An investigation of natural regeneration trend of *Brachylaena huillensis* in Bombo West Forest Reserve, Tanzania

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Abstract

Silver Oak (*Brachylaena huillensis*) is a threatened and an important versatile tree species in the family Asteraceae. *B. huillensis* regenerates through seeds however; it produces seeds with poor germination and so far seed bank is lacking; consequently, its natural size in natural habitat is questionable. The current study was conducted to investigate the natural regeneration trend of *Brachylaena huillensis* in Bombo West Forest Reserve, Tanga, Tanzania. Through biophysical survey, the number of regenerants (seedling, saplings and resprouters) and trees per hectare (based on diameter classes) were assessed in the BWFR. The current study revealed that there was declining trend of *B. huillensis* seedlings and saplings per hectare in BWFR. Also, there was a decreasing trend of trees of small, middle and upper diameter categories in the study area. Meanwhile, *B. huillensis* trees of diameter at breast height (centimeter) over 45.1 were not observed in the study area. So, collectively there was an apparent diminishing of natural regeneration trend of *B. huillensis* trees in the BWFR. The information is a basis to conservationists toward preservation and sustainable use of the tree species. However, concurrently need for development of possible and efficient alternative method of regeneration is indispensable.

Key words: Asteraceae, seedlings, saplings, resprouters, poor germination

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Introduction

Silver oak is the common name for *Brachylaena huillensis* tree species also known as Muhuhu/ Mkarambati in Kiswahili in the Family Asteraceae (Choge, 2002; WCMC, 1998). It is a threatened economically important timber species in Tanzania (IUCN, 1998; Ruffo and Maliondo, 1990) and a potential flagship species to justify conservation of its habitat. (Mrema, 2006). *B. huillensis* is a dark grey and smooth tree and grows up to 15 to 35m tall with a maximum diameter of at least 85 cm under favourable conditions (Kigomo *et al*., 1994). The species is dominant in ever-green bush, dry coastal forests and semi deciduous dry upland forests at 1500 m-2000 m above the sea level (FAO, 1986; Mrema, 2006). It is native to Central, East and Southern Africa (Kigomo *et al*., 1994). In Tanzania *B.huillensis* is found both in coastal and highland forests to about 2000 m above sea level (Mbuya *et al*., 1994; WCMC, 1991).

Silver oak is a dioecious plant and its natural regeneration can successfully occur only if a sufficient amount of growing space is available for seed germination and subsequent growth of seedlings (Panna and Sundriyal, 2008). Adults and seedlings of *B. huillensis* are patchily distributed or over dispersed (Marshall and Jenkins, 1994). This is because of reproduction, dispersal, regeneration and survival of *B. huillensis* (Kigomo *et al*., 1991).

B. huillensis is used for timber and carving artefacts, charcoal, essential oil, sleepers, flooring blocks, furniture, and turnery (Mbuya *et al.*, 1994; Bryce and Chihongo, 1999; Cunningham, 1998; Marshall and Jenkins, 1994). Also, the species is used as fence posts, building poles and transmission poles. Moreover, the tree species is used for ornamental not only that but also medicine for schistosomiasis and leaves for diabetes (Cunningham, 1998).

Even so, the Silver oak is illicitly exploited for timber, charcoal, transmission poles, carving, building poles, fencing posts, ornamental, medicine, perfumery and toilet preparations, sleepers, flooring blocks, furniture, and turnery (Marshall and Jenkins, 1994; Chonge, 2002; Bryce and Chihongo, 1999).

Seed germination of *B. huillensis* under natural environment is usually poor. It is only about 2-10 % and viability is lost after six months at room temperature. The *B. huillensis* seeds are difficult to collect because of the small size and many are eaten by insects (Mbuya *et al*., 1994). Also, the tree is dioecious that require balanced sex ratio between male and female plants.

