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Population Structure and Density of *Prunus africana* (Hook. f.) Kalkman (Rosaceae) in Kenyan Forests

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Size structure and population density of *Prunus africana* were assessed in four natural forests in Kenya to provide basic information required to develop guidelines for restoration and sustainable management and conservation of the species. The results showed that the pattern of diameter distribution in *Prunus africana* in natural closed canopy forests is unbalanced; populations in the four sites are represented almost entirely by large trees; the density of *Prunus africana* is relatively low and a high proportion (82.5 %,) of trees is >20 cm DBH. It was concluded that recruitment into large size classes is episodic and may be dependent on fine-scale canopy openings, and therefore the species can be characterised as having a gap-phase regeneration mode, selective logging of mature trees of associated timber species would produce canopy openings that might facilitate recruitment of juveniles. Although *Prunus africana* has been heavily over-exploited in parts of its range in Kenyan montane forests, it is not in danger of extinction at the species level. However, certain tree populations have been depleted, and valuable genetic resources may have been lost.

Key words: *Prunus africana*; population structure and population density.

Introduction

The worldwide revival of interest in herbal medicine is putting intense pressure on tropical biodiversity as increasing numbers of species and individuals are harvested for their medicinal properties. *Prunus africana* (Hook.f.) Kalkman (Rosaceae); is one of these important medicinal trees. Medicinal products using *Prunus africana* bark extracts are used in the treatment of benign prostatic hyperplasia (Bombardelli & Morazzoni, 1997). It is the international trade in *Prunus africana* that has led to concern for the long-term sustainability of harvesting and conservation of this species and associated *Afromontane* species (Cunningham *et al*. 1998). As a result, *Prunus africana* has been listed as endangered under Appendix II of the Convention of International Trade in Endangered Species of wild fauna and flora (CITES), and alternative species of *Prunus* with similar medicinal properties are being sought (Dawson &Powell, 1999).

The sustainability of exploiting *Prunus africana* is of concern, particularly if selective exploitation of the species was to take place. Conservation issues associated with *Prunus africana* collection in Kenya is the fact that there is little published data on population status, exploitation rates (for timber, bark etc), and on its regeneration both natural and artificial.

The objective of the study was to analyse the population size structure and density of *Prunus africana* in relation to regenerational patterns. Inferences about past successional changes and potential changes that could occur in the forest could be provisionally drawn.

Materials and Methods

The minimum DBH for inclusion in an inventory defines the sample size and therefore the completeness of the survey. Smaller DBH's yield more information per unit area of forest, but usually limit the overall geographical sample size. Larger DBH's sample fewer juvenile trees, but enable a larger area to be sampled. A compromise was sort by using a minimum DBH of 10 cm as recommended by Campbell (1989).

Sampling and measurement where undertaken in four forests (Kakamega, Kapseret, Timboroa and Elgeyo) where the forest had not been logged, burned or otherwise significantly altered by direct or indirect human activities. In order to assess the size structure and density of *Prunus africana*, in each study stand, sample plots were laid at each site, following a modification of the Plotless Sampling Method (Bullock, 1996). In this method one *Prunus africana* tree (≥10 cm DBH) located approximately in the centre of the forest stand was used as a starting point, and a complete search carried out moving out in all directions until 50 *Prunus africana* trees were identified and measured. For the 50 trees recorded, distances from one tree to the nearest conspecific neighbour, and diameter at breast height (DBH) of trees was measured. The area that was occupied by the 50 sampled trees in each forest was then determined. The numbers of saplings (trees <10 cm DBH and ≥ 1 m tall) in the same area were also counted. All trees were later classified into 10 cm diameter classes. The frequencies of these categories were scored in each population and were used to determine the population size structure of each individual stand.

