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# Population Structure and Regeneration Status of *Trichilia dregeana* Sond. in Heavily and Less Disturbed Areas of Kalinzu Forest Reserve, South Western Uganda

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## Abstract

**The population structure and regeneration status of *Trichilia dregeana* in heavily and less disturbed habitats of Kalinzu forest reserve were assessed in 2013. The species was used locally for medicines, fire wood and making household utensils, a situation that rendered it vulnerable. Given this dependence by local communities, the population of the species was under human pressure due to demand. This necessitated a critical understanding of how the population structure was affected by such disturbance although in some species, population structure disturbance increased resilience. Size-class distribution and regeneration status were used to determine the population structure as influenced by human disturbance. Four plots of 20 × 10 m were randomly established in each forest type and all *T. dregeana* trees of diameter ≥ 10 cm were counted and their DBH was measured at 1.3 m from the ground. In each of these plots, a 10 × 10 m plot was made and saplings DBH ≥ 2 - 10 cm were enumerated. Inside each 10 × 10 m plot, a 5 × 5 m plot was made and *T. dregeana* seedlings (<2 cm diameter) were identified and counted. The density of *T. dregeana* in the heavily disturbed forest was higher than in the less disturbed forest type. The size-class distribution exhibited a characteristic inverse J-shaped distribution pattern in the heavily disturbed forest whereas it was bell-shaped in the less disturbed forest type. In both forest types, the population of *T. dregeana* was found to be actively regenerating. This study concludes that the population structure of *Trichilia dregeana* is dominated by juveniles with total absence of individuals of DBH ≥ 22 cm, due to selective harvesting of mature individuals. In order to stop harvesting of this species from the natural forest, there should be an effort to provide seedlings to local communities so that they grow it on their farms.**

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## Keywords

***Trichilia dregeana*, Kalinzu Forest Reserve, Size-Class Distribution, Regeneration Status**

## 1. Introduction

*Trichilia dregeana* Sond., commonly known as forest mahogany, belongs to family Meliaceae. The species has a dark foliage and large rounded crown. Impressive heights of up to 35 m have been recorded, the tall main stem assuming a relatively straight and sometimes buttressed habit, up to 1.8 m in diameter. It has a grey bark with a smooth texture, but often rough and segmented around the base of the main stem on older trees (Pooley, 1993; Maroyi, 2007). The compound leaves can reach lengths of 70 cm and are imparipinnate with 3 - 5 pairs of leaflets and a terminal one, the petiole being 8 - 10 cm in length. The leaflets are entirely opposite to alternate, glossy and dark green in colour and can attain a size of 21 cm in length and 8.5 cm in width.

*Trichilia dregeana* has a disjunct natural distribution area in tropical Africa. It occurs from Ethiopia down to South Africa, especially in the mountain ranges of the Eastern Arc and along the Rift Valley. In West and Central Africa it occurs in Guinea, Côte d'Ivoire, and Cameroon, Democratic Republic of Congo and Angola, but is absent in the central Congolian rainforest (Pooley, 1993; Maroyi, 2007). It is found at an altitude of 800 - 1600 m in West Africa and below 500 m in the DR Congo. In Ethiopia, it is found at an altitude of 1350 - 2000 m, whereas it is found at lower altitude in Uganda and Tanzania (Maroyi, 2007). *Trcichilia dregeana* is however planted in many countries as an ornamental.

Virtually every part of *T. dregeana* is useful for humans and animals. Butterflies and bees feed on its flowers while the fruits are eaten by human and birds (Pooley, 1993). The aril serves as food for baboons. Although the seed coat is poisonous, boiled seeds are edible after the removal of the seed coat. The aril is also edible, which can be eaten or made into a drink or sauce. Poultices made from the leaves are used to treat bruises and eczema. The leaves are also believed to induce sleep and hot infusions from the leaves can be soothing when applied to bruises. In addition, the leaves can also be used in the treatment of lumbago, rectal ulcer and dysentery. In Nigeria, leaves are used for the treatment of syphilis and gonorrhea. Decoctions made from the roots are consumed as tonic and can be used against fever. It is also useful as purgative. Daily consumption of the bark decoctions and hot infusions can be used to treat diarrhea. The bark decoction is also useful in the treatment of back pain that results from kidney problems. The bark can also be used to make fish poison (Palgrave, 1977; Grace et al., 2003; Eldeen et al., 2005; Krief et al., 2005 Maroyi, 2007). The tree is also used in the treatment of inflammatory problems such as kidney pain and inflammation of the bronchus (Eldeen et al., 2007). In the fringes of Kalinzu forest reserve, *Trichilia dregeana* is used to treat stomachache, fever, scabies and backache. It is also used for fire wood and in making household utensils. These uses make *T. dregeana* an economically important species that should be conserved especially in places like Kalinzu forest reserve where it is found in a natural ecosystem that is under human pressure.

