ABUNDANCE AND SPATIAL DISTRIBUTION OF Myrianthus holstii IN BWINDI IMPENETRABLE NATIONAL PARK

BY

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Introduction

- Tropical forests are generally rich in plant species plus other species but the ecosystems are sustained largely by keystone species.
- Keystone species vary among areas even for the great apes (van Schaik *et al*., 1993).
- In Kahuzi, *M. holstii* is now taking a role of keystone foods for Gorillas and Chimpanzees (Basabose, 2002; Yamagiwa *et al*., 2005). In Bwindi, the seeds of *M. holstii* trees were found to constitute 20 % and 4 % of

the fecal samples of gorillas and chimpanzees (Stanford and Nkurunungi, 2003). The fruits are consumed in large quantities by elephants (Rode *et al,* 2006), monkeys and birds (Kissa. Pers. Obs) as well as humans (Cunningham, 1996).

- Information on plant species densities and distribution are helpful for effective forest management.

Problem statement

- The demand for non-timber plant resources by local people around BINP is ever-increasing thus making plant resource harvesting to continue with or without permission from park authorities.
- Due to the perceived importance of *M. holstii* fruits to endangered wildlife, the Park Authorities haven't permitted harvesting of the fruits from inside the park despite numerous requests forwarded by the local people.
- Little information is available on the ecology and distribution of tree species of ecological importance such as *M. holstii* trees.

Objectives

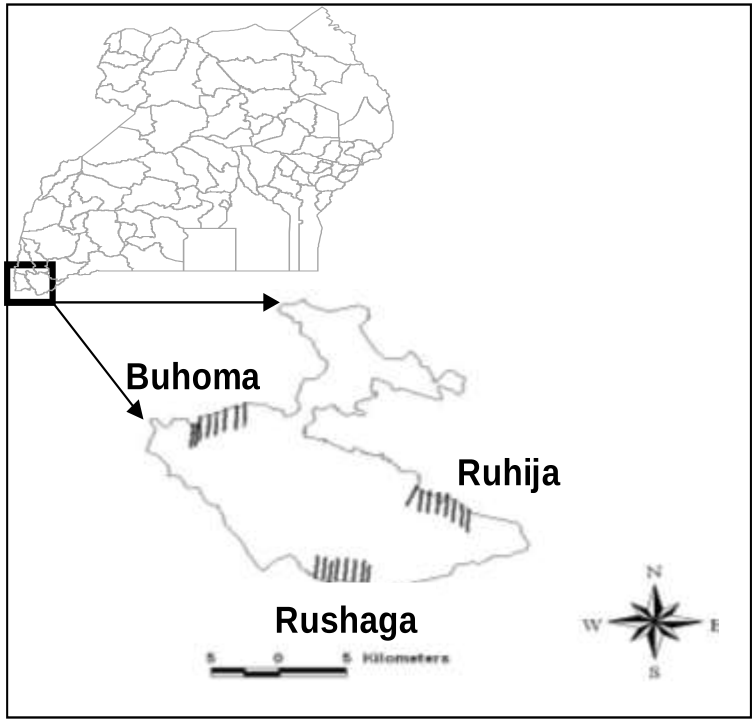
- To evaluate the bias, precision and cost of generating data using the two methods.
- To assess the density and distribution pattern of *M. holstii* trees.
- To assess the population structure and size difference in male and female *M. holstii* trees.
- To determine the effect of environmental variables (including damage) on the density, population structure and distribution pattern of *M. holstii* trees.

Justification

- Quantitative information on species of ecological importance is very vital to managers/conservationists.

- Reduction in food availability in the forest as a result of competition from humans could affect the ecology of the primates thus may lead to crop raiding in search for food.

Methods and Materials



Map showing location and sampling sites in BINP, SW Uganda.

- The study was conducted in Bwindi between October 2009 & April 2010.
- Two sampling procedures were used i.e. Distance and belt-transect methods.
- Eight transects were placed in each of the three sites.
- Transects were oriented N – S direction with the first being randomly placed.

