Forest structure and spatial patterns of tree growth in Bwindi Impenetrable National Park (Bwindi),Uganda

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Background

- Climate change impacts on tropical forest growth, composition, ecology, structure & productivity have been reported.

- Have negative effects on carbon sequestration potential of TRFs , ecosystem services & livelihood.

- Predicting how TRF's growth will respond to climatic change requires an account of the factors that influence tree and forest growth and structure .

- This is important for the ongoing discussions of ecosystem services, REDD+ and maximizing TRFs conservation options.

- Understanding the factors that control tree growth and structure is central to forest ecology because of its significance to forest dynamics & above ground biomass.

Aim ,objectives & hypotheses

Aim : To explain and understand the variation in tree growth and forest structure in Bwindi.

Objectives:

- Determine how tree growth rates vary across Bwindi.
- Identify the most important factors that influence tree growth rates in Bwindi.
- Determine how forest structure varies across Bwindi.
- Identify the most important factors that influence forest structure in Bwindi.

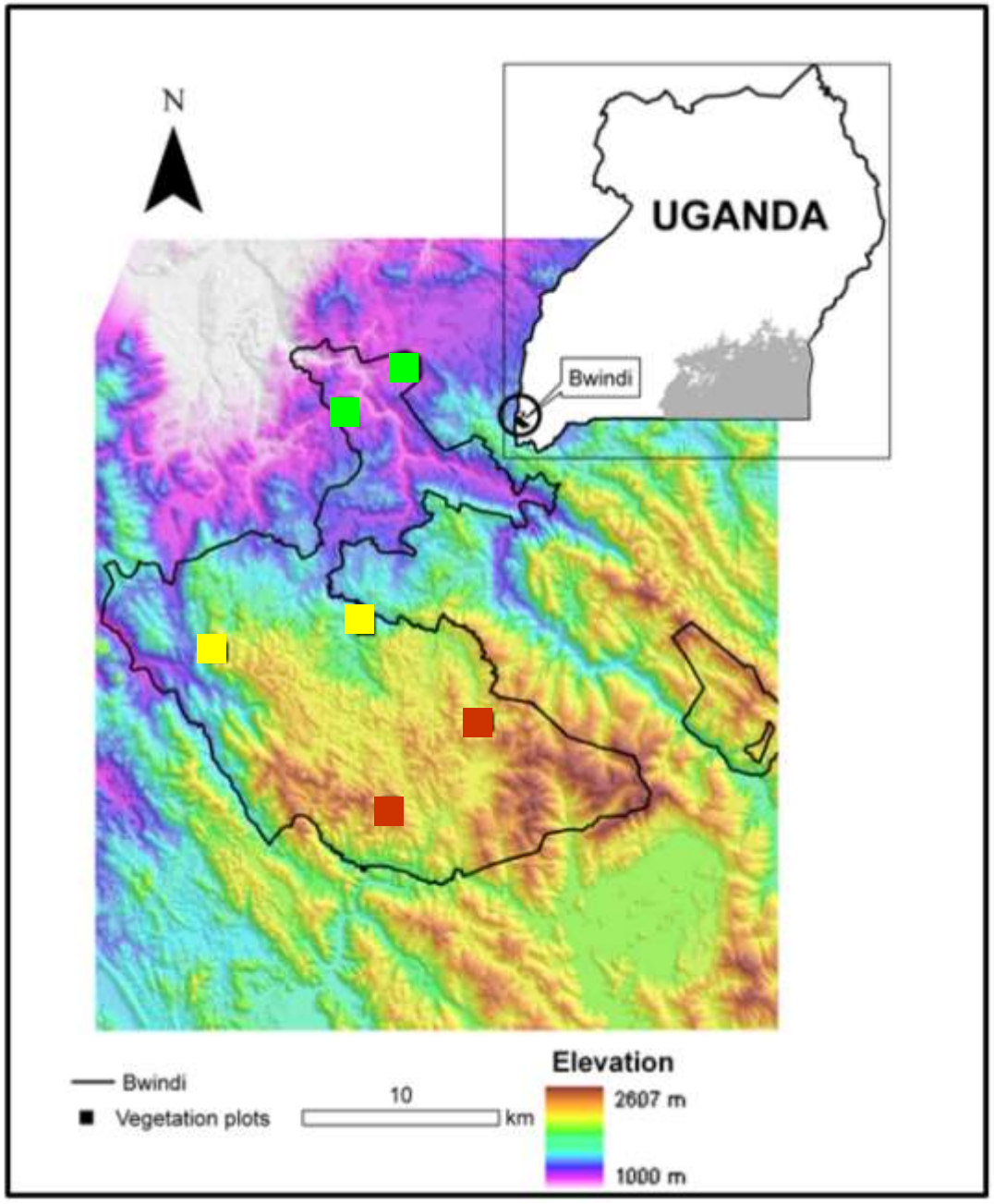
Hypotheses:

- There is a significant variation in tree growth rates across Bwindi.
- Individual tree growth rates in Bwindi vary significantly with respect to the explanatory variables.
- There is a significant variation in forest structure in Bwindi.
- Forest structure in Bwindi varies with respect to the explanatory variables.

