THE EFFECTS OF DISTURBANCES (FIRE, GRAZING) ON TREE DENSITY IN A LIVESTOCK RANGELAND IN A SAVANNA ECOSYSTEM

Farai Madzimure*

Abstract

The study tested whether disturbances such as fire and grazing affect tree density in a livestock rangeland at Makoholi Research Station, Zimbabwe. To achieve this, the data on tree species was collected in three different experimental plots at Makoholi Research Station. The position of each tree was determined using a Global Positioning System (GPS) Garmin Etrex 10. The results were exported to SPSS where they were tested for significant differences in tree density between the different plots. Results indicated that disturbances (fire, grazing) significantly ($p<0.05$) affect the density of trees in a livestock rangeland within a savanna ecosystem. The results imply that the absence of fire and grazing encourages the growth of trees. However, future studies should embark in similar studies within communal areas since the present study was carried out at a commercial rangeland. The future studies should also include other factors besides grazing and fire which were considered to be constant in this study.

Key words: rangeland, bush encroachment, fire and grazing

* **Lecturer: Zimbabwe Open University**

Introduction

The effects of disturbances such as fire and grazing on the savanna ecosystems are topical issues in ecology. Fire suppression and cattle grazing has been observed to be the major divers of the increase in the density of trees in rangelands within the savanna ecosystem (Huntley 1982, Hudak 2010). However, results from such studies cannot be generalised to Zimbabwe since the studies were conducted in areas which are different from Zimbabwe in terms of latitude, soils and climatic conditions. Rangeland ecology also remains a largely unexplored field of study in Zimbabwe. This implies that the effects of disturbances such as fire and grazing in the livestock rangelands in Zimbabwe are not well understood. There is also very little knowledge about the implications of tree density to livestock rangers. For livestock rangeland managers in Zimbabwe, the following critical questions remain unanswered: Should fire be used in livestock rangelands? Such information is critical as Zimbabwe`s rural livelihoods depends on livestock.

Study area

The study was conducted at Makoholi Research Station which is located in Masvingo Province. The area is located 32km from Masvingo town at latitude 19^0 48`S and longitude $30^0$ 45`E. Makoholi Research Station is a government institution which specialises in researching and disseminating information about how livestock can be produced intensively. The topography of the area is about 1200m above sea level. The local geology constitutes sand soils and arenosols which are shallow and poor in terms of nutrient content. Mean long term rainfall is about 500mm. The terrain is an undulating plain which is dotted by a few isolated residual hills of the granitic rock type. The main vegetation type in the area is the miombo woodlands mixed with patches of grassland (Hove 2011).

Materials

Tangible materials

The following equipment was used for tree data collection: compass, meter tape, data sheets, and Global Positioning System (GPS) Garmin Etrex 10.

Intangible materials

The following softwares were used: ILWIS, Arc View, SPSS, Ms Excel and Arc GIS.

Methods

Tree species data collection

The tree data was collected in long term experimental plots at Makoholi Research Station. The two plots are exposed to different levels of fire and grazing. The other plot was not disturbed through fire and grazing. For this study the fire and grazing are the only factors which were considered. All the other factors which may affect tree density besides fire and grazing were considered to be constant. The data was collected separately for all the three plots. A reference tree was selected within the experimental plots. The coordinates of the reference were recorded using a Global Positioning System (GPS) ETREX 10. The distance and bearing of other trees surrounding the reference tree was measured. The bearing was measured using a compass. The distance was measured using tape measures. The diameter at breast height and the height of each of these trees was also measured. All these measurements were recorded on a data sheet.

Data analysis

The coordinates of the reference tree, the distance and bearing of each of the trees from the reference tree was entered into excel. The coordinates of each of the trees were then calculated using mathematical formulae. The data was exported in SPSS to test whether there is a significance difference in tree density between the disturbed and undisturbed plots.

Results

Results of this study indicates that disturbance significantly ($p<0.05$) affect the density of tree species within the savanna ecosystem. Tree density varies significantly ($p<0.05$) depending on the extent of the disturbance. Figure 1 depicts that tree density is high (919 stems) in an undisturbed plot (plot B). Where disturbance is moderate (figure 1), tree density is moderate (63 stems). There are very few trees (6) in a plot where disturbance is high (figure 1).

