick trunk, a flat or spreading crown. **Bark:** dark grey, almost black, and spongy on old trees; **on branches**, the bark is smooth with clear lenticels while **on branchlets**, it is white and hairy. **Leaves:** compound with 5-21 leaflets including the terminal one and are scattered along the terminal twigs. **Leaflets:** discolorous with a dark green color with dense, in young leaves, or scattered, in aged leaves, white star-shaped hairs, the terminal leaflet is larger, oblong to obovate with a obtuse apex and a cuneate base; while lateral leaflets are smaller, ovate, oblong or elliptic with an obtuse apex and an unequally rounded or subcordate base.	Edible (roots, fruits), medicine (root), agroforestry, live fence, ropemaking (bark), carpentry materials, firewood.	(Nduwayezu et al., 2009) https://prota.prota4u.org/protav8.asp?g=pe&p=Lannea%20humilis https://tropical.theferns.info/viewtropical.php?id=Lannea+humilis

	Flowers: small, of a cream-yellow color, produced in spikes, the stalks and sepals have white hairs, male and female flowers are on different trees. **Fruits:** flat, ellipsoid drupes, and covered in dense grey furry hairs.		
Markhamia lutea **(Benth.) K. Schum.** Umusave Bignoniaceae	An **upright evergreen tree:** 10-15m tall sometimes recorded to even reach 40m and above, with a narrow and irregular crown, and a long taproot. **Bark:** light brown color and has vertical cracks. **Leaves:** compound and pinnate with 7-11 leaflets; **leaflets** are thin and wavy with a wide tip and round outgrowth at the base. **Flowers:** a bright yellow color, trumpet-shaped and grow in terminal clusters. **Fruits:** long, thin, and brown colored capsules hanging in clusters and splitting on the tree to release transparently winged seeds of a yellow-brown color.	Timber, medicinal (leaves, bark, and roots), agroforestry uses, building materials, erosion control, mulching materials, firewood and charcoals, ornamental, bee forage	(Nduwayezu et al., 2009) (Orwa *et al.*, 2009c) https://prota.prota4u.org/protav8.asp?g=pe&p=Markhamia+lutea https://tropical.theferns.info/viewtropical.php?id=Markhamia+lutea
Markhamia obtusifolia **(Baker) Sprague** Umukungusebeya Bignoniaceae	A **much-branched deciduous small tree:** 1.5-8m tall but can reach 15m. **Bark:** light brown-grey color, smooth but longitudinally striated in old trees; **branchlets** are velvety with golden brown hairs. **Leaves:** compound with 3-5 pairs of leaflets and a terminal one and its stalk is around 8cm long. **Leaflets:** elliptic to oblong, covered with dense golden hairs when young but mature to have less above, their tip is either rounded, notched or attenuate while the base is either square, rounded, or obtuse. **Flowers:** grow in terminal clusters and are of a bright yellow color with red-brown lines, they are bisexual and zygomorphic. **Fruits:** long, flattened capsules covered by small golden hairs when mature and containing numerous winged **seeds.**	Medicinal (fruits and roots), firewood, building materials, timber, fodders (leaves), bee forage, shade, and farm boundaries.	(Nduwayezu et al., 2009) (Orwa *et al.*, 2009d) https://www.mozambiqueflora.com/speciesdata/species.php?species_id=152410 https://treesa.org/markhamia-obtusifolia/ https://www.worldfloraonline.org/taxon/wfo-0000779030 https://plants.jstor.org/compilation/markhamia.obtusifolia https://tropical.theferns.info/viewtropical.php?id=Markhamia+obtusifolia

