CHAPTER 5

POPULATION BIOLOGY OF *ELAEODENDRON TRANSVAALENSE* JACQ. IN THE PRESENCE OF HARVESTING

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Abstract

Elaeodendron transvaalense is one of the medicinal plant species used very often by people in the Venda region. It is known to treat a variety of diseases. Due to its wide usage and importance to traditional healers it had found its way into the muthi markets and it is amongst seven most commonly traded plant species in the Venda region. The study investigated the impact of bark harvesting on the population structure of this species.

The study revealed that although the level of bark harvesting is high, the species appeared to be able to cope with the pressure since it is a fine-grained species. The population also showed the ability to regenerate as it exhibited an inverse J-shaped curve. The crown health status was generally good although some individuals, contributing 9% of the sample, had dead crowns, which are a cause for concern. A linear relationship was noticed between areas harvested and stem circumference, which is understandable considering the large surface area of harvestable bark on bigger individuals. Elasticity analysis revealed that the vegetative stage should be targeted for management action.

Keywords: Bark harvesting, matrix modeling, medicinal plants, muthi markets, population growth rate.

5.1 Introduction

In 1988 the Chiang Mai Declaration had noted that, since medicinal plants form the basis of medicines used by the majority of the population of most developing countries, the loss of certain medicinal plant species and reduced supply of other important plant species would have a direct impact on human health and wellbeing (Bodeker 1995).

Elaeodendron transvaalense is one of the medicinal plant species used very often by people around Venda. It is amongst seven medicinal plant species that are most commonly traded in muthi markets around Venda (Tshisikhawe 2002). In some parts of the country *Elaeodendron transvaalense* is at the same time, one of the medicinal plant species that is facing a serious threat of extirpation through over-harvesting of bark from stems.

Elaeodendron transvaalense is used for a variety of diseases and hence its reference by traditional healers as "mukuvhazwivhi" which literally translated means "sin-washer". The following are some of its medicinal uses (Mabogo 1990, van Wyk *et al.* 1997, Tshisikhawe 2002, Steenkamp 2003, Samie *et al.*2005, Bessong *et al*. 2005):

i. Cleaning of stomach from any disorder;
ii. Treatment of ulcers;
iii. Treatment of venereal diseases;
iv. Treatment of fungal infections;
v. Treatment of piles and haemorrhoids in humans and domestic animals;
vi. Treatment of dysmenorrhoea.

According to Mabogo (1990), van Wyk and Gericke (2000) and Tshikalange *et al.* (2008) the root or stem bark decoction or infusion is taken orally in cupfuls three to four times a day. The medicinal material is also prepared into a powder and taken as a tea or mixed with soft porridge.

Bessong *et al.* (2006) and Tshikalange *et al.* (2008) noted that *Elaeodendron transvaalense* showed 48.6 percent RNA-dependent-DNA polymerization (RDDP) activity inhibition of HIV-1 RT in the n-butanol fraction. The activity seems to be credited to the fact that many plant species said to be rich in sterols and sterolines have immuno-modulatory effects and boost the vitality of AIDS patients. The species also showed in vitro anti-HIV properties through the inhibition of both NF-kB and Tat proteins. According to Drewes *et al.* (1991) a new peltogynoid, (+)-11, 11-dimethyl-1,3,8,10-tetrahydroxy-9-methoxypeltogynan was obtained from the roots of *Elaeodendron transvaalense* along with other three pentacyclictriterpenes. A phenolic compound known as elaeocyanidin has also been isolated from the species (van Wyk *et al.* 1997).

Intense and frequent harvesting of bark from species with a high market demand often results in ring-barking of trees and the trees subsequently die, and the species becomes rare over time. Because of the demand of *E. transvaalense* as a medicine it is important to assess the effects of harvesting on its population structure. The population structure can be assessed by an analysis of the frequency distribution of stems across diameter classes (Lykke 1998, Condit *et al.* 1998, Niklas *et al.* 2003b, Lawes *et al.* 2004). The size class distribution data can also be used to assess the potential of the population for its sustainable use (Everard *et al.* 1994, Everard *et* *al.*1995, Obiri *et al.* 2002, Lawes and Obiri 2003, Gaugris and Van Rooyen 2007, Gaugris *et al.* 2007). Investigating the various aspects of the life cycle of a plant (e.g. age/size at flowering, seed output per size class) is crucial to gain an understanding of the dynamics of the population (Solbrig 1980). This knowledge can then be used to quantify the demographic variables of a population, which can be used in more refined analyses of the population, such as matrix analysis (Caswell 2001, Crone *et al.* 2011).

The objectives of the current study were to investigate the impacts of harvesting on a population of *Elaeodendron transvaalense* in the Venda region. Firstly, the population structure was examined and the extent of the harvesting was evaluated in terms of the size classes targeted and the effects on crown health and seed production. Secondly, a matrix analysis and elasticity analysis were performed to establish which size class contributed most to the population growth rate and should be targeted in future conservation efforts. Thirdly, the data were used to evaluate the potential for sustainable harvesting of the species by means of the grain concept.

5.2 Study area

Data on population parameters were collected from an *Elaeodendron transvaalense* population in the Tshirolwe area in the Venda region, Limpopo province (Figure 5.1). The Tshirolwe study area lies 38 km north of the town of Louis Trichardt and 50 km west of the town of Thohoyandou in the Vhembe District Municipality of the Limpopo province. The study area is a communal area, which is accessible to anyone and anything without any restriction. It lies within a 1 km distance from the settlements of Tshirolwe and Tshituni.

