The Ecological Implications of Harvesting Wild Climbers for Food Security products around Bwindi Impenetrable National Park, South Western Uganda

By

Institute of Tropical Forest Conservation

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Executive summary

Sustainable utilisation of Non Timber Forest Products (NTFPS) is a widely accepted forestry management approach. Unfortunately the sustainability of NTFPS in high demand like the wild climbers used by local communities is rarely investigated over a period of time. Yet extraction of these wild climbers by local community for food security purposes has been on going in Bwindi Impenetrable National Park(BINP) since 1994. This study is a precursor to a baseline study on the role of wild climbers around BINP for food security and ecological impacts of their harvest carried out by ITFC (Bitariho and Akampurira, 2019).

The study was carried out in Bwindi Impenetrable National Park in the parishes of Rutungunda, Eastern Ward and Southern Ward, where forest wild climbers harvesting by the local people was legalized since 1994. The same sampling design and sampling plots used by (Bitariho and Akampurira 2019) in 2018 were maintained for this study too. The individuals that were re-measured in this study were easily identified by the plastic tags tired around them in 2018. Our study focused on the same wild climbers that were studied a year before by (Bitariho and Akampurira 2019) and these included: *Smilax anceps, Salacia elegans, Monanthotaxis littoralis, Toddalia assiatica, Loeseneriella apocynoides, Dracaena laxissima, Pristimera gracilifolia, Embelia liberiana, Enfulensia Montana and Rytigynia rwenzoriensis*.

Results show that there was hardly any significant difference between the population structure of wild climbers in this study and those observed by Bitariho and Akampurira,(2019). The population structure for seven of the 10 harvested wild climbers (*Dracaena laxissima, Smilax anceps, Pristimera gracilifolia, Embelia liberiana, Enfulensia Montana, Salacia elegans and Rytigynia rwenzoriensis*) depicted healthy sustainable populations. As they exhibited an inverted 'J' and bell shaped type of diameter class distribution that is characteristic of plant populations that are cable of self-replicating. On the other hand population of *Loeseneriella apocynoides and Monanthotaxis littoralis* exhibited population structure of species that have experienced severe harvest impacts. Over 90% of the plants are re-sprouts and there are very few harvestable mature stems, indicating the plants have been overexploited. *Loeseneriella apocynoides and Monanthotaxis littoralis* are perhaps one of most demanded wild climbers usually used in making of tea harvesting baskets in the northern part of Bwindi. The growth of the tea economy in north of Bwindi over the past 20 years is primarily linked to the over exploitation of these species. The analysis of the basal areas of the wild climber their variation with environmental factors showed that only the *Dracaena laxissima* basal area was significantly ($p<0.005$) associated with environmental variables; Canopy, herb cover, tree cover and shrub cover. The variation of growth rate with tree diameters showed that *Draceana laxissima* (GLMM, x^2= , DF = 1, P = 0.03324) and *Smilax anceps* (GLMM, x^2= , DF = 1, P = 0.00423) demonstrated significant relationship with their growth rates.

In conclusion *Monanthotaxis littoralis and Loesenerialla apocynoides* demonstrated a population structure that has suffered the negative impacts of over harvesting or un sustainable harvesting . It is therefore important to restrict their harvest and continue their monitoring. But even perhaps more important is for the park management to work with local communities to identify potential alternatives that can help address the food security needs of local communities around Bwindi.

Introduction

Sustainable exploitation of non-timber forest products holds great potential as a method for integrating the use and conservation of tropical forests (Peters, 1994). In the past, plant resource collection by local communities was part of their traditional forest management. Following gazetting of parks, local communities were denied access to the forest resources. Currently park managers of protected areas are seeking ways of accommodating the needs of local communities while maintaining the biodiversity and ecosystem functions of the protected areas. Almost any type of resource exploitation conducted in tropical forests will have an impact on the ecological functions of the forests (Peters, 1994). The exact magnitude of this impact depends on the nature and intensity of harvesting and the particular species or type of resource under exploitation (Peters, 1994).

Tropical forests have high species diversity, which include valuable plant resources for exploitation but most of the resource plants of interest are scattered throughout the forest at very low densities (Peters, 1994). The consequence of this is that these plant resources are subject to over-harvesting. Information on how a plant population is regenerating can provide valuable data for resource management. Regeneration status of resource plants can be observed from population structure data that can be visualised in form of survivorship curves (Cunningham, 1999). Both static and dynamic population characteristics vary naturally over time. A direct comparison between natural and harvested populations yields sufficient information to assess sustainability of the resource plants (Hall and Bawa, 1993).

In Bwindi Impenetrable National Park (BINP), over forty six plant species are harvested in areas designated as Multiple Use Zones (MUZ's) and these range from herbs to trees. Some of these plants experience very minimal impacts after harvest, for example, harvesting leaves of *Mimulopsis* (a vigorous sprouting herb common in Bwindi forest gaps) has very minimal harvest impacts. However other plants such as *Loeseneriella apocynoides* may experience extreme harvest impacts. *Loeseneriella apocynoides* occurs at low densities and occurs scattered throughout BINP forest and yet is highly demanded for basketry and stretcher making (Muhwezi, 1997).

Baskets made from Loeseneriella apocynoides used for storing food items

Study justification

Harvesting of some of wild climbers has the potential to alter the plants' biological processes at many levels. The harvest impacts may be manifested in the physiology and vital rates of individual plants; changing the demographic and genetic patterns of harvested plants and altering the plants' community and ecosystem-level processes.

One of major constraints to managing a sustainable harvesting of wild climbers by local communities, is perhaps the luck of empirical knowledge on the plants being harvested and their response to disturbance (Cunningham, 2001; Binh, 2009). The purpose if this study was to make assessment on the impact of wild climbers harvest and compare these results to the baseline study by Bitariho and Akampurira,(2019) carried out in 2018. The study also aimed at showing how environmental factors like shrub cover, canopy, tree cover and herb cover impacted the distribution and growth of the wild climbers used for food security.

Objectives of the study

The major objective of this study was to assess harvest impact and the ecological functionality of wild climbers after two years of monitoring. In that regard the study was designed to achieve the following objectives

I. To determine the population structure of selected wild climber species
II. To assess the effects of environmental variables on the basal areas of selected wild climber species
III. To assess the annual growth rates of selected wild climber species

Methods

Study Area

The study was carried out in Bwindi Impenetrable National Park in the parishes of Rutungunda, and Southern Ward, where forest wild climbers harvesting by the local people was legalized since 1994. These parishes have two gazetted Multiple Use Zones (MUZs) as shown in figure 1. These parishes are all located in Kanungu district just adjacent to Bwindi Impenetrable National Park. An adaptive management approach that is focused on the category of the wild climbers plant species being harvested was employed. The wild climbers sustainable harvest levels were based on monitoring plant stem density, plant distribution; annual growth rates and regeneration characteristics of the wild climbers.