Maytenus senegalensis **(Lam.) Exell**/ *Gymnosporia senegalensis* **(Lam.) Loes.** Umushubi Celastraceae	A **shrub but can also be a multi-stemmed tree:** 8m high; the **trunk** is straight with drooping branches either with or without spines. **Bark**: trunk-grey color, rough and thick, with vertical furrows on the trunk; but smooth, red or grey-green on the branches and have spines with not hairs or dots. **Leaves:** alternate or in clusters, smooth and often fleshy, oblong or rarely ovate to obovate or oblanceolate or oblong-elliptic, the tip often wider than the base, the **edge** are finely round toothed, the petiole and midrib are often pinkish. **Flowers:** white-cream-green, developed in dense stalked clusters, with a sweet smell. **Fruits**: green turning red, round containing 1 or 2 shiny red-brown **seeds** with a soft white aril.	Firewood, edible (leaves), medicine (roots, leaves, bark), fodder (leaves), bee forage, live fence.	(Nduwayezu et al., 2009) (Orwa *et al.*,2009e) https://plants.jstor.org/stable/10.5555/al.ap.upwta.1_686 https://www.mozambiqueflora.com/speciesdata/species.php?species_id=137000 https://www.worldfloraonline.org/taxon/wfo-0000374998 https://pza.sanbi.org/gymnosporia-senegalensis
Olea europaea subsp. cuspidata **(Wall. & G.Don) Cif.** Umunzenze Oleaceae	An **evergreen tree** but can be taken for a **shrub** when stunted: 3-10m tall but can occasionally reach 14-18m with a dense and spreading crown that can reach up to 26m. **Bark** is of a grey to brownish-blackish, smooth but turns rough and deeply cracked when old. **Leaves:** simple, opposite, long, and narrow, of an oval, oblong or elliptic shape, color varies from grey green to shiny dark green at the above, and greyish to yellowish with silvery, golden, or brown scale below. **Flowers:** small, of a greenish-white or cream color, in loose axillary or occasionally terminal panicles with a sweet smell. **Fruits:** small drupes, oval and thinly fleshy with a green color when young and turning purple or purple when ripe.	Edible fruits, firewood, charcoal, timber, ornamental, medicine (stem, roots, bark, leaves), bee forage, agroforestry, ceremonial.	(Orwa *et al.*, 2009f) (Nduwayezu et al., 2009) https://prota.prota4u.org/protav8.asp?g=pe&p=Olea%20europaea%20subsp.%20cuspidata https://tropical.theferns.info/viewtropical.php?id=Olea+europaea+cuspidata https://www.nzpcn.org.nz/flora/species/olea-europaea-subsp-cuspidata/ https://www.mozambiqueflora.com/speciesdata/species.php?species_id=144170
Osyris lanceolata **Hochst. & Steud.**	An **evergreen hardy shrub or small tree**: multi-stemmed and growing to 2-6m high but can reach 10m. **Bark:** smooth, deep brown to blackish with blue-greenish **branches** when young.	Edible (fruits, roots, and bark), firewood, essential oils for cosmetics and perfumes, timber, medicine, bee forage, ornamental, agroforestry and soil conservation, tannin, and	(Nduwayezu et al., 2009) (Orwa *et al.*, 2009) https://pza.sanbi.org/osyris-lanceolata

Kabaruka/ Umusheshe Santalaceae	**Leaves:** dispersed, simple, alternate, and lanceolate sometime oval, of a blue-green color, often with a waxy coating, thick and smooth. **Flowers:** small, unisexual, of yellow-green color, and produced in axillary clusters. **Fruits:** a 1-seeded drupe, fleshy and oval, of yellow color turning red to black-purplish when ripe.	red dyestuff (bark and roots), root fibers for basketry.	https://www.zambiaflora.com/speciesdata/species.php?species_id=121290 https://tropical.theferns.info/viewtropical.php?id=Osyris+lanceolata
Pappea capensis **Eckl. & Zeyh.** Umumena Sapindaceae	An **evergreen small to medium tree:** with a dense crown, growing 2-8m long. **Bark:** pale to dark grey, smooth, showing horizontal markings. **Leaves**: simple, oblong, usually in terminal clusters, with a dull dark green color, stiff and wavy with a round base, the **margin** change from spine-toothed when young to smooth as they mature. **Flowers:** very small and of a pale yellow to greenish color, developed in spikes with female flowers at the base while male flowers are at the end. **Fruits:** round, with a hairy green capsule about 1cm across, split to reveal a bright orange-red jelly covering a shiny dark red brown to black oval **seed**.	Timber, firewood, charcoal, furniture, building materials, tool and utensil making, edible fruits, tea spice (from inner bark), medicine (oil, bark, fodder (fruit and leaves), bee forage, shad, ornamental, dye.	(Orwa *et al.*, 2009g) (Nduwayezu et al., 2009) https://pza.sanbi.org/pappea-capensis#:~:text=The%20jacket%20plum%20is%20a,%2C%20hard%2Dtextured%20and%20wavy. https://tropical.theferns.info/viewtropical.php?id=Pappea+capensis https://treesa.org/pappea-capensis/ https://growwild.co.za/product/pappea-capensis/ https://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=137450
Parinari curatellifolia **Planch. ex Benth.** Umunazi/ Umutukura Chrysobalanaceae	A **large, evergreen, spreading tree**: 20m tall, with a single stem and a dense roundish to mushroom-shaped crown. **Bark**: dark grey and rough but young twigs and branches have yellow woolly hairs. **Leaves**: visibly bicolored, with white-silver color on the undersurface and dark green-grey color on the upper surface with velvety hairs on young leaves while older ones, they are simple, alternate, with visible venation patterns on both faces, they are oblong to elliptic with a notched or broadly	Edible (fruits, seeds); medicine (roots, bark, leaves); bee forage; the bark can be used to dye; paint, varnish and soap making; firewood and charcoals; furniture making; construction materials.	(Nduwayezu et al., 2009) (Orwa *et al.*, 2009) https://pza.sanbi.org/parinari-curatellifolia https://www.cabidigitallibrary.org/doi/full/10.1079/cabicompendium.38886 https://www.malawiflora.com/speciesdata/spe