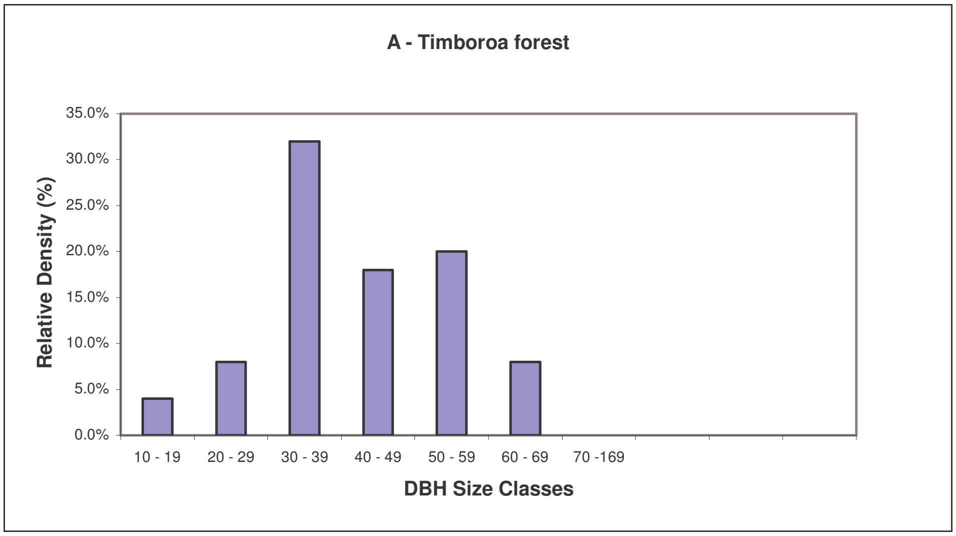
Data analysis

To estimate population size structure, seven 10 cm DBH size classes were arbitrarily established. The total numbers of individuals in each size class in each stand were divided by the total number of individuals, thus giving relative density of each size class for each stand. An analysis was then made on the basis of the relative densities of individuals in each DBH class at each individual stand and of the combined data of all stands.

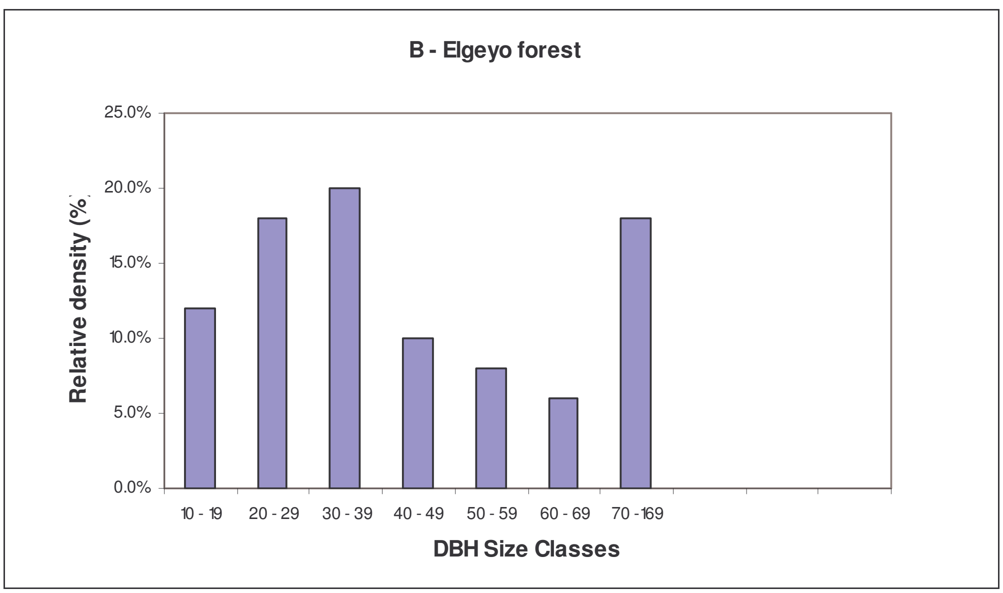
Results

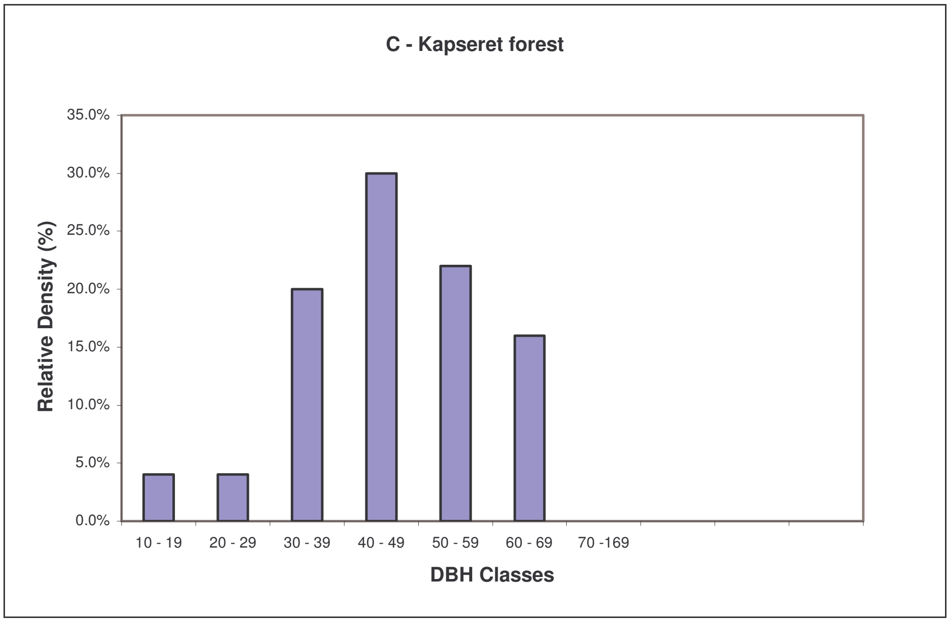
Examining diameter size classes in each of the four study sites identified the general patterns of population size structure. *Prunus africana* populations in the four study sites are represented almost entirely by larger trees (Figures 3.2a-e). The most abundant classes are the intermediate ones, with fewer larger and smaller individuals. The size structure distribution showed similar patterns in the four sites (Figures 3.2a-d), and appear to be typical for the species, as they now exist in the forests in Kenya.