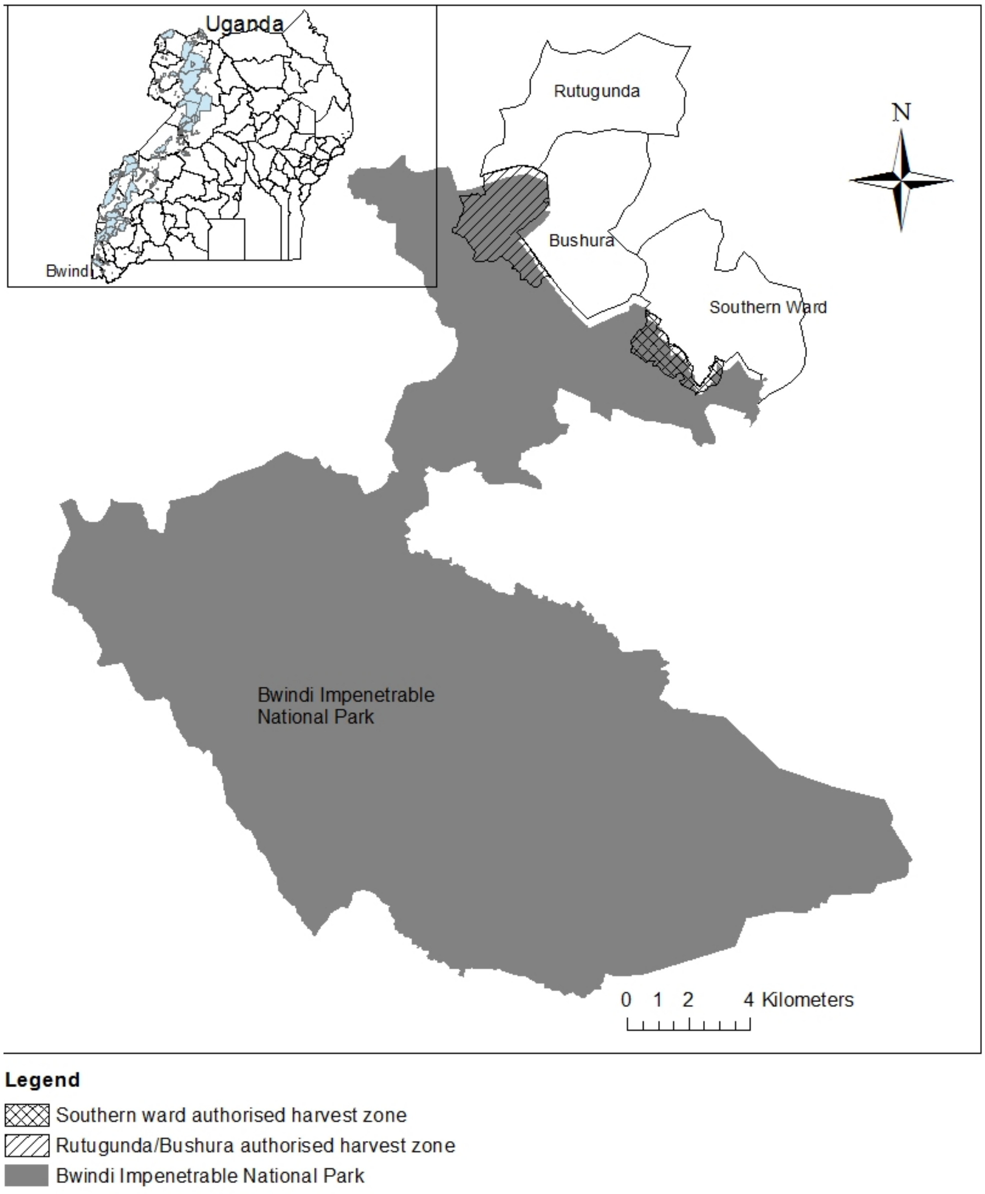


Figure 1: Map of the study area showing Multiple Use Zones and study parishes around Bwindi

Population structure of the commonly harvested wild climbers

The same sampling design and sampling plots used by (Bitariho and Akampurira 2019) in 2018 were used. We used the same 60 forest sample plots along ten 1 –km line transects running from the forest edge into the interior, five in each of the two designated Multiple Use Zones inside the park; Rutugunda and Southern ward. The first transect was randomly placed at the boundary of the Multiple Use Zone, from which subsequent transects were systematically placed at intervals of 100 m. The transects were permanently marked in the previous study (Bitariho and Akampurira 2019) using concrete blocks. On each transect, we established 30-10 x 10 m forest sample plots at intervals of 15 m. We used 10 x 10 m forest sample plots to assess the diameter size class distribution of lianas harvested for food security products following the methods of(Muhwezi et al. 2009) inside the 10 x 10 m plots, We established 5 m x 5 m forest sample plots to assess the dimeter size class distribution of vines harvested for food processing products following the methods of Hall & Bawa (1993) and Ndangalasi et al. (2007). Inside the sample plots, we counted and re-measured the size (basal diameter) of all lianas and vines that measured 1.3 m long and above using a Vernier caliper. We able to identify and re-measure stems from the previous study because we had marked them with plastic tags at base in 2018. Our study focused on the same wild climbers that were studied a year before by (Bitariho and Akampurira 2019) and these included: *Smilax anceps, Salacia elegans, Monanthotaxis littoralis, Toddalia assiatica, Loeseneriella apocynoides, Dracaena laxissima, Pristimera gracilifolia, Embelia liberiana, Enfulensia Montana* and *Rytigynia rwenzoriensis.*

Density and Size class distribution

Density or the number of individuals per unit area is probably the ecological parameter of greatest interest to ethnobotanists (Peters, 1996). The first signal that a plant population is being subjected to an overly intensive level of harvest is usually manifested in the size, class, distribution of that population (Peters, 1994; Hall and Bawa, 1993) Individual plants were counted in sample plots and the basal diameters recorded using a vernier calliper. These recordings were done and compared to recording of (Bitariho and Akampurira 2019)

Transect setting in the field site

Regeneration characteristic

Regeneration assessments are used for quantifying the initial density of seedlings in plant populations being exploited, and monitoring the way in which these densities fluctuate in response to different harvest levels (Peters, 1994). All seedlings in the same plots we used in 2018 were counted . The seedlings are individuals less than 10 cm dbh or <1.3 m in height (Peter, 1994). Young sprouts for the Lianas and Vines were also recorded in the same plots we used in 2018.

Data analysis

Population structure of the wild climbers

Forest sample plot data was grouped into size classes of 5 cm diameter class interval to depict population structure. We then plotted the grouped size classes in histograms to show the number of individuals in particular size class. We also compared diameter class histograms from 2018 (Bitariho and Akampurira 2019) to the current histograms. This helped show any changes in the population structure of wild climbers after one year. The size class distribution histograms showed the population status of the harvested wild climbers based on four classifications of diameter class distributions; inverted “J” type, bell shaped, “L” shaped and “J” shaped. The classifications for the diameter class distribution depict impacts of harvesting on plant resources (Hall and Bawa 1993; Mwavu and Witkowski 2009).

Determining annual growth rates

Stem growth of wild climbers were calculated from the two annual measurements(2018 and 2019) of basal diameter increments made to get annual stem growth rates for each plant’s dimeter(Bitariho 2013; Bitariho et al. 2006; Ndangalasi et al. 2007). The basal diameters were then plotted against the annual stem growth rates on a scatterplot to produce yield curves as recommended by Peters (1994) and Peters (1996). To analyse relationships between Growth and basal diameter, GLM with a gaussian distribution was used.

Relationships between basal area of the wild climbers and environmental variables

The diameter of wild climbers was converted to basal area per hectare using the formula (BA = 3.14*(basal diameter^2)/2. The aim was to test for the relationships between basal area and each of the environmental variables; canopy, shrub cover and herb cover. Generalized Linear Mixed Models (GLMM) with gaussian distribution were used to control for influence on basal area due to variation of other unmeasured variables. In the GLMMs, MUZ was the random variable while tree cover, shrub cover, and herb cover were the fixed variables. A simple linear regression was used to test the relationships between BA and tree cover following log transformation of the BA data after it failed to pass the normality test. The relationships between basal area and the environmental variables as derived by the GLMMs are presented in an Anova table generated from the R package car (Fox and Weisberg 2018). Model fit was assessed using a combination of residual plots and Q-Q plots. The GLMMs were implemented in R package lme4 package (Bates et al. 2015).