	tapering apex and a square base, the **margin** is entire, and the petiole is short. **Flowers**: small bell-shaped, white, yellow, or pink with a sweet smell, and are covered in hairs. **Fruits**: are small drupes, yellow orange colored with grey speckles when ripe, oval or rounded shape.		cies.php?species_id=125510 https://www.worldfloraonline.org/taxon/wfo-0000817683
Psydrax schimperianus **(A. Rich.) Bridson**/ *Canthium schimperianum* **A. Rich.** Umukirage Rubiaceae	A **tall evergreen shrub or tree**: 6m tall. **Bark:** dark green colored, rough, and granular. **Leaves:** opposite pairs, ovate, shiny above and dull on the below side, the tip is narrowed to blunt while the base is narrower and rounded, the **margin** is wavy, **triangular stipules** are present between young leaves. **Flowers:** green-white color, developed in a dense cluster, with a sweet smell. **Fruits:** small, rounded, fleshy but turn woody.	Firewood, construction materials, farm tools, tool handles, fodder, shade, medicinal (bark and roots), bee forage.	(Nduwayezu et al., 2009) (Orwa *et al.*, 2009h) https://plants.jstor.org/stable/10.5555/al.ap.flora.fz4671 https://www.worldfloraonline.org/taxon/wfo-0000288205;jsessionid=F4274CC859D23E8F401C4298A216A3C1
Rhus natalensis **Bernh.** / *Searsia natalensis* **(Bernh. ex C.Krauss) F.A.Barkley** Umusagara Anacardiaceae	A **scrambling, evergreen shrub, or small tree:** 5m tall but can reach 8m. **Bark:** on the main stem is grey-brown while **branchlets** are of a pale grey or white and with breathing pores; **branches** are angular. **Leaves:** trifoliate and smell like apple when crushed, the central **leaflet** is larger than the two others, usually of a dark olive-green at the above and light green below, they are leathery, smooth, and hairless; the **midrib** is prominent above and below; the **margin** is wavy, entire, or slightly toothed, broadly tapering to round tip, young leaves are a shiny red. **Flowers:** green yellow in a loose long panicle. **Fruits:** shiny red drupes, oblong to kidney-shape and smooth, later dry, and papery.	Edible (fruits, seeds, roots in soups, bark as tea spice, leaves); medicinal (roots, whole plant, leaves); agroforestry; toolmaking; firewood and charcoal, fodder, ornamental, shade, dye (bark of roots) and toothbrushes (twigs).	(Nduwayezu et al., 2009) (Orwa *et al.*, 2009) https://plants.jstor.org/stable/10.5555/al.ap.upwta.1_199 https://www.malawiflora.com/speciesdata/species.php?species_id=136770 https://pza.sanbi.org/searsia-natalensis https://worldfloraonline.org/taxon/wfo-0000401512
Strychnos lucens **Baker**	A **woody climber or semi-scandent small tree or shrub:** with creeping branches and growing 5-20m tall.	Medicinal (bark, sap, seeds, leaves, roots), arrow poison (seeds), firewood, charcoal, building poles, soil	(Nduwayezu et al., 2009)

Amahonnyo Loganiaceae	**Bark:** grey and smooth with lenticels on branchlets. **Leaves**: simple, opposite, oblong-elliptic to broadly elliptic, acute, shortly acuminate, or rarely rounded or subtruncate apex while the base is rounded or broadly cuneate, smooth, and stiff, shiny green above and dull beneath. **Flowers**: greenish white produced from axillary cymes. **Fruits:** rounded or ovoid berries, with a firm peel and of green color when young turning orange when ripe, with numerous **seeds.**	conservation, bee forage, edible (fruits).	https://plants.jstor.org/stable/10.5555/al.ap.flora.fz5562 https://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=144370#:~:text=Description%3A,three%2Dveined%20from%20the%20base.
Trema orientale **(L.) Blume** / *Celtis orientalis* **L.** Umugwamporo Ulmaceae	An **evergreen shrub or tree**: 18m tall with a short basally swollen trunk, a heavily branching rounded to spreading crown. **Bark**: smooth and grey or brown color but marked with parallel longitudinal lines and corky spots (lenticels); the slender branchlets are covered with white velvety hairs. **Leaves**: long, simple, alternate, stipulate (even though stipules drop early), and with three veins from the base, rough to the touch occasionally becoming smooth with age, dull above and short grey hairs below, the margin is finely toothed. **Flowers**: small, inconspicuous, green, or greenish-white, unisexual occasionally in together in the same bunch, and carried in short dense bunches. **Fruits**: small and round drupes, of a green color becoming glossy black when ripe, and carried on very short stalks; containing one dull black **seed** embedded in bright green flesh.	Edible (leaves, fruit, seed's oil); medicine (bark, whole plant, leaves, roasted wood); agroforestry; soil reclamation; soil conservation; soil improvement; cords and ropes making; dye making; utensil making; construction materials.	(Nduwayezu et al., 2009) (Orwa *et al.* , 2009i) https://pza.sanbi.org/trema-orientalis https://tropical.theferns.info/viewtropical.php?id=Trema+orientalis https://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=120090 https://www.worldfloraonline.org/taxon/wfo-0000457758

