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TREE GROWTH AND MORTALITY OF 42 TIMBER SPECIES IN CENTRAL AFRICA

Gauthier Ligot[1*], Sylvie Gourlet-Fleury[2], Kasso Dainou[1], Jean-François Gillet[1], Vivien Rossi[2,3,9], Mathurin Mazengué[5], Stevy Nna Ekome[6], Yanick Serge Nkoulou[7], Isaac Zombo[8], Eric Forni[2,4], Jean-Louis Doucet[1]

[1] Forest is life, TERRA, Gembloux Agro-Bio Tech, Université de Liège, Gembloux, Belgium
[2] UPR Forêts et Sociétés, Université de Montpellier, CIRAD, Montpellier, France
[3] UPR Forêts et Sociétés, CIRAD, Yaoundé, Cameroon
[4] UPR Forêts et Sociétés, CIRAD, Brazzaville, République du Congo
[5] Mokabi SA, BP 97, Impfondo, République du Congo
[6] CEB Precious Wood, Libreville, Gabon
[7] Pallisco CIFM, Douala, Cameroun
[8] CIB-Olam, BP 41, Ouesso, République du Congo
[9] UMMISCO, Université Yaoundé I, Yaoundé, Cameroun
*Corresponding author: gligot@uliege.be

ABSTRACT

Tree growth and mortality are two central processes in mixed and structurally complex moist tropical forests, yet accurate estimates of the variables needed to model them remain sparse and scattered. It is thus still difficult to predict forest evolution at a local scale and build reliable management plans. To help fill this gap, for 1–7 years we annually monitored 21,180 trees belonging to 42 species exploited for timber production in Central Africa. We made new species-specific estimates of diameter increments and mortality rates, and investigated how tree growth varied with tree size and logging history. We compared our results with the legal values of diameter increments, mortality rates, and minimum cutting diameters used to build forest management plans in Cameroon. Diameter increment was found to vary with tree size for most of the species studied. The relationships between diameter increment and tree size were mostly humpback-shaped. The trees with diameters close to or lower than the reference minimum cutting diameter generally grew faster than the average. We also found that tree growth could slow for 1–2 years after timber exploitation and was then spurred for at least 5 years. The tree growth response to logging was nevertheless species-specific. This study provides new estimates of tree diameter increments and mortality rates that could help make more accurate forest projections and draw up sustainable management plans in Africa.

1 INTRODUCTION

In Central Africa, tropical rainforest covers 184.7 million hectares, of which 53 million hectares (28%) are currently exploited for timber production (FRMi, 2018). These exploited forests deliver key ecosystem services. They capture about 0.7 t of carbon per hectare per year (Hubau et al., 2020), harbor an extremely broad species diversity including key pollinators of tropical crops, regulate regional weather and freshwater quantity and quality (Brandon 2014), and provide livelihoods for at least 100 million people (De Wasseige et al., 2015). These forests are typically managed with logging, harvesting 1 or 2 large trees per hectare every 25–30 years. To ensure the sustainability of the timber production, sets of variables and criteria have been adopted in national regulations (Picard et al., 2012). However, like in other tropical forest biomes (Piponiot et al., 2019), concerns have been raised about the depletion of the harvestable stocks and the expected loss of timber production profitability (Karsenty and Gourlet-Fleury, 2016), highlighting the need for in-depth analysis of management strategies with forward-looking approaches.

Tree growth and mortality are two central processes for predicting the dynamics of mixed and structurally complex tropical rainforests. However, these processes are seldom routinely estimated or accurately modeled. First, estimating them requires long-term monitoring in difficult field conditions (Picard and Gourlet-Fleury, 2008). Second, their modeling is difficult because tree growth and mortality depend on numerous abiotic and biotic factors that are also seldom assessed, especially over large areas. Tree growth and mortality depend, among other factors, on the availability of light, nutrients, and water. However, these resources vary critically in space (e.g., variability in soil features) (e.g., Baribault et al., 2012; Jucker et al., 2018) and time (e.g., annual rainfall regime) (e.g., Battipaglia et al., 2015; Breugel et al., 2011; McDowell et al., 2018) and are shared unevenly among competing trees (Muller-Landau et al., 2006). The diversity and structural complexity that characterize most tropical forests (Leigh, 1975) make predicting the effects of biotic and abiotic factors on individual performance highly challenging. Tree growth and mortality are also affected by human activities and natural disturbances whose frequencies and magnitudes are changing (Battipaglia et al., 2015; McDowell et al., 2018).

Although new remote sensing technologies may help to better describe local tree environments (Chambers et al., 2007; Jucker et al., 2018; Ndamiyehe Ncutirakiza et al., 2020), most models of tree growth and mortality rely today on a few explanatory variables that can be routinely assessed during field inventories. These are mostly tree species, forest types, regions, and occasionally tree size and competition indices. Tree growth and mortality can be estimated per species or species group (e.g., Chao et al., 2008; Claeys et al., 2019; Gourlet-Fleury et al., 2005; Hérault et al., 2011), forest type or region. These estimates are then used to calibrate models of forest dynamics and to simulate the development of forests of known structure and composition (Claeys et al., 2019; Picard et al., 2009).

In Central Africa, simulating forest dynamics over one cutting cycle with this approach has been extensively used to assess the sustainability of timber exploitation (Picard et al., 2012). The industrial production of timber is based on periodic harvesting (cutting cycle about 25–30 years) of a few species that are commercially valuable, and trees whose diameter exceeds a species-specific threshold (minimum cutting diameter) (Nasi et al., 2012). This management system (polycyclic harvest system) is viable only if the stock (i.e., number, volume, and quality) of harvestable trees recovers between cuts (Picard et al., 2009) and if forests continue delivering their different ecosystem services in the long term (Cerutti et al., 2016; Miteva et al., 2015; Nasi et al., 2012). Estimating stock recovery has thus become an important task of sustainable forest management and is enforced by national regulations and certification schemes (Nasi et al., 2012).

Since the mid-1900s, periodic tree monitoring and tree ring analyses have been carried out to study variability in tree growth across species and regions in Central Africa. De Madron et al. (2000) reviewed these studies and collected a total of about 50 estimates of annual diameter increment for 17 species. Ten years later, Picard and Gourlet-Fleury (2011) made a second, in-depth review of the available data and literature. They collected a total of 1,713 estimates of annual diameter increment for 296 species. In both reviews, substantial differences were reported among estimates depending on species, site, forest type, disturbance history, tree size, and methodology.

Fewer studies have reported estimates of mortality rates. Picard and Gourlet-Fleury (2011) found a total of 537 estimates for 220 species. The paucity of accurate information prevented them from making separate estimates for undisturbed and disturbed forests. They also found no differences between species with contrasting light requirements and concluded that the commonly used mortality rate of 1% remained acceptable.

Despite the impressive work already done in collecting and analyzing field data, estimates of tree increment and mortality rates remain sparse (about six estimates of tree growth per species), scattered, and representative of only particular sites in a vast forest biome. It is therefore likely that most forest management plans are based on locally biased values of tree growth and mortality rates. The degree and extent of these biases remain to be further quantified.

To help fill this gap, for 1–7 years we annually monitored 21,180 trees belonging to 42 species, all except one of which were exploited for timber production, in eight sites in Central Africa. We made new estimates of diameter increments and mortality rates, and we investigated how tree size and logging history could affect tree growth and mortality rates to assess whether these factors deserved more place in forest dynamics simulations.

2 MATERIALS AND METHODS

2.1 SITES

Trees were sampled in eight sites in three countries: five in Cameroon, one in Gabon and two in the Republic of the Congo. Each site was located in a forest concession (Figure 1). The sites spanned a climatic gradient ranging from evergreen forest (e.g., Ma’an and Bambidie) to semi-deciduous forests (e.g., Mbang) (Réjou-Méchain et al., 2021) characterized by varyingly dry seasons with annual rainfall ranging across sites (Figure 1). The soils were composed of a geological basement of low Precambrian sedimentary and metamorphic rocks (Table 1) with the resulting soil classified as ferralsol, acrisol, plinthosol, or gleysol (Jones et al., 2013). Logging history also varied across sites. Some sites were in undisturbed forests where practically no anthropic perturbation occurred during the last century, whereas other sites were in forests where industrial logging likely occurred several times during the last century.

Table 1. Description of the main features of each site. The last column gives a subjective index of the relative intensity of past anthropic disturbances ranging from 0 (undisturbed forests where practically no anthropic perturbation occurred during the last century) to 3 (forest where industrial logging likely occurred several times during the last century). The country names in the site column are abbreviated (Cameroon = CMR, Gabon = GAB, Republic of the Congo = COG).

Site	**Topography**	**Geology and soil**	**Forest type adapted from Réjou-Méchain et al. (2021)**	**Forest structure and main distinguishing species**	**Anthropic disturbance index**
Mamfé, CMR	Mamfé Basin	Nitisols, nutrient rich, dark red, deep, well-drained soils derived from metamorphic rocks.	Atlantic evergreen forest	Old dense secondary forest with *Lophira alata* (and Caesalpinioideae)	1
Ma'an, CMR	South Cameroonian tableland	Yellow, partially hydromorphic or shallow orthic ferralitic soils derived from Early Precambrian rocks.	Mixed evergreen	Old secondary forest with *Lophira alata* (and Caesalpinioideae)	2
Mindourou, CMR	South Cameroonian tableland	Mixed with red or yellow ferralitic soils derived from Early Precambrian rocks.	Semi-deciduous-evergreen transition	Old and young mixed secondary forest with *Terminalia superba*, *Mansonia altissima, Triplochiton scleroxylon*, *Pericopsis elata*, *Baillonella toxisperma*, *Desbordesia glaucescens* and *Celtis* spp.	1
Djoum, CMR	South Cameroonian tableland	Modal orthic red soils derived from Early Precambrian rocks[8].	Semi-deciduous-evergreen transition	Mixed secondary forest with *Distemonanthus benthamianus, Cylicodiscus gabunensis* and *Celtis* spp.	3
Mbang, CMR	South Cameroonian tableland	Red or yellow ferralitic soils derived from Early Precambrian rocks.	Semi-deciduous	Old secondary forest with *Mansonia altissima, Sterculia rhinopetala* and *Celtis* spp.	3
Bambidie, GAB	Old sedimentary basins of Franceville and Okondja	Ferralitic cambisols, mostly shallow clay soils with very low nutrient retention capacity.	Mixed evergreen	Old secondary forest with *Aucoumea klaineana, Dacryodes buettneri* (and Caesalpinioideae)	1
Loundoungou, COG	Congo Basin	Quaternary alluvial deposits, mixed clay and sand yellow poor ferralitic soils.	Semi-deciduous-evergreen transition with temporally flooded and terra firma forests, including open canopy Marantaceae forests and monodominant (semi-)evergreen dense forests.	Old mixed secondary forest with *Celtis spp.*, *Erythrophleum suaveolens* and *Petersianthus macrocarpus* and almost intact *Gilbertiodendron dewevrei* monodominant forests	1
Mokabi, COG	Carnot tableland	Red sandy, deep and well drained soils will low capacity to retain nutrients and water.	Evergreen-semi-deciduous transition on sandstone.	Dense primary forest with *Manilkara mabokeensis* and *Cleistanthus caudatus*	0

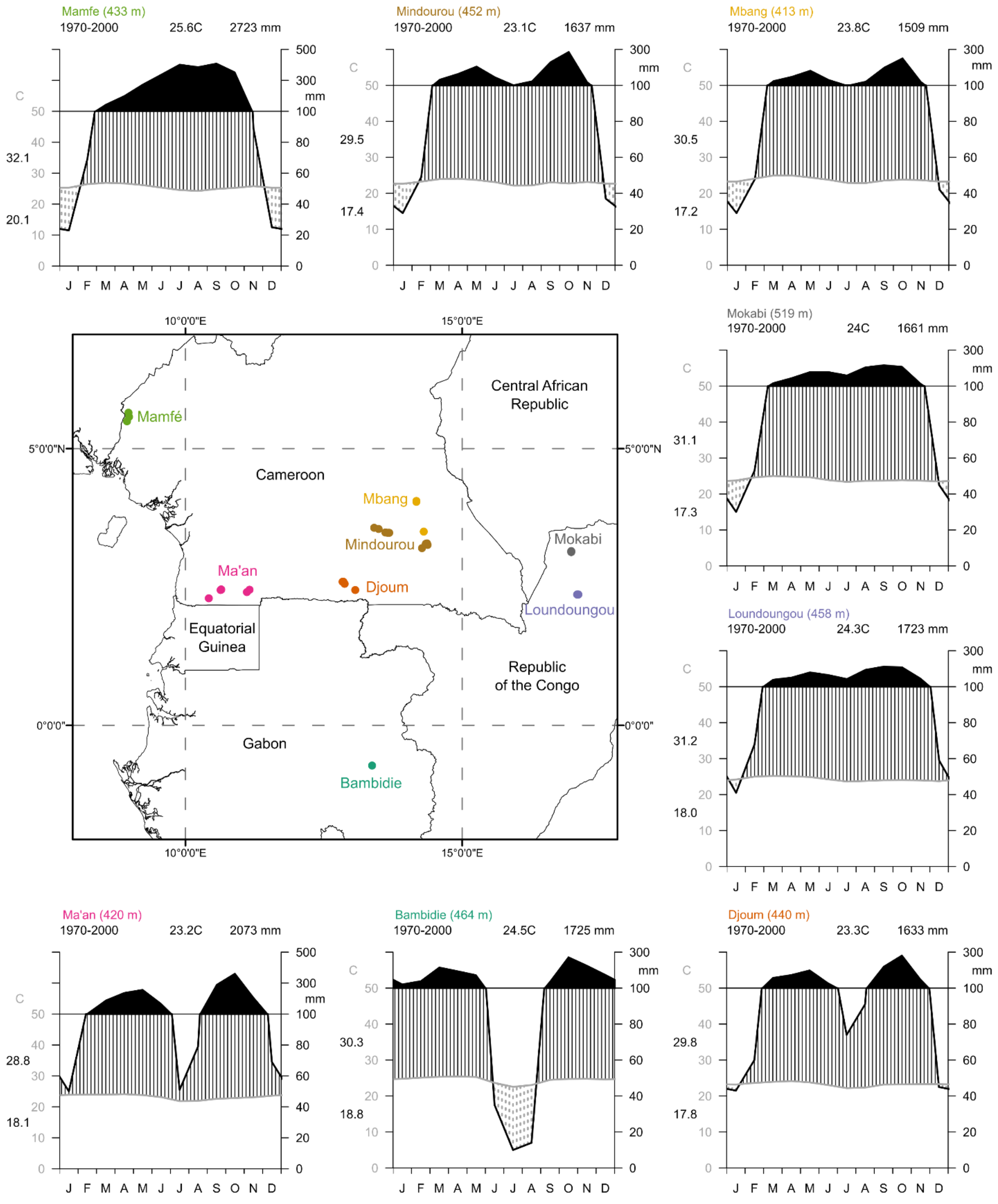

Figure 1. Location of the study sites and forest units in Central Africa with the Walter and Lieth diagrams corresponding to one of the forest units of each site. Climatic data were extracted from the WorldClim 2 database (Fick and Hijmans, 2017) and processed with the Climatol R package (Guijarro, 2019). The gray lines show mean monthly variation in temperature. The black lines show mean monthly variation in rainfall. The black areas depict rainy seasons. The dotted areas depict dry seasons.

2.2 TREE SAMPLING AND MEASUREMENTS

In the eight sites (Table 1), tree sampling was performed in forest units of about 500 ha. The logging history of each forest unit was classified as unlogged, logged, or unlogged-then-logged. Unlogged forest units were areas where no industrial exploitation had occurred for at least 20 years before the first measurement. Logged forest units were areas exploited 0–7 years before the first measurement. Unlogged-then-logged forest units were areas classified as unlogged at the first census but logged during the monitoring period. In both logged and unlogged-then-logged forest units, we checked that logging occurred in the same year in the entire forest unit.

For each selected forest unit, a set of studied species was defined. All the studied species except *Greenwayodendron suaveolens* (Engl. & Diels) Verdc. were commercially important timber species. *Greenwayodendron suaveolens* was selected because it could be found in all sites.

For each selected species and forest unit, we sampled and measured a total of 200 trees with 20 trees per 10 cm diameter class ([10–20[, [20–30[, …, [100, +∞[). The field crew advanced through the forest units and sampled trees until the target number of trees per diameter class and species was reached. They avoided selecting trees of the same diameter class that were close to each other. The trees were sampled independently of their health status, trunk shape, or tree crown position. Senescent understory trees with trunk irregularities were thus sampled alongside healthy canopy trees.

With this sampling strategy, we collected a large dataset with repeated measures for 21,180 trees. The total number of trees sampled per species ranged widely. For relatively scarce species (*Chrysophyllum beguei*, *Milicia excelsa*, *Bobgunnia fistuloides*, *Nauclea diderrichii*, *Khaya anthotheca*), we sampled fewer than 100 trees in one site, while for other species, more than 1000 trees were sampled across different sites and forest units (*Greenwayodendron suaveolens*, *Entandrophragma cylindricum*, *Erythrophleum suaveolens*, *Pterocarpus soyauxii*). On average, we sampled 481 trees per species and 189 trees per species and site. Such a dataset could not have been readily obtained by measuring trees in plots because of the very large number of plots required.

The differentiation of two species of *Erythrophleum* was difficult: they were assigned following the maps of Gorel et al. (2019) or to the *Erythrophleum* sp. taxon in one site (Djoum) where the two species coexisted (Gorel et al., 2019).

Each sampled tree was marked and located, and its diameter measured. The field crew painted an identifying number on the tree trunk and recorded its coordinates using a GPS unit (GARMIN^{TM} GPSMAP 64). The diameter was measured with a tape to the nearest millimeter. The point of measurement (POM) was also painted on the tree trunk (Figure 2). For trees with buttresses and other stem irregularities at breast height (1.3 m), the POM was raised 1 m above the buttresses or up to 4.5 m in height for the species known to rapidly develop tall buttresses (Figure 2). If buttresses or any other obstructive features (e.g., liana, wounds) reached the POM during the census interval, then a new POM was established higher, and the diameter was thereafter measured only at this new POM.

Figure 2. Measurement of tree diameter above buttresses with a tape.

2.3 DIAMETER INCREMENT

2.3.1 DATA CLEANSING

For most trees, the diameter was measured annually at least three times (i.e., in at least 2 years, see Suppl. Table 1). For each tree we fitted a linear model of tree diameter (d_i expressed in cm) as a function of the time interval since the first record (t_i expressed in years, Equation 1):

$$d_i = a + b \times \mathrm{t}_i + \varepsilon_i \ , \qquad \text{Eq. 1}$$

where *a* and *b* were the fitted parameters and ε_i the residuals. The fitted values of *b* provided estimates of the annual diameter increment This relationship was first used to identify outliers and salient observations that needed to be verified ($\mathrm{e.g.}, \varepsilon_i > 1.5$ cm and Cook's distance > 1) (Fox and Weisberg, 2011). In Mokabi, the trees were measured only twice (d_0 and d_t) and this procedure could not be applied. In this site, the increments (Δd) were computed with Equation 2 and we discarded increments of rank lower than the 1st percentile or higher than the 99th percentile:

$$\Delta d = \frac{d_t - d_0}{t} \ . \qquad \text{Eq. 2}$$

2.3.2 TREATMENT ASSIGNMENT OF DIAMETER INCREMENTS

All increments computed from the data collected in logged and unlogged forest units were assigned to the logged or unlogged treatment, respectively. In unlogged-then-logged forest units, the treatment was either logged or unlogged depending on observation dates and date of logging (Figure 3). The date of logging was not precisely known. We knew only the calendar year during which the logging occurred, so we took 30 June of that year as the logging date.