Explanatory variables

1. Species identity
2. Stem size
3. Diameter size class
4. Competition for light:
   - Dawkins' (1958) classification of tree crown position and form.
   - Basal areas of larger neighbors in the subplot of the subject tree (Coomes & Allen, 2007).
5. Other competition (competing basal area) :
   - All tree basal areas in the subplot of the subject tree (Alder & Synnott ,1992).
6. Slope position
7. Undergrowth
8. Climber infestation: Alder & Synnott (1992)
9. Past disturbance (pit sawing): Eilu & Obua (2005)
10. Altitude

Study site and method



- 6 -1ha PSPs
- 3 elevation zones
- Measured
- Tagged
- Identified
- Mapped

Data analysis

- Tree growth rates (DBHGR & BAGR):
  - $DBHGR = (DBH_f - DBH_i) / t.$
  - $BAGR = (BA_f - BA_i) / t.$

- Forest structure: DBH, Basal area and stem density

- Forest structure, tree growth and explanatory variables: ANOVA and linear regression analysis were performed.

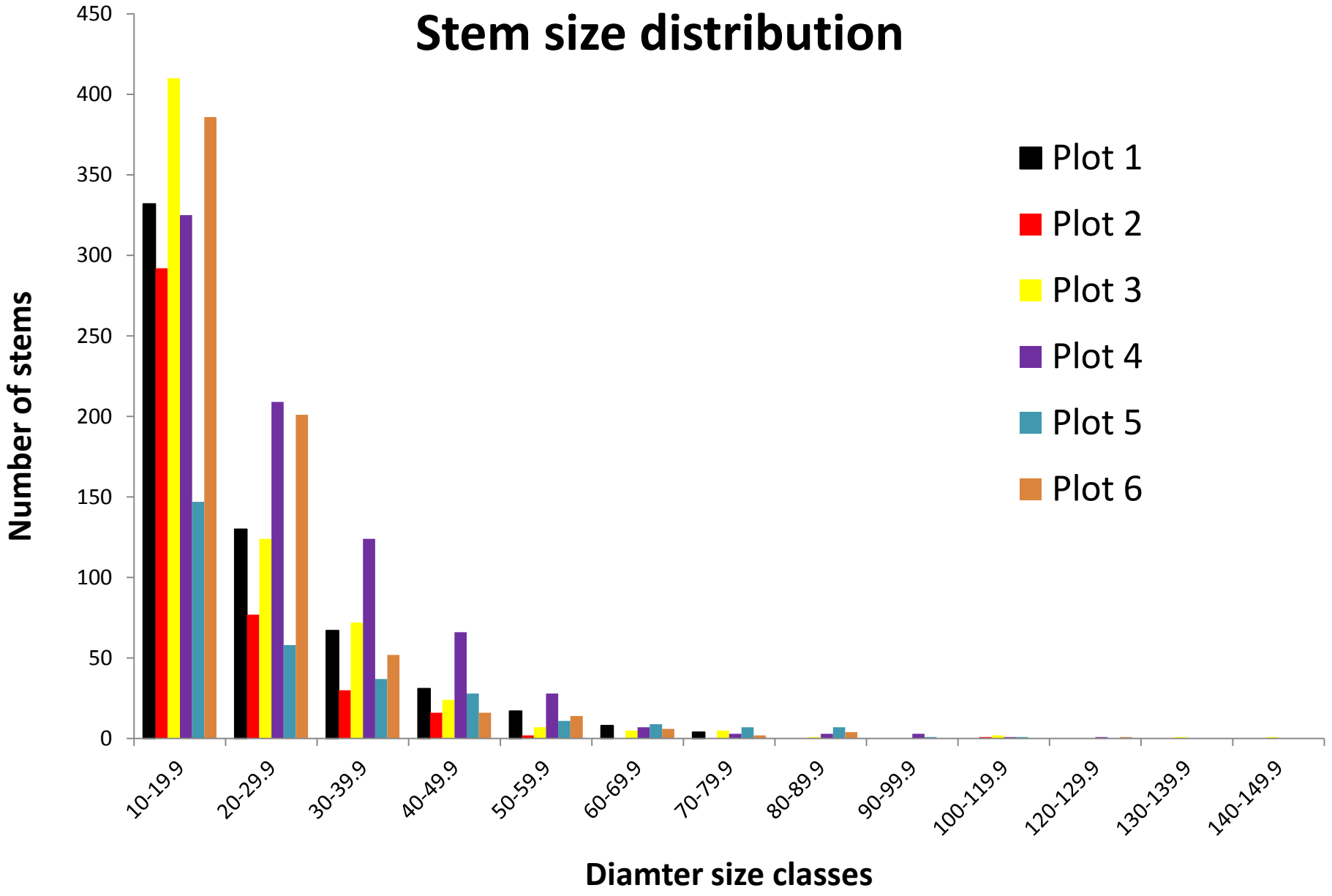
- All tests done in MINITAB .14 at 5% level of significance.

- Model selection : The AIC values were computed using the model selection application in the Spatial Analysis in Macroecology program (SAM, version 4.0; Rangel *et al*., 2006).

