SUPPORTING INFORMATION

TREE HEIGHT ALLOMETRY MODEL

We built a height allometry model to predict tree heights from DBH for all trees across all census intervals. The linear mixed model is specified as

$$\log(h_{i1}) = b + a\log(DBH_{i1}) + \gamma_s S_i + \delta_b B_i + \varepsilon_{i1}$$

where h_{i1} is the measured tree height i during the first census, DBH_{i1} is its measured stem diameter, S_i is a vector of the species of the individuals, B_i the tree's treatment block , γ_s and δ_b the random variables associated with the corresponding vectors, and the error term is ε_{i1}~N$(0, \sigma^2)$. We assigned the height estimated from this allometry ($h_{allom,ij}$) to each tree in each census that lacked height estimates. For each tree *i* whose height was measured during the first census, we added its residual (ε_{i1}) to the estimate, since trees tall for their DBH in census 1 are also likely to be tall for their DBH in later censuses, and vice versa, and because the model with residuals added fit the data better than the model without (Table S 3). Hence,

$$h_{allom,ij} = \begin{cases} h_{allom,ij} + \varepsilon_{i1}, & \text{if } h_{i1} \text{ exists} \\ h_{allom,ij}, & \text{otherwise} \end{cases}$$

When our models included DBH and not h_{allom}, the assumption is that DBH is a better proxy for height than crown exposure, insofar as we are testing whether height or crown exposure is the principal cause of drought vulnerability. To test this assumption, we fit two models (Equations 2 and 3) with scaled and centered predictors, the second of which contains the DBH allometric fit, and compared the magnitudes of the coefficients of those predictors.

$$h_{i1} = b + a\,DBH_{i1} + c\,CP_{i1} + \delta_b B_i + \varepsilon_{i1} \qquad (1)$$

$$h_{i1} = b + a\,(0.631 * DBH_{i1}{}^{0.5517}) + c\,CP_{i1} + \delta_b B_i + \varepsilon_{i1} \qquad (2)$$

HEIGHT ALLOMETRY RESULTS

The height allometry model explained 66% of the variation in log(h) ($R^2_{GLMM(c)}$), with 52% explained by the fixed effect alone (DBH; $R^2_{GLMM(m)}$; [63]). The model with fit parameters was:

$$h = 0.63\,DBH^{0.552}$$

Comparing the strength of the DBH and crown exposure predictors for tree height, we found that DBH was a stronger predictor of height than crown exposure, the former having a coefficient twice the magnitude of the latter (Table S 2). The height allometry predictor (*a* in Equation 3) was an even stronger predictor of tree height. These results indicate the DBH is a better proxy for tree height than crown exposure, and that by comparing DBH versus crown exposure predictors in our models, we are able to test the height versus crown exposure hypothesis.

Visual estimation of tree height has been shown to outperform laser hypsometers in the one case we are aware of it having been tested [64]. That the models here that include tree height predict mortality better than those that include stem diameter lends further credence to the validity of the height estimates.

INTERPRETING INTERACTIONS

Understanding the effects of tree size and crown position on drought vulnerability requires interpretation of interactive models terms. Because our models estimate effects on mortality rates, positive coefficients indicate that increases in that predictor result in increases in mortality risk whereas decreases indicate decreased mortality risk. For negative coefficients, the inverse is true. A negative DBH coefficient would indicate that increases in DBH are associated with decreased mortality rates. MCWD becomes more negative under drier conditions. Therefore, a negative MCWD coefficient would indicate that decreases in MCWD (drier conditions) are associated with increased mortality rates: ↓MCWD x ↓coefficient = ↑mortality.

An interactive term represents the product of two predictors (Figure S 1e-f), and fits a new coefficient to that new predictor. By interacting DBH with MCWD, for example, we can examine how DBH changes how MCWD affects mortality rates. If DBH and MCWD coefficients have the directions posited above and the "DBH:MCWD" term is positive, then we can infer that increases in DBH reduce the effect of MCWD, as the MCWD coefficient is always negative. Thus, we would conclude that larger trees are less sensitive to MCWD either via a reduced vulnerability to drought, a reduced benefit from wet conditions, or both. If "DBH:MCWD" is negative, then increases in DBH reinforce the negative MCWD effect, indicating that larger trees are more vulnerable to drought or benefit more from wet conditions. Figure S 1 provides a graphical description of this concept.