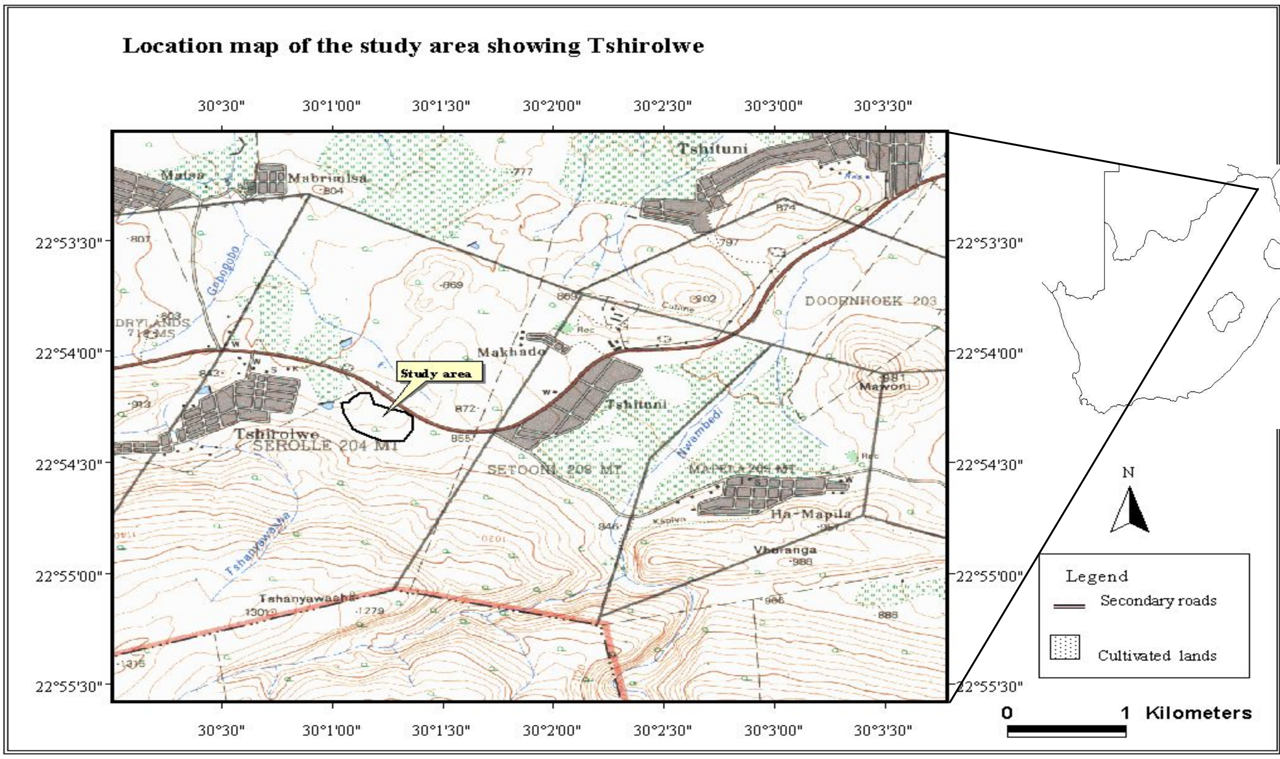

Figure 5.1: A location map showing the Tshirolwe study area where data on *Elaeodendron transvaalense* were collected in the 2004 and 2005 surveys.

According to Acocks (1988) the study area is part of the Northeastern Mountain Sourish Mixed Bushveld, whereas Mucina and Rutherford (2006) classify it as Soutpansberg Mountain Bushveld. The vegetation type is regarded as 'Vulnerable' with approximately 21% being transformed, mostly by cultivation (Mucina and Rutherford 2006). The area has a semi-arid climate with the rainfall pattern influenced by the Soutpansberg mountain range (Berger *et al.* 2003). It receives one cycle of rainfall that extends from October to March with the dry period extending from April to October. Frost is infrequent in the region.

The study area rests on the gneisses of the Limpopo belt and Bandelierkop Complex (Berger *et al.* 2003). It is situated within the Nzhelele-Formation, which is one of the seven units that constitute the Soutpansberg group of the volcano-sedimentary succession.

5.3 Materials and methods

Elaeodendron transvaalense, belonging to the family Celastraceae, is a shrub or small tree, which can sometimes reach a height of 10 to 15m. It is widespread, although not common, at low altitudes in open woodlands. It grows from KwaZulu-Natal, Swaziland, Mpumalanga and through the northern parts of South Africa into Mozambique, Zimbabwe, Botswana and Zambia. The bark, which is used medicinally, is pale grey and sometimes finely fissured and breaks up into small blocks especially in older individuals (Palgrave 1988, van Wyk 1996). Leaves are simple and usually set at twig terminals. The leaves are browsed upon by wildlife. Flowers are in a flat inflorescence and set from November to February. Fruits are borne in short clusters and are edible although not palatable. Fruit development is slow and they ripen from July to September.

Eleven transects of 100 m x 5 m were demarcated in order to sample the required data. The coordinates of each transect were recorded using a 12 channel Garmin Global Positioning System (GPS) (Garmin International, Kansas City). A rope was used to delineate the transects during data collection. No control transects were demarcated due to lack of unharvested population within the same environmental gradients. The following data were recorded on *E. transvaalense* individuals:

i. Stem circumference (in cm) – measured with a measuring tape above the basal swelling.

ii. Plant height (in m) – measured with a measuring tape and/or graduated height rod.

iii. Crown health – estimated using a 0 – 5-point scale as follows:

0 - no crown at all,

1 – severe crown damage,

2 – moderate crown damage,

3 – light crown damage,

4 – traces of crown damage,

5 – healthy crown.

iv. Bark removal area – breadth and width of harvested area measured with tape measure (in cm^2).

v. Seed count – seeds were counted from one branch of a tree and an estimate for the tree was made. The estimates were considered minimal estimates of total seed production (Schwartz *et al.* 2002).

For the size class analysis stem circumference measurements were classified into 13 size classes with 20 cm intervals. Natural logarithmic transformations of the density of the size classes (D) (Condit *et al.* 1998) of the type ln (D+1) and were used to transform the data (Niklas *et al.* 2003b) before calculating least square linear regressions. The value of 1 was added as some size class bins were not represented (Lykke 1998).

Figure 5.2: A research assistant measuring the debarked area on an *Elaeodendron transvaalense* stem in the Tshirolwe study area in the Venda region.

The mean circumference of the population, the "centroid", was calculated. A centroid skewed to the left of the midpoint of the size class distribution indicates a young and growing population, whereas one skewed to the right indicates an older, relatively undisturbed population (Niklas *et al.* 2003b).

To estimate the harvesting pressure on an individual plant, a ratio was calculated as the area harvested : the stem circumference. This ratio was used to examine the relationship between harvesting pressure and crown health.