On top of that, presently according to Tanzania Tree Seed Agency (TTSA) management, there is no tree seed centre/company in the country (Tanzania) that has been able to collect *B. huillensis* seeds. However, apart from the potential uses of *B. huillensis*, so far there is no base line information on natural regeneration trend of the tree species. Additionally, there is no alternative method of propagation (Kigomo *et al.,* 1994). Though it is basically apparent that *B. huillensis* is indispensable not only to the communities' livelihoods but also to the economic and ecological development.

In spite of the above situation, there is no report in place on the natural regeneration trend of *B. huillensis*. Thus, the current study was conducted to investigate natural regeneration trend of *B. huillensis* in BWFR.

Materials and methods

Study Area Description

Location and Status of the Forest reserve

Bombo West forest reserve (BWFR) is located in Korogwe district, Tanga, Tanzania. The reserve lies between latitude 4 ^{o} 52' and longitude 4 ^{o} 47' S and 38 ^{o} 39' and 38 ^{o} 43' E. It is 60 km away from Korogwe town. (Lovett and Pocs, 1993). BWFR is surrounded by five villages namely; Bombo-Majimoto and Magunga-Mziya in Kizara ward Kijungumoto, Kwetonge and Mtoni-Bombo in Mashewa ward. The reserve is owned by the central government; it was gazetted in 1959, and has an area of 3,523.5 hectares (Figure 1.) (Lovett and Pocs, 1993).