Results

Stem density and abundance of the wild climbers

Dracaena laxissima had the highest stem density per hectare of (18.6±3.0 stems/ha), followed by *Smilax anceps* (10.3±2.0stems/ha) and *Salacia elegans* (8.11±7.3 stems/ha). The least abundant wild climber, with the lowest *stem density was the Loeseneriella apocynoides (Omujega)* with stem densities of (0.36±2.9 stems/ha) followed by *Enfulensia montana (0.42±22.3 stems/ha).* A similar pattern was observed by *(Bitariho 2013; Bitariho and Akampurira 2019)*

Table 1: Stem density per hectare of wild climbers sampled

Plant species	**Stem densities per hectare at 95% CI**	
	Stem density/ha	**±SD**
Dracaena laxissima	**18.61**	3.0
Embelia liberiana	**0.73**	3.8
Enfulensia montana	**0.42**	22.3
Loeseneriella apocynides	0.36	2.9
Monanthotaxis littoralis	1.21	5.3
Pristimera gracilifolia	1.64	11.5
Rytigynia rwenzoreinsis	0.91	10.1
Salacia elegans	8.18	7.3

Smilax anceps	10.30	2.0
Toddalia assiatica	0.97	15.9

Population structure of the wild climbers

The graphs depicting the population structure of the 10 wild climbers in 2018 and 2019 are shown in Figure 2 to 11. There are four types of diameter class distributions exhibited by the wild climbers and these include; inverted "J"type, bell shaped, "L" shaped and "J" shaped. The four types of diameter class distributions depict impacts from harvesting intensities (Hall and Bawa, 1993; Mwavua and Witkowski, 2009). Comparison of species diameter size class distributions between 2018 and 2019 showed they was hardly any difference in population structure after a year (figure 2 to 11).

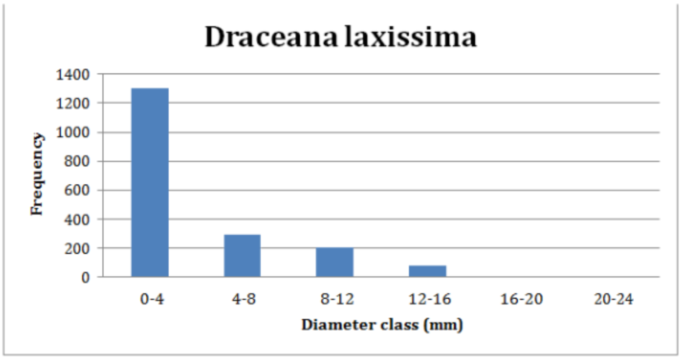
Five of the 11 species of wilder climbers exhibited an inverted 'J' type of distribution and these were *Dracaena laxissima, Pristimera gracilifolia, Rytigynia rwenzoriensis Salacia elegans* and *Smilax anceps* (figures 2,3,4,5,6). This kind of 'J' type distribution is characteristic of species that have more seedlings than adults representing a self-replacing population that is usually found in healthy plant populations (Hall and Bawa, 1993; Mwavu and Witkowski, 2009; Bitariho and Akampurira, 2019). In this study we noticed that seedlings of *Smilax anceps* had reduced significantly from about 130 seedlings in 2018 to 20 seedlings in 2019 (figure 6)

Embelia liberiana and *Enfulensia montana* (figure 7 and 8) showed a characteristic "bell" shaped histogram that depicts a population with mature enough individuals and at the same time sizeable number of seedlings. Like the inverted J type the bell distribution also indicates that the population structure of the species is healthy and replicating.

Monanthotaxis littoralis and Loesenerialla apocynoides exhibited an "L" shaped diameter size distribution (figure 10 and 11). This particular type of wild climber population is characterised by hardly any mature harvestable stems (>16mm).

This kind of size class distribution may suggest that these wild climbers have been heavily harvested (Hall and Bawa, 1993; Mwavu and Witkowski, 2009). In fact others authors like (Bitariho et al. 2006; Bitariho, 2013) have shown that *Loesenerialla apocynoides* has been over harvested around Bwindi. It was and is still the most demanded wild climber for making tea harvesting baskets in the northern part of Bwindi. The growth of tea farming in north of Bwindi over the past 20 years is primarily linked to the over exploitation of these species (Muhwezi et al. 2009).

The fourth type of class size distribution was depicted by a J shaped population structure and the species characterised by this distribution was *Toddalia assiatica* (figure 9). This kind population structure depicts many mature stems but very few or no seedlings (Figure 9).



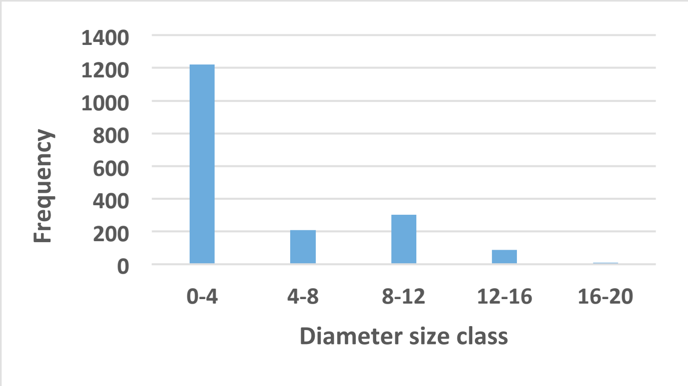
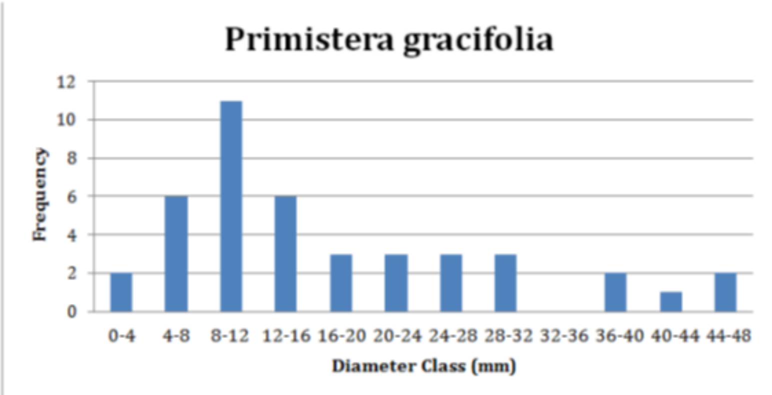


Figure 2: Diameter size class distribution of *Draceana laxissima* in 2018 and 2019 respectively



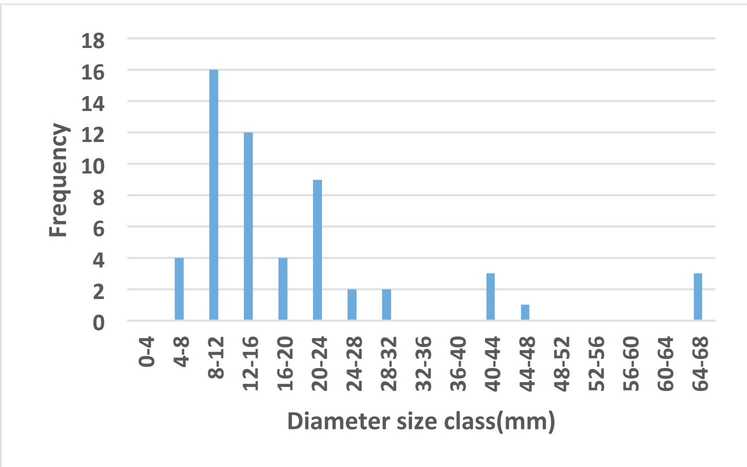
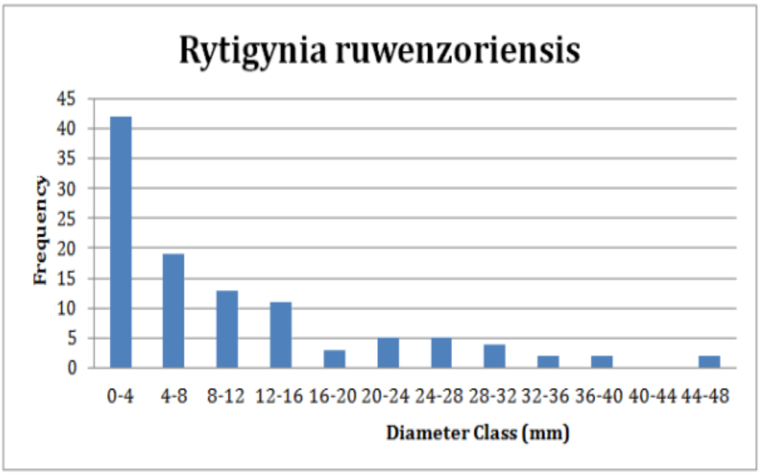