- Trees were enumerated along the transects and diameters were measured. Perpendicular distance were measured for trees (height > 1.3 m). But trees (height < 1.3 m) were only counted within the belt width.

- Trees were categorized into seedlings (height < 1.3 m), top broken (big trees of height < 1.3 m), small saplings (Dbh ≤ 2.5 cm, height > 1.3 m), large saplings (Dbh > 2.5 cm but ≤ 5.0 cm, height > 1.3 m), small adults (> 5.0 cm but ≤ 10.0cm, height > 1.3 m) and large adults (Dbh > 10.0 cm, height > 1.3 m).
- Environmental variables were recorded i.e. altitude, canopy closure, basal area, percent slope, aspect, distance from forest edge, animal damages.

Data analysis

- The density (D) of trees within belt width was estimated from D = N/2WL (Buckland, 2001) where N = total number of trees recorded in that category, 2W = effective strip width and L = total length of transects.

- Frequency tables were constructed for each sub-populations and index of dispersion calculated. The nearest neighbour distance was calculated using ARC GIS.

Data analysis cont'

- Sex ratio of mature *M. holstii* trees at two diameter classes (Dbh < 10 cm and > 10 cm) were calculated at each study site using a Chi-square test.
- The density (number) of *M. holstii* trees were tested for correlation with altitude, distance from forest edge to the interior, canopy closure, basal area and percent slope using Spearman rank correlation test (ρ).
- The incidence of damage by herbivores amongst females and males were tested using Poisson regression analysis.

Results & Discussions

Density/Standard Error (SE) of *M. holstii* trees within the three landscapes (A = Buhoma, B = Rushaga and C = Ruhija) in BINP recorded using the Distance method (height ≥ 1.3 m and Belt method (height < 1.3 m).

Tree category	*Density in the three landscapes*			*Data used*
	A	*B*	*C*	
1) Overall population (Dbh > 0.1 cm, height ≥ 1.3 m))	16.34 ± 0.85 (n = 677)	11.47 ± 0.97 (n = 517)	4.99 ± 0.68 (n = 244)	Belt
2) Large adults (Dbh > 10 cm m)	7.28 ± 0.78 (n = 418)	4.85 ± 0.46 (n = 312)	1.22 ± 0.35 (n = 122)	Belt
3) Small adults (Dbh > 5 cm to ≤ 10 cm)	3.32 ± 0.42 (n = 130)	2.13 ± 0.37 (n = 80)	1.16 ± 0.32 (n = 43)	Belt
4) Large saplings (Dbh > 2.5 cm ≤ 5 cm)	3.17 ± 0.40 (n = 58)	2.81 ± 0.41 (n = 55)	1.34 ± 0.45 (n = 37)	Belt
5) Small saplings (Dbh from 0.1 cm to ≤ 2.5 cm	3.91 ± 0.61 (n = 71)	5.08 ± 0.59 (n = 70)	2.23 ± 0.47 (n = 42)	Belt
6) Seedlings (height < 1.3 m)	1.56 ± 0.15 (n = 25)	0.69 ± 0.16 (n = 11)	0.38 ± 0.18 (n = 6)	Belt
7) Top-broken trees (height < 1.3 m)	2.63 ± 0.17 (n = 42)	1.69 ± 0.31 (n = 27)	0.69 ± 0.24 (n = 11)	Belt
8) Juveniles (Dbh < 5 cm): Adults (Dbh > 5 cm) ratio	0.32	0.47	0.53	

Objective Two: Density estimation

- The overall population densities were significantly different among the three study sites (Kruskal Wallis, $H = 15.65$ and $p < 0.0001$).