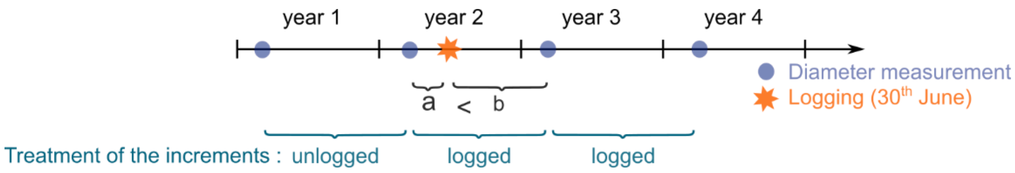

Figure 3. Treatment assignment of the computed diameter increments. Here, the second increment is assigned to the logged treatment because the period before the logging is shorter (a) than the period after the logging (b).

2.3.3 DIAMETER INCREMENT ESTIMATE

After data cleansing, we fitted Equation 1 again for each combination of tree, POM and treatment. The slope coefficients b of the fitted models were our estimates of diameter increment. For some combinations of tree and treatment, more than one increment could be obtained if the POM was raised during the monitoring period. In this case, we averaged the different estimates. The use of linear regressions to estimate the diameter increment was found to best take account of all observations (e.g., not only the first and last) and to handle observations that were unevenly distributed along the monitoring period.

2.4 MORTALITY RATE

For each forest unit, the considered period was the longest census interval in the unlogged treatment ranging between 1 and 7 years. In unlogged-then-logged forest units, we kept only the records that were made before the exploitation year. Dead trees were defined as trees whose location the field crew could confidently find and whose death they confirmed. Trees that were not found were not counted either as dead or surviving. This choice was made to avoid confounding dead trees with trees that were alive but not found or located in an area that had for example become inaccessible.

We focused on the mortality rates computed for the unlogged conditions because we had fewer data in the logged conditions. The mortality rates computed for the logged conditions are given in supplementary materials (Supplementary Material 7).

The mortality rate (λ) was calculated using Equation 3 (Condit et al., 1995):

$$\lambda = \frac{\ln(N_0) - \ln(N_t)}{t}, \qquad \text{Eq. 3}$$

where N_0 is the number of trees measured at the first census and N_t is the number of surviving trees after t years. We computed one estimate of λ per species and site thus aggregating the observations made in different forest units and during different census periods. t is the arithmetic mean of the census period length observed for the surviving trees. Condit et al. (1995) demonstrated that using the arithmetic mean provides reliable estimates.

Mortality rates computed over different census interval lengths are not rigorously comparable, λ having been reported to decrease with t owing to population heterogeneity (Lewis et al. 2004). The data series were too short to compute λ for a fixed period of 5 years as recommended by Lewis et al. (2004). Consequently, as Lewis et al. (2004) propose, we additionally report the standardized 1-year mortality rates using Equation 4.

$$\lambda_{\mathrm{corr}} = \lambda \times t^{0.08} \qquad \text{Eq. 4}$$

As mortality rate is generally very low (<1%), accurate estimates of mortality rates require large samples of trees monitored over long periods. For some combinations of site and species, the number of monitored trees was below 100, which was judged too low to compute accurate mortality rates (Picard and Gourlet-Fleury, 2008). Here we thus show only the estimates of mortality rates computed for the combinations of site and species with more than 100 monitored trees.

2.5 STATISTICAL ANALYSES

2.5.1 CONFIDENCE INTERVALS OF MEAN DIAMETER INCREMENTS

Mean diameter increments were computed for each combination of species, treatment, and site. Confidence intervals of mean diameter increments were computed assuming a normal distribution of the observations. This assumption did not hold for all samples, but these confidence intervals were mostly used for illustrative purposes.

2.5.2 COMPARISON WITH REFERENCE VALUES

Most management plans are drawn up assuming that tree growth rates are constant for the concerned diameter classes within a species. In some cases, reference values of tree growth rates are defined by local government such as in Cameroon (Ministère de l'Environnement et des Forêts, 1998). In Gabon and Congo, forest managers mostly used reference values from the literature (e.g. Picard and Gourlet-Fleury, 2011). However, locally, these estimates may be biased because tree growth varies substantially within such vast territories. To assess this bias, we compared our computed estimates of diameter increment with the values defined by the Cameroon government. This choice was essentially arbitrary but justified in that most of our study sites were in Cameroon. This should be considered as one study case. We tested the differences between our estimates and the reference values using the Wilcoxon rank sum test and correcting the obtained *p*-values for multiple tests by applying the Benjamini and Hochberg correction (Benjamini and Hochberg, 1995).

2.5.3 TREE SIZE AND SITE EFFECTS IN UNLOGGED FORESTS

We tested whether diameter increment varied with tree diameter with an additive mixed model fitted for each combination of species and site for which at least 20 trees were monitored (Eq. 5):

$$\Delta d_{j,s} = a + \mathrm{s}(d_{j,s}) + \alpha_s + \varepsilon_{j,s} \ , \qquad \text{Eq. 5}$$

where $\Delta d_{j,s}$ is the diameter increment of tree j in site s. a is a fixed number, $s(d_{j,s})$ is a fixed non-linear smooth function of tree diameter, and α_s is a random site effect. Using a smooth function had the advantage of needing no assumption about the nature of the relationship between diameter increment and initial tree diameter. To avoid model overfitting, we used cubic regression splines and forced a relatively simple overall shape (using only four base functions). The model was fitted using the mgcv package in R version 1.8-33 (Wood 2006).

2.5.4 DIAMETER INCREMENT IN LOGGED AND UNLOGGED FORESTS

We tested whether diameter increment was higher in logged than in unlogged forests for all combinations of site and species for which diameter increment could be computed in both conditions. In unlogged-then-logged forest units, the same trees were measured in both treatments. The null hypothesis could then be tested with Wilcoxon signed rank sum tests (non-parametric paired tests). In the other forest units where different trees were measured in the unlogged and logged treatment, we tested the treatment effect with

Kruskal-Wallis rank sum tests for each combination of site and species. The *p*-values obtained were corrected for multiple tests using the Benjamini and Hochberg correction.

The effect of logging on diameter increment was further examined by computing the differences between the mean diameter increment observed in logged and unlogged conditions. In particular, we analyzed the variation of the logging effect with the time elapsed between the censuses and the logging. The logging effect was also found to depend on both tree size and species, but as no general pattern was found, we placed this analysis in the supplementary material (Supplementary Material 6).

2.6 MORTALITY RATE CONFIDENCE INTERVALS

The credible intervals ($\alpha = 0.05$) of mortality rates were computed using a Bayesian framework (Kruschke, 2014). Assuming that the number of surviving trees (N_t) in a population of N_0 trees is the outcome of N_0 Bernouilli trials and using an uninformative beta prior $\mathrm{B}(1,1)$, the posterior distribution became the beta distribution $\mathrm{B}(N_0 + 1, N_0 - N_t + 1)$ from which the credible interval bounds of N_t could be computed using the quantiles 2.5% and 97.5%. The credible intervals of mortality rates λ were then computed with Equation 3.

3 RESULTS

3.1 MEAN DIAMETER INCREMENTS IN UNLOGGED FORESTS

Diameter increments varied considerably across the study species and sites (Figure 4, Suppl. Table S1). In unlogged forests, we assessed the diameter increment of 17,297 trees. The averaged estimates per study species and site ranged from 0.13 cm/year (*Afzelia bipindensis* in Loundoungou) to 1.47 cm/year (*Triplochiton scleroxylon* in Djoum). The mean of the census period length was 3.3 years and ranged from 0.9 (*Irvingia gabonensis* in Mindourou) to 6.8 years (*Lophira alata* in Mindourou).

Most study species were sampled in a limited number of sites. In the unlogged treatment, most species were monitored in fewer than four sites. Only two species were monitored in all sites (*Greenwayodendron suaveolens* and *Pterocarpus soyauxii*), three species in five sites (*Cylicodiscus gabunensis*, *Autranella congolensis* and *Erythrophleum suaveolens*) and five species in four sites (*Triplochiton scleroxylon*, *Lophira alata*, *Distemonanthus benthamianus*, *Entandrophragma cylindricum* and *Entandrophragma utile*).

Substantial differences in the estimates of diameter increment were observed across sites and for most species (Figure 4). This variation was modeled for all species that were monitored in several sites (α_s in Eq. 5). The site effect was found to be significant in most cases. It was not significant for only four species three of which (*Eribroma oblongum*, *Autranella congolensis* and *Baillonella toxisperma*) were monitored in only two sites and one (*Staudtia kamerunensis*) in three sites. The maximum standard deviation of α_s was 0.6 cm/year (*Triplochiton scleroxylon*, Suppl. Table S2). No general pattern was evidenced. The between-site variation was species-specific: some sites favored some species and disfavored others (Figure 4). For example in Mbang, *Autranella congolensis* grew fastest, whereas *Entandrophragma cylindricum* growth was slowest (Figure 4).

A few species exhibited remarkably low between-site variability, for example *Greenwayodendron suaveolens* and *Lophira alata*, which we measured in respectively eight and four sites. For these two species, our estimates ranged from 0.19 to 0.32 cm/year and from 0.42 to 0.47 cm/year, respectively.

We compared the species-specific estimates of diameter increment obtained in the unlogged treatment with the reference values (cf. Section 2.5.2). Differences were found between the estimates and the reference values of diameter increments. These differences ranged from −0.5 cm/year to 0.8 cm/year. We also expressed these differences in relative values by computing the ratio of our estimates to these legal values (Figure 5). This ratio ranged from 33% to 291%. Some of our diameter increment estimates were thus 3 times lower or higher than the reference values. 46% and 23% of our estimates were respectively significantly lower or higher than the corresponding reference values.

3.2 DIAMETER INCREMENT ACROSS TREE SIZE IN UNLOGGED FORESTS

Equation 5 was fitted for all species to test whether diameter increment depended on tree size. The significance level of the smooth function $s()$ is given in supplementary material (Suppl. Table S2) and significant relationships ($p < 0.05$) are shown in Figure 5. Significant relationships were found for 29 species over the 43 tested taxa. The relationships were mostly non-linear (edf mostly > 1 in Table S2 and Figure 5). For most species showing a significant $s()$ term, the diameter increment peaked for diameter classes relatively close to or below the reference minimum cutting diameter. For these diameter classes (where increment peaked), the predicted diameter increment was generally higher than the reference diameter increment (e.g., *Lophira alata*, *Entandrophragma cylindricum*, *Cylicodiscus gabunensis*). The percentage of explained variance averaged around 19% and ranged from 6% to 50% (Suppl. Table S2).

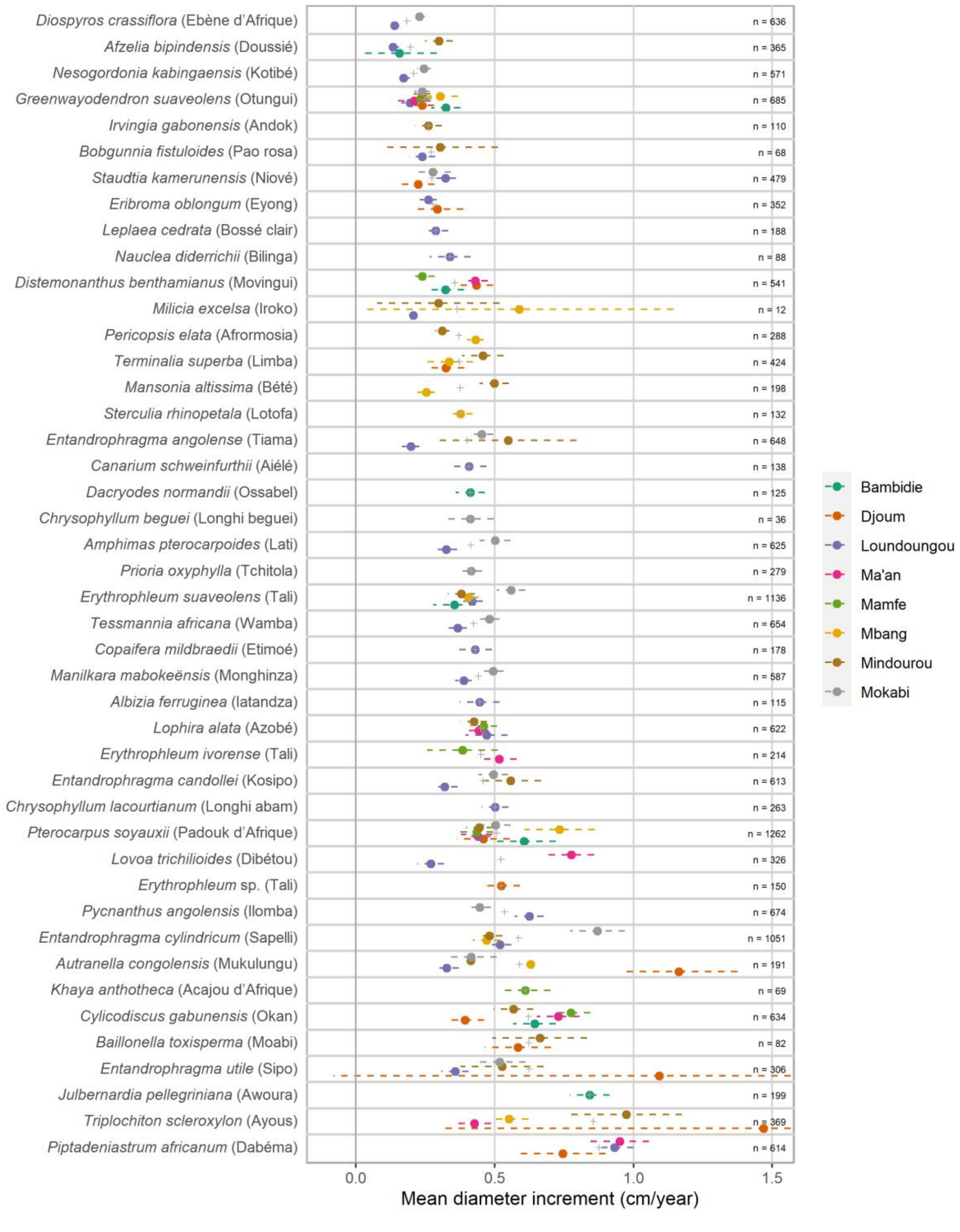

Figure 4. Variability of diameter increment estimates across species and sites. The points show the mean diameter increment by species and site. The error bars are 95% confidence intervals. The species are ordered by increasing mean diameter increment (gray crosses). The total number of monitored trees per species is shown on the right.

Figure 5. Ratio of observed mean diameter increment to the corresponding reference value. The ratios are computed for each species and site. A ratio value of 100% means that the observed increment is the same as the reference value. A ratio value of 200% means that we measured an increment double the reference value. The error bars flanking the points denote the 95% confidence intervals. The p-value level associated with the Wilcoxon rank sum tests is shown

with circles and triangles. The species are ordered by increasing mean value of this ratio (gray crosses). The total number of monitored trees per species is shown on the right.

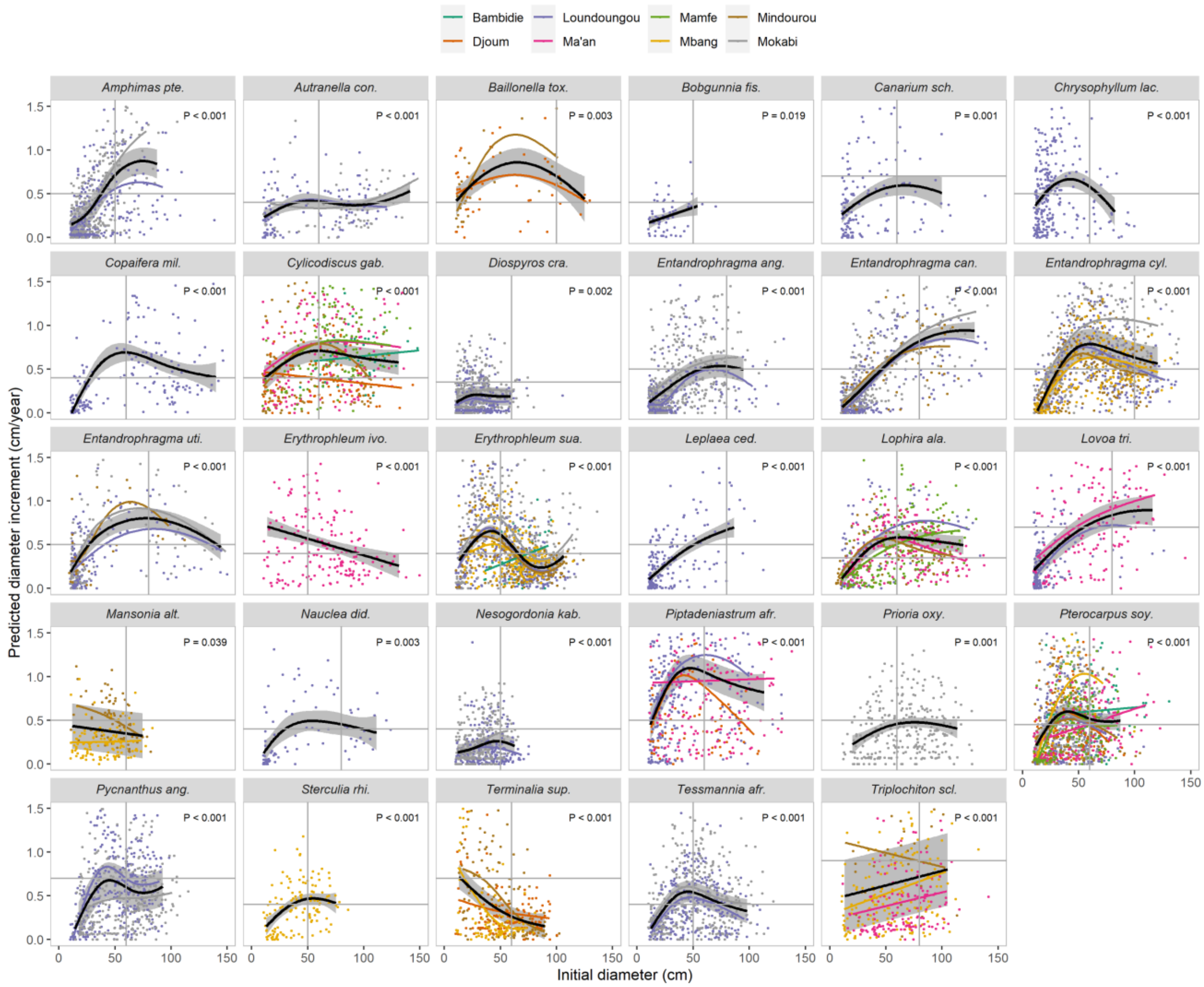

Figure 6. Relationships between diameter increment and initial diameter. The relationships are shown only for the 29 species for which the relationship was significant ($s()$ term in Equation 5). For the other 14 taxa, the relationships are shown in Supplementary Material (Figure S2.1). Black lines show the prediction of the model described in Equation 5. Colored lines show predictions of site-specific models. The horizontal and vertical gray lines indicate the species-specific reference values of diameter increment and minimum cutting diameter.