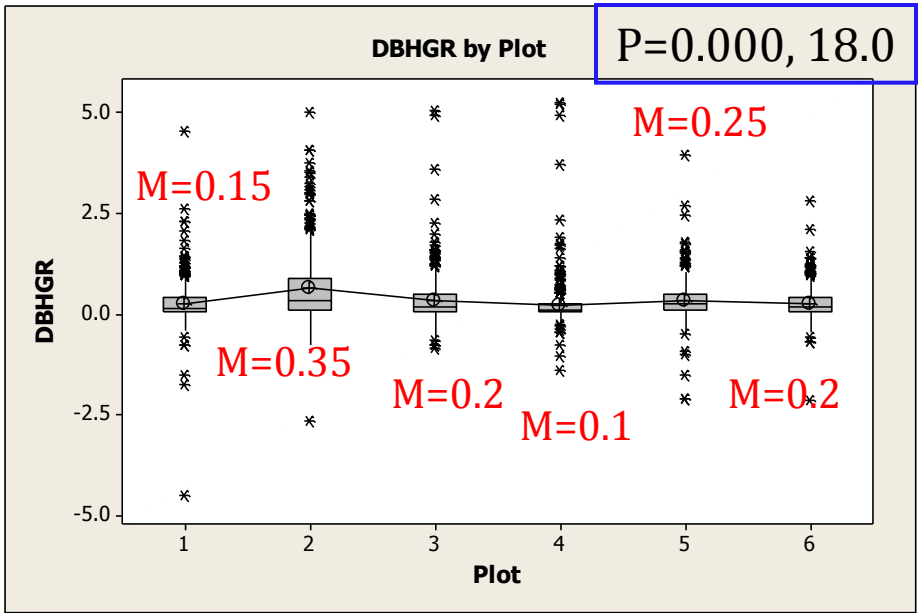
- The importance of the explanatory variables for each dependent variable was determined by their frequency of occurrence in these models.

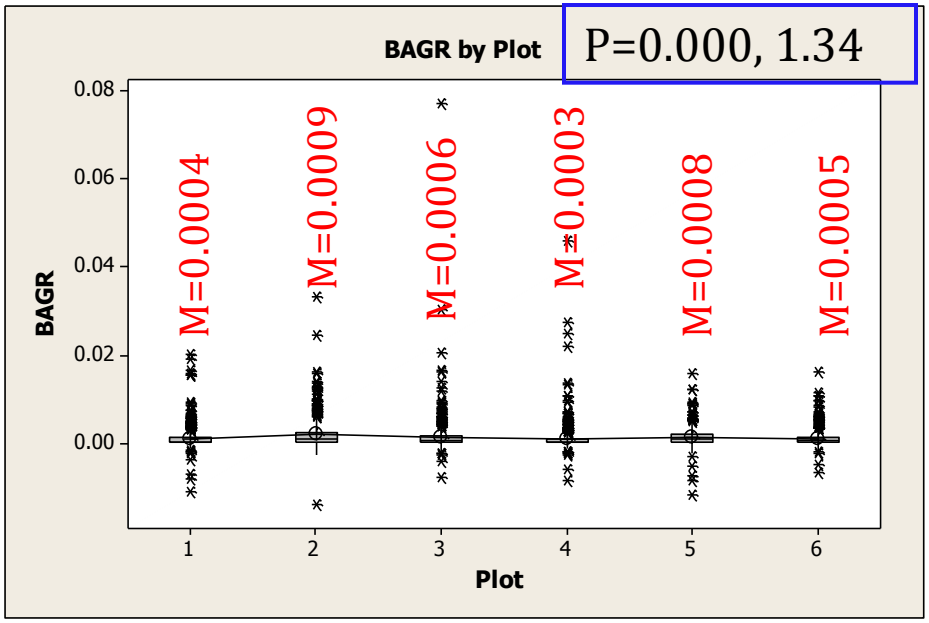
Overview of plots

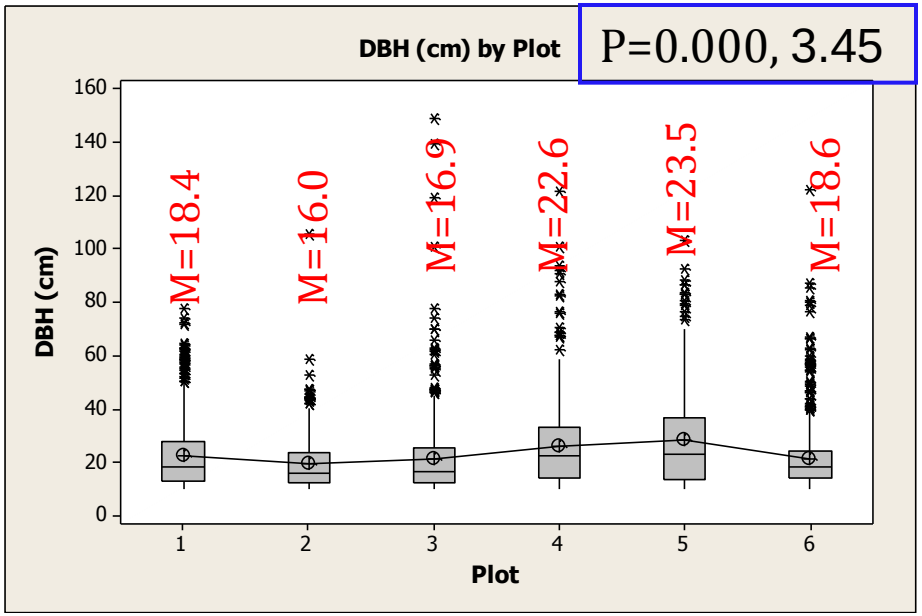
Plot label	Elevation (Zone)	Elevation (masl)	Density (trees/ha)	BA (m^2ha^{-1})	No of Species
VGBIF1	Lowest	1498	557	29.95	43
VGBIF2	Lowest	1425	335	13.39	29
VGBIF3	Middle	1934	588	30.84	39
VGBIF4	Middle	2085	681	48.09	27
VGBIF5	Highest	2088	277	25.95	29
VGBIF6	Highest	2341	632	30.88	25