Vepris nobilis **(Delile) Mziray**/ *Teclea nobilis* **Delile** Umuzo Rutaceae	An **evergreen shrub or small tree**: 2-12 m tall, it can grow taller and spread its crown when in rain forests. **Bark:** smooth, grey with visible ring marks. **Leaves:** alternate, trifoliate on a petiole of 6cm, **leaflets** are of glossy dark green color, elliptic to oblong-elliptic, 5-15 cm long and aromatic when crushed, with a cuneate base and an acute to acuminate apex, the **margin** is entire and wavy, the midrib is protruding on the below side. **Flowers**: axillary or terminal small and of cream yellow-green color, sweetly scented. **Fruits** are in a large cluster, orange-red colored drupes when ripe.	Firewood, charcoal, timber, tool making, medicinal (leaves, roots), building materials, shade, ornament, bee forage.	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009j) https://prota.prota4u.org/protav8.asp?g=pe&p=Vepris+nobilis https://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=133180 https://tropical.theferns.info/viewtropical.php?id=Vepris+nobilis
Ximenia caffra **Sond.** Amasasa Olacaceae	A **deciduous shrub or small tree:** sparsely branched, growing to 6m tall, with shapeless and untidy crown; **branches and twigs** are spine-tipped and are densely haired. **Bark**: grayish brown to black and longitudinally fissured. **Leaves:** simple, alternate, elliptic to lanceolate, leathery and of a blue-green color, the **margin** is entire with rounded or notched apex and a broadly tapering to rounded base, they are hairy when young and turn to be a shiny green while getting older. **Flowers:** greenish to creamy white sometimes with a tint of pink or red, they are small and in clusters. F**ruits:** ellipsoid or ovoid drupes, greenish when young turning orange to red when ripe.	Edible (fruits and seeds), medicinal (leaves, roots, seeds), live fence, oil from seed is used for hair coloring and caring, construction material, tool handles, firewood, shade, hedges, walking sticks.	(Orwa *et al.*, 2009k) (Nduwayezu *et al.*, 2009) https://pza.sanbi.org/ximenia-caffra https://tropical.theferns.info/viewtropical.php?id=Ximenia+caffra https://www.botswanaflora.com/speciesdata/species.php?species_id=121590
Zanthoxylum chalybeum **Engl.** Intareyirungu Rutaceae	A **deciduous spiny shrub or tree**: 12m with a rounded but open crown; the **bark** is pale grey, smooth with dark scales protecting terminal buds; the **stem and branches** have large woody spines. **Leaves:** compound with 3-5 pairs of shiny leaflets with a terminal leaflet; **leaflets** are oblong to elliptic or lanceolate, dotted by dispersed pellucid gland and have a strong citrus smell when crushed.	Firewood, utensil making, medicine (leaves, bark, and roots), food (leaves as vegetable, bark as tea spice), building materials, beehives, shade, and bee forage.	(Orwa *et al.*, 2009l) (Nduwayezu *et al.*, 2009) https://prota.prota4u.org/protav8.asp?g=pe&p=Zanthoxylum+chalybeum

	Flowers: inconspicuous, unisexual with a sweet smell, a yellowish-green color, developed in short panicle. **Fruits:** spherical, reddish-brown splitting to allow shiny black seed to party protrude.		https://tropical.theferns.info/viewtropical.php?id=Zanthoxylum+chalybeum
Ziziphus mucronata **Willd.** Umuganzacyaro/ Umukugutu Rhamnaceae	A **hardy, deciduous, small to medium sized tree:** 9m tall, **branches** are spreading and often bent downwards, above ground or near the base. **Bark:** grey-brown and smooth but often spiny when young but turning darker brown and fissured as they mature. **Leaves:** alternate, ovate to broadly ovate, mucronate, shiny, densely hairy when young to quite smooth when older, arising between two paired **strong thorns**. **Flowers:** small, yellow, bisexual, and inconspicuous, produced in tight axillary clusters. **Fruits:** round, reddish-brown and glossy drupes with a dry pulp.	Edible (fruits, young leaves, and seeds), medicinal (roots, leaves, and bark), agroforestry, live fences, soil conservation, underground water indicator, building materials, firewood and charcoals, fodder, shade, fish poison (fruits).	(Nduwayezu et al., 2009) (Orwa *et al.*, 2009m) https://pza.sanbi.org/ziziphus-mucronata https://www.botswanaflora.com/speciesdata/species.php?species_id=164400 https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:719359-1/general-information