Most of the parameters were sampled during a once-off survey. Stem circumferences of marked individuals were sampled again after one year in order to record the growth rate. The mean stem circumference growth increment of all individuals was calculated. A mean growth rate was also calculated for individuals up to a circumference of 60 cm, considered as the individuals representing the subcanopy level, and those above 60 cm in circumference, representing the canopy layer. These values could be used to estimate the ages of all the individuals sampled. However, it is acknowledged that because of phenotypic plasticity, size-class distributions cannot be readily converted into age class distributions (Silvertown and Charlesworth 2001).

The subcanopy and canopy densities were calculated as the sum of the number of individuals ≤ 60 cm circumference and larger than 60 cm circumference respectively. The use of subcanopy and canopy density, associated with frequency allows the grain of a species to be determined. The concept of species grain was developed for forests (Midgley *et al*. 1990); however, it has been successfully applied to woodlands by Gaugris *et al.* (2007) to establish which species could be harvested sustainably. The graphical model of Lawes and Obiri (2003) to determine species grain by plotting canopy density (X-axis) and subcanopy density (Y-axis) was used. The critical lower bounds for canopy and subcanopy density of 10 and 30 individuals per ha of Lawes and Obiri (2003) were retained in this study.

A stage-class matrix analysis was performed using three stages, namely: seedlings; juvenile, non-flowering plants; and mature, flowering plants. A Lefkovitz matrix was compiled with the upper row representing the fecundity, the diagonal the probability of remaining in the same stage and the sub-diagonal the probability of progressing into the next stage. The transition matrix was derived using the age of transitions of the oldest seedling and vegetative stages.

The matrix analysis was performed at the Institute of Biology of the University of Bergen in Norway using the Matlab computer package as this programme is regarded as the most appropriate package for these analyses (Caswell 2001). An elasticity analysis was subsequently performed (Caswell 2001, Norris and McCulloch 2003).

5.4 Results and discussion

5.4.1 Population structure

The size-class distribution of the *Elaeodendron transvaalense* population at Tshirolwe is illustrated in Figure 5.3. The population status resembles the typical reverse J-shaped curve. Three ideal types of size-class distribution can be recognized for tree populations (Peters 1996, Cunningham 2001). The typical reverse J-shaped curve or negative exponential curve indicates continuous recruitment of young stems, the bell-shaped curve indicates a lack of seedlings and young plants and the straight horizontal line indicates relatively low numbers of seedlings and young plants. In a closed-canopy environment the reverse J-shaped curve as displayed in Figure 5.3 is considered to indicate species which are tolerant to shade or competition while the bell-shaped curve or straight line curve will indicate shade-intolerant or competition-intolerant species. The fact that most of the adult individuals are harvested leaves the population in danger of not producing seeds due to poor health. In their study on *Pterocarpus angolensis* Desmet *et al*. (1996) found that the most important requirement for the survival of these populations was the continued presence of mature, reproductive individuals. It is also important for seedling size-class to recruit into adult size-classes without being harvested.

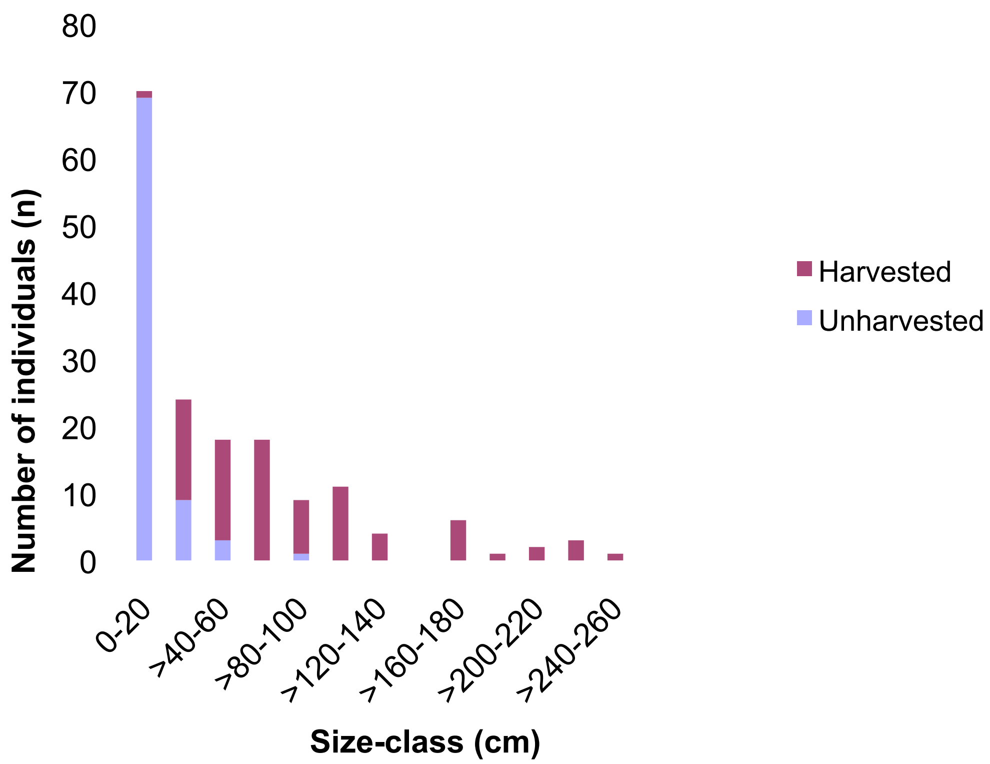

Figure 5.3: Size-class distribution of harvested and unharvested individuals in a population of *Elaeodendron transvaalense* sampled in 2004 at Tshirolwe, in the Venda region, Limpopo.

On a plant community level it has been established that the majority of species increasingly resides in the smallest size-class (Niklas *et al*. 2003a, Guedje *et al.* 2007) and that in fact species richness is a size-class dependent phenomenon. Large size-class individuals in rare species are found in small numbers thereby attributing to the rareness of the species. The fact that the *E. transvaalense* population sampled has few individuals in the large classes shows that it is not abundant and that it may become increasingly rare in the near future.