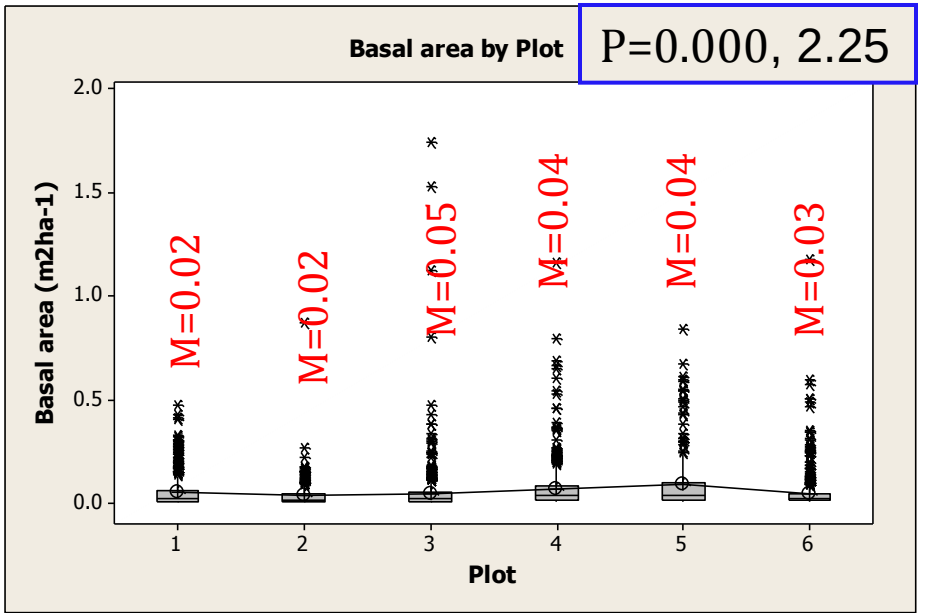

Stem size distribution
Number of stems
450
400
350
300
250
200
150
100
50
0
Plot 1
Plot 2
Plot 3
Plot 4
Plot 5
Plot 6
10-19.9
20-29.9
30-39.9
40-49.9
50-59.9
60-69.9
70-79.9
80-89.9
90-99.9
100-119.9
120-129.9
130-139.9
140-149.9
Diamter size classes