Appendix 3: Inventoried tree species native range, endemism, and conservation status

Scientific names **Vernacular names** **Family**	**Native range**	**Endemism**	**IUCN conservation status**	**References**
Abutilon angulatum **(Guill. & Perr.) Mast.** Umukungeri Malvaceae	Widespread in the drier parts of the tropical Africa: Eastern, Central and South Africa, it also occurs in Madagascar. It grows in disturbed area, open or closed woodland, riverine and grassland roadsides, and fallow areas.	Sub-Saharan	Not Evaluated **(NE)**	(Nduwayezu *et al.*, 2009) https://www.worldfloraonline.org/taxon/wfo-4000000069#distributionMap https://biodiversity.org.na/taxondisplay.php?nr=6742
Acacia gerrardi **(Benth.)**/ *Vachellia gerrardi* **(Benth.) P.J.H.Hurter**	Widespread across northern and eastern South Africa, also extending northwards through eastern and tropical	**-**	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009a)

Umugunga **Fabaceae**	Africa to Sudan and Nigeria. It grows primarily in the seasonally dry tropical biome; they are found in woodlands, wooded grasslands, and arid savanna.			https://www.catalogueoflife.org/data/taxon/7F974 https://www.iucnredlist.org/species/158017/757111
Acacia hockii **De Wild.** / *Vachellia hockii* **(De Wild.) Seigler & Ebinger** Umugenge Fabaceae	Native to African wooded grasslands and bushlands.	**-**	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009b) https://www.iucnredlist.org/species/199128811/208348535
Acacia polyacantha **Willd.** / *Senegalia polyacantha* **(Willd.) Seigler & Ebinger** Umuharata Fabaceae	Widespread in tropical and South Africa. It grows in wooded grassland, riverine woodland, near riverbanks and in swampy valleys.	**-**	Least Concern (**LC**)	(Nduwayezu *et al.*, 2009) https://www.iucnredlist.org/species/199235862/208362530 (Orwa *et al.*, 2009c)
Acokanthera schimperi **(A.DC.) Schweinf.** Umusagwe Apocynaceae	Native to Central and East Africa in dry, wooded, or rocky grassland and bushlands as well as in dry forests or forest edge.	**-**	Least concern **(LC)**	(Nduwayezu *et al.*, 2009) https://www.gbif.org/species/7576345 (Orwa *et al.*, 2009d)
Afrocanthium lactescens **(Hiern) Lantz** Umukondokondo Rubiaceae	Native to West Africa to Sudan, East to Central Africa and expending to Zambia, in dry bushland, wooded grassland and riverine or forest galleries.	**-**	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) https://www.gbif.org/species/2900911
Albizia gummifera **(J.F. Gmel.) C.A.Sm.** Umusebeya	Widespread in Africa, from West to Central Africa, East to Ethiopia and south to Mozambique, Zimbabwe, and Madagascar. It grows in riverine forest, rainforest,	**-**	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) https://www.gbif.org/species/8343428 (Orwa *et al.*, 2009e)

Fabaceae-Mimosoideae	dry lowland, sometimes in savannah.			
Allophyllus rubifolius **(Hochst, ex. A. Rich.) Engl.** Isheshe Sapindaceae	Distributed in Africa, from West Africa to Central Africa, all the way to South Africa; found in dry and moist forests, dry bushlands, and woodlands.	**-**	Least concern **(LC)**	(Nduwayezu *et al.*, 2009) https://www.gbif.org/species/7264799
Apodytes dimidiata **E.Mey. ex-Arn.** Umusibya Icacinaceae	Native to East and Central Africa going south up to South Africa, grow in montane and dry montane forests, wooded grasslands, and forest edges.	**-**	Least Concern **(LC)**	(Razafiniary, 2020a) https://identify.plantnet.org/k-world-flora/species/Apodytes%20dimidiata%20E.Mey.%20ex%20Arn./data https://www.iucnredlist.org/species/65877906/65923896
Blighia unijugata **Baker** / *Phialodiscus unijugatus* **(Baker) Radlk.** Umuturamugina Sapindaceae	Widespread and endemic to the tropical Africa from Guinea Bissau to Ethiopia, South to Angola, Zambia, Zimbabwe, Mozambique, and northern South-Africa. It is mostly found in moist evergreen forest, but also in semi-deciduous forest, in more dry areas in riverine forest, wooded grasslands; it is also found on termite mounds.	Tropical Africa	Least Concern **(LC)**	https://pza.sanbi.org/blighia-unijugata#:~:text=Blighia%20unijugata%20is%20assessed%20as,List%20of%20South%20African%20plants. https://www.southworld.net/herbs-plants-blighia-unijugata-a-plant-with-a-remarkable-healing-potentiality/ https://www.iucnredlist.org/species/146448311/146448313 (Razafiniary, 2020b)
Cadaba farinosa **Forssk.** **Umuvutavuta/ Umuryanka**	Widespread in the tropical Africa; West, North and East to Kenya; it also occurs in Saudi Arabia. It is found in deciduous bushland, grassland with scattered trees, arid and semi-arid areas in desert grass-bush	**-**	Least Concern (**LC**)	https://www.gbif.org/species/3054234 (Orwa *et al*., 2009f) https://www.iucnredlist.org/species/144034014/149013594