3.3 DIAMETER INCREMENT IN LOGGED AND UNLOGGED FORESTS

In logged forests, we assessed the diameter increment of 8,453 trees. The averaged estimates per study species and site ranged from 0.1 cm/year (*Diospyros crassiflora* in Loundoungou) to 1.59 cm/year (*Triplochiton scleroxylon* in Mindourou). The mean of the census period length was 2.4 years and ranged from 0.9 (*Greenwayodendron suaveolens* in Mamfe) to 7.2 years (*Entandrophragma cylindricum* in Mindourou).

The logging effect ranged from −0.46 to 0.62 cm/year (Suppl. Table S4). Very different effects were found depending on tree species and site. In Bambidie, we found a negative effect of logging for a notable proportion of the species, whereas positive effects were mostly found in Mindourou. In all sites except Mindourou, forest logging occurred less than 4 years before the monitoring period (Figure 7). This result therefore suggests that tree response to logging was site-specific or depended on the time elapsed between logging and the monitored period. To illustrate this second explanation, we computed the Pearson correlation coefficient between the logging effect and the time elapsed between logging and the censuses. The correlation coefficient was 0.46 and was significant (Figure 7).

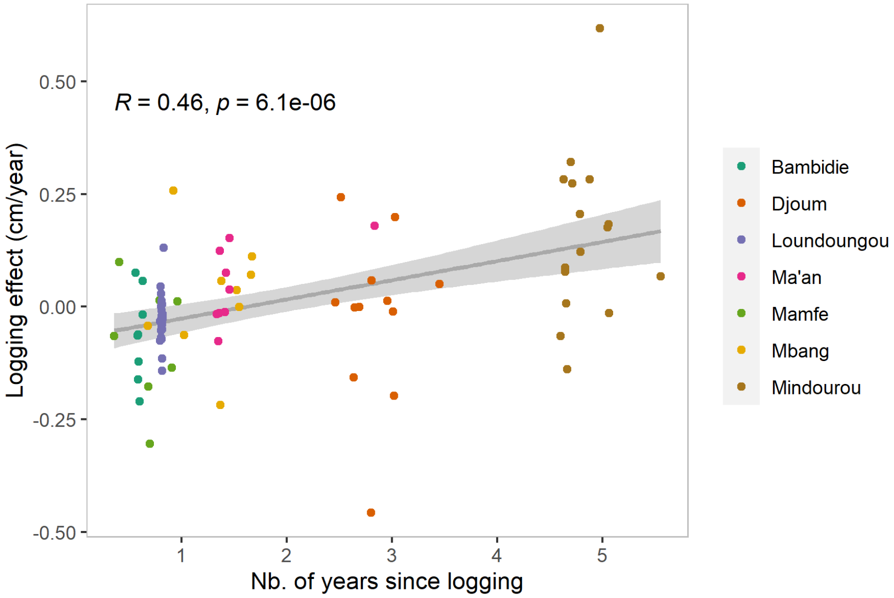

Figure 7. The logging effect is seen to increase with the time elapsed between logging and the monitored growing period in the logged treatment. The logging effect corresponds to the difference between the growth observed in the logged and unlogged treatments. In this figure, one point corresponds to the logging effect observed for one species and one site.

3.4 TREE MORTALITY RATES IN UNLOGGED FORESTS

We computed mortality rates by examining a total of 15,860 trees of 36 species that were monitored during varying census periods in the eight sites (Figure 8). The mean of the census period length was 2.8 years and ranged from 0.6 (*Piptadeniastrum africanum* in Ma'an) to 7 years (*Lophira alata* in Mindourou). Only 242 dead trees were recorded. The overall mortality rate was approximately 0.56% (λ_{corr} = 0.60%). Differences in λ and λ_{corr} were noted among sites and species but as the differences were negligible (Table S4) we continued with λ. Most values (80%) of our 74 estimates of λ were not statistically different from 1%. Fourteen (19%) estimates of λ were lower than 1% and only one was greater than 1% (1.4%, *Mansonia altissima*).

Figure 8. Estimates and 95% credible intervals of the mortality rates. The total number of monitored trees per species is given next to the credible intervals.

4 DISCUSSION

Using a particular sampling strategy, a large dataset of repeated tree measures was collected to compute estimates of tree diameter increments and mortality rates of 42 timber species in Central Africa. First, this study provides estimates of diameter increments averaged by species, site, treatment, and size class (Suppl. Table S1, Suppl. Table S2) together with mortality rates averaged by site and treatment (Suppl. Table S5, Suppl. Table S7) that can be directly used to forecast forest development and for example to compute the recovery rate of harvestable stocks between cutting cycles. Second, this dataset casts light on the potential biases in forest projections using reference values of tree diameter increments and mortality rates and applying them to site, tree size, logging history, and over time.

4.1 THERE WAS A SUBSTANTIAL WITHIN- AND BETWEEN-SITE VARIABILITY IN TREE GROWTH RATES

Tree growth in unlogged forests was found to vary remarkably across sites, species and individuals. We computed 112 estimates of annual diameter increments in forests that had not been exploited for timber for at least 20 years before the censuses. For most species, we noted that diameter increment varied across sites (Figure 4). The magnitude and sign of this site effect was not the same among the study species. Some sites favored some species and disfavored others, likely depending on species ecology (Baribault et al., 2012). Given the limitations of our tree sample (cf. Section 3.1), we could not model this spatial variability in diameter increment. We could therefore only provide increment estimates for the combinations of the species and sites we studied.

The within-site variability was also substantial and highlighted the influence of various other factors (Figure 6). This was expected because the tropical forests studied display a high level of compositional and structural complexity (Leigh, 1975; Richards, 1952). Tree performance (growth and survival) is known to depend critically on the size, proximity, and density of neighboring trees, and on the availability of resources (Baribault et al., 2012; Battipaglia et al., 2015; Jucker et al., 2018), which is changing over time (e.g., owing to disturbances and climate change) (McDowell et al., 2018; Zuidema et al., 2020). We did not attempt to model tree performance in response to changing local growing conditions (e.g., owing to climate change). Instead we assumed that the monitored trees were randomly selected across different forest types so that contrasting species-specific estimates could be obtained. This approach was also practical because the covariates required to describe the local environment (e.g., competition indices, liana loads) are not routinely assessed in inventories or implemented in the models used by forest managers. It has also been shown that the effect of species identity on tree growth can outweigh that of competition for other resources such as light (Laurans et al., 2014).

4.2 LEGAL TREE GROWTH RATES CAN BE OVERESTIMATED

In the absence of local estimates of tree growth, forest management plans are built using reference values, such as those set by the Cameroon administration (Ministère de l'Environnement et des Forêts, 1998). In this study, we compared reference values of annual diameter increment with our observed diameter increment averaged by site and species. Our analysis revealed that differences between the reference values and the averaged observations could range substantially, from 33% to 290%. In almost half (46%) of the studied combinations of species and sites, the trees grew more slowly than expected from the reference values. This high proportion of overestimated increment references is of concern, because using them can lead to overestimation of population recovery in management plans (Picard et al., 2008). We note nevertheless that such overestimation does not concern all species: opposite observations were also made but for only 23% of the study cases. For example, for *Baillonella toxisperma* and *Cylicodiscus* *gabunensis*, the reference diameter increment was lower than the observed increment in most studied sites (Figure 6).

4.3 LOGGING STIMULATES TEMPORARY TREE GROWTH AND THE MAGNITUDE OF THIS EFFECT VARIES GREATLY OVER TIME

Tree growth is likely affected by disturbances including logging but such responses vary in time (Gourlet-Fleury et al., 2013; Hérault et al., 2010; Vidal et al., 2016). Gourlet-Fleury et al. (2013) found in M'Baiki (Republic of Central Africa) that over 24 years after logging, the average above-ground biomass production in the logged plots was twice that observed in the control plots. Using data from the same experiment but focusing on *Triplochiton scleroxylon*, Ligot et al. (2019) confirmed that diameter growth followed the same pattern. They further stated that the growth response rapidly increased after logging and then gradually decreased. In total, the positive growth responses lasted over 10 to 15 years (Ligot et al., 2019). In this study, we were able to further refine this pattern. Examining diameter increment recorded 1 or 2 years after logging, we found no or even negative growth response. We hypothesize that immediately after logging, diameter growth rate decreases slightly (Figure 7) owing to an adaptation to the new growing conditions and possibly to logging damage (Shenkin et al., 2018). In the subsequent years, the increment might progressively increase before reaching a maximum growth rate, and finally revert to the level observed in unlogged forests as suggested by other studies (de Graaf et al., 1999; Gourlet-Fleury et al., 2013; Ligot et al., 2019).

Growth response to logging is, however, likely to be species- and site-specific. Logging intensity varied within and across sites and was generally lower than observed in other experimental plots such as those in M'Baiki (Gourlet-Fleury et al., 2013). In all sites, only a few species showed a significant growth response (Figure 7). Depending on site and presumably on forest structure, different species or functional groups could benefit from a canopy opening (Delcamp et al., 2008; Hérault et al., 2010; Peña-Claros et al., 2008; Villegas et al., 2009).

4.4 VARIABILITY OF TREE GROWTH RATES ACROSS TREE ONTOGENY AND DUE TO LOGGING COULD MITIGATE OVERESTIMATED REFERENCE VALUES

In line with previous studies, our data found that tree growth could vary greatly throughout ontogeny. According to Hérault et al. (2011), who studied tree growth in Paracou (French Guiana), tree growth trajectories vary greatly among species but for most of them, growth peaks when trees reach about 60% of their maximum size. Like Hérault et al. (2011), we also observed humpback-shaped growth trajectories for most studied species. Interestingly, growth trajectories mostly peaked for diameters close to the reference minimum cutting diameter (Figure 6). Different minimum cutting diameters are used across countries and regions. Nevertheless, as the growth peaks were generally wide (Figure 6), this trend should hold true for other countries and regions. In these conditions, the trees with diameter close to the harvestable dimensions grow faster than the average. The trees belonging to the diameter classes just below the minimum cutting diameter will therefore reach harvestable dimension faster than predicted using the reference value. Taking this effect into account, the estimate of population recovery as made in the management plans may underestimate the recovery of the harvestable stock in the short term.

Additionally, estimates of the annual diameter increment based on forest inventories, like those provided by this study, can underestimate the growth of the trees that will survive. We randomly sampled trees by diameter class regardless of the fate of each tree. The successful trees that will reach large dimensions might thus grow faster than the average of the sampled population. In structurally complex forests, the successful trees that reach large dimensions have likely experienced favorable growing conditions through a juvenile selection effect (Swaine et al., 1987; Terborgh et al., 1997) and persistent fast growth (Brienen and Zuidema, 2007; Groenendijk et al., 2017). During their ontogeny, such trees have faster growth and a lower probability of dying than most of the other trees. Using our estimate of the mean diameter increment could therefore also result in underestimation of forest recovery. However, the extent and variability of this bias is difficult to assess and still largely unknown. One solution requires combining diameter increments assessed from tree rings and field inventories (Ligot et al., 2019; Rozendaal et al., 2010).

Similarly, the effect of logging on the growth of remaining trees has been evidenced in many studies (e.g., Gourlet-Fleury et al., 2013) including this one, but this effect is usually ignored in most forest projections. Although further studies are needed to model tree growth response over longer time periods, it seems likely that the effect over one cutting cycle would be positive. Using increment data exclusively from unlogged forest, as recommended by Bracke et al. (2021), might therefore underestimate the true value.

The estimate of diameter increment as provided here might thus be slightly conservative, because its use can underestimate the recovery of the harvestable stock in the short term. Nevertheless, using such estimates of diameter increment to compute the recovery rate of the harvestable timber stock (e.g., with the “Dimako formula”, Durrieu De Madron et al., 1998) does not ensure the long-term sustainability of the polycyclic harvest system. Variation in tree mortality and tree recruitment could have even more importance in long-term simulations (Picard et al., 2009). Additionally, the evolution of timber quality is usually ignored even though this form of management gradually depletes the stocks of the most valuable trees (Picard et al., 2012).

4.5 USING A FIXED MORTALITY RATE OF 1% SEEMS ACCEPTABLE BUT FURTHER EFFORTS ARE REQUIRED TO PREDICT IT MORE ACCURATELY

Tree mortality depends on many factors (McDowell et al., 2018) and remains very challenging to assess and model. Monitoring tree mortality requires monitoring large tree populations for long periods. As tree mortality rate is intrinsically low (0.5–2% in Chao et al. (2008) and Lewis et al. (2004)), only a few dead trees can be recorded annually even if a large number of trees are monitored. In this study, despite monitoring over 15,000 trees for 2.8 years on average, we observed only 317 dead trees scattered across eight sites and 36 species. The number of sampled trees and the monitoring duration were likely too small to confidently and statistically evidence differences in mortality rates across species, sites, or other factors.

Our results here again support taking a mortality rate of 1% to perform forest projections (Picard and Gourlet-Fleury, 2011). Most of our estimates of mortality rates were not statistically different from 1% (Supplementary Material 7). Clearly, using a constant value across sites, species and tree size is a simplification. Though mostly statistically insignificant, we observed a substantial variability in the mortality rates across sites and species (Figure 8). Such variability was expected and has been partly related to forest structure and diversity (Baker et al., 2004; Malhi et al., 2006; ter Steege et al., 2006) of species traits such as wood density (Baker et al., 2004; Chao et al., 2008), tree size, and vigor (Chao et al., 2008).

4.6 PRACTICAL RECOMMENDATIONS

This study underlines that field monitoring of tree growth and mortality are valuable and provide insight into forest population dynamics. Monitoring nevertheless requires substantial efforts as it must include large numbers of trees and annually repeated measurements over long periods. As recommended by Lewis et al. (2004), we consider that monitoring tree growth and mortality should be performed for at least 5 years, i.e. using a longer census period than here. Repeated measures of tree diameter facilitate the detection of inevitable measurement errors and provide more robust estimates of tree growth that are less affected by inter-annual variability. If periods are too short, too few dead trees will be tallied, and mortality rates cannot be accurately estimated or modeled. Our experience also shows that monitoring thousands of trees annually for 5 years is logistically feasible. Given that forest dynamics can vary substantially across sites, we recommend implementing tree monitoring in each forest enterprise. Such monitoring should be carried out as a priority in unlogged areas. In logged forests, longer monitoring periods could be required as tree growth and mortality are expected to vary substantially for 10–20 years after logging (de Graaf et al., 1999; Gourlet-Fleury et al., 2013; Ligot et al., 2019). In logged forests, the monitoring should also begin immediately after logging to obtain as complete a picture as possible of the tree growth response.

5 CONCLUSION

We performed annual monitoring of more than 20,000 trees in Central Africa to acquire and deliver estimates of tree growth and mortality rates of 42 timber species in logged and unlogged forests. Such estimates and monitoring are essential to better understand the dynamics of tropical forests and to develop sustainable management plans. Moreover, forest management plans in Central Africa are mostly built using species-specific values of annual diameter increment (and mortality rates) and assuming them constant across tree size or over time. This study appraises this assumption and brings key insights into the variability in tree growth with tree size and logging history. We found that the Cameroon legal values of diameter increment were often overestimated, highlighting the need for a study to provide new estimates of tree growth rates. Additionally, our estimates of mortality rates were mostly lower than the mortality rate usually applied (1%). Although the demography of the overall population could be reliably predicted, the substantial variability in tree growth and mortality across species and sites remains a major brake on accurately predicting how species populations evolve at the local scale.

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7 SUPPLEMENTARY MATERIAL

Data and scripts are also available at *https://doi.org/10.1 8167/DVN1/EBN15Y*.

7.1 SUPPLEMENTARY MATERIAL 1: SAMPLE DESCRIPTION AND DIAMETER INCREMENT ESTIMATES

Table S1. Summary table by site, species, and treatment: number of diameter increment observations, number of monitored trees, mean of diameter increments, standard deviation of diameter increments, mean period duration of increments, first and last monitoring year.

Site	Species	Treatment	n_{obs}	n_{tree}	m	sd	period	First yr.	Last yr.
Bambidie	Julbernardia pellegriniana	Unlogged	574	199	0.84	0.52	1.90	2015	2018
Bambidie	Julbernardia pellegriniana	Logged	519	179	0.91	0.62	1.90	2017	2019
Bambidie	Afzelia bipindensis	Unlogged	23	8	0.16	0.16	1.87	2015	2017
Bambidie	Afzelia bipindensis	Logged	21	7	0.22	0.26	1.99	2017	2019
Bambidie	Distemonanthus benthamianus	Unlogged	285	100	0.32	0.34	1.91	2015	2018
Bambidie	Distemonanthus benthamianus	Logged	270	92	0.16	0.24	1.92	2017	2019
Bambidie	Cylicodiscus gabunensis	Unlogged	143	50	0.64	0.27	1.87	2015	2017
Bambidie	Cylicodiscus gabunensis	Logged	82	28	0.44	0.31	1.91	2017	2019
Bambidie	Dacryodes normandii	Unlogged	357	125	0.41	0.30	1.88	2015	2017
Bambidie	Dacryodes normandii	Logged	358	121	0.29	0.28	1.95	2017	2019
Bambidie	Greenwayodendron suaveolens	Unlogged	243	84	0.32	0.24	1.89	2015	2017
Bambidie	Greenwayodendron suaveolens	Logged	224	76	0.24	0.20	1.93	2017	2019
Bambidie	Pterocarpus soyauxii	Unlogged	158	54	0.61	0.42	1.94	2015	2017
Bambidie	Pterocarpus soyauxii	Logged	146	50	0.55	0.40	1.91	2017	2019
Bambidie	Erythrophleum suaveolens	Unlogged	132	46	0.36	0.26	1.92	2015	2017
Bambidie	Erythrophleum suaveolens	Logged	111	37	0.29	0.31	1.99	2017	2019
Djoum	Triplochiton scleroxylon	Unlogged	15	5	1.47	0.92	1.45	2015	2017
Djoum	Piptadeniastrum africanum	Unlogged	274	93	0.75	0.75	1.54	2015	2017
Djoum	Piptadeniastrum africanum	Logged	141	48	0.59	0.43	1.97	2015	2017
Djoum	Eribroma oblongum	Unlogged	144	49	0.29	0.32	1.40	2015	2017
Djoum	Eribroma oblongum	Logged	190	65	0.49	0.35	1.95	2015	2017
Djoum	Terminalia superba	Unlogged	465	158	0.32	0.42	1.55	2015	2017
Djoum	Terminalia superba	Logged	382	130	0.38	0.35	1.96	2015	2017
Djoum	Baillonella toxisperma	Unlogged	160	54	0.58	0.43	1.58	2015	2017
Djoum	Baillonella toxisperma	Logged	77	26	0.83	0.32	1.96	2015	2017
Djoum	Distemonanthus benthamianus	Unlogged	418	142	0.43	0.36	1.57	2015	2017
Djoum	Distemonanthus benthamianus	Logged	45	15	0.48	0.29	1.92	2015	2017
Djoum	Autranella congolensis	Unlogged	6	2	1.16	0.02	1.60	2015	2017
Djoum	Autranella congolensis	Logged	12	4	0.71	0.11	2.07	2015	2017
Djoum	Staudtia kamerunensis	Unlogged	330	113	0.22	0.32	1.57	2015	2017
Djoum	Staudtia kamerunensis	Logged	423	143	0.23	0.25	2.00	2015	2017
Djoum	Cylicodiscus gabunensis	Unlogged	348	118	0.39	0.38	1.53	2015	2017