Figure 3: Diameter size class distribution of *Primistera gracifolia* in 2018 and 2019 respectively



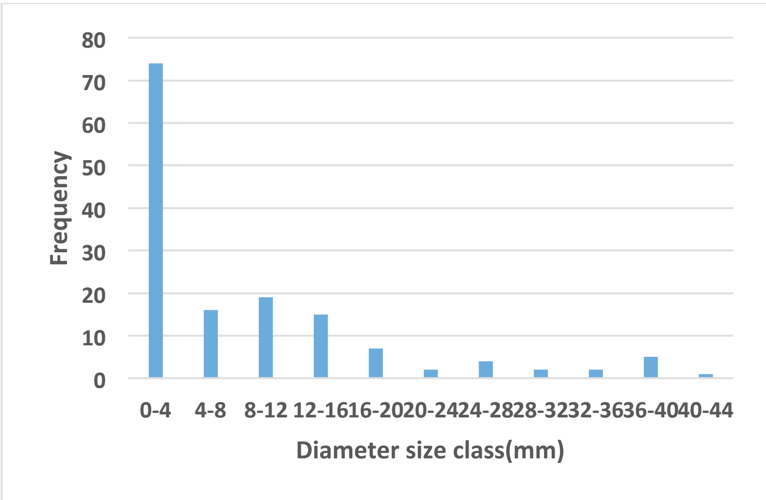
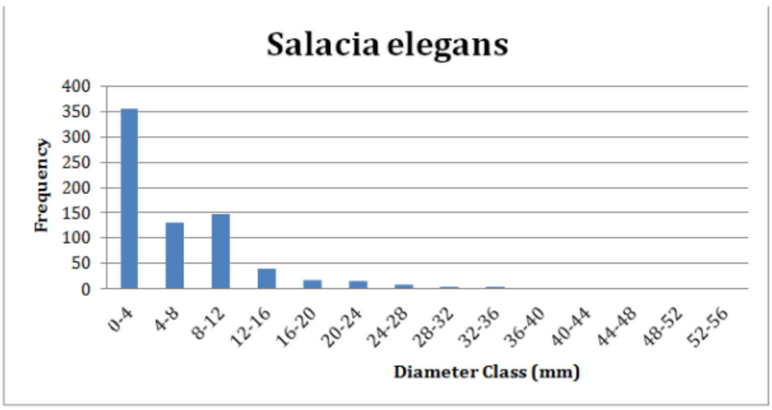


Figure 4: Diameter size class distribution of *Rytigynia rwenzoriensis* in 2018 and 2019 respectively



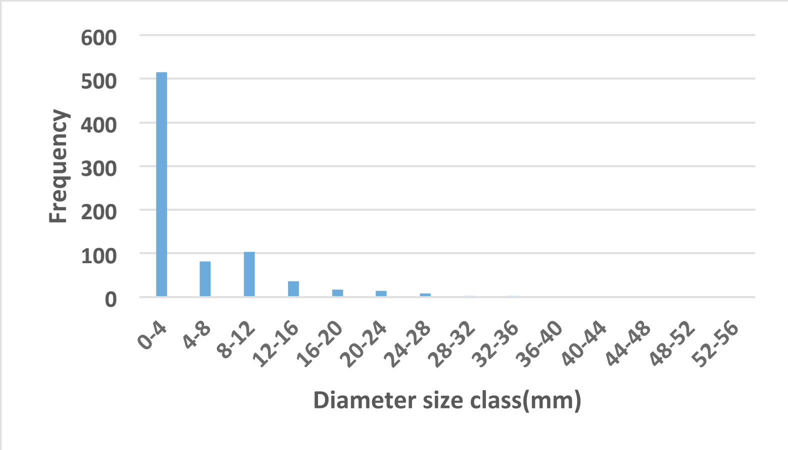
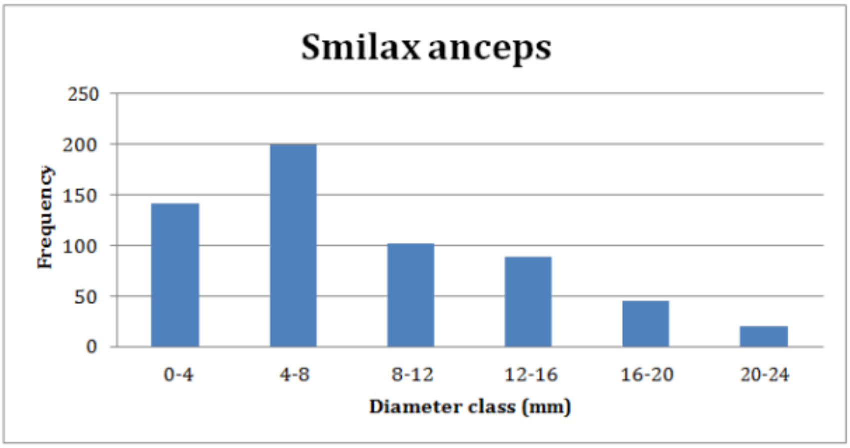


Figure 5: Diameter size class distribution of *Salacia elegans* in 2018 and 2019 respectively



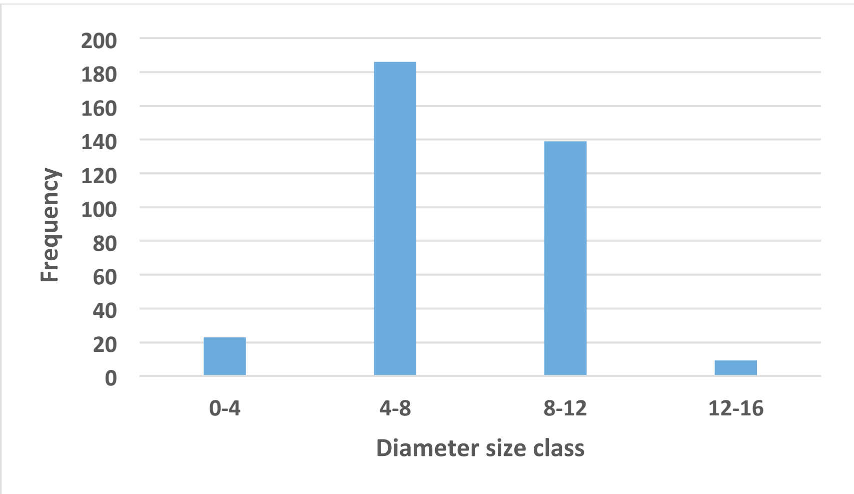
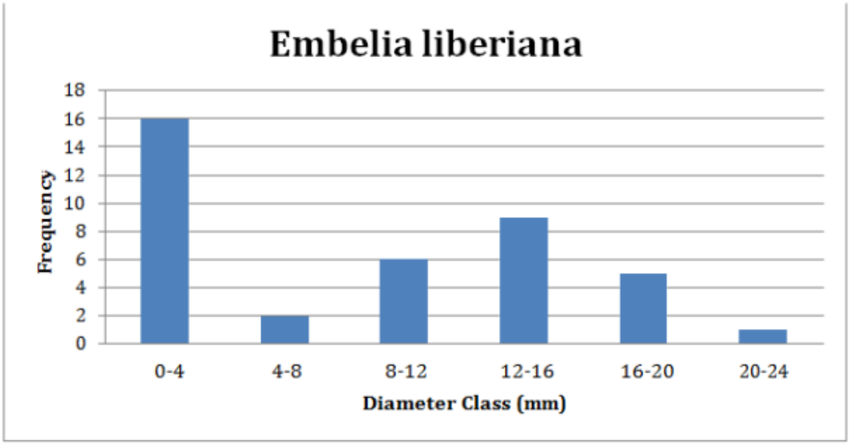