A high abundance of individuals in smaller size classes, which lead to an inverse J-shaped size class distribution, is generally regarded as an indicator of adequate regeneration and population maintenance (Peters 1996, Condit *et al.*1998, Lykke 1998, Niklas *et al.* 2003a, Ganesan and Siddappa 2004). The abundance of seedlings is therefore a manifestation of successful seed germination and establishment in the *E. transvaalense* population. The position of the centroid found to be 49.12 cm, which was left-skewed in relation to the midpoint of the circumference distribution of 130 cm stem circumference, confirmed the healthy status of the population.

It was clear that except for the smallest size class (0 – 20 cm), all the size classes had a high proportion of individuals harvested (Figure 5.3). In many size classes all individuals showed signs of harvesting.

The linear regression on the natural logarithm of the density in the size classes against the size class midpoint (Figure 5.4) produced a significant linear regression (r^2 = 0.678; y = -0.014x + 4.279; p= $5.38x10^{-4}$). The slope and Y-axis intercept of this equation can in future be used to compare other populations of *E. transvaalense* under different harvesting regimes. It can also be used to monitor and compare the same Tshirolwe population over time to detect changes in population structure (Gaugris and Van Rooyen 2011).

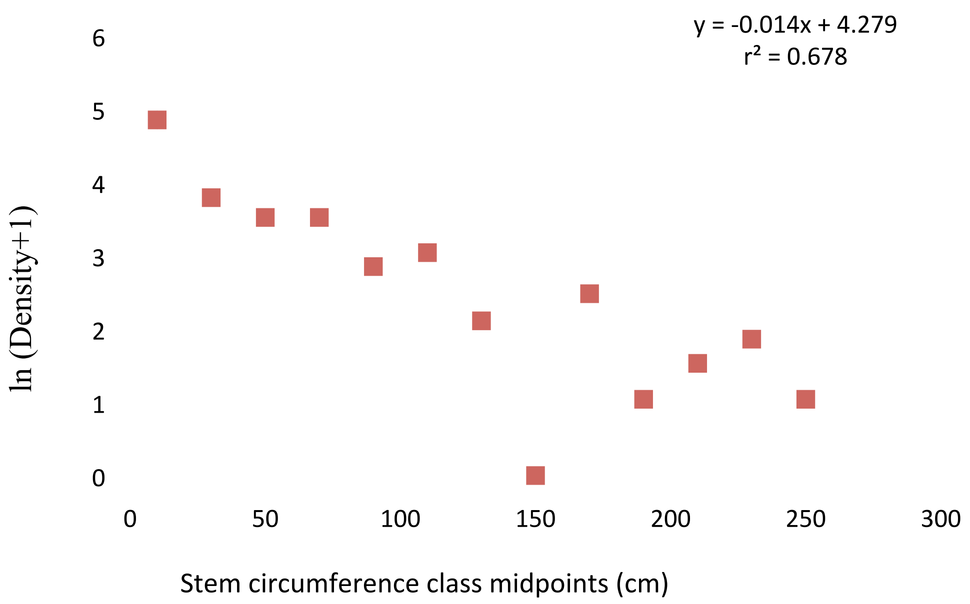

Figure 5.4: The regression of ln (D + 1) against stem circumference in a population of *Elaeodendron transvaalense* sampled in 2004 at Tshirolwe, in the Venda region, Limpopo.

Although long-term population monitoring data would be optimal to detect trends in population structure, Kohira and Ninomiya (2003) have indicated that there is merit in using the size-class distribution with single-year data. Furthermore, a range of techniques has been devised to obtain as much information as possible from single surveys. The assessment of population structure with single-year data gives an essential head start for conservation efforts with a small amount of resources.

There is a significant positive correlation between plant height and stem circumference until an optimum height is achieved as shown in Figure 5.5 (r^2 = 0.5682; y = 1.1295 ln(x) + 0.6714; p = 6.99 x 10^{-21}). Individuals of stem circumference between 10 cm and 40 cm achieved a maximum height of more than 8

m. Height of individuals is mostly affected by herbivory which was observed in the area.

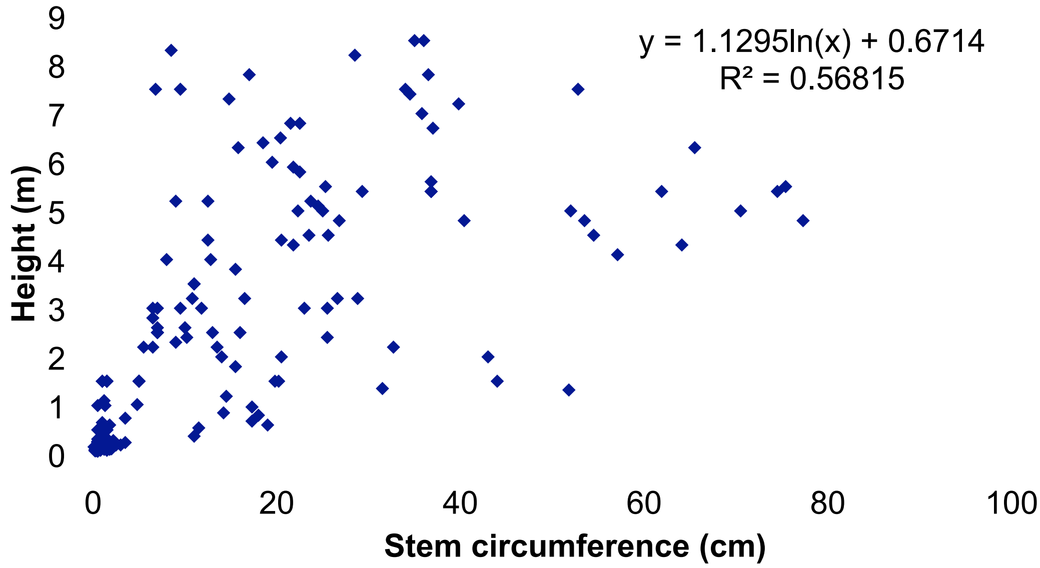

Figure 5.5: A logarithmic relationship between stem circumference and plant height in a population of *Elaeodendron transvaalense* sampled in 2004 at Tshirolwe, in the Venda region, Limpopo.

5.4.2 Harvesting

Forty eight percent of the *Elaeodendron transvaalense* individuals sampled were not harvested (Table 5.1; Figure 5.3). Most of the unharvested individuals were seedlings. The large number of unharvested seedlings indicates that the population should potentially be able to recover if harvesting intensity is reduced, although it still needs monitoring. In contrast, most of the larger size classes showed that 100% of the individuals had signs of harvesting.