Capparaceae	zones, riverine and coastal vegetation, sometimes on ant mounds, rocky ravines.			
Capparis erythrocarpos **Isert.** Munyegereze/ Umukorokombe Capparaceae	Widespread in the Tropical Africa; from Guinnea, Ivory Coast and Togo downward to Togo and Angola, passing through Central African Republic, and eastward to Ethiopia, Kenyaand Tanzania; going southward to Malawi, Mozambique, Zambia, and Zimbabwe. It grows in grassy or wooded savanna, dry deciduous woodlands, in thickets, open forests and coastal slopes.	-	Not Evaluated **(NE)**	https://www.inaturalist.org/taxa/340292-Capparis-erythrocarpos https://www.worldfloraonline.org/taxon/wfo-0000584688 https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:146430-1
Capparis spinosa **L.** Umutugunguru/ Umukorokombe Capparaceae	Natively widespread in tropical Africa from Senegal through Central and East Africa to South Africa.	-	Least Concern **(LC)**	https://www.iucnredlist.org/species/137745831/139593491 https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:146789-1
Carissa spinarum **L./** *Carissa edulis* **(Forssk.) Vahl** Umunyonza Apocynaceae	Native to tropical Africa, Asia, and Australia. Spread in the dry, deciduous to evergreen woodlands and bushlands; riverine forests, thickets, and upland forests; and on termite mounds.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) https://www.gbif.org/species/5536282 (Linn, 1994)
Combretum molle **R.Br. ex G. Don** Umurama Combretaceae	Widespread in East, Central and South Africa. It grows in wooded grassland and bushland, often on stony hills and termite mounds.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al*., 2009) https://www.gbif.org/species/7961582
Commiphora africana **(A. Rich.) Engl.** Umudahwera	Spread in dry regions of Africa, throughout the South of the Sahara Desert. It grows in dry bushlands and woodlands, usually in rocky soils.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009g) https://www.gbif.org/species/7286896

Burseraceae				
Dichrostachys cinerea subsp. africana **Brenan & Brummitt** Umukamba/ Umuyebe Fabaceae-Mimosoideae	Naturally widespread in southern and tropical Africa to India and Australia. It usually grows on poor, occasionally clayey soils; in bush wood, thickets, hedges, teak forest, and wooded grassland, in savannah areas.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009h) https://www.iucnredlist.org/species/164134/20066865
Erythrina abyssinica **Lam.** Umuko/Umurinzi Papilionoideae	Natively widespread in the Eastern and Southern tropical Africa; It grows in grassland, open woodland and in rocky places.	Eastern-South Africa	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009b) https://www.gbif.org/species/7659098 https://tropical.theferns.info/viewtropical.php?id=Erythrina+abyssinica
Euclea racemosa subsp. schimperi **(A.DC.) F.White** Umushikiri Ebenaceae	Widespread in East, Central to South Africa; mostly in dry montane, dry lowland forests, wooded thickets, and grasslands.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009i) https://www.iucnredlist.org/species/173650/1393578
Euphorbia candelabrum **Welw.** Umuduha/ Ikiha Euphorbiaceae	Widespread in dry areas of the tropical Africa; Sudan to Ethiopia through East and Central Africa to South Africa. In dry deciduous or evergreen open and wooded grasslands, on rocky slopes, sometimes on termite mounds.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Razafiniary, 2020c) https://www.iucnredlist.org/species/144255180/149007130
Ficus thonningii **Blume** Umuvumu/Umutaba Moraceae	Widespread in tropical Africa; in upland forests, grasslands, riverine and rocky areas as well as in savannah.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009a) https://www.gbif.org/species/5361900 https://www.iucnredlist.org/species/146188444/