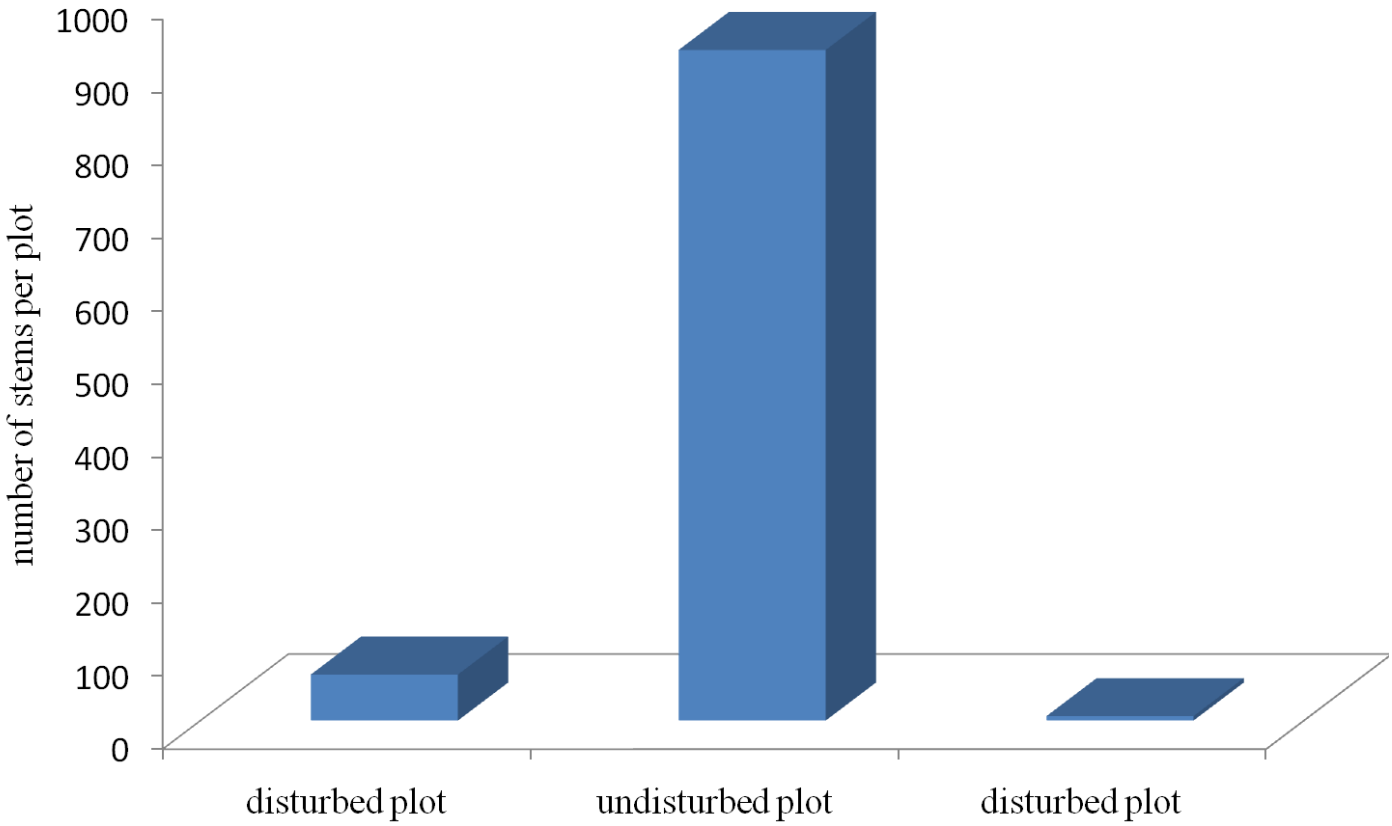

Figure 1: Number of trees in different plots

The maps in figure 2, 3 and 4 illustrate the spatial distribution of tree stems within the three plots with varying degrees of disturbances. It can be observed from figure 3 that there are more tree stems which are densely populated in a plot that has not been disturbed through fire and grazing. Figure 2 depicts fewer trees in a moderately disturbed plot. As depicted by the map in figure 4, tree stems are very few in a plot that has been exposed to more disturbances.