In order to identify plant species for conservation priority, it is imperative to have baseline information on population structure in terms of density, stem size and regeneration potential (Tuxill & Nabhan, 2001). This assessment of plant populations based on their stem diameters, showing size-class distribution tells a lot about plant population structure that indicates the chances of plants in one size to survive into the next size class (Cunningham, 2001). Martin (1995) notes that measuring numbers of individuals from different size classes of tree species can generate baseline data necessary for understanding how population structure of concerned species changes over time. This kind of information on how a plant population is regenerating is very valuable in resource management and sets a basis in planning for sustainable forest management. For conservation and proper management of the existing *Trichilia dregeana* stands in Kalinzu forest reserve, the present study assessed the size-class distribution and regeneration status of the species in heavily and less disturbed forest types in the reserve in order to establish the impact of human disturbance on the species' population structure.

## 2. Materials and Methods

Study plots were randomly established in two forest types of Kalinzu forest reserve with different management histories. One forest type referred to as heavily disturbed has a history of having been heavily mechanically pitsawn for a long time and has remained under human pressure and the other forest type (less disturbed), has a history of minimal disturbance in 1970s but is currently not experiencing human disturbance (Howard, 1991; Kagolo *et al*., 2003; Muhanguzi et al., 2005). There are established trails which are numbered in each forest type. Trail numbers were separately written on pieces of paper for each forest type which were rolled and mixed thoroughly in a basin. For each forest type, four pieces of paper were picked randomly from the basin without being replaced while ensuring the shaking of the basin at each removal. The four selected trails in each forest type were identified and a plot of 20 m × 10 m was established 5 m from the mark of each trail. Each of these plots was divided into nested plots of 10 m × 10 m and 5 m × 5 m. In the 20 m × 10 m plot, large trees (diameter ≥ 10 cm) were identified, counted and diameter at breast height (DBH) measured at 1.3 m from the ground using a DBH meter. The diameter of trees with buttresses was measured at a point just above the buttresses. In the 10 m × 10 m saplings (DBH ≥ 2 < 10 cm) were identified and diameter measured. In the 5 m × 5 m plot, seedlings (<2 cm diameter) (Luoga et al., 2004; Lejju, 2004) were identified and counted. The DBH of saplings and trees were categorized into five classes: 2.0 - 5.9 cm, 6.0 - 9.9 cm, 10.0 - 13.9 cm, 14.0 - 17.9 cm and 18.0 - 21.9 cm. Regeneration status was assessed using the densities of seedlings, saplings and trees in each forest type.

## 3. Results and Discussion

The density of *Trichilia dregeana* individuals with stems of DBH ≥ 2 cm was 143 stem $ha^{-1}$ in the heavily disturbed forest and 71 stems $ha^{-1}$ in the less disturbed forest type. One would expect the density in the heavily disturbed forest to be lower than in the less disturbed forest type. Findings of this study however, contradict this expectation because harvesters of *Trichilia dregeana* target mature trees from which they get leaves, bark, roots and seeds. This leaves juveniles to grow for future use. These juveniles were responsible for the high density in the heavily disturbed forest type. Again, there are gaps in this forest type which allow light to reach the forest floor and aid germination of *T. dregeana* seeds unlike in the less disturbed forest where the closed canopy limits germination of seeds of the species. As a result, there are more individuals undergoing transition to sapling stage in the heavily disturbed forest type than in the less disturbed type.

In the heavily disturbed forest, *T. dregeana* individuals were only found in three DBH classes; 2.0 - 5.9 cm, 6.0 - 9.9 cm and 10.0 - 13.9 cm. There were no individuals in higher DBH classes in this forest type. The density of individuals decreased with increase in DBH and this resulted in a characteristic inversed J shape diameter-class distribution pattern. In the less disturbed forest type, there were few stems per hectare in the 2.0 - 5.9 cm DBH class than 6.0 - 9.9 cm class. From here, the density decreased with increase in DBH but with a gap in the 10.0 - 13.9 cm DBH class. This distribution resulted into a bell shaped pattern for the less disturbed forest type. There were no individuals with a DBH ≥ 22 cm that were encountered in any plot.