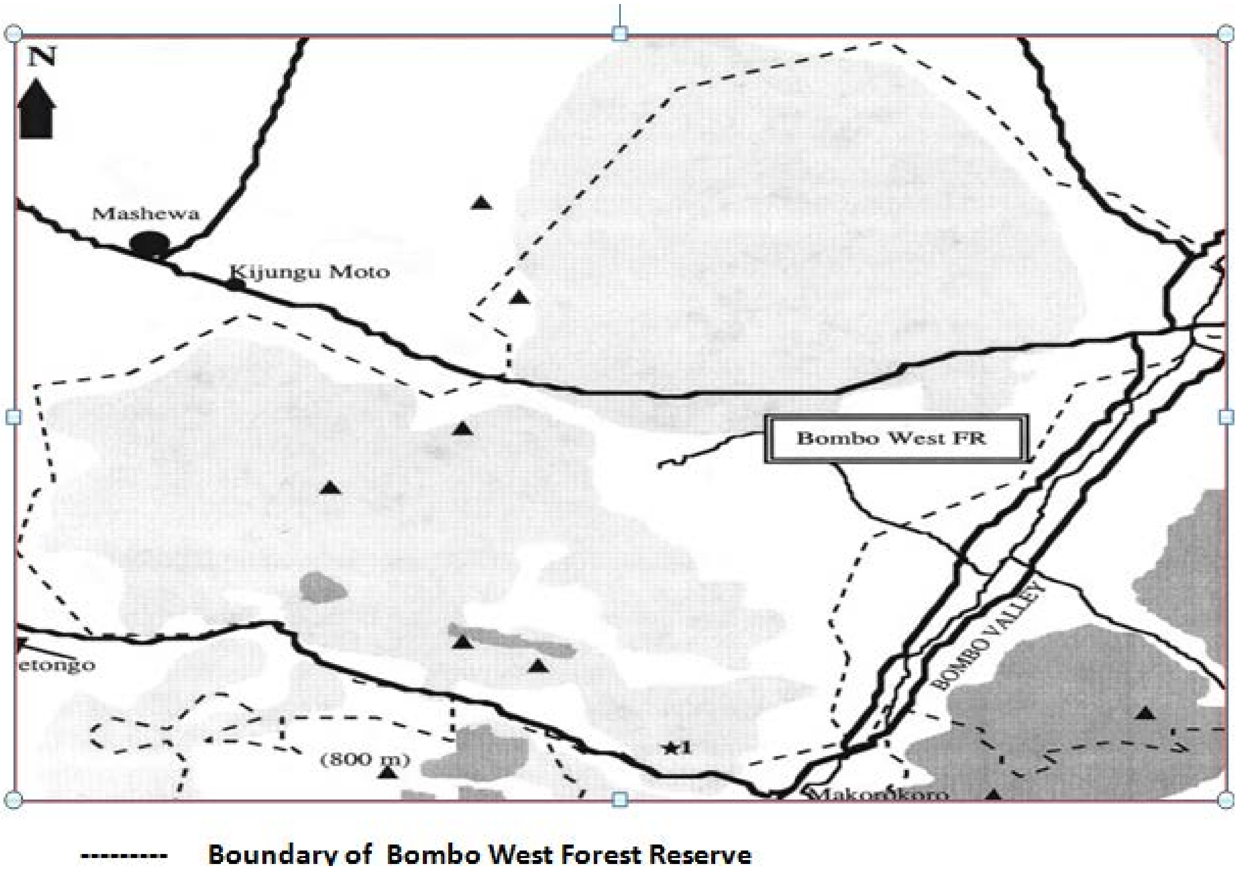

Figure 1: Map of Bombo West Forest Reserve.

Climate and vegetation

Generally, the area is influenced by oceanic rainfall and temperatures. Based on the nearest rainfall station in located Magoma Sisal Estate, it has an average annual rainfall of 750 mm with two peaks namely February to May (long rains season) and September to November (short rains season). The reserve is located in the Lwengera valley rain shadow on the west of the East Usambara Mountains with the mean annual temperature ranging from 21^{0}C in July to 26^{0}C in February (Lovett and Pocs, 1993).

The vegetation in Bombo -West forest reserve is grassy, pyric climax, open woodland with extensive areas of *B. huillensis* species. The woodlands are composed of tall trees and tree clumps of *Acacia spp.*, *Grewia spp.* and *Sterculia africana*. The thickets are composed of dense scrub dominated by *B. huillensis* with *Adenium obesum, Croton* spp, *Cymomera* spp, *Euphorbia* spp, *Strychnos* spp, *Teclea* spp and *Uvaria* spp. The reserve was created to protect *B. huillensis* stocks and has relatively low catchment values (Lovett and Pocs, 1993; Madoffe and Munishi, 2005).

Major human impacts and threats include *B. huillensis* harvesting, grazing, firewood collection and fire burning that greatly affect the grassland (Lovett and Pocs, 1993; Madoffe and Munishi, 2005). Although the big size and more accessible *B. huillensis* individual have been extracted, there may still be some big trees of good form that can serve for seed source. The *B. huillensis* thickets appear to be species rich in comparison to the wooded grassland and may contain coastal forest species of restricted distribution (Lovett and Pocs, 1993; Madoffe and Munishi, 2005).

Population

The communities adjacent to Bombo West forest reserve are composed of different ethnic groups. The main tribes are Sambaa and Zigua while the minor ones are Waha, Hehe, Ngoni, Nyamwezi, Sukuma and Bena (KDC, 2007). The communities surrounding the Bombo West forest reserve has a population of 7541 people from four villages in the two wards (URT, 2002).

Social economic activities

Semi-subsistence agriculture is the main economic activity in the communities surrounding the BWFR, which includes crop production and livestock keeping. The main food crops grown are maize, cassava, beans, banana, yams, paddy, and sweat potatoes, while sisal, cardamom, groundnuts and fruits such as mango, orange are the main cash crops (KDC, 2007). Other economic activities include petty business and casual labor in sisal and development activities.

Data collection

The study involved biophysical survey/forest inventory in the study area. However, secondary data were also collected.