				146218892
Gardenia ternifolia **Schumach. & Thonn.** Umutarama Rubiaceae	Widely spread in the tropical Africa, from Senegal to Cameroon to Sudan and Central to East Africa. In woodlands, wooded grasslands and riverine vegetations	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Razafiniary, 2020d) https://www.gbif.org/species/5334974 https://www.iucnredlist.org/species/146215560/146215562
Grewia bicolor **Juss.** Umukomagabo Tiliaceae	Widespread in semi-arid tropics of Africa and India; in dry bushlands and bushed grasslands.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009) https://pza.sanbi.org/grewia-bicolor#:~:text=According%20to%20Raimondo%20et%20al,Endangered%2C%20Vulnerable%20or%20Near%20Threatened.
Grewia similis **K.Schum.** Umukomagore Tiliaceae	Widespread in tropical Africa, especially in evergreen mountain forests and forest edges, evergreen bushlands, and grasslands.	-	Not Evaluated **(NE)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009b) https://worldfloraonline.org/search?query=Gardenia+similis&view=&limit=24&start=0&sort=searchable.label_sort_asc&facet=taxon.measurement_or_fact_threatStatus_txt%3a_null_&facet=taxon.family_ss%3aMalvaceae&facet=taxon.taxonomic_status_s%3aAccepted
Haplocoelum foliolosum **(Hiern) Bullock** Umujwiri Sapindaceae	Widespread in tropical East Africa, from DRC and Angola to East and South Africa to Tanzania, Malawi, Mozambique, Zambia, and Zimbabwe. It grows in open woodlands, grasslands, thickets, and often on termite mounds.	-	Least Concern **(LC)**	https://www.gbif.org/species/7265029 https://prota.prota4u.org/protav8.asp?g=pe&p=Haplocoelum+foliolosum https://www.iucnredlist.org/species/153941296/153941298

Lannea humilis **(Oliv.) Engl.** **Umukundambazo/ Ikiryoheramuhoro** Anacardiaceae	Widespread in tropical Africa, from Senegal to Sudan, through East and Central Africa, going south in South Africa. It grows in deciduous bushlands and woodlands, dry savanna, wooded grasslands, often at edges of seasonally flooded valleys, plains below hillsides and other local water catchment.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) https://identify.plantnet.org/k-world-flora/species/Lannea%20humilis%20(Oliv.)%20Engl./data https://www.iucnredlist.org/species/208180097/208354423
Markhamia lutea **(Benth.) K. Schum.** Umusave Bignoniaceae	Widespread in the tropical Africa from Ivory Coast through Nigeria to central Africa and East Africa. It is found in savannah forests, submontane forests, forest edges, forest galleries; it is known to resist drought but not waterlogging.	-	Least Concern (**LC**)	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009c) https://www.gbif.org/species/5668625 https://www.iucnredlist.org/species/144259403/149036077
Markhamia obtusifolia **(Baker) Sprague** Umukungusebeya Bignoniaceae	Native to tropical Africa in dry lowland forests, grasslands, and woodlands; in open deciduous forests, and xerophytic forests	-	Least Concern (**LC**)	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009d) https://www.gbif.org/species/5668622 https://www.iucnredlist.org/species/146201827/146201829
Maytenus senegalensis **(Lam.) Exell**/ *Gymnosporia senegalensis* **(Lam.) Loes.** Umushubi Celastraceae	Widespread in tropical and sub-Saharan Africa, from Morocco eastwards to Eritrea, through Algeria and Egypt, southwards through East and Central Africa to South Africa and Madagascar. It is also found elsewhere in Spain, Middle East, India, Pakistan, Afghanistan, and Bangladesh. It grows indeciduous woodlands, thickets, scrubs, wooded	-	Least Concern (**LC**)	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009e) https://pza.sanbi.org/gymnosporia-senegalensis