Figure 6: Diameter size class distribution of *smilax anceps* in 2018 and 2019 respectively



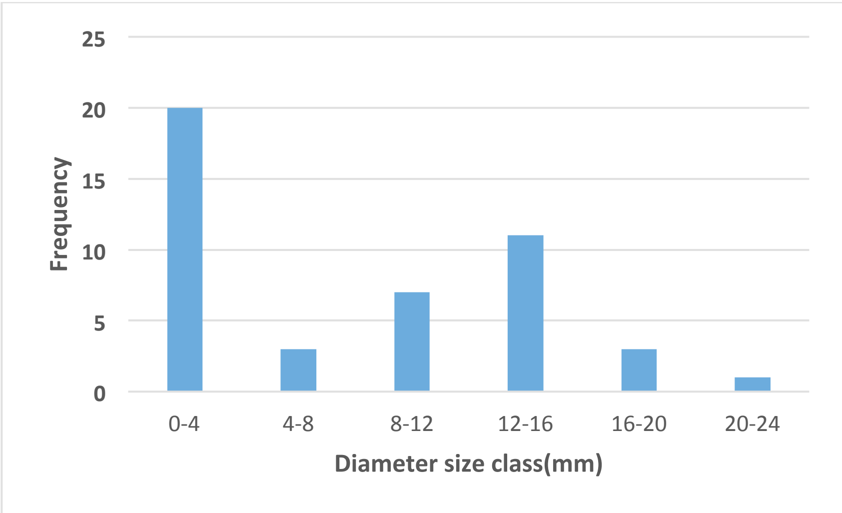
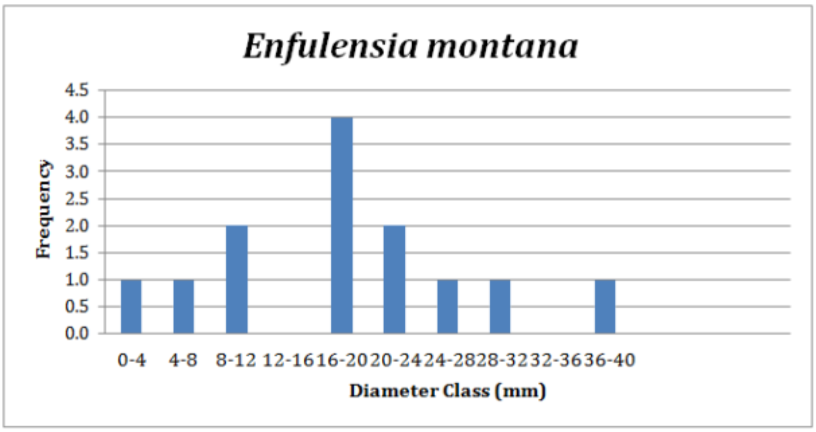


Figure 7: Diameter size class distribution of *Embelia liberiana* in 2018 and 2019 respectively



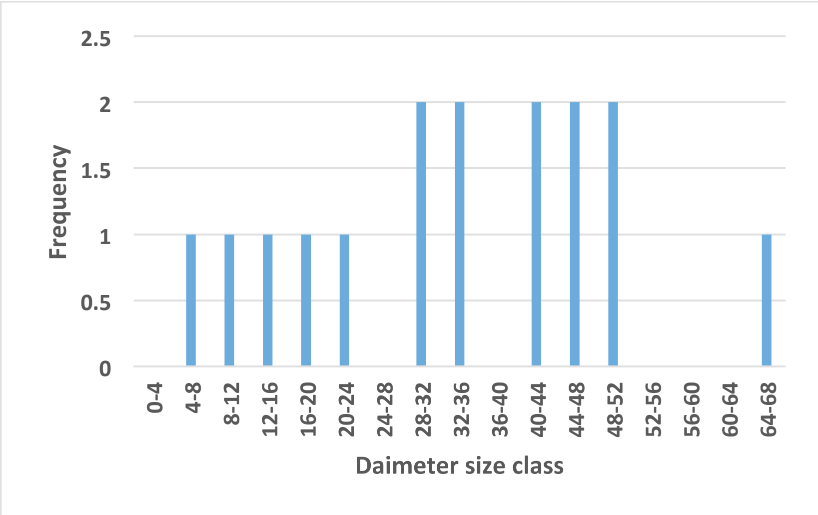


Figure 8 : Diameter size class distribution of *Enfulensia montana* in 2018 and 2019 respectively

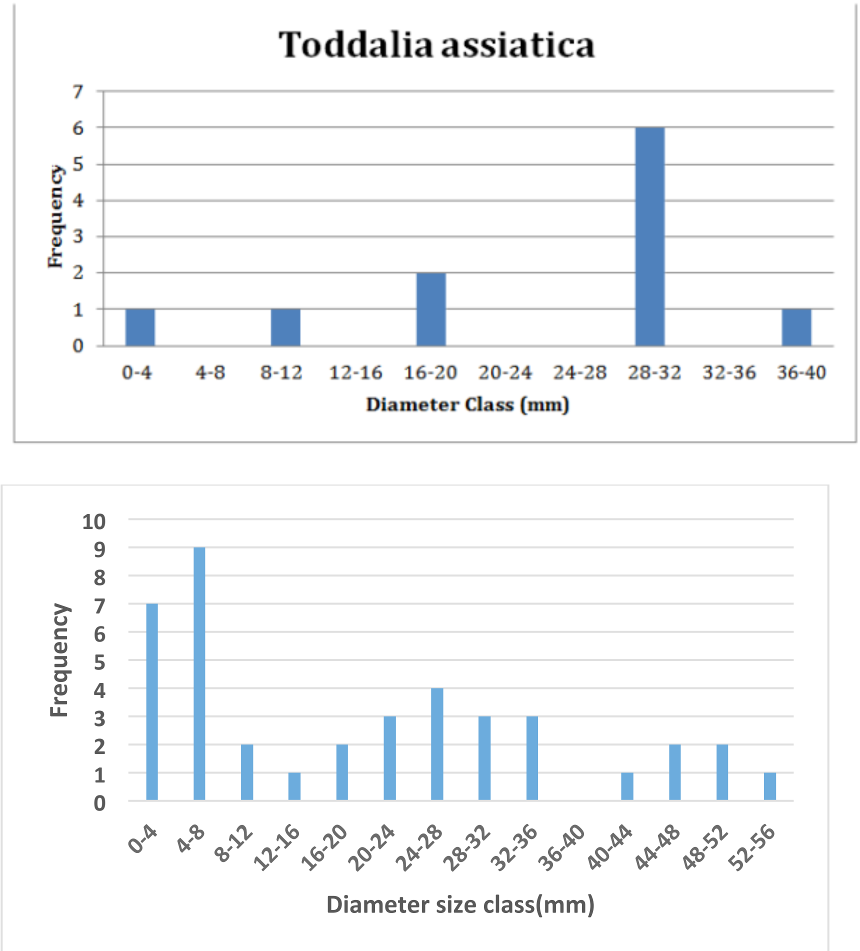
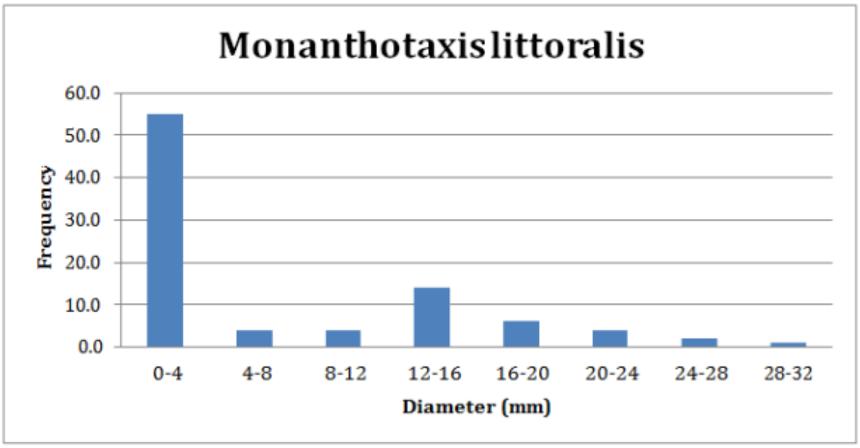