According to (Cunningham, 2001), plant population structure may change due to changes in recruitment of individuals at low diameter size classes or exploitation of individuals at high size classes or throughout the class size structure. This means that plant population structural change is a function of regeneration pattern of individuals within the community. Thus, the low DBH of *Trichilia dregeana* trees observed in the two forest types implies that individuals with bigger diameters which are the most preferred have been selectively harvested. Selective harvesting of larger and reproducing individuals has a negative effect on the soil seed bank and hence tree recruitment.

In this study, the diameter-class distribution of *Trichilia dregeana* trees in the heavily disturbed forest type generally displays the characteristic of De iocourt's factor procedure (inverse J distribution) where stems frequencies decrease with the increase in DBH. This generally indicates that stands are developing and regeneration in the forest is present. The high number of trees in the 2.0 - 9.9 cm DBH class in the heavily disturbed forest can be explained in two ways. First, trees of this size are not usually preferred for harvesting and are left to grow for future use. Secondly, due to canopy gaps in the heavily disturbed forest, a lot of light reaches the forest floor and allows quick recruitment (**Figure 1**).

The distribution in the less disturbed forest type displayed a bell shaped pattern indicating that the population of *T. dregeana* is unstable and under threat due to fewer regenerating individuals. This low number in lower DBH classes is probably due to closed forest canopy in this forest type which limits germination of the species. It is also possible that past harvesting targeted mature trees and only left few reproducing individuals. This led to decline in the overall density as argued in (Tewari, 1993; Sinha & Bawa, 2001) that harvesting of forest plant resources has costs which range from decline of the resources to changes in the population dynamics and demography of harvested species.

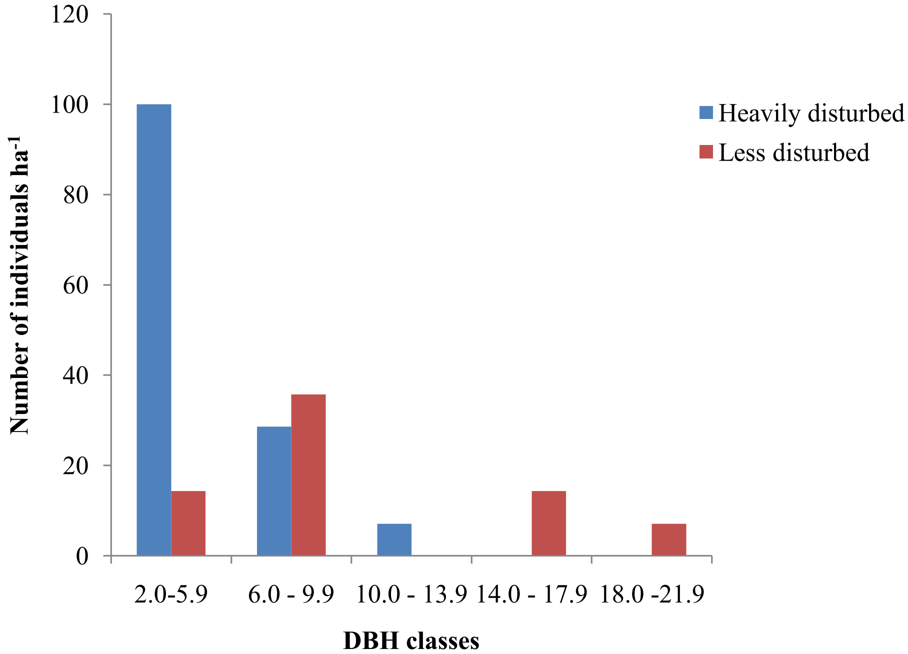


**Figure 1.** Diameter-class distribution of *Trichilia dregeana* in the two forest types.

### Regeneration Status *Trichilia dregeana* in the Two Forest Types

Regeneration potential of *T. dregeana* was established from the density of seedlings, saplings and trees. The number of individuals that underwent a successful transition from one growth stage to another was considered to reflect the species regeneration potential. The density of *T. dregeana* seedlings was 1300 individuals ha$^{-1}$ in the heavily disturbed forest which was higher than that of 200 individuals ha$^{-1}$ found in the less disturbed forest type. This is probably because the gaps in the canopy as observed in the field allow much light to reach the forest floor in the heavily disturbed forest types and create a microclimate that favours germination of seed of the species (Denslow, 1995) unlike in the less disturbed forest where the relatively closed canopy limits the amount of light reaching the forest floor and hence fewer seeds are germinating. Uhl & Clark (1983) reported that germination of several light-demanding species is promoted by direct solar radiation in newly formed gaps but inhibited by shade. It is likely that *T. dregeana* is one such species whose seed germination is enhanced by direct solar radiation. **Figure 2** shows the density of *T. dregeana* seedlings, sapling and trees in each forest type.