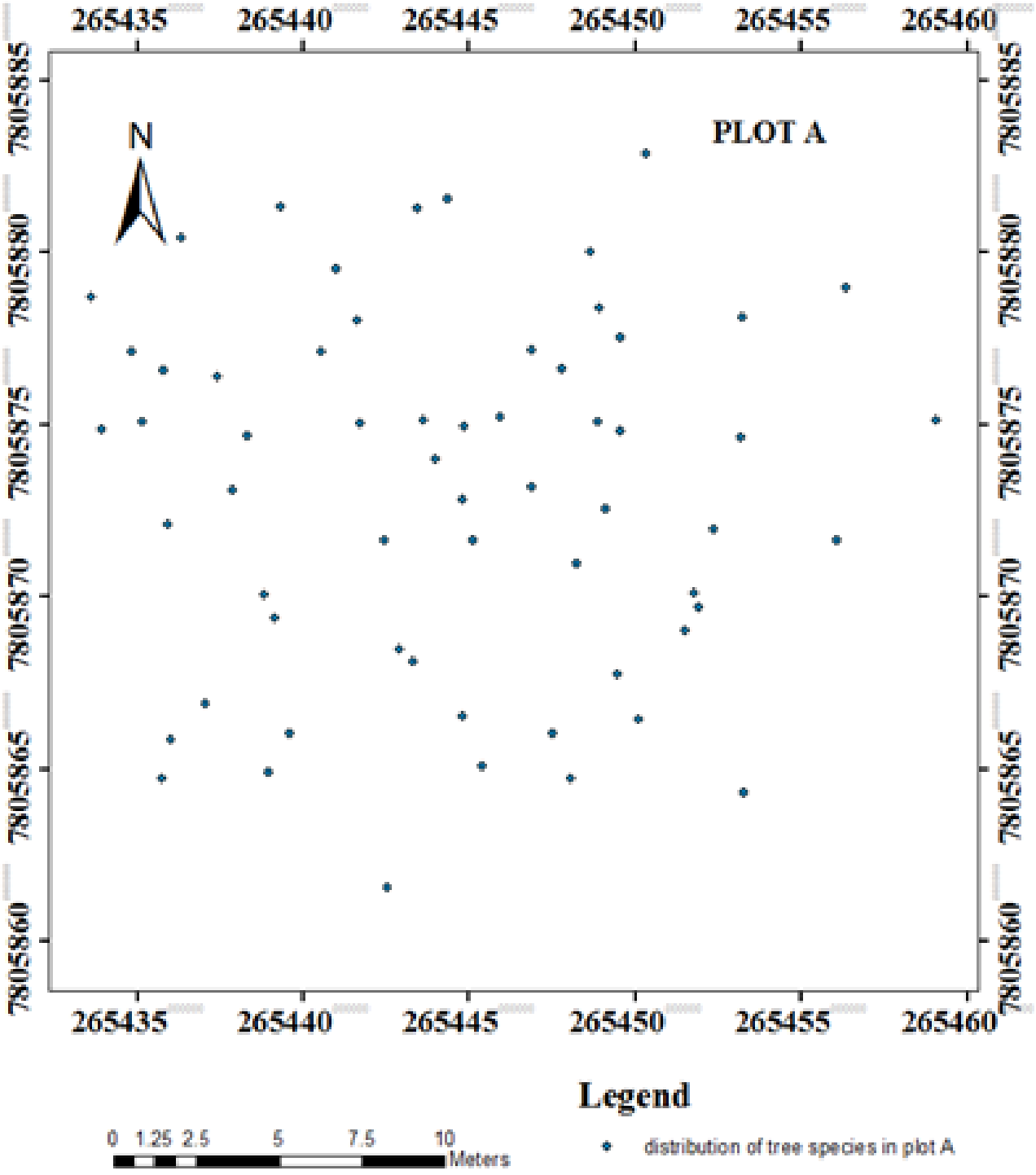

Figure 2: Density of trees in plot in a disturbed plot

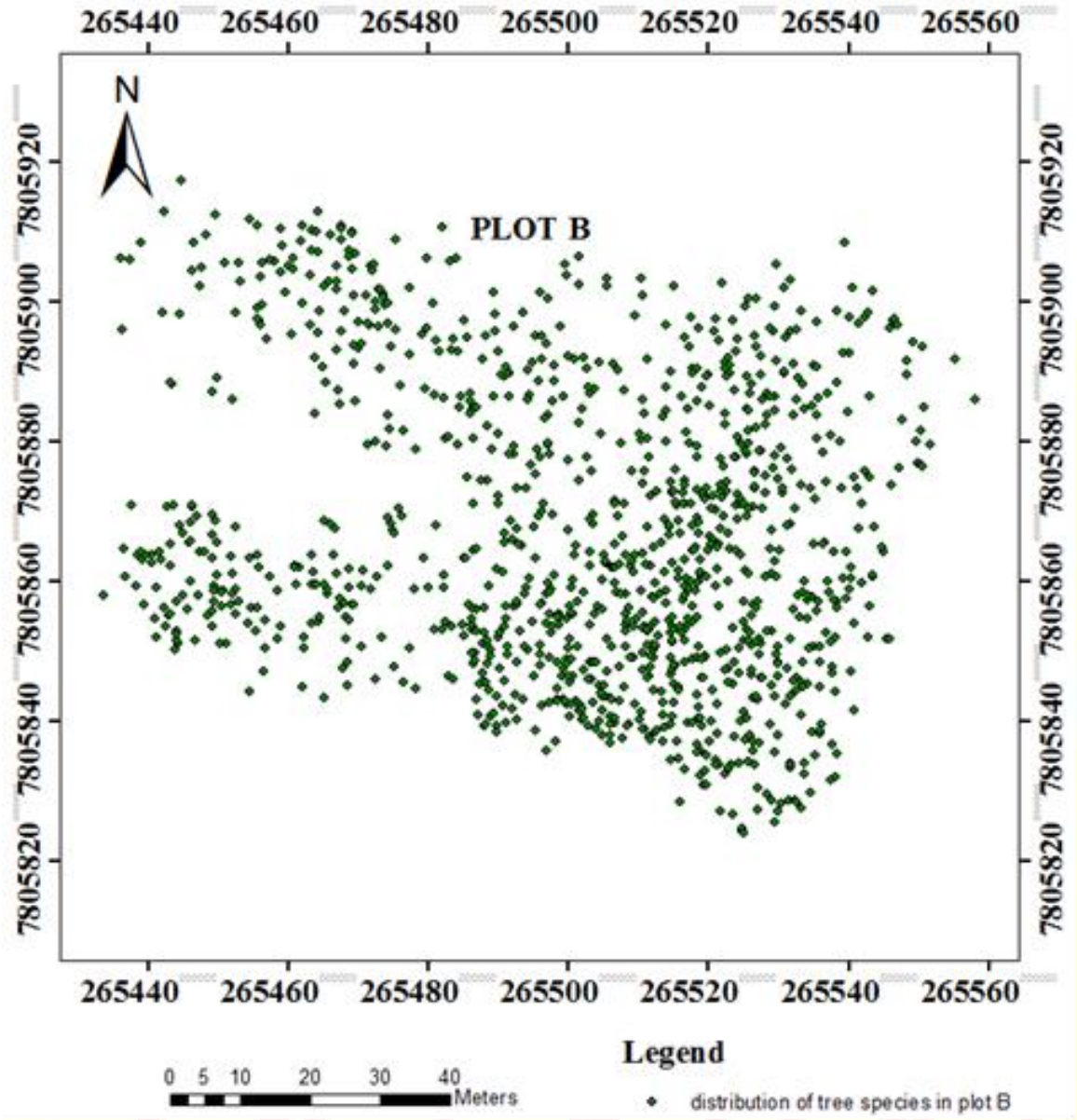

Figure 3: Density of trees in an undisturbed plot

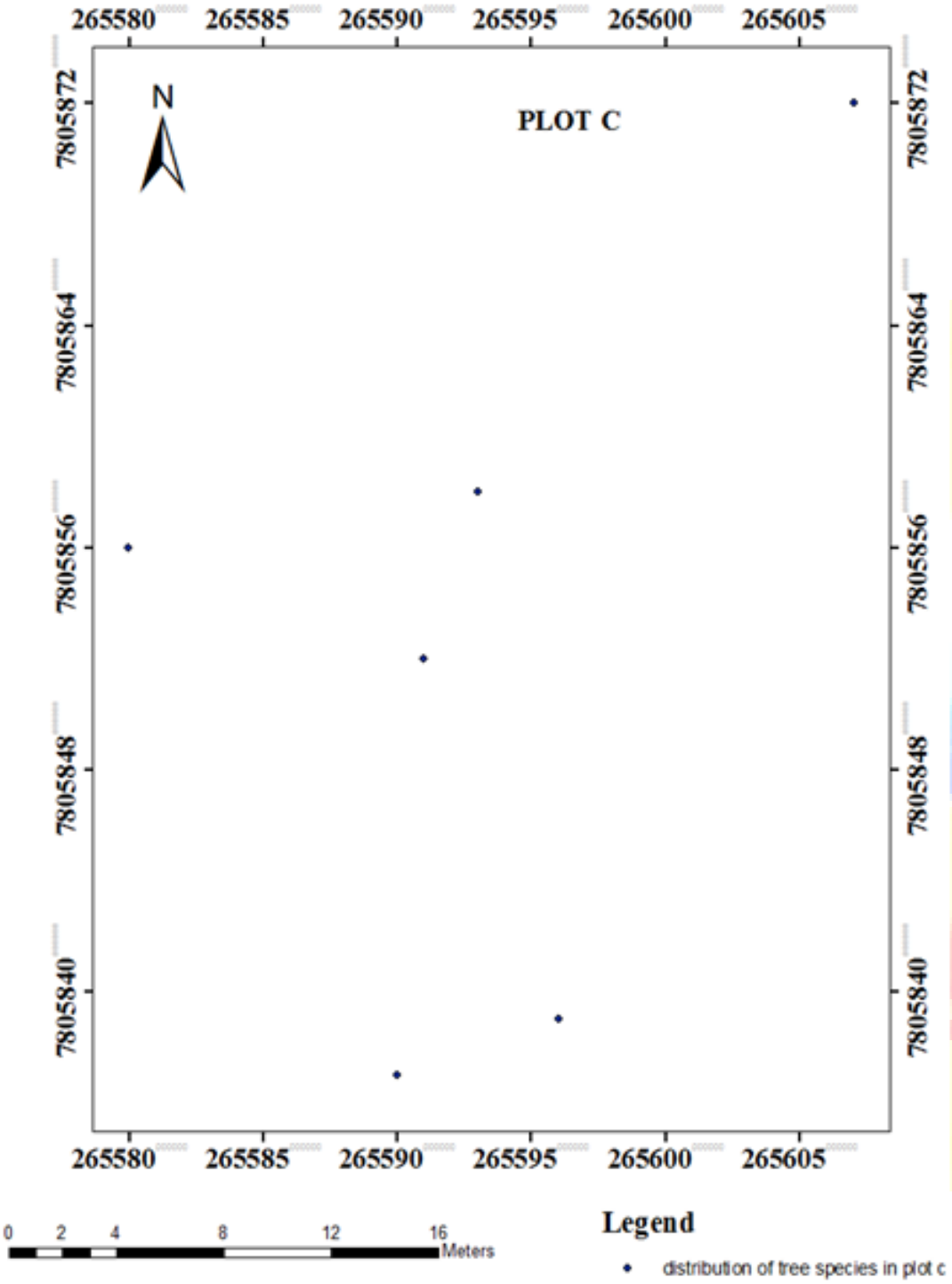

Figure 4: Density of trees in a disturbed plot

Discussion

Results of this study indicated that tree density among the plots tend to vary significantly ($p<0.05$) depending on the extent of the disturbance. In an undisturbed plot, there were more trees. This is not a new observation as the current results are consistent with previous studies which indicated that the interaction of disturbances such as fire and grazing greatly influences tree density in the savanna ecosystem (Higgins 2000). A decrease in fire intensity makes it possible for the survival of tree seeds. The recruitment of young trees is therefore enhanced, resulting in bush encroachment (Van Langevelde 2003). This implies that without disturbances such as fire and grazing, tree cover can increase (Masocha 2011).