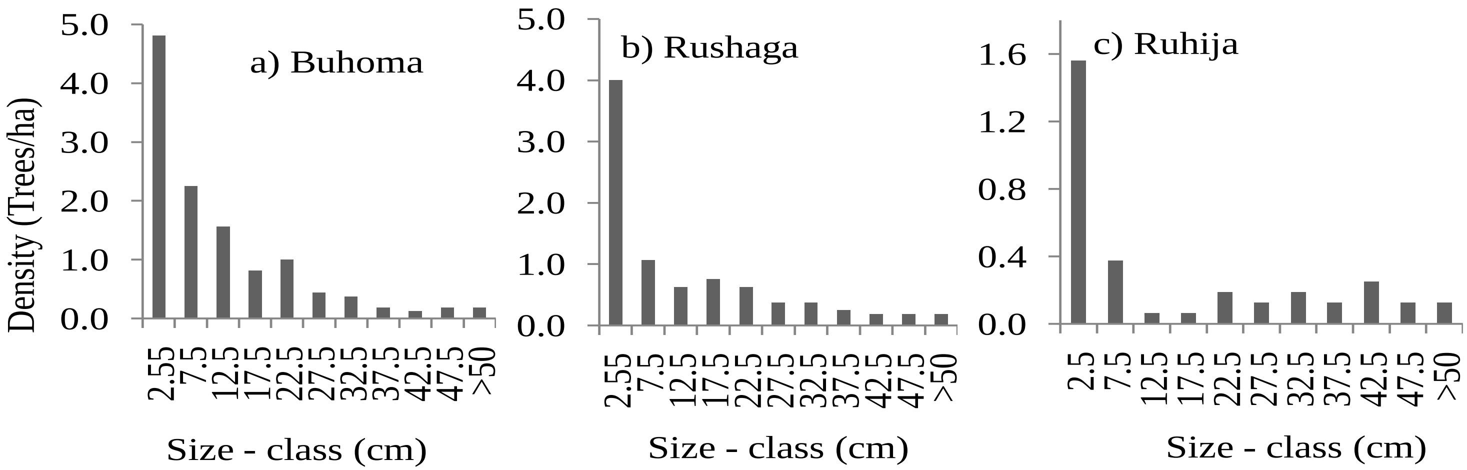
- Variations in density could be due to the altitude since number of mature *M. holstii* trees decreased significantly with altitude across the entire study sites. Soil moisture and air temperature are relatively higher in low elevated areas compared to high elevated areas (Kennenni & Vandermaarel, 1990). In Bwindi, the same situation applies (www.itffc.org/climate data) and few Myrianthus were recorded above altitude of 2300 m asl.

•The dispersion indices were greater than 1.0 for all size-classes (Table below) suggesting that the distribution of *M. holstii* trees is clumped/aggregated.

Site	*Tree population*	*Type of pattern*	*Nearest neighbour distance (m)*	*Index of dispersion (S^2/x)*	*Calculated G value*	*Critical G value*	*df*	*p-value*
	Small saplings	Clumped	0.33	2.57	5.62	11.07	5	0.585
	Large saplings	Clumped	0.59	1.69	1.74	7.81	3	0.884
	Males	Clumped	0.34	1.50	9.34	14.07	7	0.407
A	Females	Clumped	0.58	2.55	8.72	16.92	9	0.726
	Small saplings	Clumped	0.53	1.75	5.62	9.49	4	0.585
	Large saplings	Clumped	0.63	5.44	3.83	7.81	3	0.574
	Males	Clumped	0.32	2.25	10.02	12.59	6	0.264
B	Females	Clumped	0.41	2.24	6.53	12.59	6	0.588
	Small saplings	Clumped	0.51	8.55	7.50	7.81	3	0.186
	Large saplings	Clumped	1.01	6.90	8.84	9.49	4	0.116
	Males	Clumped	1.69	5.01	7.10	9.49	4	0.312
C	Females	Clumped	0.35	4.31	7.14	14.07	7	0.522

•The aggregation tendencies of *M. holstii* trees could be that since many frugivores feed on the fruits, they end up depositing the seeds at close distance. The aggregation could also be caused by variation of basal area and percent slope.

Objective Three: Population structure



- The size-class distribution patterns at Buhoma and Rushaga conformed to nearly an inverse “J” curve suggesting recruitment of juveniles (above) but SCD curve was sporadic at Ruhija.
- Population structure of tree species with the classic inverse J-shaped SCD represents a healthy regenerating population (Wilson & Witkowski, 2003).