Tree growth and forest structure variation among plots

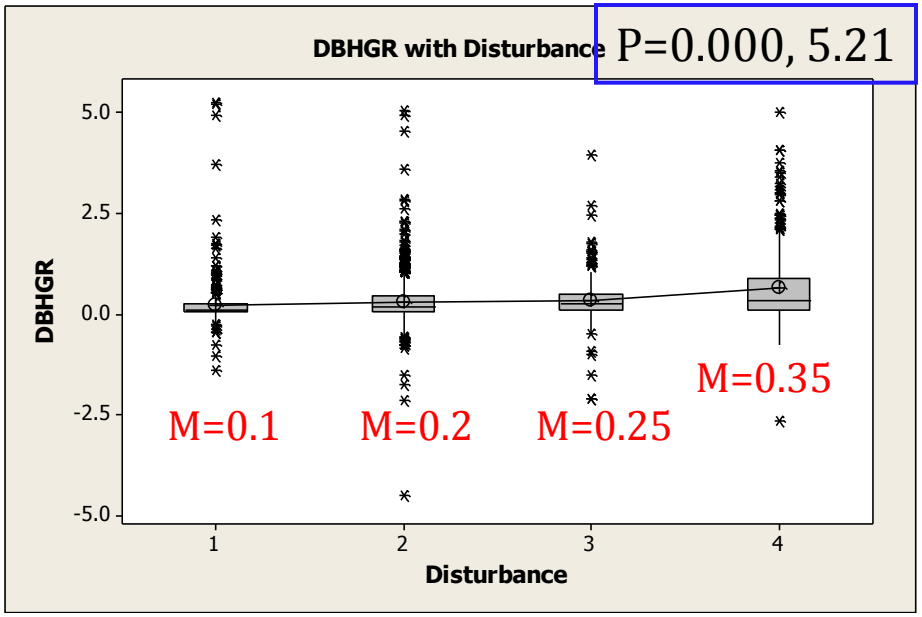


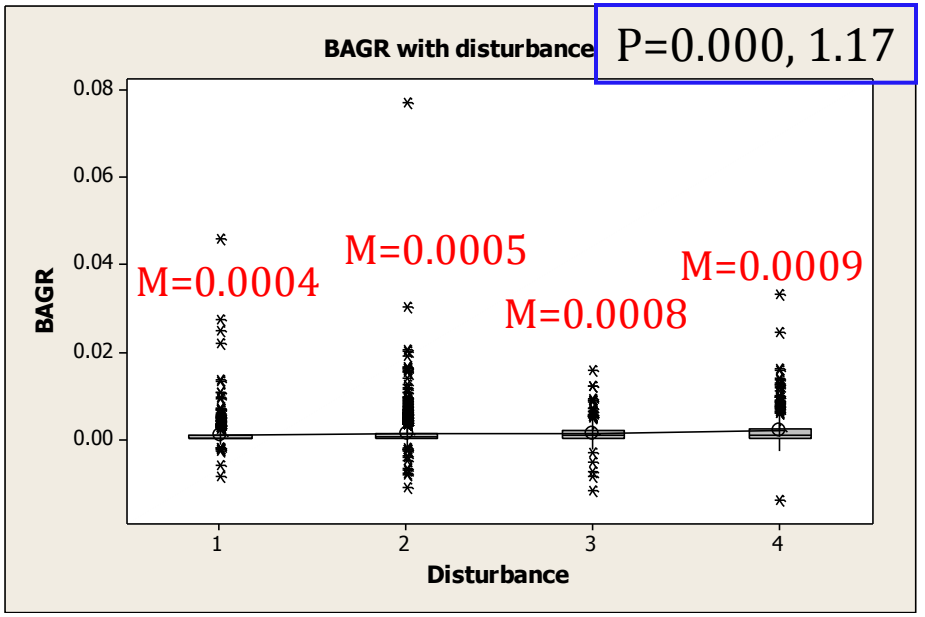


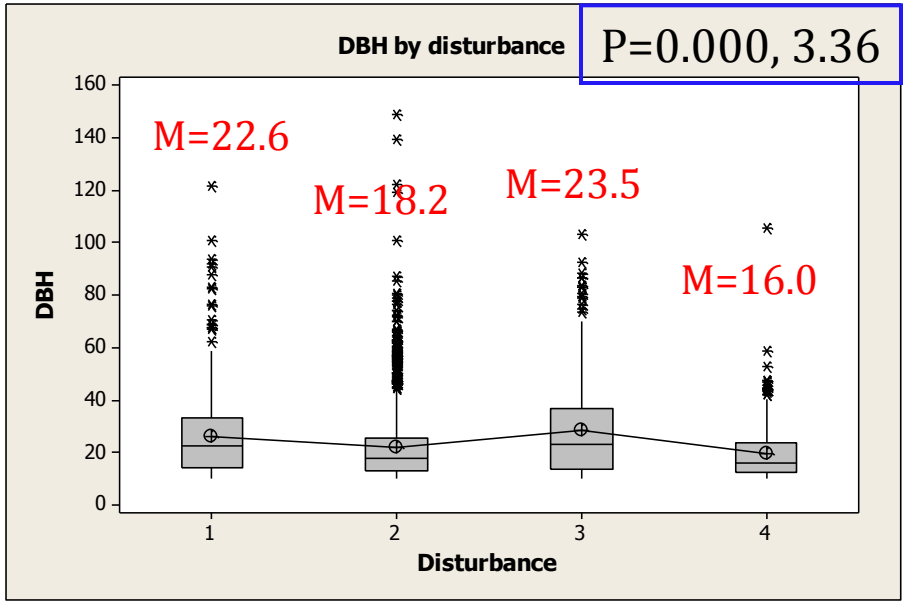


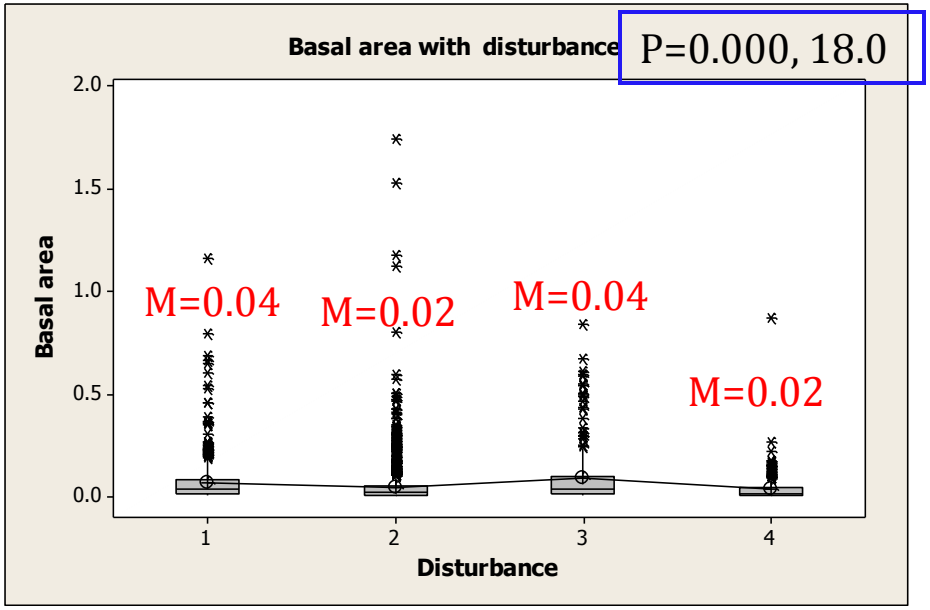


Tree growth and forest structure variation with disturbance

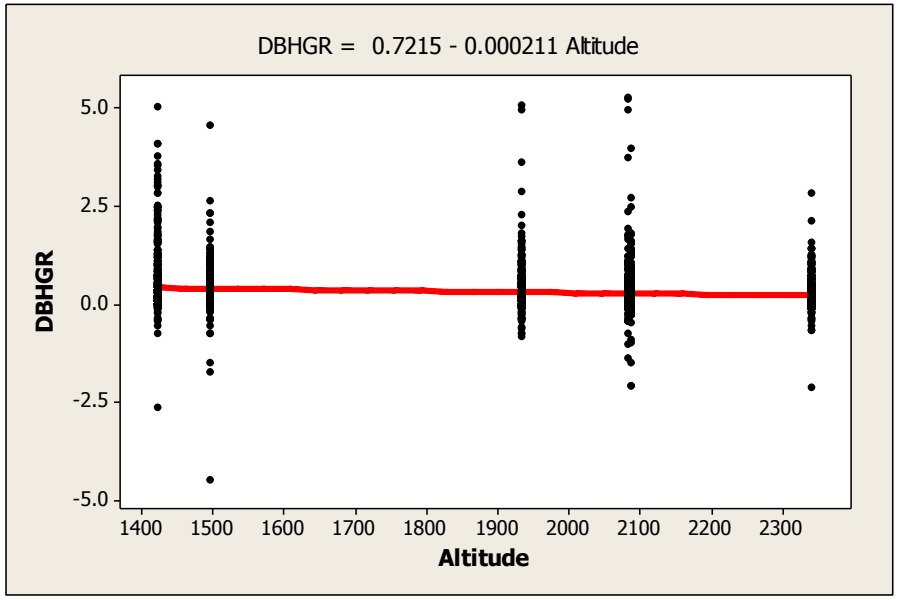


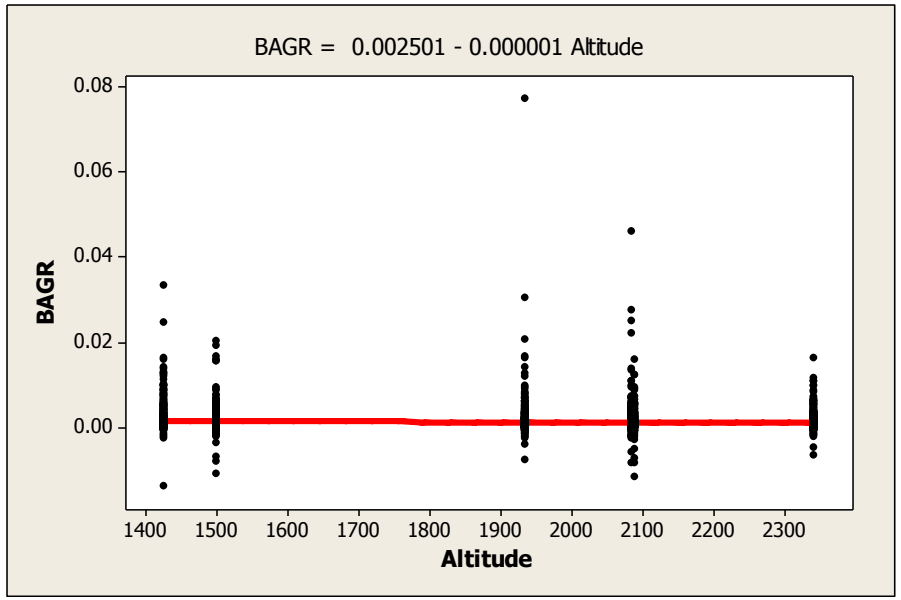


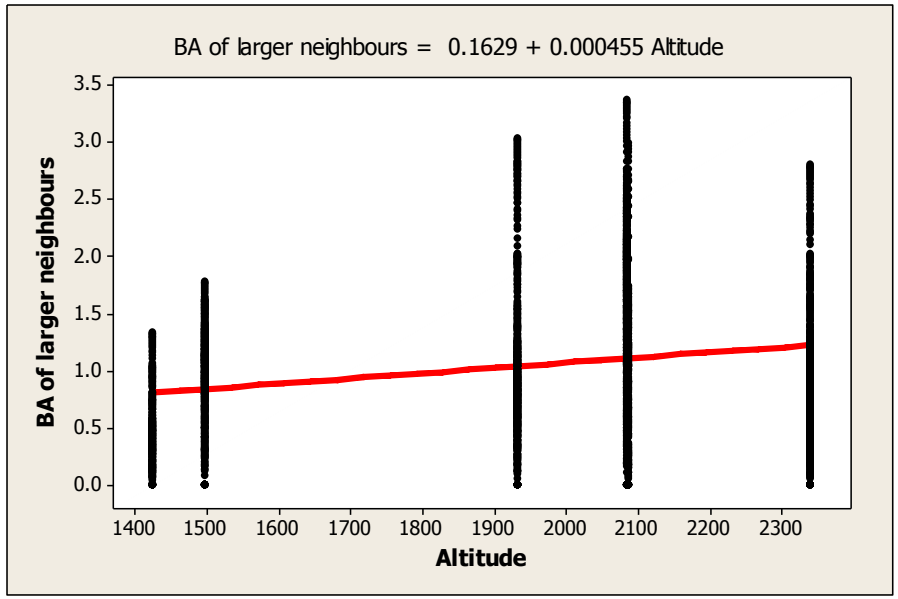


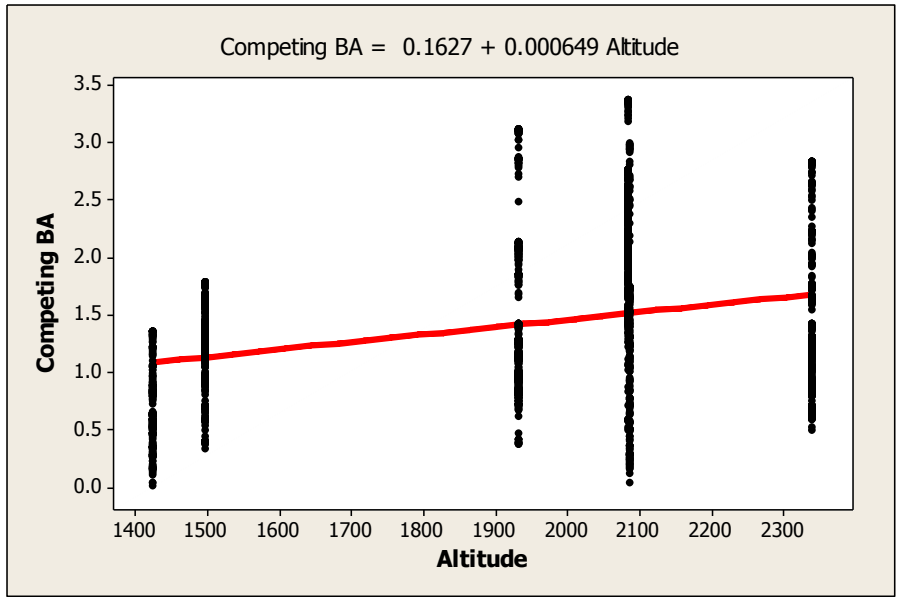


Tree growth and forest structure variation with altitude

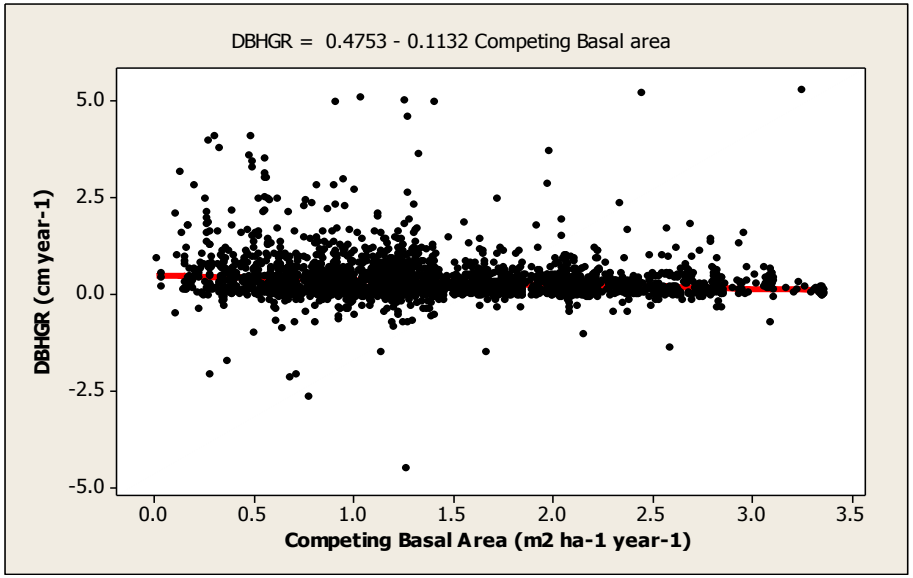


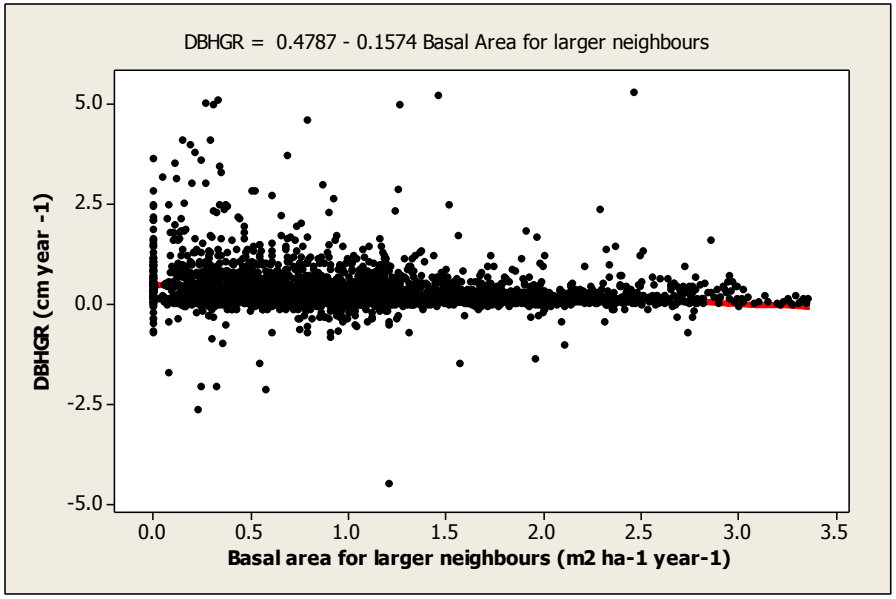


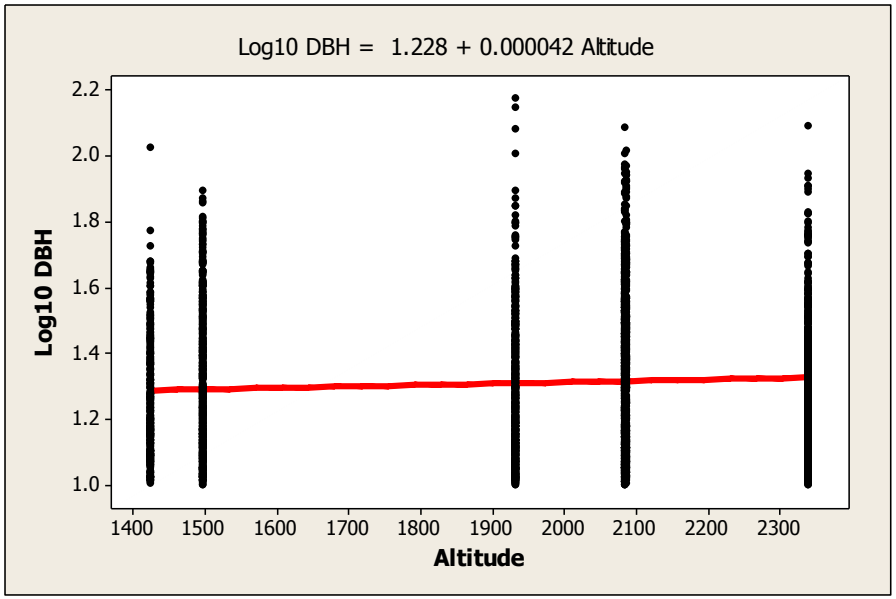


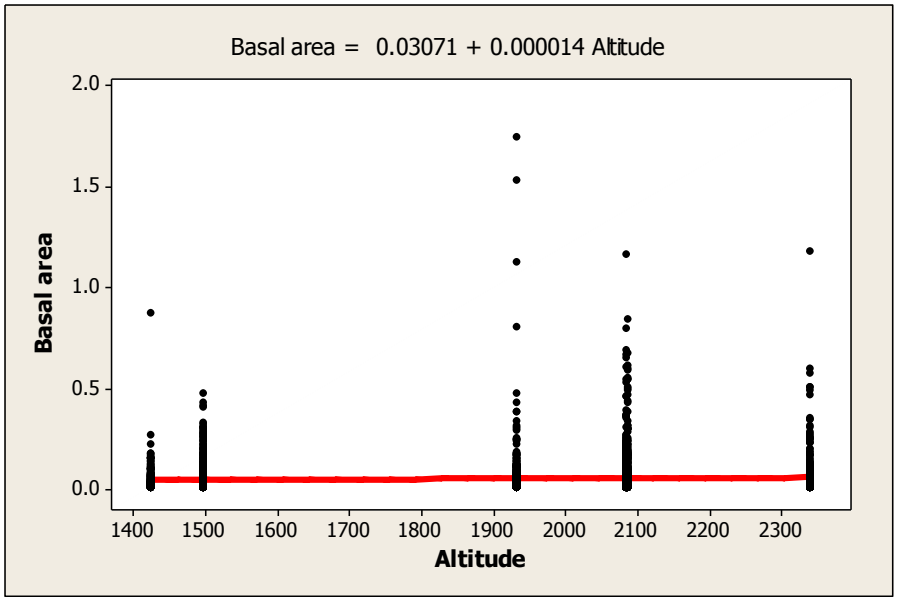


Tree growth and forest structure variation with altitude-Contd