Site	Species	Treatment	n_{obs}	n_{tree}	m	sd	period	First yr.	Last yr.
Djoum	Cylicodiscus gabunensis	Logged	299	103	0.39	0.32	1.96	2015	2017
Djoum	Greenwayodendron suaveolens	Unlogged	222	75	0.24	0.19	1.57	2015	2017
Djoum	Greenwayodendron suaveolens	Logged	331	112	0.24	0.21	2.05	2015	2017
Djoum	Pterocarpus soyauxii	Unlogged	300	102	0.46	0.48	1.55	2015	2017
Djoum	Pterocarpus soyauxii	Logged	367	125	0.45	0.40	1.94	2015	2017
Djoum	Entandrophragma utile	Unlogged	9	3	1.09	0.47	1.79	2015	2017
Djoum	Entandrophragma utile	Logged	36	12	0.90	0.39	1.99	2015	2017
Djoum	Erythrophleum sp.	Unlogged	440	150	0.52	0.42	1.52	2015	2017
Djoum	Erythrophleum sp.	Logged	414	140	0.54	0.43	1.78	2015	2017
Loundoungou	Canarium schweinfurthii	Unlogged	625	138	0.41	0.38	3.52	2015	2020
Loundoungou	Canarium schweinfurthii	Logged	120	60	0.35	0.35	1.01	2018	2019
Loundoungou	Lophira alata	Unlogged	453	100	0.47	0.39	3.50	2015	2020
Loundoungou	Lophira alata	Logged	72	36	0.45	0.36	1.02	2018	2019
Loundoungou	Lovoa trichilioides	Unlogged	762	172	0.27	0.32	3.49	2015	2020
Loundoungou	Lovoa trichilioides	Logged	140	70	0.31	0.37	1.01	2018	2019
Loundoungou	Nauclea diderrichii	Unlogged	389	88	0.34	0.35	3.46	2015	2020
Loundoungou	Nauclea diderrichii	Logged	96	48	0.16	0.30	1.02	2018	2019
Loundoungou	Leplaea cedrata	Unlogged	857	188	0.29	0.32	3.50	2015	2020
Loundoungou	Leplaea cedrata	Logged	138	69	0.21	0.27	1.01	2018	2019
Loundoungou	Piptadeniastrum africanum	Unlogged	1494	333	0.93	0.65	3.55	2015	2020
Loundoungou	Piptadeniastrum africanum	Logged	282	141	0.87	0.72	1.02	2018	2019
Loundoungou	Afzelia bipindensis	Unlogged	1257	277	0.13	0.19	3.57	2015	2020
Loundoungou	Afzelia bipindensis	Logged	212	106	0.12	0.25	1.01	2018	2019
Loundoungou	Diospyros crassiflora	Unlogged	1409	315	0.14	0.17	3.55	2015	2020
Loundoungou	Diospyros crassiflora	Logged	296	148	0.11	0.19	1.02	2018	2019
Loundoungou	Copaifera mildbraedii	Unlogged	786	178	0.43	0.40	3.55	2015	2020
Loundoungou	Copaifera mildbraedii	Logged	192	96	0.41	0.45	1.01	2018	2019
Loundoungou	Eribroma oblongum	Unlogged	1378	303	0.26	0.27	3.53	2015	2020
Loundoungou	Eribroma oblongum	Logged	224	112	0.23	0.30	1.02	2018	2019
Loundoungou	Albizia ferruginea	Unlogged	524	115	0.45	0.39	3.48	2015	2020
Loundoungou	Albizia ferruginea	Logged	84	42	0.49	0.56	1.01	2018	2019
Loundoungou	Pycnanthus angolensis	Unlogged	1527	342	0.62	0.49	3.56	2015	2020
Loundoungou	Pycnanthus angolensis	Logged	332	166	0.50	0.46	1.01	2018	2019
Loundoungou	Milicia excelsa	Unlogged	4	1	0.21	#N/A	3.37	2015	2018
Loundoungou	Milicia excelsa	Logged	2	1	0.00	#N/A	1.00	2018	2019
Loundoungou	Entandrophragma candollei	Unlogged	1307	296	0.32	0.41	3.52	2015	2020
Loundoungou	Entandrophragma candollei	Logged	298	149	0.27	0.40	1.01	2018	2019
Loundoungou	Nesogordonia kabingaensis	Unlogged	1178	264	0.17	0.19	3.55	2015	2020
Loundoungou	Nesogordonia kabingaensis	Logged	242	121	0.15	0.27	1.01	2018	2019
Loundoungou	Amphimas pterocarpoides	Unlogged	1461	324	0.33	0.36	3.57	2015	2020

Site	Species	Treatment	n_{obs}	n_{tree}	m	sd	period	First yr.	Last yr.
Loundoungou	Amphimas pterocarpoides	Logged	304	152	0.36	0.42	1.02	2017	2019
Loundoungou	Chrysophyllum lacourtianum	Unlogged	1166	263	0.50	0.40	3.53	2015	2020
Loundoungou	Chrysophyllum lacourtianum	Logged	248	124	0.49	0.42	1.02	2018	2019
Loundoungou	Autranella congolensis	Unlogged	532	118	0.33	0.24	3.49	2015	2020
Loundoungou	Autranella congolensis	Logged	100	50	0.32	0.27	1.02	2018	2019
Loundoungou	Staudtia kamerunensis	Unlogged	921	204	0.32	0.28	3.57	2015	2020
Loundoungou	Staudtia kamerunensis	Logged	166	83	0.27	0.24	1.02	2018	2019
Loundoungou	Greenwayodendron suaveolens	Unlogged	486	105	0.19	0.15	3.61	2015	2020
Loundoungou	Greenwayodendron suaveolens	Logged	64	32	0.16	0.24	1.01	2018	2019
Loundoungou	Manilkara mabokeënsis	Unlogged	1442	321	0.39	0.28	3.56	2015	2020
Loundoungou	Manilkara mabokeënsis	Logged	286	143	0.31	0.29	1.02	2018	2019
Loundoungou	Pterocarpus soyauxii	Unlogged	1324	293	0.44	0.40	3.60	2015	2020
Loundoungou	Pterocarpus soyauxii	Logged	270	135	0.46	0.54	1.02	2018	2019
Loundoungou	Bobgunnia fistuloides	Unlogged	263	59	0.24	0.18	3.52	2015	2020
Loundoungou	Bobgunnia fistuloides	Logged	54	27	0.37	0.37	1.01	2018	2019
Loundoungou	Entandrophragma cylindricum	Unlogged	1531	343	0.52	0.39	3.55	2015	2020
Loundoungou	Entandrophragma cylindricum	Logged	280	140	0.43	0.42	1.02	2017	2019
Loundoungou	Entandrophragma utile	Unlogged	778	175	0.36	0.33	3.56	2015	2020
Loundoungou	Entandrophragma utile	Logged	160	80	0.32	0.36	1.02	2018	2019
Loundoungou	Erythrophleum suaveolens	Unlogged	1652	369	0.42	0.39	3.58	2015	2020
Loundoungou	Erythrophleum suaveolens	Logged	328	164	0.44	0.50	1.01	2018	2019
Loundoungou	Entandrophragma angolense	Unlogged	1330	299	0.20	0.28	3.55	2015	2020
Loundoungou	Entandrophragma angolense	Logged	288	144	0.18	0.37	1.01	2018	2019
Loundoungou	Tessmannia africana	Unlogged	1442	324	0.37	0.31	3.54	2015	2020
Loundoungou	Tessmannia africana	Logged	304	152	0.25	0.25	1.01	2018	2019
Ma'an	Triplochiton scleroxylon	Unlogged	851	148	0.43	0.37	5.00	2011	2017
Ma'an	Lophira alata	Unlogged	824	214	0.44	0.27	2.91	2011	2017
Ma'an	Lophira alata	Logged	1377	318	0.53	0.35	3.14	2012	2016
Ma'an	Lovoa trichilioides	Unlogged	644	154	0.78	0.52	3.34	2011	2017
Ma'an	Lovoa trichilioides	Logged	270	83	0.99	0.60	2.14	2013	2017
Ma'an	Piptadeniastrum africanum	Unlogged	767	188	0.95	0.74	3.23	2011	2017
Ma'an	Piptadeniastrum africanum	Logged	414	127	0.90	0.77	2.16	2013	2016
Ma'an	Distemonanthus benthamianus	Unlogged	756	191	0.43	0.32	3.05	2011	2017
Ma'an	Distemonanthus benthamianus	Logged	436	134	0.36	0.29	2.22	2012	2016
Ma'an	Cylicodiscus gabunensis	Unlogged	800	174	0.73	0.51	3.75	2011	2017
Ma'an	Cylicodiscus gabunensis	Logged	231	68	0.85	0.59	2.34	2013	2016
Ma'an	Greenwayodendron suaveolens	Unlogged	114	39	0.21	0.19	2.47	2013	2017
Ma'an	Greenwayodendron suaveolens	Logged	72	26	0.38	0.27	2.60	2013	2016
Ma'an	Pterocarpus soyauxii	Unlogged	600	165	0.43	0.37	2.72	2011	2017
Ma'an	Pterocarpus soyauxii	Logged	436	130	0.42	0.37	2.27	2013	2016

Site	Species	Treatment	n_{obs}	n_{tree}	m	sd	period	First yr.	Last yr.
Ma'an	Erythrophleum ivorense	Unlogged	728	198	0.52	0.44	2.75	2011	2017
Ma'an	Erythrophleum ivorense	Logged	548	170	0.52	0.41	2.14	2013	2016
Mamfe	Lophira alata	Unlogged	1164	198	0.46	0.35	5.27	2011	2016
Mamfe	Lophira alata	Logged	272	136	0.47	0.38	1.58	2015	2017
Mamfe	Distemonanthus benthamianus	Unlogged	640	108	0.24	0.24	5.07	2011	2016
Mamfe	Distemonanthus benthamianus	Logged	40	20	0.06	0.18	1.36	2015	2017
Mamfe	Khaya anthotheca	Unlogged	409	69	0.61	0.38	5.19	2011	2016
Mamfe	Khaya anthotheca	Logged	32	16	0.62	0.48	1.42	2015	2017
Mamfe	Cylicodiscus gabunensis	Unlogged	839	144	0.78	0.43	5.16	2011	2016
Mamfe	Cylicodiscus gabunensis	Logged	30	15	0.64	0.50	1.12	2015	2017
Mamfe	Greenwayodendron suaveolens	Unlogged	271	69	0.23	0.16	2.61	2014	2016
Mamfe	Greenwayodendron suaveolens	Logged	98	49	0.33	0.28	0.88	2016	2017
Mamfe	Pterocarpus soyauxii	Unlogged	795	136	0.43	0.35	5.01	2011	2016
Mamfe	Pterocarpus soyauxii	Logged	140	70	0.13	0.24	1.48	2015	2017
Mamfe	Erythrophleum ivorense	Unlogged	92	16	0.38	0.24	5.06	2011	2016
Mamfe	Erythrophleum ivorense	Logged	18	9	0.32	0.38	1.06	2015	2017
Mbang	Pericopsis elata	Unlogged	584	120	0.43	0.17	3.84	2009	2014
Mbang	Pericopsis elata	Logged	436	111	0.50	0.21	2.93	2012	2016
Mbang	Triplochiton scleroxylon	Unlogged	1068	181	0.55	0.48	4.94	2009	2015
Mbang	Triplochiton scleroxylon	Logged	600	174	0.81	0.63	2.44	2014	2017
Mbang	Mansonia altissima	Unlogged	688	118	0.25	0.17	4.87	2009	2015
Mbang	Mansonia altissima	Logged	379	104	0.19	0.19	2.64	2014	2017
Mbang	Terminalia superba	Unlogged	567	108	0.34	0.45	4.23	2009	2015
Mbang	Terminalia superba	Logged	331	91	0.37	0.37	2.68	2012	2017
Mbang	Milicia excelsa	Unlogged	22	4	0.59	0.35	5.25	2009	2015
Mbang	Milicia excelsa	Logged	13	4	0.33	0.38	2.18	2013	2017
Mbang	Sterculia rhinopetala	Unlogged	910	132	0.38	0.26	5.91	2009	2015
Mbang	Sterculia rhinopetala	Logged	379	127	0.34	0.27	2.01	2015	2017
Mbang	Autranella congolensis	Unlogged	7	1	0.63	#N/A	5.98	2009	2015
Mbang	Autranella congolensis	Logged	3	1	0.72	#N/A	1.96	2015	2017
Mbang	Greenwayodendron suaveolens	Unlogged	350	126	0.30	0.37	1.71	2012	2015
Mbang	Greenwayodendron suaveolens	Logged	385	116	0.34	0.28	2.55	2012	2017
Mbang	Pterocarpus soyauxii	Unlogged	347	58	0.73	0.48	4.95	2009	2015
Mbang	Pterocarpus soyauxii	Logged	178	53	0.54	0.41	2.44	2012	2017
Mbang	Entandrophragma cylindricum	Unlogged	826	174	0.47	0.33	3.71	2009	2013
Mbang	Entandrophragma cylindricum	Logged	531	134	0.60	0.39	3.00	2012	2016
Mbang	Erythrophleum suaveolens	Unlogged	937	184	0.41	0.26	4.11	2009	2016
Mbang	Erythrophleum suaveolens	Logged	526	142	0.41	0.30	2.78	2012	2017
Mindourou	Irvingia gabonensis	Unlogged	220	110	0.26	0.25	0.90	2018	2019
Mindourou	Pericopsis elata	Unlogged	1159	168	0.31	0.17	5.82	2013	2019

Site	Species	Treatment	n_{obs}	n_{tree}	m	sd	period	First yr.	Last yr.
Mindourou	Pericopsis elata	Logged	1030	171	0.40	0.19	6.86	2012	2019
Mindourou	Triplochiton scleroxylon	Unlogged	237	35	0.97	0.58	5.41	2013	2019
Mindourou	Triplochiton scleroxylon	Logged	784	115	1.59	0.79	6.83	2012	2019
Mindourou	Lophira alata	Unlogged	852	110	0.42	0.25	6.80	2011	2019
Mindourou	Mansonia altissima	Unlogged	546	80	0.50	0.24	5.50	2013	2019
Mindourou	Mansonia altissima	Logged	999	146	0.67	0.35	7.14	2012	2019
Mindourou	Afzelia bipindensis	Unlogged	538	80	0.30	0.22	5.54	2013	2019
Mindourou	Afzelia bipindensis	Logged	421	62	0.29	0.20	6.31	2013	2019
Mindourou	Terminalia superba	Unlogged	1071	158	0.46	0.48	5.66	2013	2019
Mindourou	Terminalia superba	Logged	1132	181	0.66	0.62	7.01	2012	2019
Mindourou	Milicia excelsa	Unlogged	41	7	0.30	0.24	4.85	2013	2019
Mindourou	Milicia excelsa	Logged	173	32	0.62	0.40	4.69	2012	2019
Mindourou	Entandrophragma candollei	Unlogged	303	60	0.56	0.43	4.11	2013	2019
Mindourou	Entandrophragma candollei	Logged	313	61	0.56	0.37	4.23	2012	2019
Mindourou	Baillonella toxisperma	Unlogged	138	28	0.66	0.44	3.99	2015	2019
Mindourou	Baillonella toxisperma	Logged	393	79	0.60	0.43	3.98	2015	2019
Mindourou	Autranella congolensis	Unlogged	5	1	0.41	#N/A	4.08	2015	2019
Mindourou	Cylicodiscus gabunensis	Unlogged	759	148	0.57	0.44	4.17	2013	2019
Mindourou	Cylicodiscus gabunensis	Logged	757	151	0.85	0.58	4.04	2012	2019
Mindourou	Greenwayodendron suaveolens	Unlogged	593	86	0.24	0.14	5.80	2013	2019
Mindourou	Greenwayodendron suaveolens	Logged	470	78	0.31	0.19	5.55	2012	2019
Mindourou	Pterocarpus soyauxii	Unlogged	965	182	0.44	0.34	4.34	2013	2019
Mindourou	Pterocarpus soyauxii	Logged	879	169	0.52	0.42	4.31	2012	2019
Mindourou	Bobgunnia fistuloides	Unlogged	53	9	0.30	0.27	4.84	2013	2019
Mindourou	Bobgunnia fistuloides	Logged	78	15	0.49	0.38	4.65	2014	2019
Mindourou	Entandrophragma cylindricum	Unlogged	1477	213	0.48	0.34	5.82	2013	2019
Mindourou	Entandrophragma cylindricum	Logged	1359	212	0.76	0.48	7.17	2012	2019
Mindourou	Entandrophragma utile	Unlogged	190	35	0.53	0.44	4.42	2013	2019
Mindourou	Entandrophragma utile	Logged	267	49	0.80	0.54	4.73	2012	2019
Mindourou	Erythrophleum suaveolens	Unlogged	1321	195	0.38	0.34	5.71	2013	2019
Mindourou	Erythrophleum suaveolens	Logged	999	161	0.50	0.37	7.09	2012	2019
Mindourou	Entandrophragma angolense	Unlogged	85	17	0.55	0.48	4.05	2015	2019
Mindourou	Entandrophragma angolense	Logged	197	39	0.41	0.37	4.12	2012	2019
Mokabi	Diospyros crassiflora	Unlogged	642	321	0.23	0.18	1.55	2015	2017
Mokabi	Pycnanthus angolensis	Unlogged	664	332	0.45	0.39	1.54	2015	2017
Mokabi	Entandrophragma candollei	Unlogged	514	257	0.50	0.43	1.52	2015	2017
Mokabi	Nesogordonia kabingaensis	Unlogged	614	307	0.24	0.22	1.53	2015	2017
Mokabi	Amphimas pterocarpoides	Unlogged	602	301	0.50	0.49	1.54	2015	2017
Mokabi	Chrysophyllum beguei	Unlogged	72	36	0.41	0.25	1.62	2016	2017
Mokabi	Autranella congolensis	Unlogged	138	69	0.41	0.38	1.56	2015	2017

Site	Species	Treatment	n_{obs}	n_{tree}	m	sd	period	First yr.	Last yr.
Mokabi	Staudtia kamerunensis	Unlogged	324	162	0.28	0.43	1.51	2015	2017
Mokabi	Greenwayodendron suaveolens	Unlogged	202	101	0.24	0.14	1.54	2015	2017
Mokabi	Manilkara mabokeënsis	Unlogged	532	266	0.49	0.32	1.53	2015	2017
Mokabi	Pterocarpus soyauxii	Unlogged	544	272	0.50	0.46	1.53	2015	2017
Mokabi	Entandrophragma cylindricum	Unlogged	642	321	0.87	0.90	1.56	2015	2017
Mokabi	Entandrophragma utile	Unlogged	186	93	0.52	0.46	1.58	2015	2017
Mokabi	Erythrophleum suaveolens	Unlogged	684	342	0.56	0.48	1.55	2015	2017
Mokabi	Prioria oxyphylla	Unlogged	558	279	0.41	0.34	1.53	2015	2017
Mokabi	Entandrophragma angolense	Unlogged	664	332	0.45	0.40	1.57	2015	2017
Mokabi	Tessmannia africana	Unlogged	660	330	0.48	0.34	1.53	2015	2017

7.2 SUPPLEMENTARY MATERIAL 2: RELATIONSHIPS BETWEEN TREE DIAMETER AND DIAMETER INCREMENT

For each species, the model of Eq. 5 was fitted and the results are shown in Table S2. Significant relationships are illustrated in the main text and nonsignificant relationships are illustrated below (Figure S2.1).