Figure 9 : Diameter size class distribution of *Toddalia assiatica* in 2018 and 2019 respectively



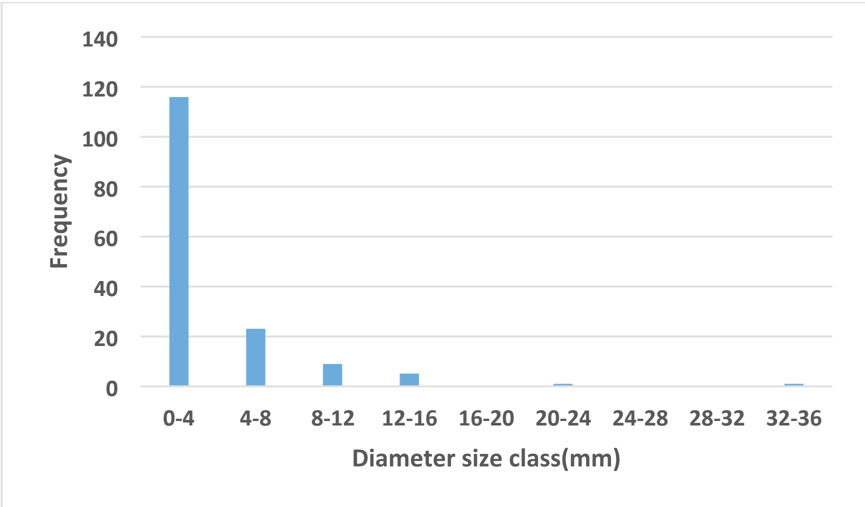
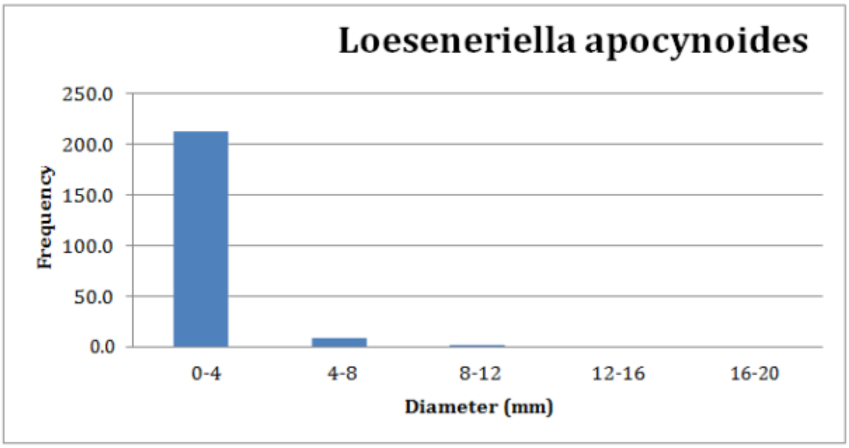


Figure10: Diameter size class distribution of *Monanthotaxis littoralis* in 2018 and 2019 respectively



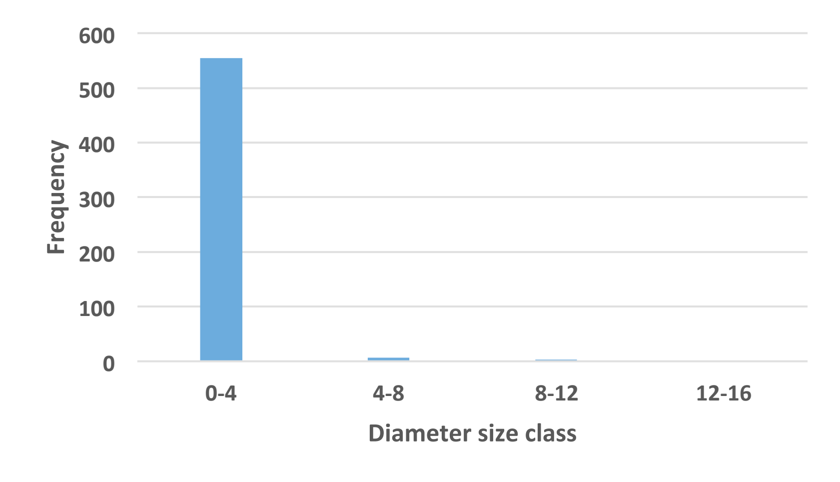


Figure11: Diameter size class distribution of *Loesenerilla apocynoides* in 2018 and 2019 respectively

Relationships between basal area of the wild climbers and environmental variables

Table 2 shows the relationships between basal area and environmental variables the sampled wild climbers. The analysis showed that only the basal area of *Draceana laxissima* that varied signifcantly with enviromental varaibles(canopy percent, tree cover, herb cover and shrub cover). *Primistera gracifolia's* basal area also varied signifcantly with shrub cover(Table 2). The rest of the wild climber species did not vary significantly with any of the variables measured during the study.

Table 2 : Relationship between basal area of wild climbers and environmental variables; conopy percent, tree cover, herb cover and shrub cover.