In disturbed plots, tree density was low. These findings are consistent with (Angassa 2012) who noted that disturbance reduces the threat of bush encroachment by altering the niche which facilitates the survival of tree seeds and young trees. The results are also supported by (Beckage 2006) who observed that disturbances limit tree growth through altering the environmental niche. The reduction in the frequency of disturbances results to a shift from grasslands to forests (Beckage 2006). (Van Langevelde 2003) also observed that high level grazing and fire is directly associated with reduced fuel load which makes fire less intense and less damaging to trees .

Though the results from this study were not different from those of previous authors, it was necessary to test the previous researchers' hypotheses by venturing into a similar study in Zimbabwe. The reason behind this is that the previous studies were carried out in areas which have different edaphic and climatic factors from Zimbabwe. For environmental law enforcers like Environmental Management Agency (EMA) and other relevant environmental policy makers, laws and regulations on sustainable ways of maintaining livestock rangelands in both communal and commercial areas in Zimbabwe should be formulated.

Conclusion

The main objective of this study was to test whether disturbance significantly affect on tree density within a savanna livestock rangeland in Zimbabwe. It can be concluded that disturbances such as fire and grazing significantly ($p<0.05$) affect tree density in a rangeland within a savanna

ecosystem. The results imply that if livestock rangelands are disturbed through fire and grazing, tree density will decrease. However, future studies should embark in similar studies within communal areas since the present study was carried out at a commercial rangeland. The future studies an also include other factors besides grazing and fire which were considered to be constant in this study.

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