Table S2. Statistics of the models of the relationships between tree diameter and increment. For each species, the table shows the effective degrees of freedom (edf), the F statistics and p-value of the smooth term $s()$, the p-value of the site effect (p-value$_\alpha$), the number of site (n_{site}), the standard deviation of the site effect (α_{sd}) and the percentage of explained variance (%D).

Species	edf	*F*	*p*-value	*p*-value$_\alpha$	n_{site}	α_{sd}	%D
Afzelia bipindensis	2.49	1.05	0.27	0.00	2	0.29	12.29
Albizia ferruginea	1.90	2.65	0.08	/	1	/	5.81
Amphimas pterocarpoides	2.91	99.19	0.00	0.00	2	0.32	34.80
Autranella congolensis	2.83	6.41	0.00	0.48	2	0.00	10.25
Baillonella toxisperma	2.19	6.28	0.00	0.28	2	0.17	17.83
Bobgunnia fistuloides	1.00	5.83	0.02	/	1	/	9.27
Canarium schweinfurthii	2.00	6.63	0.00	/	1	/	11.35
Chrysophyllum beguei	1.18	0.04	0.90	/	1	/	1.27
Chrysophyllum lacourtianum	2.23	9.33	0.00	/	1	/	9.67
Copaifera mildbraedii	2.90	23.72	0.00	/	1	/	28.67
Cylicodiscus gabunensis	2.83	9.84	0.00	0.00	5	0.35	12.83
Dacryodes normandii	1.57	2.62	0.06	/	1	/	5.14
Diospyros crassiflora	2.81	5.31	0.00	0.00	2	0.26	8.51
Distemonanthus benthamianus	2.35	2.05	0.16	0.00	4	0.35	6.85
Entandrophragma angolense	2.43	39.63	0.00	0.00	2	0.30	25.21
Entandrophragma candollei	2.65	187.85	0.00	0.00	3	0.23	49.72
Entandrophragma cylindricum	2.94	56.23	0.00	0.00	4	0.41	20.81
Entandrophragma utile	2.81	39.79	0.00	0.00	3	0.26	32.33

Species	**edf**	***F***	***p*-value**	***p*-value$_\alpha$**	***n*$_{site}$**	**α_{sd}**	**%D**
Eribroma oblongum	1.95	2.49	0.07	0.36	2	0.00	2.01
Erythrophleum ivorense	1.00	16.39	0.00	/	1	/	7.72
Erythrophleum sp.	1.00	1.82	0.18	/	1	/	1.22
Erythrophleum suaveolens	2.99	61.87	0.00	0.00	5	0.25	17.01
Greenwayodendron suaveolens	1.77	1.31	0.25	0.00	8	0.19	3.92
Irvingia gabonensis	1.00	1.67	0.20	/	1	/	1.52
Julbernardia pellegriniana	1.00	2.50	0.12	/	1	/	1.25
Khaya anthotheca	1.00	0.03	0.85	/	1	/	0.05
Leplaea cedrata	1.82	44.92	0.00	/	1	/	34.28
Lophira alata	2.91	50.82	0.00	0.00	4	0.27	20.36
Lovoa trichilioides	2.21	34.66	0.00	0.00	2	0.29	40.65
Manilkara mabokeënsis	2.22	1.77	0.11	0.00	2	0.25	4.12
Mansonia altissima	1.00	4.33	0.04	0.00	2	0.43	27.81
Nauclea diderrichii	2.53	6.07	0.00	/	1	/	16.43
Nesogordonia kabingaensis	2.67	7.81	0.00	0.00	2	0.24	7.44
Pericopsis elata	2.68	1.26	0.29	0.00	2	0.34	12.52
Piptadeniastrum africanum	2.92	17.33	0.00	0.01	3	0.33	8.72
Prioria oxyphylla	2.23	6.43	0.00	/	1	/	6.07
Pterocarpus soyauxii	2.96	27.72	0.00	0.00	8	0.34	9.06
Pycnanthus angolensis	2.96	25.34	0.00	0.00	2	0.38	14.09
Staudtia kamerunensis	2.40	3.27	0.07	0.13	3	0.16	2.68
Sterculia rhinopetala	2.17	10.74	0.00	/	1	/	18.45
Terminalia superba	2.00	28.34	0.00	0.00	3	0.29	15.91
Tessmannia africana	2.94	31.38	0.00	0.00	2	0.29	15.14
Triplochiton scleroxylon	1.00	13.63	0.00	0.00	3	0.60	13.70

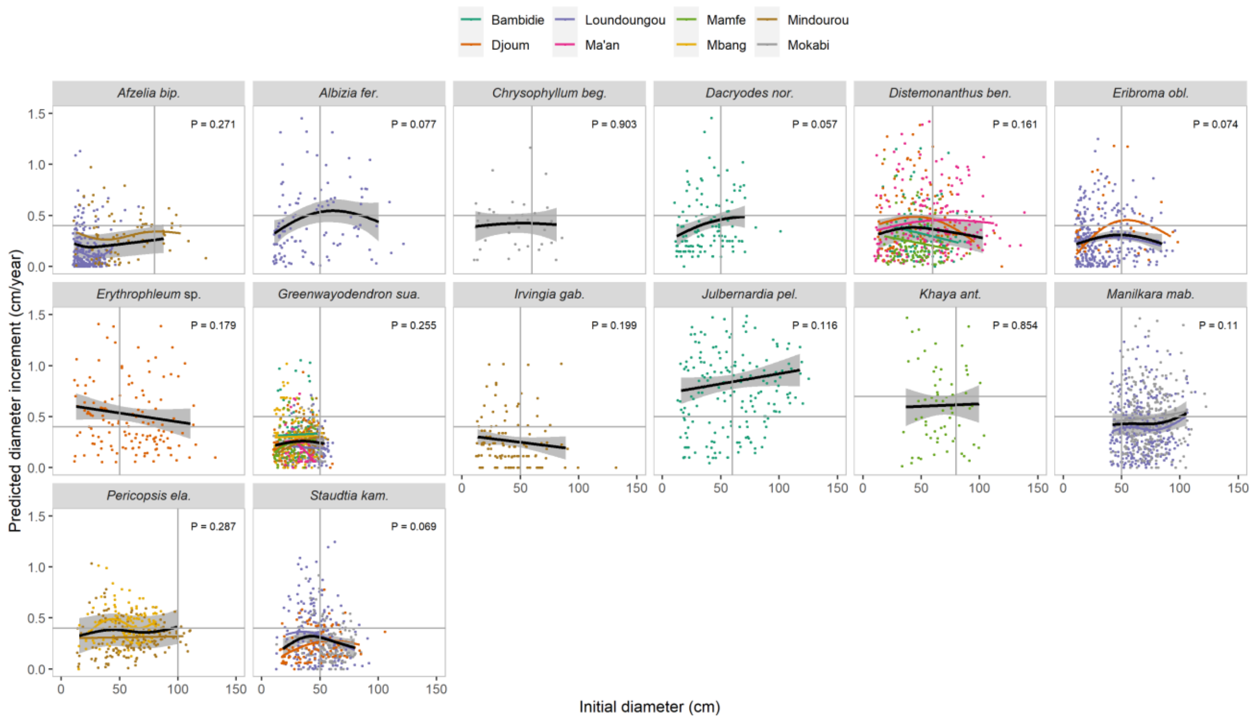

Figure S2.1. Nonnsignificant relationships between diameter increment and intial diameter. The horizontal and vertical lines indicate species-specific reference diameter increment and minimum diameter cutting limit.

7.3 SUPPLEMENTARY MATERIAL 3: TREE GROWTH RATE IN UNLOGGED FORESTS

Table S3: Estimates of diameter increment per species, site. Additionally, estimates were computed per size class when the effect of tree diameter was found significant (see Section 3.2). Three diameter classes were considered: diameter ranging between 10 and 50 cm, between 50 and 90 cm, and greater than 90 cm. When the effect of tree diameter was not significant, the estimates were computed averaging the data collected on trees of all sizes.

Site	Species	Size class	n_{obs}	n_{tree}	m	sd	Period	First yr.	Last yr.
Bambidie	Julbernardia pellegriniana	all	574	199	0.84	0.52	1.90	2015	2018
Bambidie	Afzelia bipindensis	all	23	8	0.16	0.16	1.87	2015	2017
Bambidie	Distemonanthus benthamianus	all	285	100	0.32	0.34	1.91	2015	2018
Bambidie	Cylicodiscus gabunensis	10-50	3	1	0.29	/	2.05	2015	2017
Bambidie	Cylicodiscus gabunensis	50-90	70	24	0.64	0.31	1.91	2015	2017
Bambidie	Cylicodiscus gabunensis	90+	70	25	0.66	0.23	1.82	2015	2017
Bambidie	Dacryodes normandii	all	357	125	0.41	0.30	1.88	2015	2017
Bambidie	Greenwayodendron suaveolens	all	243	84	0.32	0.24	1.89	2015	2017
Bambidie	Pterocarpus soyauxii	10-50	46	16	0.60	0.54	1.89	2015	2017
Bambidie	Pterocarpus soyauxii	50-90	94	32	0.61	0.39	1.95	2015	2017
Bambidie	Pterocarpus soyauxii	90+	18	6	0.57	0.16	2.00	2015	2017
Bambidie	Erythrophleum suaveolens	10-50	23	8	0.26	0.20	1.88	2015	2017
Bambidie	Erythrophleum suaveolens	50-90	100	35	0.35	0.26	1.92	2015	2017
Bambidie	Erythrophleum suaveolens	90+	9	3	0.61	0.19	2.00	2015	2017

Site	Species	Size class	n_{obs}	n_{tree}	m	sd	Period	First yr.	Last yr.
Djoum	Triplochiton scleroxylon	10-50	6	2	2.06	1.10	1.50	2015	2017
Djoum	Triplochiton scleroxylon	50-90	9	3	1.08	0.73	1.42	2015	2017
Djoum	Piptadeniastrum africanum	10-50	155	52	0.80	0.75	1.55	2015	2017
Djoum	Piptadeniastrum africanum	50-90	93	32	0.73	0.80	1.53	2015	2017
Djoum	Piptadeniastrum africanum	90+	26	9	0.48	0.54	1.49	2015	2017
Djoum	Eribroma oblongum	all	144	49	0.29	0.32	1.40	2015	2017
Djoum	Terminalia superba	10-50	204	69	0.37	0.44	1.56	2015	2017
Djoum	Terminalia superba	50-90	244	83	0.29	0.41	1.55	2015	2017
Djoum	Terminalia superba	90+	17	6	0.33	0.27	1.47	2015	2017
Djoum	Baillonella toxisperma	10-50	99	33	0.59	0.43	1.62	2015	2017
Djoum	Baillonella toxisperma	50-90	27	9	0.75	0.58	1.59	2015	2017
Djoum	Baillonella toxisperma	90+	34	12	0.44	0.27	1.47	2015	2017
Djoum	Distemonanthus benthamianus	all	418	142	0.43	0.36	1.57	2015	2017
Djoum	Autranella congolensis	90+	6	2	1.16	0.02	1.60	2015	2017
Djoum	Staudtia kamerunensis	all	330	113	0.22	0.32	1.57	2015	2017
Djoum	Cylicodiscus gabunensis	10-50	130	44	0.45	0.44	1.55	2015	2017
Djoum	Cylicodiscus gabunensis	50-90	148	50	0.38	0.32	1.56	2015	2017
Djoum	Cylicodiscus gabunensis	90+	70	24	0.31	0.35	1.44	2015	2017
Djoum	Greenwayodendron suaveolens	all	222	75	0.24	0.19	1.57	2015	2017
Djoum	Pterocarpus soyauxii	10-50	198	67	0.50	0.52	1.58	2015	2017
Djoum	Pterocarpus soyauxii	50-90	100	34	0.39	0.38	1.51	2015	2017
Djoum	Pterocarpus soyauxii	90+	2	1	0.10	/	0.97	2016	2017
Djoum	Entandrophragma utile	10-50	6	2	0.95	0.58	1.86	2015	2017
Djoum	Entandrophragma utile	50-90	3	1	1.37	/	1.65	2015	2017
Djoum	Erythrophleum sp.	all	440	150	0.52	0.42	1.52	2015	2017
Loundoungou	Canarium schweinfurthii	10-50	479	105	0.36	0.36	3.53	2015	2020
Loundoungou	Canarium schweinfurthii	50-90	115	26	0.59	0.42	3.48	2015	2019
Loundoungou	Canarium schweinfurthii	90+	31	7	0.49	0.36	3.51	2015	2019
Loundoungou	Lophira alata	10-50	339	75	0.39	0.37	3.50	2015	2020
Loundoungou	Lophira alata	50-90	65	14	0.80	0.38	3.51	2015	2020
Loundoungou	Lophira alata	90+	49	11	0.63	0.19	3.53	2015	2020
Loundoungou	Lovoa trichilioides	10-50	692	157	0.24	0.30	3.47	2015	2020
Loundoungou	Lovoa trichilioides	50-90	37	8	0.54	0.31	3.55	2015	2020
Loundoungou	Lovoa trichilioides	90+	33	7	0.71	0.32	3.66	2015	2020
Loundoungou	Nauclea diderrichii	10-50	228	52	0.28	0.35	3.47	2015	2020
Loundoungou	Nauclea diderrichii	50-90	104	23	0.47	0.34	3.49	2015	2020
Loundoungou	Nauclea diderrichii	90+	57	13	0.33	0.30	3.36	2015	2020
Loundoungou	Leplaea cedrata	10-50	681	151	0.20	0.24	3.49	2015	2020
Loundoungou	Leplaea cedrata	50-90	153	32	0.63	0.39	3.59	2015	2020
Loundoungou	Leplaea cedrata	90+	23	5	0.66	0.34	3.50	2015	2020

Site	**Species**	**Size class**	n_{obs}	n_{tree}	**m**	**sd**	**Period**	**First yr.**	**Last yr.**
Loundoungou	Piptadeniastrum africanum	10-50	1049	238	0.84	0.66	3.51	2015	2020
Loundoungou	Piptadeniastrum africanum	50-90	321	68	1.24	0.58	3.69	2015	2020
Loundoungou	Piptadeniastrum africanum	90+	124	27	0.93	0.49	3.55	2015	2020
Loundoungou	Afzelia bipindensis	all	1257	277	0.13	0.19	3.57	2015	2020
Loundoungou	Diospyros crassiflora	10-50	1316	295	0.14	0.17	3.54	2015	2020
Loundoungou	Diospyros crassiflora	50-90	88	19	0.15	0.12	3.61	2015	2020
Loundoungou	Diospyros crassiflora	90+	5	1	0.20	/	4.01	2015	2019
Loundoungou	Copaifera mildbraedii	10-50	305	70	0.20	0.22	3.52	2015	2020
Loundoungou	Copaifera mildbraedii	50-90	226	50	0.75	0.42	3.60	2015	2020
Loundoungou	Copaifera mildbraedii	90+	255	58	0.43	0.37	3.54	2015	2020
Loundoungou	Eribroma oblongum	all	1378	303	0.26	0.27	3.53	2015	2020
Loundoungou	Albizia ferruginea	all	524	115	0.45	0.39	3.48	2015	2020
Loundoungou	Pycnanthus angolensis	10-50	696	159	0.58	0.55	3.52	2015	2020
Loundoungou	Pycnanthus angolensis	50-90	790	174	0.67	0.45	3.60	2015	2020
Loundoungou	Pycnanthus angolensis	90+	41	9	0.64	0.30	3.53	2015	2019
Loundoungou	Milicia excelsa	all	4	1	0.21	/	3.37	2015	2018
Loundoungou	Entandrophragma candollei	10-50	950	217	0.17	0.25	3.50	2015	2020
Loundoungou	Entandrophragma candollei	50-90	187	42	0.70	0.41	3.54	2015	2020
Loundoungou	Entandrophragma candollei	90+	170	37	0.79	0.53	3.63	2015	2020
Loundoungou	Nesogordonia kabingaensis	10-50	867	197	0.18	0.20	3.52	2015	2020
Loundoungou	Nesogordonia kabingaensis	50-90	311	67	0.14	0.17	3.62	2015	2020
Loundoungou	Amphimas pterocarpoides	10-50	1154	258	0.26	0.30	3.56	2015	2020
Loundoungou	Amphimas pterocarpoides	50-90	259	56	0.60	0.45	3.62	2015	2020
Loundoungou	Amphimas pterocarpoides	90+	48	10	0.57	0.39	3.71	2015	2019
Loundoungou	Chrysophyllum lacourtianum	10-50	1027	231	0.51	0.40	3.54	2015	2020
Loundoungou	Chrysophyllum lacourtianum	50-90	122	28	0.45	0.41	3.53	2015	2019
Loundoungou	Chrysophyllum lacourtianum	90+	17	4	0.18	0.07	3.27	2015	2019
Loundoungou	Autranella congolensis	10-50	283	64	0.29	0.26	3.44	2015	2020
Loundoungou	Autranella congolensis	50-90	135	29	0.34	0.20	3.60	2015	2020
Loundoungou	Autranella congolensis	90+	114	25	0.41	0.23	3.51	2015	2020
Loundoungou	Staudtia kamerunensis	all	921	204	0.32	0.28	3.57	2015	2020
Loundoungou	Greenwayodendron suaveolens	all	486	105	0.19	0.15	3.61	2015	2020
Loundoungou	Manilkara mabokeënsis	all	1442	321	0.39	0.28	3.56	2015	2020
Loundoungou	Pterocarpus soyauxii	10-50	855	192	0.45	0.42	3.57	2015	2020
Loundoungou	Pterocarpus soyauxii	50-90	464	100	0.42	0.35	3.65	2015	2020
Loundoungou	Pterocarpus soyauxii	90+	5	1	0.20	/	3.95	2016	2019
Loundoungou	Bobgunnia fistuloides	10-50	253	57	0.23	0.18	3.51	2015	2020
Loundoungou	Bobgunnia fistuloides	50-90	10	2	0.37	0.02	3.95	2015	2019
Loundoungou	Entandrophragma cylindricum	10-50	631	144	0.38	0.35	3.50	2015	2020
Loundoungou	Entandrophragma cylindricum	50-90	549	121	0.72	0.40	3.59	2015	2020