Table 5.1: Extent of harvesting on *Elaeodendron transvaalense* individual trees in the Tshirolwe population sampled in 2004

Stem circumference size class (cm)	No. of harvested individuals	No. of unharvested individuals	Total number of individuals	Percentage of size class harvested	Total area harvested (m^2)	Mean area harvested per individual (m^2)
0-20	1	69	70	1.43	0.04	0.04
>20-40	15	9	24	62.5	1.12	0.07
>40-60	15	3	18	83.3	4.29	0.29
>60-80	18	0	18	100.0	12.21	0.68
>80-100	8	1	9	88.9	4.29	0.54
>100-120	11	0	11	100.0	9.89	0.90
>120-140	4	0	4	100.0	2.31	0.58
>140-160	0	0	0	0.0	0.00	0.00
>160-180	6	0	6	100.0	4.96	0.83
>180-200	1	0	1	100.0	1.99	1.99
>200-220	2	0	2	100.0	4.02	2.01
>220-240	3	0	3	100.0	4.94	1.68
>240-260	1	0	1	100.0	1.31	1.31

Some individuals showed severe bark removal with some of the individuals ending up dead due to harvesting pressure. Harvesting area increased with an increase in stem circumference (Table 5.1, Figure 5.6, $r^2 = 0.6219$ and $y = 0.1437x - 0.1662$). This is understandable because large trees have more available bark to harvest.

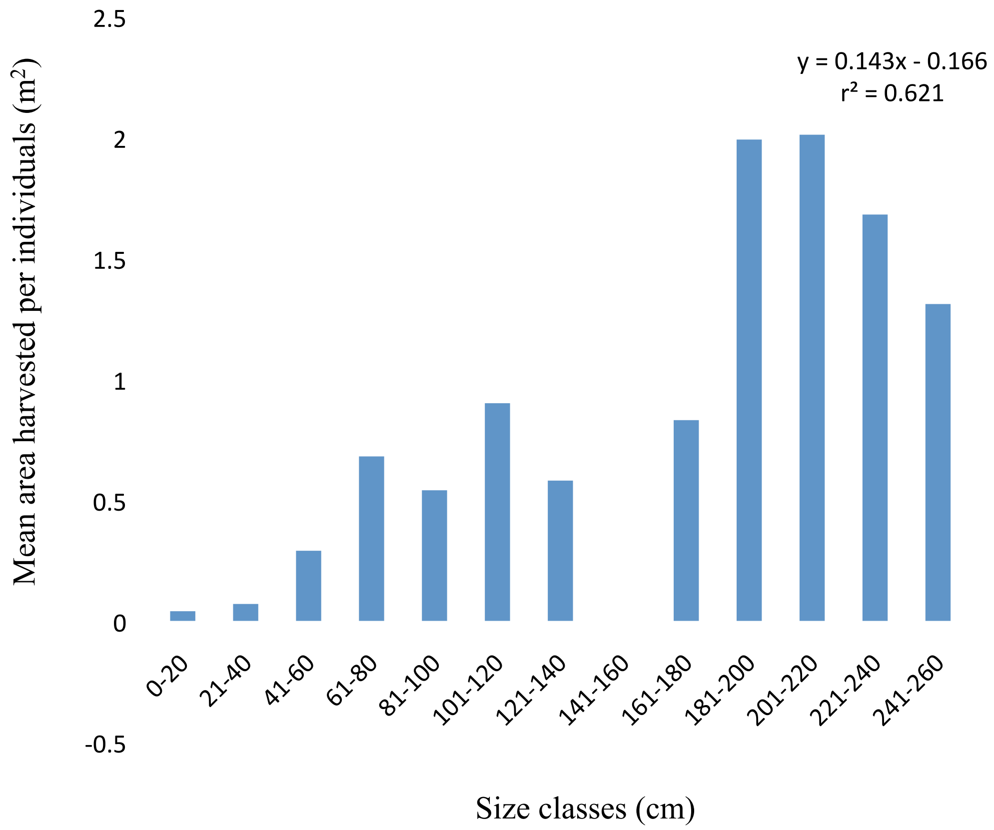

Figure 5.6: Relationship between the stem circumference classes and mean harvested area in a population of *Elaeodendron transvaalense* sampled in 2004 at Tshirolwe, in the Venda region, Limpopo.

Overharvesting could be the reason for the absence of any individuals either harvested or unharvested in the larger than 140 to 160 cm circumference size class in the studied *Elaeodendron transvaalense* population. The three size classes most affected by the bark removal practices were the >180-200, >200-220, and >220-240 cm circumference classes (Figure 5.6). These three size class categories also constituted 30% of the individuals that showed 100% crown mortality.

Figure 5.7: Stem size classes against ratio of the area: stem circumference in a population of *Elaeodendron transvaalense* sampled in 2004 at Tshirolwe, in the Venda region, Limpopo.

When the ratio of harvested area : stem circumference was plotted against the different size classes it was clear that some of the smaller size classes were experiencing the same high harvesting pressure as the larger ones. It is clear that harvesting of medicinal materials is also done on young individuals.

5.4.3 Crown health

Defoliation is widely used as an indicator for the vitality of forest trees and the degree of damage (Zierl 2004, Wang *et al.* 2007). Crown health was assessed on a 0 - 5-point scale with 0 indicating 100% crown mortality and 5 indicating a healthy crown (Sunderland and Tako 1999) and gave a good indication of overall tree health.

The crown health of the *Elaeodendron transvaalense* population was generally not in a good state (Figure 5.8). Ten percent (10%) of the *E. transvaalense* population crowns sampled was found to be completely dead. The death of a tree is regarded as an ultimate indicator of its non-vitality (Dobbertin and Brang 2001). Five percent (5%) had severe crown damage while 10% had moderate crown damage. Twenty-nine percent (29%) of the individuals sampled showed some traces of crown damage while 19% of individuals showed relatively healthy crowns. There was a weak negative relationship between the size of the individual and crown health (Figure 5.9; $r^2 = 0.1464$; $y = -0.0096x + 3.7846$; $p= 0.10171$) with most of the large individuals showing a poorer health status than the smaller individuals.