In both forest types, seedlings had the highest density followed by saplings and then trees. This resulted in a characteristic inversed J-shape distribution pattern for each forest type reflecting a regenerating population. However, the density of seedlings in the heavily disturbed forest was far higher than that in the less disturbed forest type. This is probably because the relatively closed canopy in the less disturbed forest type limits light penetration yet germination of *T. dregeana* seeds is light demanding. The density of trees in the heavily disturbed forest was lower than that in the less disturbed forest type. This is expected for *T. dregeana* since harvesters target mature trees. Thus the extremely low number of trees in the heavily disturbed forest is due to selective harvesting of mature trees. It could also be as a result of few individuals undergoing transition from sapling to tree stage. In the less disturbed forest, the numbers of seedlings, saplings and trees did not have sharp differences and this indicates that at each stage, there was a proportionately high number of individuals undergoing transition to the next growth stage. The lower density across all the growth stages in this forest type is due to past disturbance which probably targeted mature individuals hence reducing seed production. However, the species is re-establishing itself steadily due to absence of human disturbance in this forest type.

## 4. Conclusion

Population structure of *Trichilia dregeana* is dominated by juveniles due to selective harvesting of mature individuals. The inverse J-shaped size class distribution exhibited in the heavily disturbed forest type shows that the

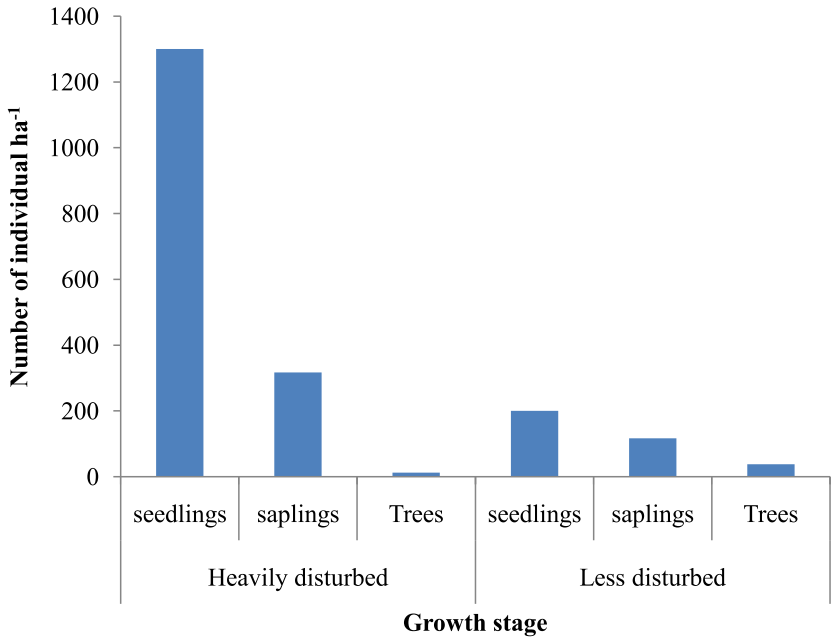


**Figure 2.** Regeneration status of *T. Dregeana* in heavily disturbed and less disturbed forest types.

species is actively regenerating (Alvarez-Buylla & Martinez-Ramos, 1992). This active regeneration can be due to canopy gaps that affect forest light regimes which influence seed germination and early seedling growth (Hart, 1988).

The bell-shaped size class distribution pattern displayed by the less disturbed forest type is due to low number of individuals in lower and higher DBH classes. The low number in lower DBH classes is due to closed forest canopy in this forest type which limits germination of the species while that in higher classes is due to past harvesting which targets mature trees and only left few reproducing individuals leading to a decline in the overall density as argued in (Tewari, 1993; Sinha & Bawa, 2001). However, elimination of human disturbance will stabilize the population of *T. dregeana* as indicated by the regeneration status in each forest type. In order to stop harvesting of this species from the natural forest, there should be an effort to provide seedlings to local communities so that they grow it on their farms.