- *M. holstii* tree species is resilient to minor disturbances such as debarking and top breaking by resprouting in order to recruit fairly regularly over time thus exhibiting a continuous representation of individuals. However, the sporadic SCD at Ruhija could be due to heavy damage of the stems by elephant. Struhsaker (1997) indicates that, elephants can suppress regeneration of trees in large open gaps because of their frequent visitation to such gaps.

- The smallest fertile single-stem male was 5.7 cm (Dbh) at A, 5.9 cm at B and 6.8 at C. The equivalent smallest diameter of fertile female was 6.8 cm at A, 7.0 cm at B and 8.1 cm at C. The mean diameter of females was higher compared to the males at all the landscapes (ANOVA, $F = 6.07$, $p < 0.014$).

- Other studies have also revealed early maturation among males (Ueno *et al*, 2007). This are attributed to a lower reproductive cost in males compared to females.

Sex ratio

		Reproductive state					
Tree category	*Sites*	*Non –repro*	*Nrep*	*Male*	*Female*	*Female proportion*	*(P – value)*
Small adults	Buhoma	71	44	17	27	1.59	0.132
	Rushaga	38	28	20	8	0.4	**0.023**
	Ruhija	27	12	5	7	1.4	0.564
Large adults	Buhoma	59	366	150	216	1.44	**0.001**
	Rushaga	53	268	130	138	1.06	0.667
	Ruhija	9	114	59	55	0.93	0.778
Total		**257**	**832**	**381**	**451**		

Bold p – values shows significantly biased sex ratio at p = 0.05

- Sex ratio was significantly female biased in large adults at lower altitude and male biased in small adults at middle altitude.
- Again female-biased sex ratio has been reported at lower altitude (Marques *et al*, 2002), linked to habitats where soils have high nutrient and water contents (Freeman *et al.*, 1980).

Objective Four: Environmental variables

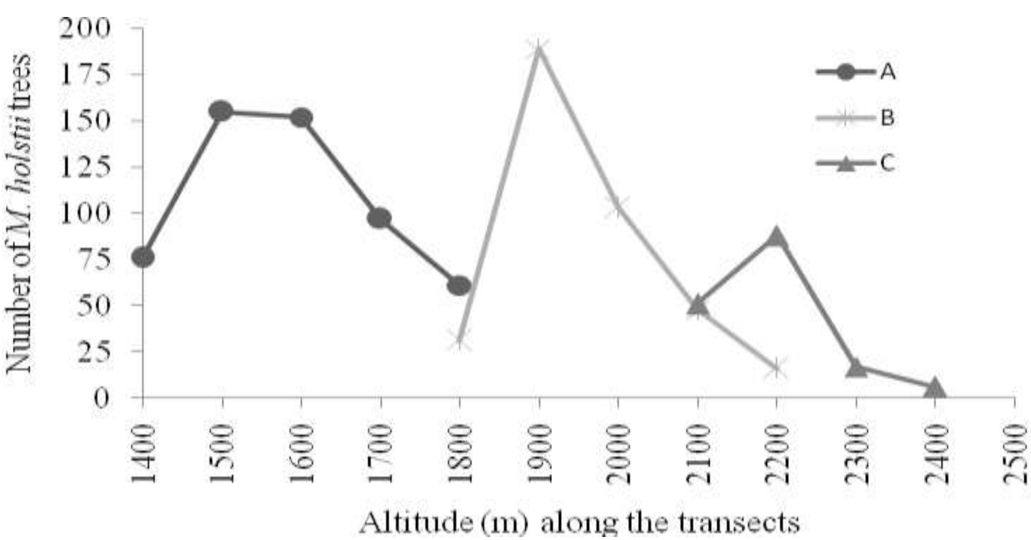
Table 4 Comparison of damages by size in male and female trees.