To determine whether crown exposure or DBH was associated with increased mortality during droughts, we fit models that included either the crown position:MCWD interaction or the DBH:MCWD interaction. We compare the fit of these models to the data using corrected-AIC. If trees with either exposed crowns or large diameter trunks experienced especially elevated mortality rates during dry census intervals, we would expect to see negative interaction terms between crown position and MCWD, or DBH and MCWD, respectively.

DETAILED DISCUSSION OF MODEL RESULTS

MODELS THAT IGNORE LOGGING

Height-based models

When height instead of DBH was included in models that did not distinguish logged vs unlogged plots, neither height nor crown exposure were strong predictors of drought-induced mortality (i.e. h:MCWD and CP:MCWD were small; Figure 3b, Table S 7). Instead, height was strongly and negatively associated with overall (not drought-induced) mortality risk. The direct effect of crown exposure switched from being strongly associated with increased survival probabilities in DBH-based models (Table S 7) to being associated with slight increases in mortality risk in height-based models.

The model including the CP:MCWD interaction (Model 7) was slightly better than the one including the h:MCWD interaction (Model 6; $\Delta AICc_{7\text{-}6} = -0.59$), and the magnitude of the CP:MCWD predictor was slightly larger than the h:MCWD predictor (Table S 7, Figure 3b). Thus, while crown exposure is a slightly stronger predictor of drought-included mortality than tree height, neither factor is a strong predictor when tree height is included in the model.

DBH-based models

Across all plots, when including only DBH as the size predictor, mortality rates of large trees were less sensitive to drought than those of smaller trees (DBH:MCWD > 0; Table S 7, Figure S 9). In other words, mortality rates of small trees increase more as a result of drought than large trees. According to the full DBH model (Table S 7), in wet conditions, annual mortality rates of large and small trees are predicted to be nearly identical, with rates between 1% for fully exposed trees and 2% for fully shaded trees (Figure S 13a, Figure S 14). As conditions become drier, however, mortality rates of small trees (10cm DBH) increase rapidly to

3-4%. Large trees suffer little due to drought if they are shaded, but they suffer more if exposed (Figure S 13a, Figure S 14). Annual mortality rates range from 1.0 – 1.3% for 150 cm DBH trees in crown exposure classes 3 – 5 in wet conditions, but increase to 1.7% during droughts; this represents an absolute increase of 0.4 – 0.7%, compared with an increase of 2.4 – 2.8% for 10 cm trees. These results hold even when crown position is removed from our models and only DBH or height are tested (Table S 7).

Increased crown exposure is associated with increased vulnerability to drought – the opposite effect of tree size (CP:MCWD < 0; Table S 7,). In other words, mortality rates of exposed trees rose more as a result of drying conditions than those of shaded trees (Figure S 13b). Mortality rates of 10 cm trees rose 2.4% (absolutely, not as HR) across the wettest to driest conditions when in canopy position 1 (no direct light), compared with a 2.8% rise when in canopy position 5 (exposed from above and laterally). In contrast, mortality rates of 150 cm trees rose only 0.4% when in canopy position 3 and by 0.6% when in canopy position 5.

Logging models

Across the suite of tested models, a consistent pattern emerged of how logging shifts the roles of tree size and crown exposure in determining drought-induced mortality. Tree size, both in terms of DBH and height, was less of a disadvantage during droughts in logged plots compared to unlogged plots (Figure 3, Figure S 9). DBH shifted from conferring drought tolerance in logged plots to being a non-factor in unlogged plots. Height shifted from being a non-factor in logged plots to magnifying drought-vulnerability in unlogged plots. The effect of crown exposure on drought-induced mortality was consistent between logged and unlogged plots, and varied primarily as a result of whether tree height was included in the model or not. Crown exposure was associated with increased risk of drought-induced mortality in DBH models, and was not an important predictor of drought-induced mortality in height models. The most parsimonious height-based logging model (Model 28) contains a negative interaction between logging and crown exposure, indicating that tree mortality was largely insensitive to variation in crown exposure in logged plots, whereas tree mortality increased with increasing crown exposure mortality in unlogged plots. We examine these patterns in more detail below.

Height-based models

Unlike the DBH-based models, including whether or not a plot was logged did not improve height-based models. We found no large differences in AICc between the models with CP:logged interactions (Model 26 – Model 28) and height:logged interactions (Model 25;Table S 4). Models fit to logged (Model 19, Figure 3c) and unlogged (Model 20, Figure 3d) data show that taller trees are more sensitive to droughts than shorter trees in unlogged plots (h:MCWD < 0; Figure 3d), but not in logged plots (Figure 3c). The CP:MCWD interaction did not change appreciably in the logged and unlogged models.