It is important to note that crown defoliation is a non-specific indicator of some underlying factors that may have caused stress for a tree. Total tree defoliation is a useful parameter in predicting year to year tree mortality (Dobbertin and Brang 2001).

Individuals with severe crown damage are likely to to die from stress that resulted in their defoliation.

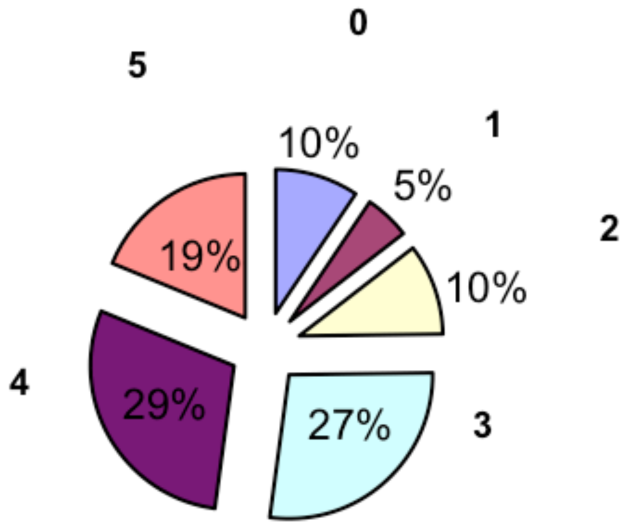

Figure 5.8: Crown health status of *Elaeodendron transvaalense* population in the Tshirolwe study area, Venda region, Limpopo, as determined by a survey in 2004. Crown health was assessed on a scale of 0–5 with 0 indicating 100% crown mortality and 5 indicating a healthy crown.

Although bark removal seemed to be the most likely factor contributing to the loss of crown health in the case of the Tshirolwe population, Zierl (2004) cautioned that it is important to devote more effort to the identification of other possible stress factors that may cause tree decline. In some cases the decline may be due to natural processes that involve environmental stresses such as water availability or exceptionally high or low temperatures (Zierl 2004).

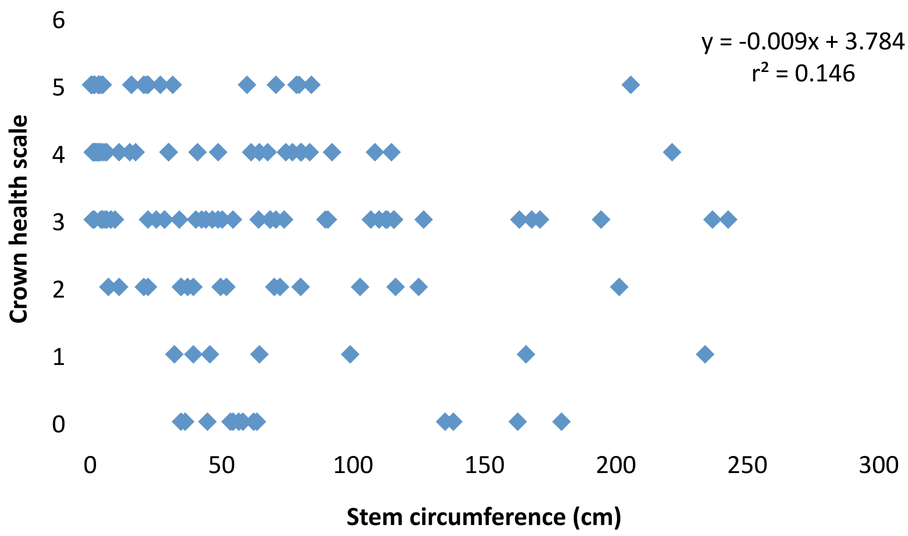

Figure 5.9: Stem circumference versus crown health status in a population of *Elaeodendron transvaalense* sampled in 2004 at Tshirolwe, in the Venda region, Limpopo.

In the Tshirolwe *E. transvaalense* population stress factors such as herbivory, trampling by livestock and wood harvesting for firewood were evident. The livestock observed in the study area were goats and cattle. In the population under study a number of seedlings were browsed on and the effect of herbivory on seedling survival will have to be monitored in future. Fortunately, the collection of wood for firewood, which is very prominent in the area, is only done for *E. transvaalense* after the individuals have died from ring-barking.

5.4.4 Regeneration

The relationship between seed production and the size of the plant as illustrated in Figure 5.10 indicated high seed production in middle-aged individuals of stem circumference of 50 cm to 150 cm as compared to older individuals with stem circumference of more than 150 cm to 250 cm. In general, irrespective of the few individuals bearing seeds, seedling establishment seemed to be good with a large number of seedlings observed.

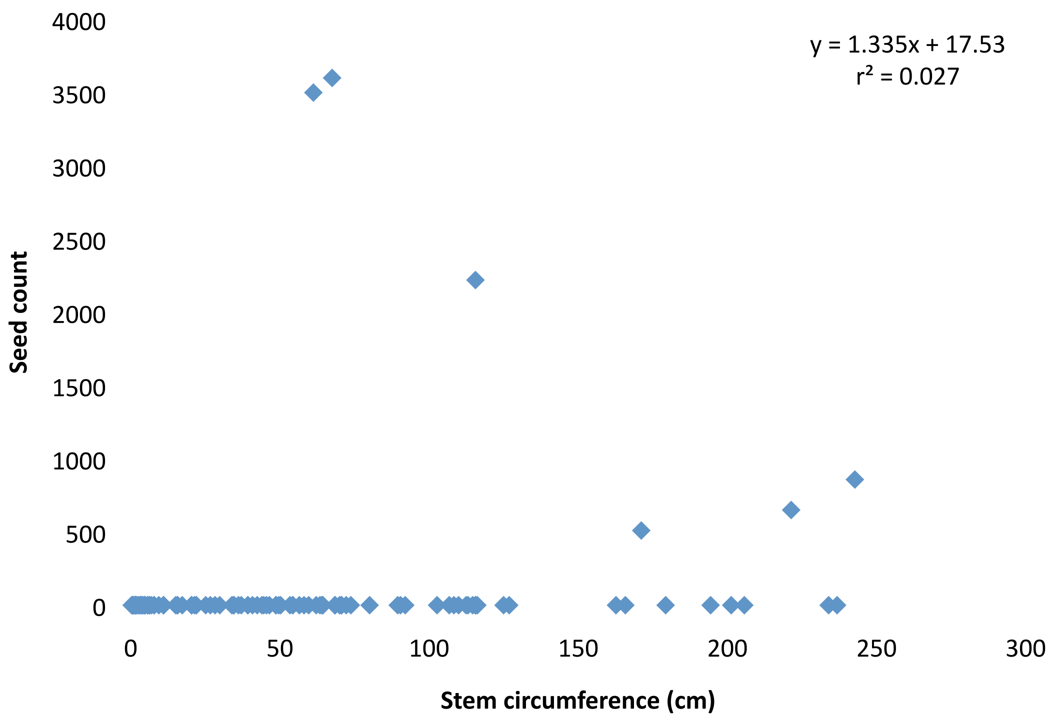

Figure 5.10: Stem circumference versus seed count as per individual.