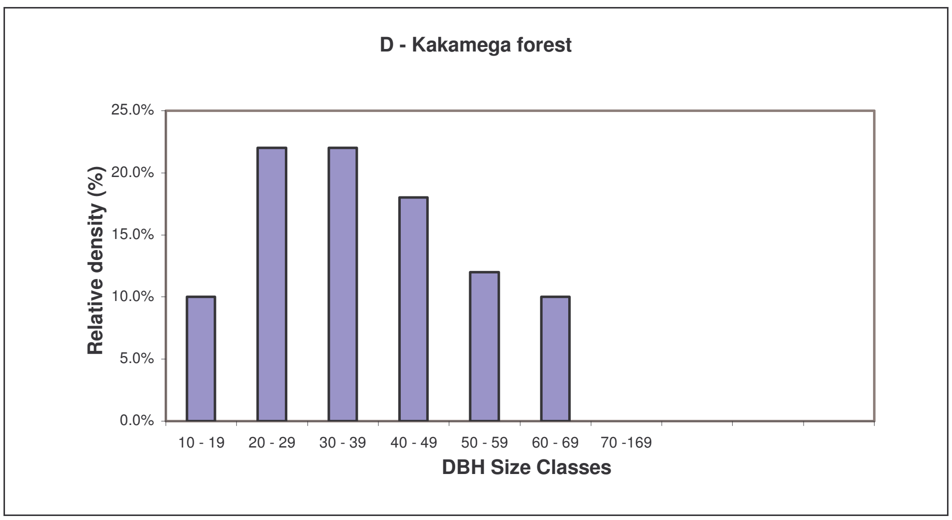
In the four study sites, the areas sampled ranged from 4.6 ha in Timboroa to 12.3 ha in Elgeyo. The variability in sampling area was due to variation in distances between trees, and the requirement to sample 50 trees more than 10 cm DBH. A total of 17.67 hectares was sampled overall.