Primary Data

Prior to actual survey/forest inventory, reconnaissance survey was carried out to make acquainted with the area and get prior information about the study area. Biophysical data were collected through random sampling design in the forest. In determining the random plots, previous to the actual survey for data collection Geographic Positioning System receiver (GPS) was used to locate and mark numerous points in the forest that were almost twice the number of plots required to be sampled depending on the sampling intensity of the study. Thereafter, the exactly number of plots to be sampled were picked randomly from the pool of the located/marked points (sampling frame). Plots of 15m radius (0.0706ha) were established in the selected points for biophysical data collection. Circular sample plots were adopted for data collection. The choice of circular plot was motivated by the fact that it has advantage of reducing edge effect in the sample (Krebs, 1989). The boundary length; area ratios are noted to be lowest in circular as compared to square and rectangular quadrants and therefore sampling error is thought to be less for circular shaped plots (Bonman,1989). Circular plots are not uncommon as they have been used by Nduwamungu (1997) and Issango (2004) among others. The present study employed a sampling intensity of 0.3% that yielded a total of 150 plots. Three participants were involved in this survey/inventory; researcher, field assistant and one for opening and clearing way in the forest (panga-man). As regards to data collection within the selected plots, diameter of all *B. huillensis* trees above 4cm were measured and recorded in the data forms. Measurements in the data form were categorized in to diameter classes i.e. (4.1-5, 5.1-10, 10.1-15, 16.1-20, 20.1-25, and 25.1-30, 30.1-35, 35.1 – 40, 40.1 – 45 and > 45.1). For *B. huillensis* trees with diameter of 0 to < 1 cm were counted and categorized as seedlings following Luoga *et al.* (2002). Seedlings are newly established plants that have not yet been damaged and thus have never resprouted. Saplings which are defined as individuals with diameters of 1 to < 4 cm (Luoga *et al.* 2002) and resprouters were also counted and recorded in different data collection forms. In order to maintain consistence, during data collection in the sample plots measurements were carried out starting from the north in clockwise direction (URT, 2010).

Secondary data

Secondary data in terms of main threats, species biology and ecology were collected from journals, articles, scientific papers, books, internet as well as annual reports.

Statistical analysis

The MS Excel software was used to analyze biophysical survey (inventory) quantitative data to determine number of trees, resprouters and regenerants per hectare of *B. huillensis*.

Results

The results of the present study showed that the number of *B. huillensis* seedlings in the BWFR per hectare is 11 while that of sapling is 14 per hectare (Table 1).The number of resprouters of *B. huillensis* per hectare was 3. Also, the results showed that there is a decrease of the number of young trees diameter category (4.1 - 10 cm diameter) by 44.38% from the middle age class category trees (10.1 25cm diameter) (Table 2). This implies that the lower diameter class trees (young trees) have less number of trees per category compared to the middle diameter class trees of *B. huillensis* in the study area.

Table 1: *B. huillensis* seedling, saplings and resprouters in the BWFR

Category	No. of seedling/ saplings/resprouters/ha.	Total no. of regenerants/resprouters	Plot size	Total area
Seedlings	155	697653	0.0706	3523.5
Saplings	198	546142.5	0.0706	3523.5
Resprouters	3	10570	0.0706	3523.5

Moreover, the results of the current study showed that there is a decrease on the number of *B. huillensis* trees in the upper diameter class (25.1 - 45cm diameter) from that of the middle age class by 25.19% (Table 2). On top of that, the results of the current study showed that *B.*

huillensis trees of diameter of over 45.1 cm were not observed in the study area (Table 2). Generally the results of this study entail that there are fewer younger and older trees (4.1 - 10cm and 25.1 – 45cm diameter) of *B. huillensis* in BWFR compared to those of middle diameter class (10.1 – 25) in the BWFR (Table 2).