Regeneration in a forest or woodland is an indicator of the wellbeing of the forest (Murthy *et al.* 2002). Studies relating to the regeneration of a specific species or the forest in general have always looked at the factors responsible for degradation. In spite of the large number of seedlings, the seedlings of *Elaeodendron transvaalense* were suppressed by herbivory. The effect of herbivory was largely counteracted by the ability of *E. transvaalense* to develop lignotubers (Figure 5.11) which store starch and enable the seedling to develop quickly after being browsed upon. The lignotuber is a storage organ, which resprouts vigorously when everything else above the ground has been destroyed by herbivores or fire. In the current study resprouts were generally classified as seedlings since it could only be established that they were resprouts after digging up the lignotuber. The classification of resprouts as seedlings could give a false impression of the success of regeneration by seeds. It is important to note that plant size is the most significant determinant of resprouting response (Neke *et al.* 2006)

Figure 5.11: An *Elaeodendron transvaalense* seedling resprout showing a well-developed lignotuber in the 2004 survey at the Tshirolwe, Limpopo study area.

The rate at which plant biomass is consumed by herbivores does not necessarily indicate control of plant standing crop by herbivores (Chase *et al.* 2000). Plants are able to compensate for losses to herbivory by regrowing tissues. Therefore the amount of plant biomass consumed by herbivores may have little to do with controlling effects of herbivores on plants. Maron and Crone (2006) also noted that in terms of consumer effects on plant abundance and distribution, demographic sensitivities alone may not provide accurate predictions on whether consumers that attack specific life stages of plants will have consequences on a population scale. The relative magnitude of the response of that particular life stage is also of importance.

5.4.5 Stem growth rate

When analysing the stem growth increment of *Elaeodendron transvaalense* a positive linear relationship was observed between the annual growth increments and stem circumference size (Figure 5.12; $r^2 = 0.8618$; $y = 0.0452x + 3.9228$; $p = 3.05 \times 10^{-12}$). The mean stem diameter increment for the entire sample was 2.57 cm per annum. Although this growth rate appears to be high it compares very well with growth rates of other woodland savanna species such as *Garcinia livingstonei* (2.6 cm/year), *Sclerocarya birrea* (1.33 cm/year) and *Albizia versicolor* (1.20 cm/year) as indicated in Gaugris *et al.* (2008).

In many tree species the growth rate of a tree changes with its life history (Kurokawa *et al.* 2003). Trees are expected to have their highest growth rate at middle size stages before growth is limited by the metabolic rate and reproduction. The mean stem circumference increment value of individuals in their vegetative stage was 5.74 cm (1.83 cm diameter increment) while it doubled to 10.56 cm (3.36 cm diameter increment) in the flowering stage (Figure 5.12). This however, showed that in *E.*

transvaalense the stem circumference growth rate continued to increase as circumference increased.

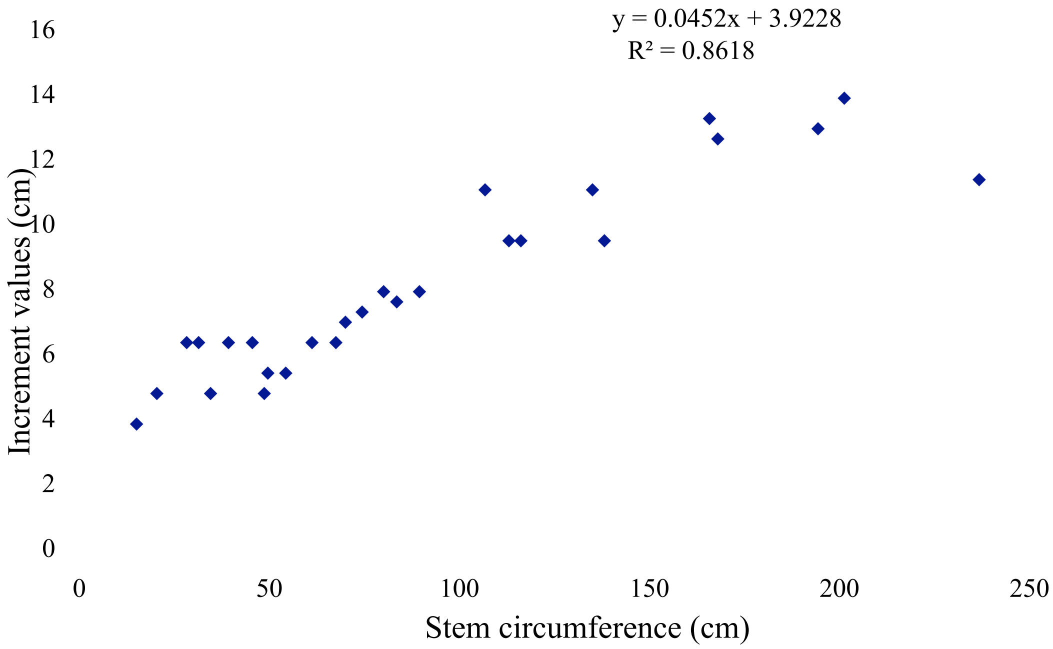

Figure 5.12: *Elaeodendron transvaalense* annual stem circumference increment as measured at Tshirolwe, Venda region between 2004 and 2005.