Site	Species	Size class	n_{obs}	n_{tree}	m	sd	Period	First yr.	Last yr.
Loundoungou	Entandrophragma cylindricum	90+	351	78	0.46	0.29	3.56	2015	2020
Loundoungou	Entandrophragma utile	10-50	602	135	0.28	0.29	3.57	2015	2020
Loundoungou	Entandrophragma utile	50-90	92	21	0.79	0.26	3.51	2015	2020
Loundoungou	Entandrophragma utile	90+	84	19	0.40	0.29	3.54	2015	2019
Loundoungou	Erythrophleum suaveolens	10-50	744	168	0.54	0.47	3.56	2015	2020
Loundoungou	Erythrophleum suaveolens	50-90	752	168	0.33	0.29	3.57	2015	2020
Loundoungou	Erythrophleum suaveolens	90+	156	33	0.23	0.22	3.70	2015	2020
Loundoungou	Entandrophragma angolense	10-50	1086	246	0.16	0.26	3.54	2015	2020
Loundoungou	Entandrophragma angolense	50-90	182	40	0.43	0.31	3.60	2015	2020
Loundoungou	Entandrophragma angolense	90+	62	13	0.27	0.34	3.60	2015	2020
Loundoungou	Tessmannia africana	10-50	791	177	0.35	0.32	3.55	2015	2020
Loundoungou	Tessmannia africana	50-90	590	134	0.40	0.30	3.51	2015	2020
Loundoungou	Tessmannia africana	90+	61	13	0.29	0.22	3.68	2015	2020
Ma'an	Triplochiton scleroxylon	10-50	281	48	0.37	0.40	5.11	2011	2017
Ma'an	Triplochiton scleroxylon	50-90	439	78	0.42	0.33	4.85	2011	2017
Ma'an	Triplochiton scleroxylon	90+	131	22	0.56	0.42	5.28	2011	2017
Ma'an	Lophira alata	10-50	326	82	0.39	0.27	3.05	2011	2014
Ma'an	Lophira alata	50-90	342	91	0.53	0.27	2.81	2011	2015
Ma'an	Lophira alata	90+	156	41	0.37	0.20	2.82	2011	2017
Ma'an	Lovoa trichilioides	10-50	246	49	0.48	0.38	4.28	2011	2017
Ma'an	Lovoa trichilioides	50-90	283	73	0.85	0.53	3.00	2011	2017
Ma'an	Lovoa trichilioides	90+	115	32	1.05	0.46	2.70	2011	2017
Ma'an	Piptadeniastrum africanum	10-50	309	76	0.95	0.81	3.18	2011	2017
Ma'an	Piptadeniastrum africanum	50-90	327	78	0.98	0.72	3.35	2011	2017
Ma'an	Piptadeniastrum africanum	90+	131	34	0.89	0.65	3.09	2011	2017
Ma'an	Distemonanthus benthamianus	all	756	191	0.43	0.32	3.05	2011	2017
Ma'an	Cylicodiscus gabunensis	10-50	315	67	0.62	0.59	3.85	2011	2017
Ma'an	Cylicodiscus gabunensis	50-90	314	64	0.83	0.48	4.12	2011	2017
Ma'an	Cylicodiscus gabunensis	90+	171	43	0.75	0.41	3.05	2011	2017
Ma'an	Greenwayodendron suaveolens	all	114	39	0.21	0.19	2.47	2013	2017
Ma'an	Pterocarpus soyauxii	10-50	271	76	0.31	0.36	2.60	2011	2017
Ma'an	Pterocarpus soyauxii	50-90	273	74	0.54	0.32	2.81	2011	2017
Ma'an	Pterocarpus soyauxii	90+	56	15	0.56	0.43	2.79	2011	2017
Ma'an	Erythrophleum ivorense	10-50	272	72	0.66	0.56	2.84	2011	2017
Ma'an	Erythrophleum ivorense	50-90	303	83	0.48	0.35	2.73	2011	2017
Ma'an	Erythrophleum ivorense	90+	153	43	0.34	0.29	2.62	2011	2017
Mamfe	Lophira alata	10-50	447	77	0.28	0.32	5.20	2011	2016
Mamfe	Lophira alata	50-90	468	79	0.54	0.35	5.30	2011	2016
Mamfe	Lophira alata	90+	249	42	0.64	0.24	5.31	2011	2016
Mamfe	Distemonanthus benthamianus	all	640	108	0.24	0.24	5.07	2011	2016

Site	**Species**	**Size class**	n_{obs}	n_{tree}	**m**	**sd**	**Period**	**First yr.**	**Last yr.**
Mamfe	Khaya anthotheca	all	409	69	0.61	0.38	5.19	2011	2016
Mamfe	Cylicodiscus gabunensis	10-50	163	28	0.57	0.53	5.09	2011	2016
Mamfe	Cylicodiscus gabunensis	50-90	428	74	0.85	0.42	5.16	2011	2016
Mamfe	Cylicodiscus gabunensis	90+	248	42	0.78	0.32	5.20	2011	2016
Mamfe	Greenwayodendron suaveolens	all	271	69	0.23	0.16	2.61	2014	2016
Mamfe	Pterocarpus soyauxii	10-50	454	77	0.42	0.39	5.07	2011	2016
Mamfe	Pterocarpus soyauxii	50-90	335	58	0.46	0.29	4.93	2011	2016
Mamfe	Pterocarpus soyauxii	90+	6	1	0.42	/	5.15	2011	2016
Mamfe	Erythrophleum ivorense	10-50	6	1	0.06	/	5.25	2011	2016
Mamfe	Erythrophleum ivorense	50-90	42	7	0.51	0.21	5.25	2011	2016
Mamfe	Erythrophleum ivorense	90+	44	8	0.31	0.21	4.86	2011	2016
Mbang	Pericopsis elata	all	584	120	0.43	0.17	3.84	2009	2014
Mbang	Triplochiton scleroxylon	10-50	468	80	0.44	0.43	4.87	2009	2014
Mbang	Triplochiton scleroxylon	50-90	480	81	0.60	0.46	5.00	2009	2015
Mbang	Triplochiton scleroxylon	90+	120	20	0.81	0.63	5.01	2009	2014
Mbang	Mansonia altissima	10-50	457	78	0.25	0.18	4.88	2009	2014
Mbang	Mansonia altissima	50-90	231	40	0.27	0.17	4.86	2009	2015
Mbang	Terminalia superba	10-50	375	69	0.44	0.52	4.40	2009	2015
Mbang	Terminalia superba	50-90	192	39	0.15	0.15	3.92	2009	2015
Mbang	Milicia excelsa	all	22	4	0.59	0.35	5.25	2009	2015
Mbang	Sterculia rhinopetala	10-50	565	82	0.35	0.29	5.89	2009	2015
Mbang	Sterculia rhinopetala	50-90	345	50	0.42	0.19	5.95	2009	2015
Mbang	Autranella congolensis	10-50	7	1	0.63	/	5.98	2009	2015
Mbang	Greenwayodendron suaveolens	all	350	126	0.30	0.37	1.71	2012	2015
Mbang	Pterocarpus soyauxii	10-50	289	48	0.73	0.50	4.98	2009	2015
Mbang	Pterocarpus soyauxii	50-90	53	9	0.80	0.43	4.87	2009	2015
Mbang	Pterocarpus soyauxii	90+	5	1	0.37	/	3.94	2009	2013
Mbang	Entandrophragma cylindricum	10-50	363	75	0.29	0.26	3.79	2009	2013
Mbang	Entandrophragma cylindricum	50-90	296	60	0.66	0.37	3.87	2009	2013
Mbang	Entandrophragma cylindricum	90+	167	39	0.53	0.21	3.32	2009	2013
Mbang	Erythrophleum suaveolens	10-50	334	64	0.49	0.32	4.23	2009	2016
Mbang	Erythrophleum suaveolens	50-90	574	113	0.36	0.22	4.10	2009	2015
Mbang	Erythrophleum suaveolens	90+	29	7	0.35	0.19	3.17	2009	2013
Mindourou	Irvingia gabonensis	all	220	110	0.26	0.25	0.90	2018	2019
Mindourou	Pericopsis elata	all	1159	168	0.31	0.17	5.82	2013	2019
Mindourou	Triplochiton scleroxylon	10-50	97	14	1.02	0.69	5.45	2014	2019
Mindourou	Triplochiton scleroxylon	50-90	115	17	0.90	0.52	5.47	2013	2019
Mindourou	Triplochiton scleroxylon	90+	25	4	1.12	0.57	5.04	2014	2019
Mindourou	Lophira alata	10-50	385	49	0.40	0.30	6.94	2011	2019
Mindourou	Lophira alata	50-90	301	40	0.47	0.21	6.58	2011	2019

Site	Species	Size class	n_{obs}	n_{tree}	m	sd	Period	First yr.	Last yr.
Mindourou	Lophira alata	90+	166	21	0.40	0.20	6.89	2011	2019
Mindourou	Mansonia altissima	10-50	292	42	0.59	0.24	5.61	2013	2019
Mindourou	Mansonia altissima	50-90	254	38	0.39	0.19	5.38	2013	2019
Mindourou	Afzelia bipindensis	all	538	80	0.30	0.22	5.54	2013	2019
Mindourou	Terminalia superba	10-50	509	74	0.70	0.50	5.75	2013	2019
Mindourou	Terminalia superba	50-90	541	81	0.25	0.33	5.57	2013	2019
Mindourou	Terminalia superba	90+	21	3	0.06	0.01	5.80	2013	2019
Mindourou	Milicia excelsa	all	41	7	0.30	0.24	4.85	2013	2019
Mindourou	Entandrophragma candollei	10-50	123	24	0.29	0.29	4.16	2013	2019
Mindourou	Entandrophragma candollei	50-90	113	22	0.72	0.44	4.23	2013	2019
Mindourou	Entandrophragma candollei	90+	67	14	0.76	0.37	3.84	2015	2019
Mindourou	Baillonella toxisperma	10-50	108	22	0.58	0.43	3.97	2015	2019
Mindourou	Baillonella toxisperma	50-90	10	2	0.95	0.59	4.07	2015	2019
Mindourou	Baillonella toxisperma	90+	20	4	0.96	0.37	4.06	2015	2019
Mindourou	Autranella congolensis	50-90	5	1	0.41	/	4.08	2015	2019
Mindourou	Cylicodiscus gabunensis	10-50	364	73	0.50	0.46	4.04	2013	2019
Mindourou	Cylicodiscus gabunensis	50-90	231	43	0.81	0.43	4.40	2013	2019
Mindourou	Cylicodiscus gabunensis	90+	164	32	0.40	0.26	4.16	2013	2019
Mindourou	Greenwayodendron suaveolens	all	593	86	0.24	0.14	5.80	2013	2019
Mindourou	Pterocarpus soyauxii	10-50	641	124	0.45	0.34	4.21	2013	2019
Mindourou	Pterocarpus soyauxii	50-90	297	54	0.44	0.34	4.51	2013	2019
Mindourou	Pterocarpus soyauxii	90+	27	4	0.18	0.14	5.84	2013	2019
Mindourou	Bobgunnia fistuloides	10-50	29	5	0.40	0.33	4.71	2013	2019
Mindourou	Bobgunnia fistuloides	50-90	24	4	0.18	0.13	5.00	2013	2019
Mindourou	Entandrophragma cylindricum	10-50	560	81	0.37	0.36	5.80	2013	2019
Mindourou	Entandrophragma cylindricum	50-90	570	82	0.60	0.34	5.82	2013	2019
Mindourou	Entandrophragma cylindricum	90+	347	50	0.46	0.22	5.86	2013	2019
Mindourou	Entandrophragma utile	10-50	139	26	0.39	0.36	4.35	2013	2019
Mindourou	Entandrophragma utile	50-90	34	6	1.04	0.47	4.67	2013	2019
Mindourou	Entandrophragma utile	90+	17	3	0.64	0.14	4.53	2014	2019
Mindourou	Erythrophleum suaveolens	10-50	395	59	0.63	0.45	5.55	2013	2019
Mindourou	Erythrophleum suaveolens	50-90	647	95	0.28	0.22	5.79	2013	2019
Mindourou	Erythrophleum suaveolens	90+	279	41	0.26	0.16	5.76	2013	2019
Mindourou	Entandrophragma angolense	10-50	75	15	0.54	0.51	4.06	2015	2019
Mindourou	Entandrophragma angolense	50-90	10	2	0.62	0.20	4.04	2015	2019
Mokabi	Diospyros crassiflora	10-50	594	297	0.23	0.19	1.54	2015	2017
Mokabi	Diospyros crassiflora	50-90	48	24	0.24	0.18	1.62	2015	2017
Mokabi	Pycnanthus angolensis	10-50	270	135	0.41	0.39	1.55	2015	2017
Mokabi	Pycnanthus angolensis	50-90	352	176	0.46	0.40	1.53	2015	2017
Mokabi	Pycnanthus angolensis	90+	42	21	0.50	0.24	1.54	2015	2017

Site	**Species**	**Size class**	n_{obs}	n_{tree}	**m**	**sd**	**Period**	**First yr.**	**Last yr.**
Mokabi	Entandrophragma candollei	10-50	350	175	0.30	0.26	1.52	2015	2017
Mokabi	Entandrophragma candollei	50-90	96	48	0.78	0.39	1.51	2015	2017
Mokabi	Entandrophragma candollei	90+	68	34	1.11	0.40	1.53	2015	2017
Mokabi	Nesogordonia kabingaensis	10-50	568	284	0.23	0.22	1.52	2015	2017
Mokabi	Nesogordonia kabingaensis	50-90	46	23	0.37	0.25	1.58	2015	2017
Mokabi	Amphimas pterocarpoides	10-50	496	248	0.38	0.39	1.53	2015	2017
Mokabi	Amphimas pterocarpoides	50-90	102	51	1.06	0.50	1.54	2015	2017
Mokabi	Amphimas pterocarpoides	90+	4	2	1.55	0.33	1.51	2016	2017
Mokabi	Chrysophyllum beguei	all	72	36	0.41	0.25	1.62	2016	2017
Mokabi	Autranella congolensis	10-50	34	17	0.46	0.49	1.56	2016	2017
Mokabi	Autranella congolensis	50-90	40	20	0.27	0.27	1.51	2016	2017
Mokabi	Autranella congolensis	90+	64	32	0.48	0.36	1.59	2015	2017
Mokabi	Staudtia kamerunensis	all	324	162	0.28	0.43	1.51	2015	2017
Mokabi	Greenwayodendron suaveolens	all	202	101	0.24	0.14	1.54	2015	2017
Mokabi	Manilkara mabokeënsis	all	532	266	0.49	0.32	1.53	2015	2017
Mokabi	Pterocarpus soyauxii	10-50	350	175	0.51	0.47	1.53	2015	2017
Mokabi	Pterocarpus soyauxii	50-90	194	97	0.49	0.43	1.54	2015	2017
Mokabi	Entandrophragma cylindricum	10-50	256	128	0.57	0.72	1.54	2015	2017
Mokabi	Entandrophragma cylindricum	50-90	252	126	1.09	0.95	1.56	2015	2017
Mokabi	Entandrophragma cylindricum	90+	134	67	1.03	0.96	1.58	2015	2017
Mokabi	Entandrophragma utile	10-50	132	66	0.45	0.45	1.57	2015	2017
Mokabi	Entandrophragma utile	50-90	20	10	0.81	0.45	1.66	2015	2017
Mokabi	Entandrophragma utile	90+	34	17	0.61	0.41	1.59	2015	2017
Mokabi	Erythrophleum suaveolens	10-50	240	120	0.72	0.57	1.57	2015	2017
Mokabi	Erythrophleum suaveolens	50-90	336	168	0.48	0.45	1.53	2015	2017
Mokabi	Erythrophleum suaveolens	90+	108	54	0.45	0.28	1.57	2015	2017
Mokabi	Prioria oxyphylla	10-50	182	91	0.34	0.32	1.53	2015	2017
Mokabi	Prioria oxyphylla	50-90	258	129	0.47	0.32	1.53	2015	2017
Mokabi	Prioria oxyphylla	90+	118	59	0.42	0.37	1.53	2015	2017
Mokabi	Entandrophragma angolense	10-50	416	208	0.37	0.38	1.58	2015	2017
Mokabi	Entandrophragma angolense	50-90	230	115	0.59	0.40	1.55	2015	2017
Mokabi	Entandrophragma angolense	90+	18	9	0.65	0.31	1.55	2015	2017
Mokabi	Tessmannia africana	10-50	296	148	0.45	0.34	1.53	2015	2017
Mokabi	Tessmannia africana	50-90	316	158	0.51	0.34	1.53	2015	2017
Mokabi	Tessmannia africana	90+	48	24	0.48	0.34	1.52	2016	2017

7.4 SUPPLEMENTARY MATERIAL 4: THE EFFECT OF PAST EXPLOITATION ON DIAMETER INCREMENT

Table S4. Significance of the logging effect for all possible combinations of sites and species. The results (number of observations, statistics, and associated p-value) of parametric and non-parametric tests are shown. The logging effect corresponds to the difference between the growth observed in the logged and unlogged treatments.