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## References

Alvarez-Buylla, E. R., & Martinez-Ramos, M. (1992). Demography and Allometry of *Cecropia obtusifolia*, a Neotropical Pioneer Tree—An Evaluation of the Climax—Pioneer Paradigm for Tropical Rain Forests. *Journal of Ecology, 80,* 278-290. http://dx.doi.org/10.2307/2261011

Cunningham, A. B. (2001). *Applied Ethnobotany. People Wild Plant Use and Conservation*. London: Earthscan Publications Ltd.

Denslow, J. S. (1995). Disturbance and Diversity in Tropical Rainforests: The Density Effect. *Ecological Applications, 5,* 962-968. http://dx.doi.org/10.2307/2269347

Eldeen, I. M. S., Elgorashi, E. E., & van Staden, J. (2005). Antibacterial, Anti-Inflammatory, Anti-Cholinesterase and Mutagenic Effects of Extracts Obtained from Some Trees Used in South African Traditional Medicine. *Journal of Ethnopharmacology, 102,* 457-464. http://dx.doi.org/10.1016/j.jep.2005.08.049

Eldeen, I. M. S., Van Heerden, F. R., & Van Staden, J. (2007). Biological Activities of Cycloart-23-ene-3,25-diol Isolated from the Leaves of *Trichilia dregeana*. *South African Journal of Botany, 73,* 366-371.

Grace, O. M., Prendergast, H. D. V., Jäger, A. K., & van Staden, J. (2003). Bark Medicines used in Traditional Healthcare in KwaZulu-Natal, South Africa: An Inventory. *South African Journal of Botany, 69,* 301-363. http://dx.doi.org/10.1016/S0254-6299(15)30318-5

Hart, J. W. (1988). Light and Plant Growth. London: Unwin.

Howard, P. C. (1991). *Nature Conservation in Uganda's Tropical Forest Reserves*. Gland and Cambridge: IUCN. http://dx.doi.org/10.1007/978-94-011-5996-8

Kagolo, M. E. S., Mosses, M., & Mugote, E. (2003). *Forest Management Plan for Kalinzu Forest Reserve for the Period 1st January 2003 to 31st December 2013*. Second Revision, Forest Department.

Lejju, J. B. (2004). Ecological Recovery of an Afromontane Forest in South Western Uganda. *African Journal of Ecology, 42,* 64-69. http://dx.doi.org/10.1111/j.1365-2028.2004.00463.x

Luoga, E. J., Witkowski, E. T. F., & Balkwaill, K. (2004). Regeneration by Coppicing (Resprouting) of Miombo Trees in Relation to Land Use. *Forest Ecology and Management, 189,* 23-25. http://dx.doi.org/10.1016/j.foreco.2003.02.001

Maroyi, A. (2007). *Trichilia dregeana* Sond. In H. A. M. van der Vossen, & G. S. Mkamilo (Eds.), *PROTA 14: Vegetable oils/Oléagineux (CD-Rom)*. Wageningen: PROTA.

Martin, G. J. (1995). *Ethnobotany: A Method Manual*. London: Chapman and Hall. http://dx.doi.org/10.1007/978-1-4615-2496-0

Muhanguzi, H. D. R., Obua, J., Oryem-Origa, H., & Vetaas, O. R. (2005). Forest Site Disturbances and Seedling Emergence in Kalinzu Forest, Uganda. *Tropical Ecology, 46,* 91-98.

Palgrave, K. C. (1977). *Trees of Southern Africa*. Cape Town: C. Struik Publishers.

Pooley, E. (1993). *The Complete Field Guide to Trees of Natal, Zululand & Transkei.* Durban: Natal Flora Publications Trust.

Sinha, A., & Bawa, K. S. (2001). Impacts of Anthropogenic Pressures on Population Dynamics, Demography, and Sustainable Use of Forest Species in the Western Ghats, India. In K. N. Ganeshaiah, R. U. Shaanker, & K. S. Bawa (Eds.), *Tropical Ecosystems: Structure, Diversity and Human Welfare* (pp. 101-103). New Delhi: Oxford & IBH Publications.

Tewari, D. N. (1993). Non-Timber Forest Produce in Poverty Alleviation. *Indian Forester, 119,* 959-969.

Tuxill, J., & Nabhan, G. P. (2001). *People, Plants and Protected Areas. A Guide to in Situ Management*. London: Earthscan Publication Ltd.

Uhl, C., & Clark, K. (1983) Seed Ecology of Selected Amazon Basin Successional Species. *Botanical Gazette, 144,* 419-425. http://dx.doi.org/10.1086/337392