Draceana laxissima				
Variable	Sum Sq	Df	F value	Pr(>F)
Canopy_percent	0,45	1	6,4451	**0,01137***
Tree_cover	0,0054627	4	40,861	**< 2.2e-16***
Shrub_cover	0,0053648	4	39,936	**< 2.2e-16***
Herb_cover	0,0054047	4	40,312	**< 2.2e-16***
Monanthotaxis littoralis				
Varaible	Sum Sq	Df	F value	Pr(>F)
Canopy_percent	0,3574	1	3,0638	0,08834
Tree_cover	0,00000627	1	0,1628	0,6889
Shrub_cover	0,00002273	2	0,2907	0,7495
Herb_cover	0,00014081	1	4,0392	0,05179
Smilax anceps				
Variable	Sum Sq	Df	F value	Pr(>F)
Canopy_percent	0,0008	1	0,0138	0,9065
Tree_cover	0,00002068	2	1,557	0,2123

Shrub_cover	0,00000692	2	0,5177	0,5964
Herb_cover	0,00003251	2	2,4601	0,08696
Salacia elegans				
Variable	Sum Sq	Df	F value	Pr(>F)
Canopy_percent	0,025	1	0,1428	0,7058
Tree_cove	r 0.000866	3	0,4278	0,7332
Shrub_cover	0,000341	2	0,253	0,7767
Herb_cover	0,000705	3	0,3483	0,7904
Rytigynia rwenzoriensis				
Variable	Sum Sq	Df	F value	Pr(>F)
Canopy_percent	1,0986	1	3,5997	0,06164
Tree_cover	0,000232	1	0,2323	0,6312
Shrub_cover	0	1	5,00E-04	0,9828
Herb_cover	0,000226	2	0,1116	0,8945
Primistera gracifolia				
Variable	Sum Sq	Df	F value	Pr(>F)
Canopy_percent	0,0294	1	0,1334	0,7164
Tree_cover	0,009581	1	3,2814	0,07585
Shrub_cover	0,051588	3	7,8295	**0,0002217***
Herb_cover	0,000436	2	0,069	0,9334
Enfulensia Montana				
Variable	Sum Sq	Df	F value	Pr(>F)
Canopy_percent	0,67441	1	2,681	0,1298
Tree_cover	0,000599	2	0,0538	0,9479
Shrub_cover	0,000288	1	0,0566	0,8164
Herb_cover	0,013288	3	0,9283	0,4659
Loesenerilla apocynoides				
Variable	Sum Sq	Df F	value	Pr(>F)
Canopy_percent	0,36744	1	4,105	0,07026
Tree_cover	3,88E-06	1	0,2117	0,6553
Shrub_cove	3,88E-06	1	0,2117	0,6553
Herb_cover	1,05E-06	1	0,0561	0,8175

The annual stem growth rates of the wild climbers

Table 3 shows the variation of the diameters of *Draceana laxissima, Monanthotaxis littoralis, smilax anceps, Loesenerilla apocynoide* and *Rytigynia rwenzoriensis* with annual stem growth rates. Only the diameters of *Draceana laxissima* (GLMM, x^2= , DF = 1, P = 0.03324) and *Smilax anceps* (GLMM, x^2= , DF = 1, P = 0.01423) demostrated signficant varaition with their annual stem growth rate. *Monanthotaxis littoralis, Loesenerilla apocynoides* and *Rytigynia rwenzoriensis* showed no signficant variation in annual stem growth rates their P values were: P>0.005).

Figures and figures 12, 13, 14, 14 and 16 shows the yield curves (annual stem growth rates) for *Draceana laxissima, Monanthotaxis littoralis, smilax anceps, Loesenerilla apocynoide* and *Rytigynia rwenzoriensis.* With the exception of *Monanthotaxis littoralis,* the the stem growth rates of most of the wild climbers *increased exponentially with dbh up to 15mm diameter (*figures 12, 13, 14, 14 and 16*. However, further increases in the wild climbers diameter (after 20mm) had little effect on the stems growth rates of the climbers; beyond this size, stem growth rates began to decrease.*

Table 3: Variation of diamaters of wild climbers and annual growth rate(2018-2019)

Species	LR Chisq	Df	Pr(>Chisq)
Dracaena	4,5334	1	0,03324*
Monthotaxis	0,019107	1	0,8901
Smilax anceps	6,0097	1	0,01423*
Loeseniella	0,064627	1	0,7993
R.ruwenzoriensis	0,65674	1	0,4177