5.4.6 Population growth rate

A Lefkovitch transition matrix for structured populations was constructed (Giho and Seno 1997, Caswell 2001) with the population divided into three stages, namely: seedling, vegetative, and flowering stages. The stages were differentiated by stem circumference assuming that there was a relationship between age and stem circumference (Perryman and Olsen 2000, Suarez *et al.* 2008, Stoffberg *et al.* 2009).The diagonal values of the transition matrix were derived from the ages of individuals that were obtained from stem circumference increments. However, the matrix was derived with the assumption that all vegetative plants will reach flowering stage since there was no information on mortality.

After subjecting the matrix derived from *Elaeodendron transvaalense* data through the lambda script on the Matlab programme, lambda was found to be 1.041. When using a constant transition matrix for multiplication the prediction of future population size is generally of little relevance (Desmet *et al.* 1996, Morris and Doak 2002).

An elasticity analysis was performed to evaluate the relative importance of the population projection matrix cell entries and lower-level parameters on lambda. This analysis can be used to determine the stages of a species' life cycle that should be targeted for management action (Link and Doherty 2002, Norris and McCullogh 2003, Crone *et al.* 2011).

The elasticity analysis showed that the highest elasticity value was in the cell indicating the probability of a vegetative individual remaining in the vegetative stage, which had a value of 0.6420. This means that 64.2% of the influence on λ can be ascribed to this stage. It therefore indicates that for management purposes it can be important to put more effort into protecting plants that are in the vegetative stage.

5.4.7 Species grain

The species grain concept provides information on whether a tree species can potentially sustain moderate harvesting levels or whether it may not survive such harvesting (Obiri *et al.* 2002). This approach provides a useful framework upon which to base operational harvesting rates.

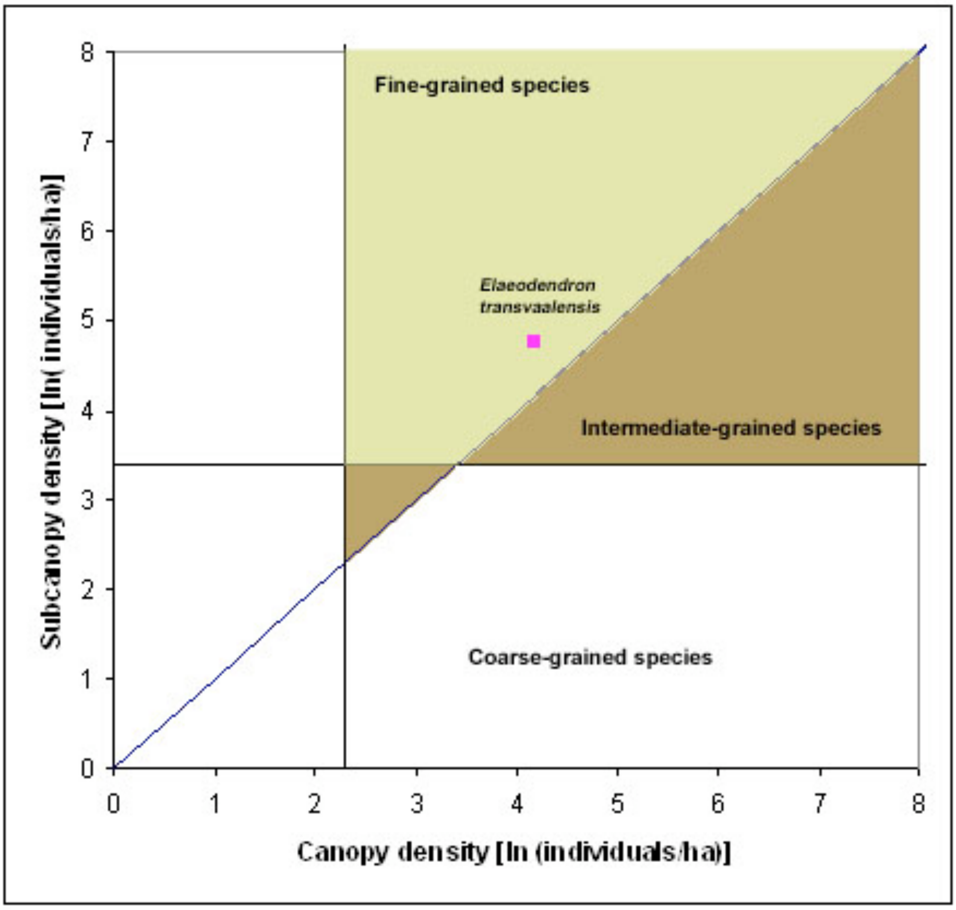

Figure 5.13: Species grain of the *Elaeodendron transvaalense* population of Tshirolwe from data collected in 2004.

The population of *Elaeodendron transvaalense* under study could be classified as a fine-grained species (Figure 5.13). According to Obiri *et al.* (2002) the species grain theory suggests that fine-grained species should be able to withstand moderate levels of use. It would therefore appear possible to harvest *E. transvaalense* sustainably. In the case of *E. transvaalense,* individuals are not used for construction or other purposes and bark-harvesting therefore represents the only form of harvest. Therefore with the proper harvesting techniques, *E. transvaalense* may survive such moderate harvesting.

5.5 Conclusions

The use of a size-class distribution analysis provided a practical field method for investigating the population structure of *Elaeodendron transvaalense* and illustrated the response of the population to harvesting pressures. The population showed a healthy population structure with an inverse J-shaped curve. Therefore, in spite of the current harvesting pressure the population was still showing good recruitment. The data collected during this once-off survey can be used for monitoring changes in the population structure over time in the presence of harvesting.

The study has shown that the exploitation of *E. transvaalense* by local people around Venda is currently very high. Despite the reasonable level of seedling establishment, the destruction rate of large trees is a point of concern. Bark harvesting for medicinal purposes is the major contributor to the loss of *E. transvaalense* individuals, since people only utilize it for firewood after it has died from debarking and is dry. Cultivation intervention should be considered to reduce the stress experienced by *E. transvaalense*.

The matrix analysis allows one to answer a number of questions that cannot be answered by simple calculations. However, to improve the analysis it is important to get repeated data on every individual in the population. Data should be recorded for many years in order to get a clear picture in terms of changes that occur. Data on mortality is especially needed to improve the parameterization of the cell entries in the transition matrix. This kind of information can also indicate the longevity of the individual.

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