Site	**Species**	**Logging effect**	***n***	***t***	***p*-value**	**test**	***p*-value**	**test**
Bambidie	Afzelia bipindensis	0.057	7	0.477	0.817	paired t-test	0.832	Wilcoxon
Loundoungou	Afzelia bipindensis	0.007	106	0.380	0.846	paired t-test	0.786	Wilcoxon
Mindourou	Afzelia bipindensis	-0.014	142	-0.385	0.846	2-sample t-test	0.832	Kruskal-Wallis
Loundoungou	Albizia ferruginea	-0.039	42	-0.772	0.621	paired t-test	0.576	Wilcoxon
Loundoungou	Amphimas pterocarpoides	0.045	152	1.904	0.123	paired t-test	0.301	Wilcoxon
Djoum	Autranella congolensis	-0.457	6	-5.393	0.019	2-sample t-test	0.12	Kruskal-Wallis
Loundoungou	Autranella congolensis	0.013	50	0.372	0.846	paired t-test	0.834	Wilcoxon
Djoum	Baillonella toxisperma	0.243	80	2.543	0.038	2-sample t-test	0.012	Kruskal-Wallis
Mindourou	Baillonella toxisperma	-0.065	107	-0.680	0.674	2-sample t-test	0.664	Kruskal-Wallis
Loundoungou	Bobgunnia fistuloides	0.130	27	2.627	0.04	paired t-test	0.023	Wilcoxon
Mindourou	Bobgunnia fistuloides	0.183	24	1.247	0.382	2-sample t-test	0.396	Kruskal-Wallis
Loundoungou	Canarium schweinfurthii	-0.009	60	-0.337	0.851	paired t-test	0.655	Wilcoxon
Loundoungou	Chrysophyllum lacourtianum	0.005	124	0.214	0.914	paired t-test	0.832	Wilcoxon
Loundoungou	Copaifera mildbraedii	0.001	96	0.028	0.978	paired t-test	0.678	Wilcoxon
Bambidie	Cylicodiscus gabunensis	-0.210	28	-3.392	0.009	paired t-test	0.012	Wilcoxon
Djoum	Cylicodiscus gabunensis	-0.002	221	-0.040	0.978	2-sample t-test	0.649	Kruskal-Wallis
Ma'an	Cylicodiscus gabunensis	0.075	68	1.880	0.132	paired t-test	0.096	Wilcoxon
Mamfe	Cylicodiscus gabunensis	-0.135	159	-1.146	0.406	2-sample t-test	0.444	Kruskal-Wallis
Mindourou	Cylicodiscus gabunensis	0.282	299	4.725	<0.001	2-sample t-test	<0.001	Kruskal-Wallis
Bambidie	Dacryodes normandii	-0.121	120	-4.923	<0.001	paired t-test	<0.001	Wilcoxon
Loundoungou	Diospyros crassiflora	-0.019	148	-1.337	0.336	paired t-test	0.065	Wilcoxon
Bambidie	Distemonanthus benthamianus	-0.161	91	-5.388	<0.001	paired t-test	<0.001	Wilcoxon
Djoum	Distemonanthus benthamianus	0.051	157	0.523	0.78	2-sample t-test	0.416	Kruskal-Wallis
Ma'an	Distemonanthus benthamianus	-0.077	134	-3.647	0.002	paired t-test	<0.001	Wilcoxon
Mamfe	Distemonanthus benthamianus	-0.177	128	-3.110	0.009	2-sample t-test	<0.001	Kruskal-Wallis
Loundoungou	Entandrophragma angolense	-0.026	144	-1.371	0.336	paired t-test	0.022	Wilcoxon
Mindourou	Entandrophragma angolense	-0.139	56	-1.181	0.403	2-sample t-test	0.598	Kruskal-Wallis
Loundoungou	Entandrophragma candollei	-0.050	149	-2.102	0.091	paired t-test	0.077	Wilcoxon
Mindourou	Entandrophragma candollei	0.007	121	0.094	0.97	2-sample t-test	0.799	Kruskal-Wallis
Loundoungou	Entandrophragma cylindricum	-0.045	140	-2.003	0.112	paired t-test	0.065	Wilcoxon
Mbang	Entandrophragma cylindricum	0.111	134	5.903	<0.001	paired t-test	<0.001	Wilcoxon

Site	**Species**	**Logging effect**	***n***	***t***	***p*-value**	**test**	***p*-value**	**test**
Mindourou	Entandrophragma cylindricum	0.282	425	6.962	<0.001	2-sample t-test	<0.001	Kruskal-Wallis
Djoum	Entandrophragma utile	-0.197	15	-0.755	0.637	2-sample t-test	0.396	Kruskal-Wallis
Loundoungou	Entandrophragma utile	-0.023	80	-1.018	0.49	paired t-test	0.725	Wilcoxon
Mindourou	Entandrophragma utile	0.273	84	2.461	0.042	2-sample t-test	0.046	Kruskal-Wallis
Djoum	Eribroma oblongum	0.199	114	3.075	0.01	2-sample t-test	0.006	Kruskal-Wallis
Loundoungou	Eribroma oblongum	-0.036	112	-1.653	0.202	paired t-test	0.124	Wilcoxon
Ma'an	Erythrophleum ivorense	-0.017	169	-0.807	0.597	paired t-test	0.396	Wilcoxon
Mamfe	Erythrophleum ivorense	-0.065	25	-0.528	0.78	2-sample t-test	0.725	Kruskal-Wallis
Djoum	Erythrophleum sp.	0.012	290	0.246	0.898	2-sample t-test	0.832	Kruskal-Wallis
Bambidie	Erythrophleum suaveolens	-0.017	37	-0.416	0.843	paired t-test	0.776	Wilcoxon
Loundoungou	Erythrophleum suaveolens	-0.016	164	-0.645	0.693	paired t-test	0.301	Wilcoxon
Mbang	Erythrophleum suaveolens	-0.001	142	-0.043	0.978	paired t-test	0.832	Wilcoxon
Mindourou	Erythrophleum suaveolens	0.122	356	3.249	0.006	2-sample t-test	<0.001	Kruskal-Wallis
Bambidie	Greenwayodendron suaveolens	-0.062	76	-2.479	0.042	paired t-test	0.02	Wilcoxon
Djoum	Greenwayodendron suaveolens	-0.001	187	-0.038	0.978	2-sample t-test	0.769	Kruskal-Wallis
Loundoungou	Greenwayodendron suaveolens	-0.047	32	-1.002	0.494	paired t-test	0.046	Wilcoxon
Ma'an	Greenwayodendron suaveolens	0.179	64	3.107	0.01	2-sample t-test	0.022	Kruskal-Wallis
Mamfe	Greenwayodendron suaveolens	0.099	118	2.416	0.043	2-sample t-test	0.032	Kruskal-Wallis
Mbang	Greenwayodendron suaveolens	0.057	95	1.315	0.344	paired t-test	0.444	Wilcoxon
Mindourou	Greenwayodendron suaveolens	0.067	164	2.601	0.031	2-sample t-test	0.068	Kruskal-Wallis
Bambidie	Julbernardia pellegriniana	0.075	178	1.913	0.123	paired t-test	0.06	Wilcoxon
Mamfe	Khaya anthotheca	0.012	85	0.109	0.968	2-sample t-test	0.832	Kruskal-Wallis
Loundoungou	Leplaea cedrata	-0.025	69	-0.880	0.551	paired t-test	0.444	Wilcoxon
Loundoungou	Lophira alata	-0.033	36	-0.996	0.494	paired t-test	0.761	Wilcoxon
Ma'an	Lophira alata	0.152	155	0.946	0.507	2-sample t-test	0.477	Kruskal-Wallis
Ma'an	Lophira alata	0.038	168	2.912	0.014	paired t-test	0.006	Wilcoxon
Mamfe	Lophira alata	0.014	334	0.337	0.851	2-sample t-test	0.832	Kruskal-Wallis
Loundoungou	Lovoa trichilioides	0.029	70	0.957	0.507	paired t-test	0.807	Wilcoxon
Ma'an	Lovoa trichilioides	0.124	83	3.260	0.007	paired t-test	0.006	Wilcoxon
Loundoungou	Manilkara mabokeënsis	-0.069	143	-3.813	0.001	paired t-test	0.001	Wilcoxon
Mbang	Mansonia altissima	-0.063	104	-4.198	<0.001	paired t-test	<0.001	Wilcoxon
Mindourou	Mansonia altissima	0.175	226	4.023	<0.001	2-sample t-test	<0.001	Kruskal-Wallis

Site	**Species**	**Logging effect**	***n***	***t***	***p*-value**	**test**	***p*-value**	**test**
Mindourou	Milicia excelsa	0.321	39	2.021	0.117	2-sample t-test	0.079	Kruskal-Wallis
Loundoungou	Nauclea diderrichii	-0.142	48	-4.866	<0.001	paired t-test	<0.001	Wilcoxon
Loundoungou	Nesogordonia kabingaensis	-0.021	121	-1.244	0.372	paired t-test	0.04	Wilcoxon
Mbang	Pericopsis elata	0.070	111	4.264	<0.001	paired t-test	<0.001	Wilcoxon
Mindourou	Pericopsis elata	0.086	339	4.373	<0.001	2-sample t-test	<0.001	Kruskal-Wallis
Djoum	Piptadeniastrum africanum	-0.157	141	-1.345	0.336	2-sample t-test	0.799	Kruskal-Wallis
Loundoungou	Piptadeniastrum africanum	-0.073	141	-2.431	0.042	paired t-test	0.019	Wilcoxon
Ma'an	Piptadeniastrum africanum	-0.015	127	-0.327	0.851	paired t-test	0.877	Wilcoxon
Bambidie	Pterocarpus soyauxii	-0.064	50	-1.371	0.336	paired t-test	0.204	Wilcoxon
Djoum	Pterocarpus soyauxii	-0.011	227	-0.184	0.928	2-sample t-test	0.634	Kruskal-Wallis
Loundoungou	Pterocarpus soyauxii	0.004	135	0.126	0.966	paired t-test	0.821	Wilcoxon
Ma'an	Pterocarpus soyauxii	-0.012	130	-0.492	0.796	paired t-test	0.396	Wilcoxon
Mamfe	Pterocarpus soyauxii	-0.304	206	-6.493	<0.001	2-sample t-test	<0.001	Kruskal-Wallis
Mbang	Pterocarpus soyauxii	-0.218	53	-3.681	0.003	paired t-test	0.004	Wilcoxon
Mindourou	Pterocarpus soyauxii	0.078	351	1.928	0.12	2-sample t-test	0.266	Kruskal-Wallis
Loundoungou	Pycnanthus angolensis	-0.115	166	-4.592	<0.001	paired t-test	<0.001	Wilcoxon
Djoum	Staudtia kamerunensis	0.009	256	0.267	0.891	2-sample t-test	0.832	Kruskal-Wallis
Loundoungou	Staudtia kamerunensis	-0.053	83	-2.624	0.031	paired t-test	0.037	Wilcoxon
Mbang	Sterculia rhinopetala	-0.043	127	-1.951	0.12	paired t-test	0.012	Wilcoxon
Djoum	Terminalia superba	0.058	288	1.256	0.37	2-sample t-test	0.003	Kruskal-Wallis
Mbang	Terminalia superba	0.037	91	1.163	0.404	paired t-test	0.004	Wilcoxon
Mindourou	Terminalia superba	0.205	339	3.368	0.004	2-sample t-test	0.002	Kruskal-Wallis
Loundoungou	Tessmannia africana	-0.076	152	-4.518	<0.001	paired t-test	<0.001	Wilcoxon
Mbang	Triplochiton scleroxylon	0.258	174	9.100	<0.001	paired t-test	<0.001	Wilcoxon
Mindourou	Triplochiton scleroxylon	0.618	150	4.267	<0.001	2-sample t-test	<0.001	Kruskal-Wallis

7.5 SUPPLEMENTARY MATERIAL 5: MORTALITY RATE ESTIMATES

Table S5: Estimate (λ) and credible intervals (ci) of the mortality rate (%). Also shown the number of monitored trees at the beginning of the census period (N0), the number of trees alive at the end of the census period (Nt), the length of the census period in years (t) and the corrected estimated of the mortality rates (λ_{corr}).

Site	**Species**	**N0**	**Nt**	***t***	**λ**	**ci**	**λ_{corr}**
Loundoungou	Afzelia bipindensis	277	271	3.196	0.685	0.32-1.49	0.752
Loundoungou	Albizia ferruginea	115	113	3.152	0.557	0.17-1.99	0.610
Loundoungou	Amphimas pterocarpoides	324	323	3.096	0.100	0.02-0.55	0.109

Site	Species	N0	Nt	*t*	λ	ci	λ_{corr}
Mokabi	Amphimas pterocarpoides	330	329	1.535	0.198	0.05-1.1	0.205
Loundoungou	Autranella congolensis	118	117	3.092	0.275	0.07-1.52	0.301
Loundoungou	Canarium schweinfurthii	138	134	3.054	0.963	0.39-2.45	1.053
Loundoungou	Chrysophyllum lacourtianum	263	255	3.060	1.009	0.52-1.98	1.104
Loundoungou	Copaifera mildbraedii	178	177	2.989	0.188	0.05-1.04	0.206
Djoum	Cylicodiscus gabunensis	117	116	1.569	0.547	0.13-3.02	0.567
Ma'an	Cylicodiscus gabunensis	171	169	3.389	0.347	0.11-1.25	0.383
Mamfe	Cylicodiscus gabunensis	143	141	5.247	0.268	0.08-0.96	0.307
Mindourou	Cylicodiscus gabunensis	148	147	4.411	0.154	0.04-0.85	0.173
Bambidie	Dacryodes normandii	115	115	1.046	0.000	0-3.04	0.000
Loundoungou	Diospyros crassiflora	315	307	3.083	0.834	0.43-1.64	0.913
Mokabi	Diospyros crassiflora	334	333	1.550	0.193	0.05-1.07	0.200
Djoum	Distemonanthus benthamianus	141	141	1.606	0.000	0-1.62	0.000
Ma'an	Distemonanthus benthamianus	191	190	2.236	0.235	0.06-1.3	0.250
Mamfe	Distemonanthus benthamianus	108	106	5.147	0.363	0.11-1.3	0.414
Loundoungou	Entandrophragma angolense	299	291	3.075	0.882	0.45-1.73	0.965
Mokabi	Entandrophragma angolense	357	353	1.565	0.720	0.29-1.84	0.746
Loundoungou	Entandrophragma candollei	296	294	3.008	0.225	0.07-0.81	0.246
Mokabi	Entandrophragma candollei	283	280	1.525	0.699	0.25-2.04	0.723
Loundoungou	Entandrophragma cylindricum	343	339	3.096	0.379	0.15-0.97	0.415
Mbang	Entandrophragma cylindricum	175	173	3.049	0.377	0.12-1.35	0.412
Mindourou	Entandrophragma cylindricum	213	213	4.805	0.000	0-0.36	0.000
Mokabi	Entandrophragma cylindricum	361	360	1.550	0.179	0.04-0.99	0.185
Loundoungou	Entandrophragma utile	175	173	3.073	0.374	0.12-1.34	0.409
Mokabi	Entandrophragma utile	102	102	1.583	0.000	0-2.26	0.000
Loundoungou	Eribroma oblongum	302	293	3.203	0.945	0.5-1.79	1.037
Ma'an	Erythrophleum ivorense	199	197	1.792	0.564	0.17-2.03	0.591
Djoum	Erythrophleum sp.	151	150	1.551	0.428	0.1-2.37	0.444
Loundoungou	Erythrophleum suaveolens	369	364	3.107	0.439	0.19-1.02	0.481
Mbang	Erythrophleum suaveolens	186	182	3.489	0.623	0.25-1.59	0.689
Mindourou	Erythrophleum suaveolens	190	189	4.803	0.110	0.03-0.61	0.125
Mokabi	Erythrophleum suaveolens	376	374	1.551	0.344	0.11-1.24	0.356
Loundoungou	Greenwayodendron suaveolens	105	101	3.338	1.164	0.47-2.95	1.281
Mokabi	Greenwayodendron suaveolens	111	110	1.544	0.586	0.14-3.24	0.607
Bambidie	Julbernardia pellegriniana	198	197	1.031	0.491	0.12-2.72	0.492
Loundoungou	Leplaea cedrata	188	185	3.150	0.511	0.18-1.48	0.560
Loundoungou	Lophira alata	100	99	3.108	0.323	0.08-1.78	0.354
Ma'an	Lophira alata	213	213	1.961	0.000	0-0.88	0.000
Mamfe	Lophira alata	200	194	5.372	0.567	0.26-1.23	0.649
Mindourou	Lophira alata	108	101	7.025	0.954	0.47-1.95	1.115

Site	Species	N0	Nt	t	λ	ci	λ_{corr}
Loundoungou	Lovoa trichilioides	172	164	3.130	1.522	0.78-2.98	1.667
Ma'an	Lovoa trichilioides	154	151	2.748	0.716	0.26-2.08	0.776
Loundoungou	Manilkara mabokeënsis	321	313	3.116	0.810	0.42-1.59	0.887
Mokabi	Manilkara mabokeënsis	301	294	1.530	1.538	0.76-3.16	1.591
Mbang	Mansonia altissima	121	109	4.093	2.552	1.46-4.42	2.857
Loundoungou	Nesogordonia kabingaensis	264	261	3.085	0.370	0.13-1.08	0.405
Mokabi	Nesogordonia kabingaensis	338	334	1.527	0.780	0.32-1.99	0.807
Mbang	Pericopsis elata	121	119	3.047	0.547	0.17-1.96	0.598
Mindourou	Pericopsis elata	168	167	4.823	0.124	0.03-0.69	0.140
Loundoungou	Piptadeniastrum africanum	333	327	3.136	0.580	0.27-1.26	0.635
Ma'an	Piptadeniastrum africanum	187	182	2.418	1.121	0.49-2.6	1.203
Mokabi	Prioria oxyphylla	296	293	1.528	0.667	0.24-1.94	0.690
Djoum	Pterocarpus soyauxii	102	102	1.572	0.000	0-2.28	0.000
Loundoungou	Pterocarpus soyauxii	293	292	3.129	0.109	0.03-0.61	0.120
Ma'an	Pterocarpus soyauxii	165	162	1.692	1.085	0.39-3.15	1.131
Mamfe	Pterocarpus soyauxii	138	132	5.147	0.864	0.4-1.87	0.985
Mindourou	Pterocarpus soyauxii	181	179	4.449	0.250	0.08-0.9	0.281
Mokabi	Pterocarpus soyauxii	330	328	1.537	0.396	0.12-1.42	0.409
Loundoungou	Pycnanthus angolensis	342	339	3.067	0.287	0.1-0.84	0.314
Mokabi	Pycnanthus angolensis	360	360	1.542	0.000	0-0.66	0.000
Djoum	Staudtia kamerunensis	112	112	1.608	0.000	0-2.03	0.000
Loundoungou	Staudtia kamerunensis	204	202	3.171	0.311	0.1-1.12	0.341
Mokabi	Staudtia kamerunensis	180	180	1.520	0.000	0-1.34	0.000
Mbang	Sterculia rhinopetala	132	128	5.023	0.613	0.25-1.56	0.697
Djoum	Terminalia superba	159	155	1.593	1.600	0.65-4.07	1.660
Mbang	Terminalia superba	109	104	3.500	1.342	0.59-3.1	1.483
Mindourou	Terminalia superba	158	153	4.779	0.673	0.29-1.56	0.763
Loundoungou	Tessmannia africana	324	312	3.070	1.229	0.71-2.14	1.345
Mokabi	Tessmannia africana	342	338	1.531	0.768	0.31-1.96	0.795
Ma'an	Triplochiton scleroxylon	146	137	5.278	1.206	0.64-2.27	1.377
Mbang	Triplochiton scleroxylon	181	178	4.038	0.414	0.15-1.2	0.463

7.6 SUPPLEMENTARY MATERIAL 6: INTERACTION BETWEEN LOGGING EFFECT AND TREE SIZE

For each combination of site and species, for which the number of monitored trees was at least greater than 50 in both the unlogged and logged treatment, we fitted an additive model (Eq. 6):

$$\Delta d_{j,s} = a + \mathrm{s}_1(d_{j,s}) + \mathrm{s}_2(d_{j,s}|\mathrm{logged}) + \epsilon_{j,s}\ , \qquad \text{Eq. 6}$$

Where $\mathrm{s}_1()$ is a non-linear smooth function of tree diameter and $s_2()$a second non-linear smooth function of tree diameter that was added to the first and that applies only to the observations of the logged treatment. This second function then expressed how the logging effect varied with tree size. It was used to identify what tree size classes were the most affected by logging.

Out of the 59 fitted models, 13 showed a significant interaction between tree size and logging effect ($s_2()$). These relationships showed very different patterns (Figure S5.1). For instance, growth reduction measured for few years after logging affected mostly the large *Entandrophragma cylindricum* in Loundoungou. In Mindourou where the post-logging growth was assessed several years after logging, canopy openness had likely been of most benefit to trees of intermediate size. In the same site when examining the results for *Pericopsis elata*, canopy openness seemed to benefit mostly small and intermediate trees.

It therefore seemed risky to generalize on how logging affects trees of varying size. Our sample was likely too limited to conclude confidently.