While increased crown exposure was associated with lower mortality rates in the DBH models discussed above, it was associated with higher mortality rates in height models run on the unlogged data, and had no bearing on mortality in height models run on the logged data. Tree height was strongly associated with lower mortality rates in all models tested.

DBH-based models

Logging resulted in the expected increase in crown exposure of small trees (Figure S 6). We tested the effects of logging on drought-induced mortality in two ways: with models run on data from logged and unlogged plots separately (Model 9, Model 10), and with models run on the complete dataset and including the logging variable (Model 13-17). For this latter set of models, AICc supported the form with a 3-way interaction between DBH, *logged*, and MCWD, and an interaction between CP and MCWD (Model 15, Figure S 9, Table S 4). Predictions for that model are shown in Figure S 14. This model indicates that large trees fare slightly better in logged vs unlogged plots ($HR_{DBH:logged}$= -4.4%), and that large trees suffer less from droughts in logged plots than they do in unlogged plots ($HR_{DBH:logged:MCWD}$ = 7.9%; Table S 7). This latter finding is supported by the models run on separate logged/unlogged datasets (Model 9 and 10), where $HR_{DBH:MCWD, logged}$ = 5.2%, and $HR_{DBH:MCWD, unlogged}$ = 0.8%. This 3-way interaction between DBH, MCWD, and logging is strong enough to reverse the direction of the relationship between DBH and drought in logged vs unlogged plots. In logged plots, large trees suffer less than small trees due to drought; in unlogged plots, large trees suffer more. A crossover in mortality rates of large and small tree occurs in the unlogged plots (Figure S 14), but is absent in the logged plots. In contrast to tree size, the role of crown position in drought-induced mortality does not change due to logging, maintaining its association with elevated drought-induced mortality risk across treatments ($HR_{CP:MCWD,logged}$ = -3.1%, $HR_{CP:MCWD,unlogged}$ = -3.8%; Table S 7).

Aside from the effect of tree size on drought response, our models are equivocal as to how logging influences drought-induced mortality across all stems regardless of size. While our separate data models (Model 9 and 10) suggest that all trees in logged plots may be more resistant to drought (Table S 7, $HR_{MCWD, logged}$ = 13%, $HR_{MCWD, unlogged}$ = 22%), models integrating all data do not show a significant logged:MCWD interaction (Table S 7, Figure S 9).

To test the prediction based on previous studies that large trees are more vulnerable to drought than small trees in unlogged tropical forests, we removed canopy position from the unlogged model (Model 11). In this formulation, while the DBH:MCWD interaction changes direction (Figure S 9), bootstrap tests on GLMs do not find significant differences in mortality rates of the largest trees across logging treatments during the drought.

Height + DBH-based models

Shifts in the roles of DBH, h, and CP in drought-induced mortality across logging treatments were consistent between models with all predictors (Model 30, Model 31; Figure S 10b,c) and models with just DBH or h. Crown exposure did not affect drought-induced mortality in these models, consistent with the height-based models, and contradicting the DBH-based models.

In these models, in unlogged plots, tree height was associated with increased risk of drought-induced mortality; neither DBH nor CP had a strong influence. In logged plots, DBH decreased the risk of drought-induced mortality, whereas neither height nor CP had strong influence.

RELATIVE IMPORTANCE OF TREE SIZE VERSUS CROWN EXPOSURE

The roles of DBH, tree height, and crown exposure change magnitude and direction depending on whether plots were logged and with the covariates included in the models. In DBH-based models, crown exposure was the principal negative influence on drought-induced mortality in unlogged plots, whereas DBH and crown exposure had similar effect magnitudes but opposite directions in logged plots (Figure S 9a,e,f). In height-based models, height was a stronger predictor of drought-induced mortality than crown exposure in unlogged plots, whereas neither height nor crown exposure were associated with drought-induced mortality in logged plots (Figure 3). In models including both height and DBH, height was the strongest predictor of drought-induced mortality in unlogged plots, while DBH and crown exposure had little influence. In logged plots, DBH decreased the risk of drought-induced mortality while height and crown exposure had little influence (Figure S 10b,c).

The ranking of drought-induced mortality predictors above, keeping in mind that height-based models were better predictors of mortality than DBH-based models, leads us to conclude that height is the most important determinant of drought-induced mortality in unlogged plots. In logged plots, DBH was the most important predictor, but acted in a direction opposite than what was expected (i.e., drought-induced mortality decreased with tree size). While crown exposure was important in predicting drought-induced mortality in DBH-based models, its diminution in height-based models indicates that it may serve as a proxy for height.