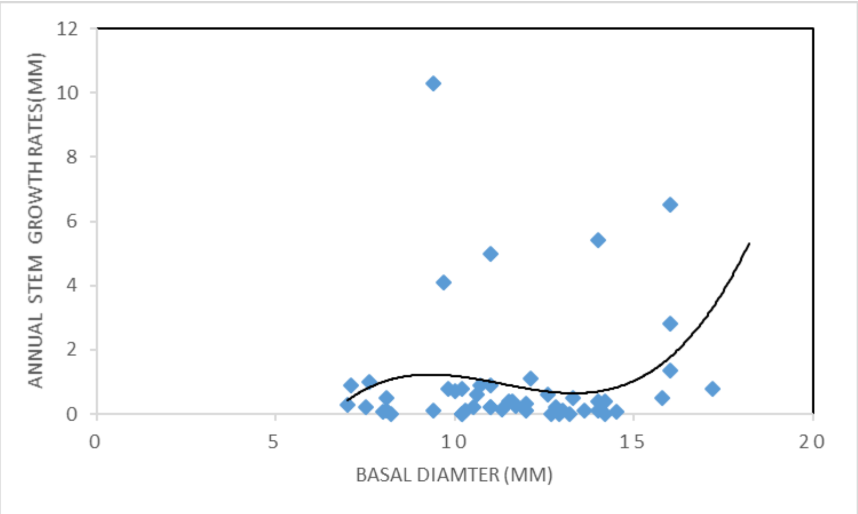


Figure 12 Annaual growth curve of *Draceana laxissima*

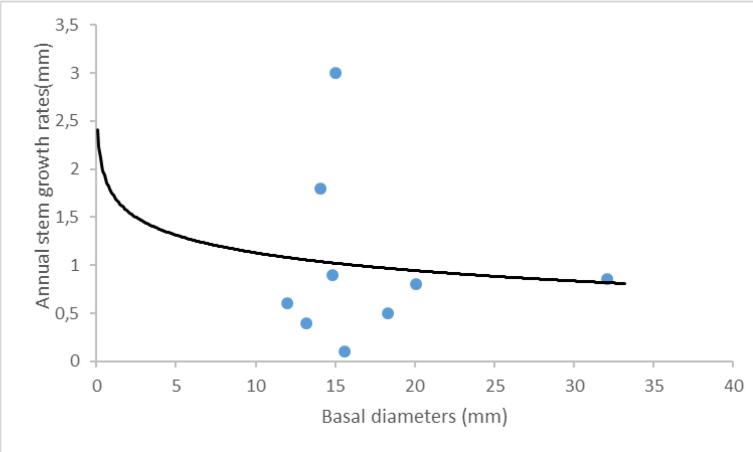


Figure 13 Annaual growth curve of *Monanthotaxis littoralis*

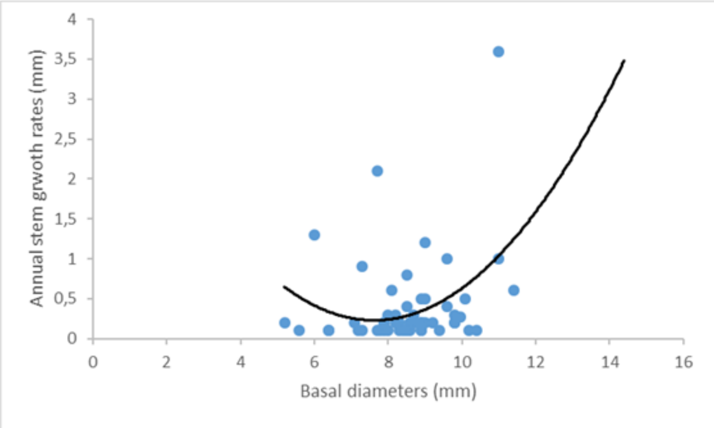


Figure 14 Annaual growth curve *smilax anceps*

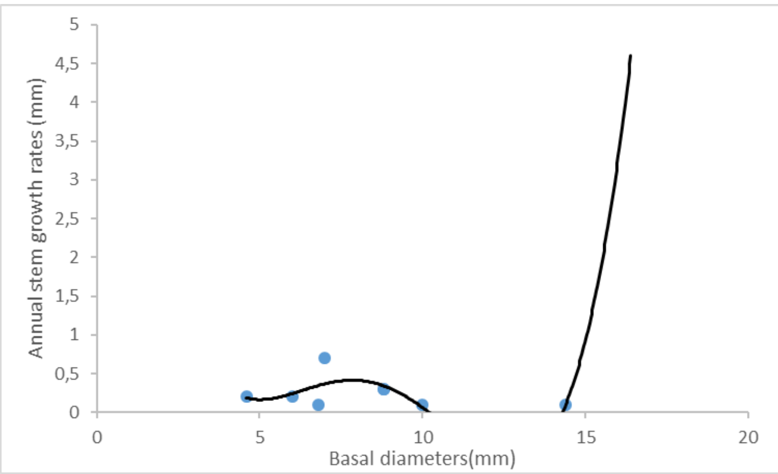


Figure 15 Annual growth *Loesenerilla apocynoides*

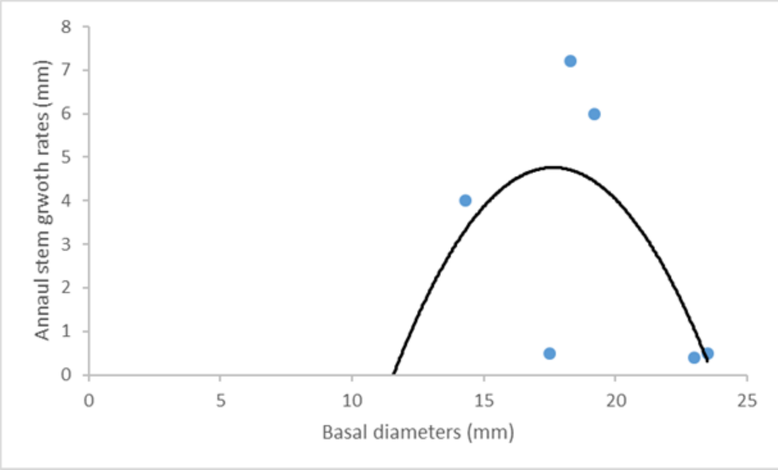


Figure 16 Annual growth Rytigynia rwenzoriensis

Discussion

Population structure of the wild climbers

Size class histograms provide an immediate identification of the poorly represented stages of the life history, therefore indicating the heavily harvested individuals that require immediate attention (Hall & Bawa, 1993). The first indication that a plant population is being subjected to an overly intensive level of harvest is usually manifested in the size-class distribution of that population (Hall & Bawa, 1993; Peters, 1994). The diameter class distribution of *Dracaena laxissima, Pristimera gracilifolia, Rytigynia rwenzoriensis Salacia elegans* and *Smilax anceps* (figures 2,3,4,5,6) together with that of *Embelia liberiana* and *Enfulensia montana* (figure 7 and 8) show a population with an almost evenly distributed age categories. They are slighlty more juviniles and seedlings than mature individuals, which is reflcetive of natural populations (Hall & Bawa, 1993). This kind of inverted 'J' and bell type distribution respectively are representive of a self-replicating popupaltion that is often in many health plant populations (Hall and Bawa, 1993; Mwavu and Witkowski, 2009). The fact that these species showed this type of distribution may be an indication that they sustainably harvested as defined by (Struhsaker, 1998; Pfab and Scholes 2003).

Loeseneriella apocynoides and Monanthotaxis littoralis on the other hand, exhbited an“L” type of population structure the same one they exhibted in 2018. This kind of population structure suggests that these two wild climber have been heavily harvested by the local people in the past hence, the many sprouts and hardly any mature nor juvenile ndivduals (Hall and Bawa, 1993; Mwavu and Witkowski, 2009). Indeed these two wild climbers are perphaps the most desribale wild climbers around Bwindi(Ndangalasi et al., 2007; Muhwezi et al., 2009; Bitariho, 2013; Bitariho and Akampurira, 2019), they in demand for tea harvest baskets and granaries mostly and play a signficant role in food security of many households. As emphasised by Bitariho and Akampurira, (2019) it is important to restrict the harvest of these wild climbers and continue they regular monitoring, but also seek to find alternatives to these two species that local people can use.

Just like in the previuos study by Bitariho and Akampurira, (2019) *Toddalia assiatica* depicted a “J” type of size class distribution. This kind of distribution is charateristic of species whose whose regeneration may be limited by tree canopy size (Hall & Bawa, 1993; Peters,

1994; Peters, 1996; Tuxill & Nabhan, 1998). Continued harvesting of *Toddalia assiatica* stems unsustaianbly could have inevitably resulted into this kind of distribution where there are few or hardly any seedlings needed for regeneration.


Because of the unavailability of Loeseneriella apocynoides used to pick tea, people around Bwindi are now using alternatives like plastics

Relationships between basal area of the wild climbers and environmental variables

Environmental factors have a significant influence on the status of harvested climbers (Ticktin, 2004). In this study we able to show that *Draceana laxissima* was the only wild climber species that varied signficantly with canopy, shrub cover, tree cover and herb cover. Bitariho,(2013) observed similar results for *Draceana laxissima* . These findings are important considering the role environmental variation plays in our understanding of the ecological impacts of wild climber extraction (Ticktin, 2004). The lack of signficant varaition between the basal areas of the other species and enviromental variables is perphaps related to their low stem desnity per hecatre (table 1)

The annual stem growth rates of sampled wild climbers

Growth curves can be used to to predict the growth and quantity of resource produced by a plant. Signifacant values like those generated by *Draceana laxissima* and *Smilax anceps* suggest a signficant change in growth rate by these species

(Peters, 1994). However a closer look at the stem densities of these species per hecatre of these two species suggests that they are outcompeting the others by the virtue of their abundance.

Conclusion

Out of the 10 wild climbers we sampled in study only three of them (*Toddalia assiatica, Monanthotaxis littoralis and Loesenerialla apocynoides*) demonstrated a population strcuture that has suffered the negative impacts of over harvesting or unsustainable harvesting . Bitariho , (2013) observed the same for *Monanthotaxis littoralis* and also Ndangalasi et al., (2007) observed a similar partner for *Loesenerialla apocynoides.* This suggests that these species have for long been unsustainbly been harvested. It is therefore important to restrict their harvest and continue their monitoring. But even perhaps more important is for the park management to work with local commuties to identify potential alternatives that can help adresss the food security needs of local communities around Bwindi.

Better still the study also concludes that *Dracaena laxissima, Pristimera gracilifolia, Rytigynia rwenzoriensis Salacia elegans* and *Smilax anceps* together with that of *Embelia liberiana* and *Enfulensia montana* have a healthy replcating population and have been harvested sustainably in these two parishes. Hence it is important that communities are allowed to continue harvest of these spcies but with regular monitoring.

Recommendations

- Results indicate that; *Toddalia assiatica, Monanthotaxis littoralis and Loesenerialla apocynoides* species have been harvested un sustainably and hence, we recommend that more strict protection should offered to these species. Harvesting of these species should be burnt altogether until their populations recover.
- We also recommend that park management work with local communities to find alternative spcies to *Toddalia assiatica, Monanthotaxis littoralis and Loesenerialla apocynoides*, that can perform the same functions. For example *Simlax anceps* is known to perform similar functions to *Loesenerialla apocynoides* and from our study *Simlax anceps* its harvest is sustainable and it has health natural regeneration.
- Efforts such as planting of the most utilised wild climbers within community farmland should be initiated and promoted by BMCT. Concentrating on wild climbers that are sufficiently valuable to local communities would likely enhance such practices. The Institute of Tropical Forest Conservation (ITFC) has an ethnobotanical garden at Ruhija that breeds indigenous tree seedlings. This creates an opportunity for NGOs like Bwindi Mgahinga ConservationTrust (BMCT) to encourage and help the local communities they work with to acquire some of the wild climberseedlings and plant them on their land.

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