ANOVA & Regression analysis of tree growth and explanatory variables

	Significance (P, (r^2 %))				Model selection	
Predicting variable	**DBHGR**	**REG**	**BAGR**	**REG**	**DBHGR**	**BAGR**
Species Identity	P=0.000, 18.0		P=0.000, 20.1		X	X
DBH size class	P= 0.000, 3.4		P=0.000, 37.2		X	X
Slope position	P= 0.021,0.38		P= 0.108,0.25		X	X
Crown form	P=0.000, 7.39		P= 0.000, 5.53		X	X
Crown position	P=0.000, 5.55		P= 0.000, 8.37		X	X
Log10 (DBH)	P= 0.000, 0.6	+0.19	P= 0.000, 12.0	+0.00	X	X
BA_l	P= 0.000, 4.2	-0.15	P= 0.000, 5.3	-0.00	X	X
BA_c	P= 0.000, 2.1	-0.11	P= 0.000,0.5	-0.00	X	X
Undergrowth	P=0.000, 1.89		P= 0.000, 0.92		X	X
Climber infestation	P= 0.018,0.45		P= 0.342, 0.18			
Basal area	P= 0.000, 1.0	0.56	P= 0.000, 21.8	+0.01	X	X
Past disturbance	P= 0.000,5.21		P= 0.000,1.17		X	X
Altitude	P= 0.000,5.50		P= 0.000,1.18		X	X

ANOVA & Regression analysis of forest structure and explanatory variables

	Significance (P, r^2 (%))				Model selection	
Predicting variable	**DBH**	**REGR**	**BA**	**REGR**	**DBH**	**BA**
BAGR	P=0.000, 16.5	+ 29.15	P=0.000, 26.4	+ 16.78	X	X
DBHGR	P=0.000, 3.3	+ 0.07246	P= 0.001, 2.1	+ 0.02663	X	X
Species identity	P=0.000, 29.88		P=0.000, 24.1			
DBH size class	P=0.000, 93.35		P=0.000,93.7		X	
Slope position	P= 0.038, 0.33		P=0.189,0.20		X	X
Crown form	P=0.000, 5.95		P=0.000,3.38		X	
Crown position	P=0.000, 28.72		P=0.000,18.2		X	X
Log10 (DBH)	NA		P=0.000,57.3	+ 0.3450	X	X
BA_l	P= 0.000, 13.2	- 0.1109	P= 0.000, 9.0	- 0.04182	X	X
BA_c	P= 0.000,0.4	+ 0.01963	P= 0.144,0.1	+0.00373	X	X
Undergrowth	P=0.000, 1.1		P= 0.000, 0.7			X
Climber infestation	P= 0.000,1.32		P= 0.006,0.52		X	X
Basal area	P= 0.000, 57.3	+ 1.661	NA	NA	X	
Past disturbance	P= 0.000,5.21		P= 0.000,2.23		X	X
Altitude	P= 0.000,3.36		P= 0.000,2.25		X	X

Conclusions and Recommendation

- There is a significant variation of tree growth and forest structure in Bwindi.

- All explanatory variables (with exception of slope position, undergrowth & climber infestation) had significant influence on DBHGR, BAGR, DBH & BA

- Understanding the differences in tree growth and structure are important for determining the current and future patterns of forest productivity in Bwindi.

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