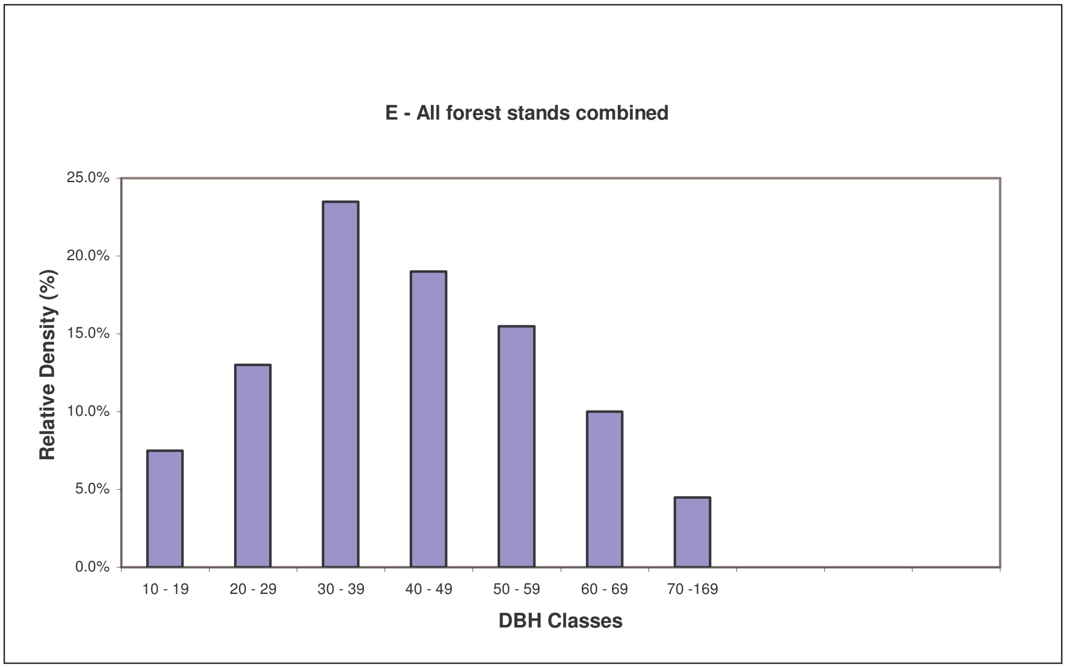


The mean distances between trees were, 30.7, 33.5, 40.9 and 48.1 m for Kapseret, Kakamega, Timboroa and Elgeyo respectively. The mean area per tree ranged from 942.5 m^2 in Kapseret to 2313 m^2 in Elgeyo. Tree density per hectare ranged from 4.3 stems/ha in Elgeyo site to 10.6 stems/ha in Kapseret, while sapling density ranged from 0.7 saplings/ha in Elgeyo site to 2.4 saplings/ha in Timboroa.




C - Kapseret forest
Relative Density (%)
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
10 - 19
20 - 29
30 - 39
40 - 49
50 - 59
60 - 69
70 -169
DBH Classes


D - Kakamega forest
Relative density (%)
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
10 - 19
20 - 29
30 - 39
40 - 49
50 - 59
60 - 69
70 -169
DBH Size Classes



Figures 3. 2a-e Population structure of Prunus africana in the four study stands. Combined (Fig 3.2e) represents pooled data from all the four stands

Discussion

The study shows that the density of *Prunus africana* is relatively low and a high proportion (82.5%, Fig. 3e) of trees is >20 cm DBH (n=200) in all sample plots. It was observed that *Prunus africana* is most abundant along forest edges and on forest patches. In this study, the average density of trees >10cm DBH ranged from 4.1 stems/ha to 10.9 stems/ha and the mean is 6 trees/ha. The spatial pattern of tree locations in *Prunus africana* was observed to be clumped, and could be linked to gap creation. Trees were arranged in clumps, with wide spacing between clumps, relative to that within clumps.

The spatial pattern of these trees, which might have resulted from gap recruitment, may have been affected by logging disturbances, tree falls or both. These types of disturbances usually result in patchwork patterns, which create the perfect environment for clumps of seedling recruitment.

Prunus africana populations in the four sites are represented almost entirely by larger trees (Figures 3.2a–d), apparently because they have difficulty recruiting in the under storey environment. The smaller size classes (10-20 cm DBH) are missing. Under this scenario, the bias towards adult rather than sapling or pole abundance indicates an episodic recruitment whereby successful recruitment is followed by disappearance of conditions that permit establishment and survival of young juveniles. Peaks in establishment may be attributed to climatic conditions controlling seed or seedling ecophysiology, fluctuations in seed production, seed predation, herbivory, or increased canopy disturbances during that period.

It appears therefore that chance plays an important role in recruitment of *Prunus africana* to larger diameter classes. After the seedling stage, the pattern that develops is determinate in its response to recognizable environmental discontinuities, thus producing irregularity in diameter class distribution. This kind of species can be referred to as an 'infrequent' recruiter. Due to the great longevity (100 years and more) of *Prunus africana*, infrequent recruitment may be sufficient to maintain the current low density. Sparse recruitment is not a rare phenomenon in tropical tree species, in some species recruitment events may be separated by gaps of more than 10 years without any perceptible change in overall population structure.

Conclusions

Size structure suggests that *Prunus africana* recruitment into large size classes is episodic and may be dependent on fine-scale canopy openings, and therefore the species can be characterised as having a gap-phase regeneration mode. Selective logging of mature associated timber tree species is likely to produce canopy openings that can improve recruitment of *Prunus africana* juveniles.

Although the pattern of diameter distribution in *Prunus africana* in natural closed canopy forests is unbalanced, there is a potential for sustainable management based on small scale gaps (tree-fall size) and spatial dynamics at stand scale need to be considered to ensure the regeneration of mature trees. Gap–based approaches (Coates & Burton, 1997) may provide a conceptual basis for sustainable management of this species in natural forests.

Acknowledgement

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