ACCOUNTING FOR VARIABLE CENSUS LENGTHS IN MODELS

The probability that a tree dies in a year ($\Delta t = 1$) is μ_0, and its probability of surviving is $1 - \mu_0$. Its probability of surviving a variable interval Δt is $(1 - \mu_0)^{\Delta t}$, and of dying during that interval is

$$\mu = 1 - (1 - \mu_0)^{\Delta t} \qquad \text{(S1)}$$

If the annual probability of mortality μ_0 is a function of a linear combination of factors x, then the probability of mortality $\mu_0 = f(\beta x)$. In our models, $f(\,)$ is the complementary log-log function

$C(\mu) = \log\big(-\log(1 - \mu)\big)$.

To model annual mortality rates, we account for varying census lengths by incorporating an offset term. The inverse complementary log-log function is

$$\mu = C^{-1}(\eta) = 1 - \exp\big(-\exp(\eta)\big)$$

η is our linear predictor, βX. If μ_0 is the mortality rate over a period $\Delta t = 1$ and $\mu_0 = C^{-1}(\eta)$, then

$$\begin{aligned} C^{-1}(\eta + \log \Delta t) &= 1 - \exp(-\exp(\eta + \log \Delta t)) \\ &= 1 - \exp(-\exp(\eta))^{\Delta t} \\ &= 1 - \exp(-\exp(\eta))^{\Delta t} \\ &= 1 - (1 - \mu_0)^{\Delta t} \end{aligned}$$

This formulation, equivalent to Equation S1, correctly incorporates variable census intervals in our annual mortality models. The general form of our models is thus

$$\mu_{ij} = C^{-1}\big(\beta X_{ij} + \log \Delta t_{ij} + \gamma_i U_i + \delta_k W_k + \varepsilon_{ij}\big)$$

across *i* individuals, *j* censuses, where the error is $\varepsilon \sim \mathrm{N}(0, \sigma^2)$. β incorporates the coefficient terms of interest that we estimate. γ_i and δ_k are random variables, $\sim \mathrm{N}(0, D)$, across the *i* individuals and *k* treatments, respectively.

TABLES

Table S 1. Model formulations fit in this study. Models are named for convenience if they are referenced often in the text. When presenting model formulations, we present just the linear predictor (βX_{ij}) for readability, where '+' indicates an additive model, '*' indicates the combination of main and interactive effects, and ':' indicates the interactive effect only. Normal order of operations governs additive and interactive operators.

	Name	Linear predictor (βX)	Dataset
		DBH Models	
Model 1	Full DBH	(DBH + CP) * MCWD	All
Model 2	DBH only	DBH * MCWD + CP	All
Model 3	CP only (DBH)	DBH + CP * MCWD	All
Model 4		DBH + CP + MCWD	All
		Height Models	
Model 5	Full height	(h + CP) * MCWD	All
Model 6	Height only	h * MCWD + CP	All
Model 7	CP only (H)	h + CP * MCWD	All
Model 8		h + CP + MCWD	All
		Logging Models (DBH)	
Model 9	Full logged	(DBH + CP) * MCWD	Logged plots
Model 10	Full unlogged	(DBH + CP) * MCWD + Block	Unlogged plots
Model 11	DBH-only unlogged	DBH * MCWD + Block	Unlogged plots
Model 12	Simple DBH logging	DBH * logged * MCWD	All
Model 13		(DBH + CP + logged) * MCWD	All
Model 14		DBH * logged * MCWD + CP	All
Model 15		DBH * logged * MCWD + CP * MCWD	All
Model 16		DBH + CP * logged * MCWD	All
Model 17		DBH * MCWD + CP * logged * MCWD	All
Model 18		DBH + CP * MCWD + logged * MCWD + CP * logged	All
		Logging Models (Height)	
Model 19		(h + CP) * MCWD	Logged plots
Model 20		(h + CP) * MCWD + Block	Unlogged plots
Model 21		h * MCWD + Block	Unlogged plots
Model 22	Simple height logging	h * logged * MCWD	All
Model 23		CP * logged * MCWD	All
Model 24		(h + CP + logged) * MCWD	All
Model 25		h * logged * MCWD + CP	All
Model 26		h + CP * logged * MCWD	All
Model 27		h * MCWD + CP * logged * MCWD	All
Model 28		h + CP * MCWD + logged * MCWD + CP * logged	All

Model 29	Full height logging	h * logged * MCWD + CP * logged * MCWD	All
		Logging Models (DBH + Height)	
Model 30		(h + DBH + CP) * MCWD	Logged plots
Model 31		(h + DBH + CP) * MCWD + Block	Unlogged plots

Table S 2. Height allometry model fits.