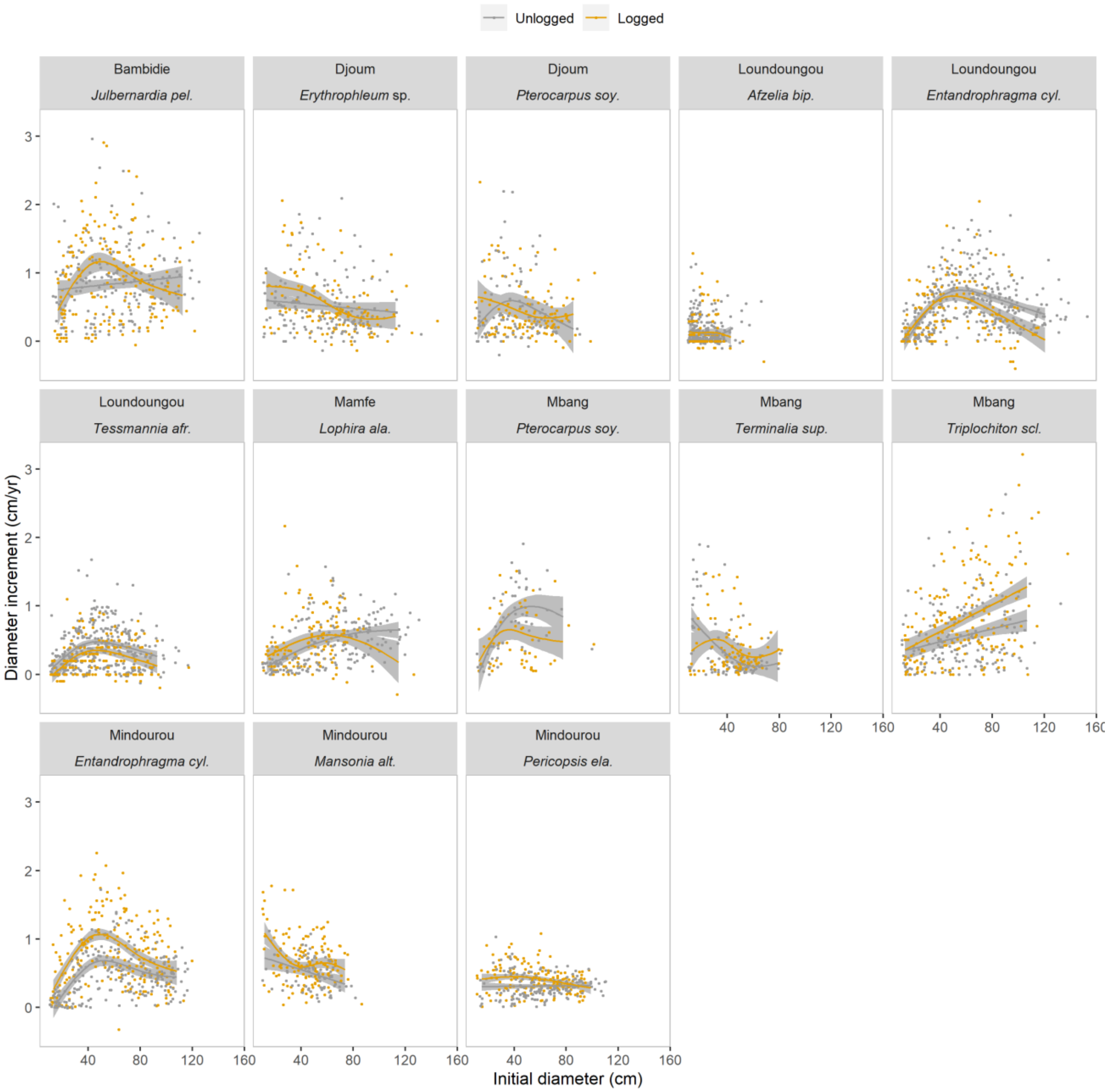

Figure S6. Relationships between tree increment, tree size and treatment. These relationships are shown only for combination of site and species for which the interaction between tree size and logging effect was found significant ($s_2()$ term in Eq. 6).

7.7 SUPPLEMENTARY MATERIAL 7: MORTALITY RATES IN LOGGED CONDITIONS

In logged forests, we examined 6,281 trees of 29 species that were monitored during varying census periods in the seven sites. The mean of the census period length was 2.8 years and ranged from 0.9 to 7.7 years. Only 116 dead trees were recorded. The overall mortality rate was approximately 0.7%, i.e., slightly greater than that observed in unlogged forests. The differences between pairs of estimates were tested with the Fisher test. Significant differences were found for only four pairs (i.e., combination of site and species) and for one of them the mortality rate was the highest in the unlogged conditions. We also expected that mortality rate could decrease over time after logging, but we did not evidence any relationship between the mortality rate and the time elapsed between the logging and the monitoring.

Table S7. Estimate and confidence intervals of the mortality rate (%) in logged and unlogged conditions. Also shown the number of monitored trees at the beginning of the census period (N0), the number of trees alive at the end of the census period (Nt), the length of census period in years (t) and the corrected estimated of the mortality rates (λ_{corr}).

Site	Species	Treatment	N0	Nt	*t*	λ	ci	λ_{corr}	N0
Loundoungou	Afzelia bipindensis	Unlogged	277	271	3.196	0.685	0.32-1.49	0.752	0.679
Loundoungou	Afzelia bipindensis	Logged	106	105	1.013	0.935	0.22-5.16	0.936	0.679
Loundoungou	Albizia ferruginea	Unlogged	115	113	3.152	0.557	0.17-1.99	0.610	/
Loundoungou	Amphimas pterocarpoides	Unlogged	324	323	3.096	0.100	0.02-0.55	0.109	1.000
Loundoungou	Amphimas pterocarpoides	Logged	152	152	1.015	0.000	0.00-2.37	0.000	1.000
Mokabi	Amphimas pterocarpoides	Unlogged	330	329	1.535	0.198	0.05-1.10	0.205	/
Loundoungou	Autranella congolensis	Unlogged	118	117	3.092	0.275	0.07-1.52	0.301	/
Loundoungou	Canarium schweinfurthii	Unlogged	138	134	3.054	0.963	0.39-2.45	1.053	/
Loundoungou	Chrysophyllum lacourtianum	Unlogged	263	255	3.060	1.009	0.52-1.98	1.104	0.282
Loundoungou	Chrysophyllum lacourtianum	Logged	126	125	1.016	0.784	0.19-4.33	0.785	0.282
Loundoungou	Copaifera mildbraedii	Unlogged	178	177	2.989	0.188	0.05-1.04	0.206	/
Djoum	Cylicodiscus gabunensis	Unlogged	117	116	1.569	0.547	0.13-3.02	0.567	0.055
Djoum	Cylicodiscus gabunensis	Logged	106	100	2.053	2.838	1.32-6.12	3.006	0.055
Ma'an	Cylicodiscus gabunensis	Unlogged	171	169	3.389	0.347	0.11-1.25	0.383	/
Mamfe	Cylicodiscus gabunensis	Unlogged	143	141	5.247	0.268	0.08-0.96	0.307	/
Mindourou	Cylicodiscus gabunensis	Unlogged	148	147	4.411	0.154	0.04-0.85	0.173	1.000
Mindourou	Cylicodiscus gabunensis	Logged	151	150	4.545	0.146	0.04-0.81	0.165	1.000
Bambidie	Dacryodes normandii	Unlogged	115	115	1.046	0.000	0.00-3.04	0.000	1.000
Bambidie	Dacryodes normandii	Logged	121	120	1.989	0.417	0.10-2.31	0.441	1.000
Loundoungou	Diospyros crassiflora	Unlogged	315	307	3.083	0.834	0.43-1.64	0.913	0.283
Loundoungou	Diospyros crassiflora	Logged	148	147	1.015	0.668	0.16-3.70	0.668	0.283
Mokabi	Diospyros crassiflora	Unlogged	334	333	1.550	0.193	0.05-1.07	0.200	/
Djoum	Distemonanthus benthamianus	Unlogged	141	141	1.606	0.000	0.00-1.62	0.000	/
Ma'an	Distemonanthus benthamianus	Unlogged	191	190	2.236	0.235	0.06-1.30	0.250	1.000
Ma'an	Distemonanthus benthamianus	Logged	134	134	2.212	0.000	0.00-1.24	0.000	1.000
Mamfe	Distemonanthus benthamianus	Unlogged	108	106	5.147	0.363	0.11-1.30	0.414	/
Loundoungou	Entandrophragma angolense	Unlogged	299	291	3.075	0.882	0.45-1.73	0.965	0.282
Loundoungou	Entandrophragma angolense	Logged	144	143	1.015	0.687	0.17-3.80	0.687	0.282
Mokabi	Entandrophragma angolense	Unlogged	357	353	1.565	0.720	0.29-1.84	0.746	/
Loundoungou	Entandrophragma candollei	Unlogged	296	294	3.008	0.225	0.07-0.81	0.246	1.000
Loundoungou	Entandrophragma candollei	Logged	150	149	1.014	0.659	0.16-3.65	0.660	1.000
Mokabi	Entandrophragma candollei	Unlogged	283	280	1.525	0.699	0.25-2.04	0.723	/
Loundoungou	Entandrophragma cylindricum	Unlogged	343	339	3.096	0.379	0.15-0.97	0.415	0.328
Loundoungou	Entandrophragma cylindricum	Logged	140	140	1.014	0.000	0.00-2.58	0.000	0.328
Mbang	Entandrophragma cylindricum	Unlogged	175	173	3.049	0.377	0.12-1.35	0.412	1.000

Site	Species	Treatment	N0	Nt	*t*	λ	ci	λ_{corr}	N0
Mbang	Entandrophragma cylindricum	Logged	136	135	2.990	0.247	0.06-1.37	0.269	1.000
Mindourou	Entandrophragma cylindricum	Unlogged	213	213	4.805	0.000	0.00-0.36	0.000	0.007
Mindourou	Entandrophragma cylindricum	Logged	210	203	7.410	0.458	0.22-0.94	0.537	0.007
Mokabi	Entandrophragma cylindricum	Unlogged	361	360	1.550	0.179	0.04-0.99	0.185	/
Loundoungou	Entandrophragma utile	Unlogged	175	173	3.073	0.374	0.12-1.34	0.409	/
Mokabi	Entandrophragma utile	Unlogged	102	102	1.583	0.000	0.00-2.26	0.000	/
Loundoungou	Eribroma oblongum	Unlogged	302	293	3.203	0.945	0.50-1.79	1.037	0.735
Loundoungou	Eribroma oblongum	Logged	112	110	1.015	1.775	0.54-6.35	1.777	0.735
Ma'an	Erythrophleum ivorense	Unlogged	199	197	1.792	0.564	0.17-2.03	0.591	1.000
Ma'an	Erythrophleum ivorense	Logged	163	161	2.193	0.563	0.17-2.02	0.599	1.000
Djoum	Erythrophleum sp.	Unlogged	151	150	1.551	0.428	0.10-2.37	0.444	1.000
Djoum	Erythrophleum sp.	Logged	141	140	1.815	0.392	0.09-2.17	0.411	1.000
Loundoungou	Erythrophleum suaveolens	Unlogged	369	364	3.107	0.439	0.19-1.02	0.481	0.672
Loundoungou	Erythrophleum suaveolens	Logged	164	163	1.013	0.604	0.15-3.34	0.604	0.672
Mbang	Erythrophleum suaveolens	Unlogged	186	182	3.489	0.623	0.25-1.59	0.689	0.138
Mbang	Erythrophleum suaveolens	Logged	139	139	2.744	0.000	0.00-0.96	0.000	0.138
Mindourou	Erythrophleum suaveolens	Unlogged	190	189	4.803	0.110	0.03-0.61	0.125	0.013
Mindourou	Erythrophleum suaveolens	Logged	161	153	7.488	0.681	0.35-1.33	0.800	0.013
Mokabi	Erythrophleum suaveolens	Unlogged	376	374	1.551	0.344	0.11-1.24	0.356	/
Djoum	Greenwayodendron suaveolens	Logged	114	110	2.084	1.714	0.69-4.35	1.818	/
Loundoungou	Greenwayodendron suaveolens	Unlogged	105	101	3.338	1.164	0.47-2.95	1.281	/
Mbang	Greenwayodendron suaveolens	Logged	124	109	2.586	4.986	3.01-8.16	5.380	/
Mokabi	Greenwayodendron suaveolens	Unlogged	111	110	1.544	0.586	0.14-3.24	0.607	/
Bambidie	Julbernardia pellegriniana	Unlogged	198	197	1.031	0.491	0.12-2.72	0.492	0.108
Bambidie	Julbernardia pellegriniana	Logged	181	176	1.993	1.406	0.62-3.26	1.486	0.108
Loundoungou	Leplaea cedrata	Unlogged	188	185	3.150	0.511	0.18-1.48	0.560	/
Loundoungou	Lophira alata	Unlogged	100	99	3.108	0.323	0.08-1.78	0.354	/
Ma'an	Lophira alata	Unlogged	213	213	1.961	0.000	0.00-0.88	0.000	0.024
Ma'an	Lophira alata	Logged	316	308	3.195	0.803	0.41-1.58	0.881	0.024
Mamfe	Lophira alata	Unlogged	200	194	5.372	0.567	0.26-1.23	0.649	0.043
Mamfe	Lophira alata	Logged	143	143	1.584	0.000	0.00-1.62	0.000	0.043
Mindourou	Lophira alata	Unlogged	108	101	7.025	0.954	0.47-1.95	1.115	/
Loundoungou	Lovoa trichilioides	Unlogged	172	164	3.130	1.522	0.78-2.98	1.667	/
Ma'an	Lovoa trichilioides	Unlogged	154	151	2.748	0.716	0.26-2.08	0.776	/
Loundoungou	Manilkara mabokeënsis	Unlogged	321	313	3.116	0.810	0.42-1.59	0.887	0.286
Loundoungou	Manilkara mabokeënsis	Logged	144	143	1.015	0.687	0.17-3.80	0.687	0.286
Mokabi	Manilkara mabokeënsis	Unlogged	301	294	1.530	1.538	0.76-3.16	1.591	/
Mbang	Mansonia altissima	Unlogged	121	109	4.093	2.552	1.46-4.42	2.857	/
Mindourou	Mansonia altissima	Logged	146	144	7.283	0.189	0.06-0.68	0.222	/
Loundoungou	Nesogordonia kabingaensis	Unlogged	264	261	3.085	0.370	0.13-1.08	0.405	1.000

Site	**Species**	**Treatment**	**N0**	**Nt**	***t***	**λ**	**ci**	**λ_{corr}**	**N0**
Loundoungou	Nesogordonia kabingaensis	Logged	123	122	1.014	0.805	0.19-4.45	0.806	1.000
Mokabi	Nesogordonia kabingaensis	Unlogged	338	334	1.527	0.780	0.32-1.99	0.807	/
Mbang	Pericopsis elata	Unlogged	121	119	3.047	0.547	0.17-1.96	0.598	0.160
Mbang	Pericopsis elata	Logged	113	107	2.988	1.826	0.85-3.94	1.993	0.160
Mindourou	Pericopsis elata	Unlogged	168	167	4.823	0.124	0.03-0.69	0.140	0.121
Mindourou	Pericopsis elata	Logged	169	163	7.194	0.503	0.23-1.09	0.588	0.121
Loundoungou	Piptadeniastrum africanum	Unlogged	333	327	3.136	0.580	0.27-1.26	0.635	1.000
Loundoungou	Piptadeniastrum africanum	Logged	146	143	1.015	2.045	0.74-5.94	2.048	1.000
Ma'an	Piptadeniastrum africanum	Unlogged	187	182	2.418	1.121	0.49-2.60	1.203	0.703
Ma'an	Piptadeniastrum africanum	Logged	140	138	2.187	0.658	0.2-2.36	0.701	0.703
Mokabi	Prioria oxyphylla	Unlogged	296	293	1.528	0.667	0.24-1.94	0.690	/
Djoum	Pterocarpus soyauxii	Unlogged	102	102	1.572	0.000	0.00-2.28	0.000	0.503
Djoum	Pterocarpus soyauxii	Logged	126	124	2.006	0.798	0.24-2.86	0.843	0.503
Loundoungou	Pterocarpus soyauxii	Unlogged	293	292	3.129	0.109	0.03-0.61	0.120	0.096
Loundoungou	Pterocarpus soyauxii	Logged	136	133	1.015	2.197	0.79-6.37	2.200	0.096
Ma'an	Pterocarpus soyauxii	Unlogged	165	162	1.692	1.085	0.39-3.15	1.131	0.627
Ma'an	Pterocarpus soyauxii	Logged	141	140	2.273	0.313	0.08-1.73	0.334	0.627
Mamfe	Pterocarpus soyauxii	Unlogged	138	132	5.147	0.864	0.40-1.87	0.985	/
Mindourou	Pterocarpus soyauxii	Unlogged	181	179	4.449	0.250	0.08-0.90	0.281	0.499
Mindourou	Pterocarpus soyauxii	Logged	167	167	4.764	0.000	0.00-0.46	0.000	0.499
Mokabi	Pterocarpus soyauxii	Unlogged	330	328	1.537	0.396	0.12-1.42	0.409	/
Loundoungou	Pycnanthus angolensis	Unlogged	342	339	3.067	0.287	0.10-0.84	0.314	0.554
Loundoungou	Pycnanthus angolensis	Logged	166	166	1.015	0.000	0.00-2.18	0.000	0.554
Mokabi	Pycnanthus angolensis	Unlogged	360	360	1.542	0.000	0.00-0.66	0.000	/
Djoum	Staudtia kamerunensis	Unlogged	112	112	1.608	0.000	0.00-2.03	0.000	0.505
Djoum	Staudtia kamerunensis	Logged	143	141	2.034	0.692	0.21-2.48	0.733	0.505
Loundoungou	Staudtia kamerunensis	Unlogged	204	202	3.171	0.311	0.10-1.12	0.341	/
Mokabi	Staudtia kamerunensis	Unlogged	180	180	1.520	0.000	0.00-1.34	0.000	/
Mbang	Sterculia rhinopetala	Unlogged	132	128	5.023	0.613	0.25-1.56	0.697	0.122
Mbang	Sterculia rhinopetala	Logged	127	127	2.014	0.000	0.00-1.43	0.000	0.122
Djoum	Terminalia superba	Unlogged	159	155	1.593	1.600	0.65-4.07	1.660	0.382
Djoum	Terminalia superba	Logged	131	130	2.027	0.378	0.09-2.09	0.400	0.382
Mbang	Terminalia superba	Unlogged	109	104	3.500	1.342	0.59-3.10	1.483	/
Mindourou	Terminalia superba	Unlogged	158	153	4.779	0.673	0.29-1.56	0.763	0.776
Mindourou	Terminalia superba	Logged	180	173	7.306	0.543	0.27-1.11	0.637	0.776
Loundoungou	Tessmannia africana	Unlogged	324	312	3.070	1.229	0.71-2.14	1.345	0.406
Loundoungou	Tessmannia africana	Logged	153	150	1.013	1.955	0.71-5.68	1.957	0.406
Mokabi	Tessmannia africana	Unlogged	342	338	1.531	0.768	0.31-1.96	0.795	/
Ma'an	Triplochiton scleroxylon	Unlogged	146	137	5.278	1.206	0.64-2.27	1.377	/
Mbang	Triplochiton scleroxylon	Unlogged	181	178	4.038	0.414	0.15-1.20	0.463	0.290

Site	**Species**	**Treatment**	**N0**	**Nt**	***t***	**λ**	**ci**	**λ_{corr}**	**N0**
Mbang	Triplochiton scleroxylon	Logged	133	128	2.995	1.279	0.56-2.96	1.397	0.290
Mindourou	Triplochiton scleroxylon	Logged	115	111	7.042	0.503	0.20-1.28	0.588	/

Figure S7. Estimate and confidence intervals of the mortality rate (%) in logged and unlogged conditions.

7.8 SUPPLEMENTARY MATERIAL 7: DATA AND R SCRIPT

The supplementary tables and all the data and R script needed to reproduce the results are available at *https://doi.org/10.18167/DVN1/EBN15Y*. A permanent DOI link will be created once the publication is accepted.

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