Table 2: *B. huillensis* trees per each category (diameter class) and per hectare against their percentages in the BWFR

Diameter category/diameter class	**No. of trees/ category**	**No. of trees/ha.**	**Percentage of trees/ category**
Lower diameter class (4.1 – 10.0)	137	12.94	12.65
Middle diameter class (10.1 – 25.0)	607	57.32	56.05
Upper diameter class (25.1 – 45.0)	339	32.01	31.3
>45.1	0		
Total	**1083**		

Discussion

Regeneration status of all species in a given stand is considered to be good if numbers of seedlings are greater than saplings and saplings are greater than adult trees. Conversely, regeneration status of all species is considered to be fair if seedlings are greater than saplings and saplings are less or equal to adult trees (Sukumar *et al*., 1992).The results of this study (Table 1 & 2) revealed that there was a declining natural regeneration trend of *B. huillensis* in the study area. The results showed that the number of seedlings of *B.huillensis* per hectare was neither greater nor equal but rather lower than that of saplings. Similar to our study, Mumwi, (2009) concluded that *B. huillensis* does not show good recruitment and regeneration trend in the BWFR. Moreover, the regenerants figures in this study are somehow close to that of Mrema,

(2006) which established that *B. huillensis* had 407 regenerants per hectare in Dindii forest reserve. On the other hand, the results of the present study showed that there are few number of mature *B. huillensis* trees than that of middle age. These results agree with that of (Mumwi, 2009; Mrema, 2006) in BWFR and Dindii forest reserve respectively which found that *B. huillensis* were heavily exploited and density distribution by diameter at breast-height size classes indicated abnormal trend that did not follow a normal reversed J-shape common in natural forests which signifies poor recruitment and regeneration failure.

The presence of few mature trees of *B. huillensis* has detrimental effect as regards to its natural regeneration. In a study by Ganzhorn, (1995), it was observed that all types of regeneration depended on the presence of the mother trees at that particular time. In addition, (Veltheim *et al*., 2002) concluded that in Mfundia village forest reserve, the most common size of cut trees of *B.huillensis* was 5-15 cm diameter at breast height which is used for local construction and this may lead to depletion of mother seed trees important for future regeneration of the species. Furthermore, Mumwi, (2009) and Mrema, (2006) observed preferential harvesting of *B. huillensis* tree for different uses specifically females trees as compared with others woody plants in Bombo West and Dindii forest reserves. This practice was concluded to presents a serious ecological threat to its future successful reproduction due to the fact that *B. huillensis* is dioecious. Thus, balance between male and female tree is of great importance in the regeneration of the tree species.

The results of the current study showed that the number of resprouters of *B. huillensis* in the BWFR is comparatively very low (3 resprouters per hectare). This result is in congruence with that of Mrema, (2006) in Dindii forest reserve who revealed that the number of coppices (resprouters) of *B. huillensis* was very poor. Also, Business Oriented Conservation and Agroforestry (BOCAF) mangers within the limited scope of their activities in conservation near the study area, based on casual observation and experience learnt that almost all stumps of *B. huillensis* have dried out. However, once in a while, they come across off-shoots of the tree, so probably the tree is capable of coppicing under certain conditions (Fig.1).

Figure. 2: *B. huillensis* coppice/resprouter on the Mwakijembe plain.
Source: Maggogo and Ndakidemi (2005)

Conclusion

Conclusively, in general, there was a decrease of *B. huillensis* seedlings, saplings and trees in small, middle and upper diameter categories trees per hectare in BWFR. Meanwhile, *B. huillensis* trees of diameter over 45.1 centimeters at breast height were not observed. So, collectively there is an apparent diminishing of natural regeneration trend of *B. huillensis* trees in the BWFR. Basically, the established diminishing natural regeneration trend is a base line to conservationists toward preservation and sustainable utilization of the tree species. However, currently need for development of possible and efficient alternative method of regeneration is indispensable. In this view we suggests; 1) Intentional human intervention through further research in *in situ*, *ex situ* and *in vitro* methods of propagation of *B. huillensis* 2) Further research regarding *B. huillensis* regeneration status elsewhere in Tanzania 3) Natural regeneration of *B. huillensis* species should be enhanced through effective tailor- made management plans with special focus on fire control and illegal harvesting of mature trees for all forests harboring this tree species in Tanzania

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