	Female (n = 451)					*Male (n = 381)*				
Damage category	*No. trees (n)*	*Diameter*		*Height*		*No. trees (n)*	*Diameter*		*Height*	
		B	*p – value*	*B*	*p - value*		*B*	*p – value*	*B*	*p - value*
Debarked	17	-0.254	0.0001	-0.202	0.035	16	-0.358	0.0001	-0.26	0.015
Top broken	194	-0.227	0.0001	-0.260	0.0001	163	-0.235	0.0001	-0.28	0.0001
Browsed	229	-0.122	0.0001	-0.095	0.013	190	-0.153	0.0001	-0.11	0.011
Bent	11	-0.071	**0.326**	-0.081	**0.453**	12	-0.351	0.0001	-0.29	0.02

Bold = not significant

- The juveniles are heavily browsed, debarked and suffer from frequent top-breaking by herbivores. This is because the young stems of *M. holstii* trees are hollow making them to be more susceptible to damage by herbivores. Larger stems can survive top-breaking by herbivores such as elephants due to their developed strength and resistance (Sheil & Salim (2004).

Site	Dependent Variable	Independent variables	Coefficient (B)	P-value	r^2	df	Significance of F	
Buhoma	Tree density	Intercept	120.43	0.101				
		Distance	-0.01	0.095				
		Percent Slope	0.16	0.477	0.413	4	2.641	0.075
		Stand BA	-4.05	**0.023**				
		Canopy closure	-0.93	0.28 4				
Rushaga	Tree density	Intercept	-98.50	0.192				
		Distance	-0.02	**0.001**				
		Percent Slope	0.07	0.776	0.571	4	4.983	**0.009**
		Stand BA	-0.67	0.838				
		Canopy closure	-1.64	0.076				
Ruhija	Tree density	Intercept	4.55	0.368				
		Distance	-0.01	0228				
		Percent Slope	0.10	0.484	0.358	4	2.052	0.138
		Stand BA	-1.32	0261				
		Canopy closure	-0.06	0552				



Relationship of *M. holstii* trees (Dbh > 5.0 cm) with altitude within the three lanscapes (A, B and C) in BINP.

•The density of *M. holstii* trees decreased with distance, basal area and canopy but increased with percent slope at all the sites.

M. holstii (Dbh > 5.0 cm) were recorded at altitudinal range of 1438 – 2344 m only. The density decreased significantly only across all the sites (Pearson, r = -0.649, p < 0.022

- Plant density is influenced by many factors such as adequate soil nutrients, high amount of soil moisture and air temperature. Soil moisture and air temperature are relatively higher in low elevated areas compared to high elevated areas (Kennenni & Vandermaarel, 1990).
- Our result of high stem density of *M. holstii* trees within 1 km from the forest edge is not different from what was reported by Olupot *et al* (2009). The decrease in density of *M. holstii* trees with distance from the forest edge is because the old logging and fire incidences were concentrated near the forest edge (Howard, 1991).

- Again *M. holstii* trees occurred within areas with low stem density, relatively lower canopy closure and slightly higher percent slope compared to the general forest conditions measured by the systematic points taken along the transects. Plant growth is favoured by increased light intensity, increased soil temperature; reduce competition for water and nutrients. These conditions are higher in disturbed areas compared to the undisturbed areas (Sapkota *et al*, 2009). The anthropogenic factors such as intensive logging and bush fires in BINP could have enhanced such conditions.

Conclusion and recommendations

- **Conclusions**
- The density of *M. holstii* trees related negatively with distance from the forest edge. This implies that, the species are more concentrated within the areas of multiple use zones and this can lead to serious competition for fruits between humans and wildlife incase harvesting is allowed by management.
- It is important that, on farm planting of fruit trees such as *M. holstii* be promoted among the local communities surrounding BINP.

- **Recommendations**
- The distance line-transect should be used to inventory low abundance species but its application should be done with caution especially for species that resemble each other.
- The fact that majority of the species are found within the Buffer zones and are clumped, there is likelihood of serious human–wildlife conflict and over harvesting of fruits. Therefore, on farm planting of *M. holstii* should be promoted in order to reduce the demand pressure being created by local people.

THANK YOU FOR LISTENING