	grasslands, on termite mounds and riverbanks.			
Olea europaea subsp. cuspidata **(Wall. & G.Don) Cif.** Umunzenze Oleaceae	Widespread from Eastern to Southern Africa and Madagascar. It prefers warm temperatures and semi-arid areas, riverside bushlands, and grasslands. It can naturalize in disturbed areas.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009f) http://redlist.sanbi.org/species.php?species=1947-4004
Osyris lanceolata **Hochst. & Steud.** **Kabaruka/ Umusheshe** Santalaceae	Widespread in tropical Africa, northern, eastern, and southern Africa from Morocco to South Africa; it is also found in southern Europe and in Asia. It exists in dry evergreen forests, on rocky areas, wooded grasslands, and forest margins.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) https://www.gbif.org/species/3788959 (Orwa *et al.*, 2009)
Pappea capensis **Eckl. & Zeyh.** Umumena Sapindaceae	Widespread from Eritrea, Ethiopia and Northern Somalia through Central and East Africa to South Africa; in dry forests, open woodlands, bushlands, bushed grasslands and on rocky hillsides, especially in black clay soils.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) https://www.gbif.org/species/3785741 (Orwa *et al.*, 2009g)
Parinari curatellifolia **Planch. ex Benth.** Umunazi/ Umutukura Chrysobalanaceae	Widespread in tropical Africa, in the Guinea Savanna region of West Africa from Senegal to Kenya, south to Botswana and the tropics of South Africa. It grows in wooded grassland with high water-table and poor drainage, deciduous woodlands, it is known to persist in secondary bushland and cultivated lands.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009) https://www.gbif.org/species/8185443
Psydrax schimperianus **(A. Rich.) Bridson**/ *Canthium schimperianum* **A. Rich.** Umukirage	Widespread in the Central and Eastern tropical Africa. It grows in dry forest, mixed evergreen bushland, mixed deciduous woodlands, thickets, and wooded grassland in rocky areas	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) https://www.gbif.org/species/2893075 (Orwa *et al.*, 2009h)

Rubiaceae				
Rhus natalensis **Bernh.** / *Searsia natalensis* **(Bernh. ex C.Krauss) F.A.Barkley** Umusagara Anacardiaceae	Widespread in tropical Asia and Africa, from Guinea to Somalia, through East Africa and Central Africa to South Africa. It grows in wooded deciduous and evergreen savanna bushlands and woodlands, forest edges and riverine forest, most of the time on well-drained slopes.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009) https://www.iucnredlist.org/species/149509219/149509221
Strychnos lucens **Baker** Amahonnyo Loganiaceae	Widespread in Eastern and Central Africa, also native southwards in Angola, Zambia, Malawi, Namibia, Zimbabwe, Botswana, and South Africa. It grows in riverine forest, thickets, and semi-evergreen bushlands on rocky hills.	-	Not Evaluated **(NE)**	(Nduwayezu *et al.*, 2009) https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:547293-1
Trema orientale **(L.) Blume** / *Celtis orientalis* **L.** Umugwamporo Ulmaceae	Widespread in from tropical Africa from Senegal to Sudan through East and Central Africa, southwards to South Africa and Madagascar. It grows in higher rainfall areas in riverine forests or forest margins, woodlands, and wooded grassland, most of the time, as pioneer species in open gaps.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009i) https://www.iucnredlist.org/species/61988133/61988136
Vepris nobilis **(Delile) Mziray**/ *Teclea nobilis* **Delile** Umuzo Rutaceae	Widespread from Ethiopia through Eastern and Central Africa to Malawi and Zimbabwe; they thrive in woodland, evergreen, and riverine forests.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) https://www.iucnredlist.org/species/153944693/153944695 (Orwa *et al.*, 2009j)
Ximenia caffra **Sond.** Amasasa Olacaceae	Widespread in the East and Central Africa, southwards to Malawi, Mozambique, and South Africa. It grows in dry woodland, wooded grasslands, on rocky hillsides and termite mounds.	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009k)

				https://www.iucnredlist.org/species/165445233/165445341
Zanthoxylum chalybeum **Engl.** Intareyirungu Rutaceae	Widespread in tropical East Africa from Ethiopia southwards through East and Central Africa to Zimbabwe. It grows in semi-evergreen or dry bushland, wooded grassland, and dry forest, mostly on rocky sites	-	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009l) https://www.iucnredlist.org/species/146222176/146222178
Ziziphus mucronata **Willd.** Umuganzacyaro/ Umukugutu Rhamnaceae	Widespread in tropical East, Central and Southern Africa, also found in Arabian Peninsula and in Madagascar. It grows in riverine, forest margins and dry lowlands forests, woodland, and wooded grassland.	Sub-Saharan Africa	Least Concern **(LC)**	(Nduwayezu *et al.*, 2009) (Orwa *et al.*, 2009m) https://www.iucnredlist.org/species/146199970/146199972 https://biodiversity.org.na/taxondisplay.php?nr=4005

Appendix 4: Some detailed figures showing the data collection process.

Figure 1. Transect location marked by pinpoints (Google Earth Pro, 2023).

Figure 2. Example of a transect in the middle of RICA Forest (Picture by Kamugire, 2023).

Figure 3. Beating method for collection of foliage insects (Picture by Kamugire, 2023).

Appendix 5: Some identified Insect specimens.

Table 1. Examples of identified insect specimens collected during the field study with their corresponding taxonomic classification (Pictures by Kamugire, 2023).

Specimen figure				
Taxonomic identification	***Lepisiota sp.***	***Cataulacus sp.***	**Chrysomelidae family**	**Curculionidea family**