	Dependent variable:		
	log(h)	h	
	H allom	DBH vs CP	DBH allom vs CP
	(1)	(2)	(3)
log(DBH)	0.552^{***}		
	(0.545, 0.558)		
DBH (scaled)		2.940^{***}	
		(2.896, 2.984)	
0.631(DBH)^0.5517 (scaled)			3.272^{***}
			(3.229, 3.315)
CP (scaled)		1.516^{***}	1.213^{***}
		(1.472, 1.560)	(1.170, 1.256)
Intercept	0.631^{***}	12.879^{***}	12.883^{***}
	(0.592, 0.670)	(12.646, 13.111)	(12.654, 13.112)
Observations	33,617	33,617	33,617
Log Likelihood	-1,607.272	-88,698.780	-87,211.820
Akaike Inf. Crit.	3,224.544	177,407.600	174,433.600
Bayesian Inf. Crit.	3,266.658	177,449.700	174,475.700
Note:	$^{*}p\,^{**}p\,^{***}p<0.01$		

Table S 3. AIC comparison of mortality models with height predictors. h_plus_resid is the height allometry prediction plus model residuals for individual trees (described in Methods), and h is the height prediction with no correction from residuals.

Modnames	AICcWt	Cum.Wt	Delta_AICc	K	ModelLik
h_plus_resid * MCWD + CP * MCWD	1.00	1.00	0.00	8.00	1.00
h * MCWD + CP * MCWD	0.00	1.00	215.58	8.00	0.00

Table S 4. AIC comparisons of models fit to data across all treatments. Models fit on data from logged or control plots are not included here.

Modnames	AICcWt	Cum.Wt	Delta_AICc	K	ModelLik
h + CP + MCWD	0.22	0.22	0.00	6.00	1.00
h + CP * MCWD	0.18	0.40	0.35	7.00	0.84
h * MCWD + CP	0.13	0.53	0.94	7.00	0.63
h + CP * MCWD + logged * MCWD + CP * logged	0.10	0.63	1.54	10.00	0.46
h + CP * logged * MCWD	0.08	0.71	2.06	11.00	0.36
h * MCWD + CP * MCWD	0.07	0.78	2.18	8.00	0.34
h * MCWD	0.06	0.84	2.45	6.00	0.29
h * logged * MCWD + CP * logged * MCWD	0.05	0.89	3.01	14.00	0.22
h * logged * MCWD + CP	0.04	0.93	3.35	11.00	0.19
h * logged * MCWD + CP * MCWD	0.03	0.96	3.80	12.00	0.15
h * logged * MCWD	0.03	0.99	4.24	10.00	0.12
h * MCWD + CP * MCWD + logged * MCWD	0.01	1.00	6.17	10.00	0.05
DBH * logged * MCWD + CP * MCWD	0.00	1.00	260.24	12.00	0.00
DBH * logged * MCWD + CP	0.00	1.00	261.87	11.00	0.00
DBH + CP + MCWD	0.00	1.00	263.00	6.00	0.00
DBH * MCWD + CP * MCWD	0.00	1.00	263.07	8.00	0.00
DBH + CP * MCWD	0.00	1.00	263.60	7.00	0.00
DBH + CP * MCWD + logged * MCWD + CP * logged	0.00	1.00	264.09	10.00	0.00
DBH + CP * logged * MCWD	0.00	1.00	264.42	11.00	0.00
DBH * MCWD + CP	0.00	1.00	264.51	7.00	0.00
DBH * MCWD + CP * MCWD + logged * MCWD	0.00	1.00	267.02	10.00	0.00
DBH * logged * MCWD	0.00	1.00	284.70	10.00	0.00
CP * logged * MCWD	0.00	1.00	285.46	10.00	0.00
DBH * MCWD	0.00	1.00	287.51	6.00	0.00

Table S 5. Observations of crown exposure classes versus stem diameter classes across all censuses except the last. The last census is excluded because we use the DBH and crown exposure classes from the beginning of each census interval in our models.

	1	**2**	**3**	**4**	**5**
[0,10]	148	100	55	43	3
(10,20]	12719	16966	14323	4696	1813
(20,30]	4713	12966	22416	11492	4627
(30,40]	672	3147	8890	8548	4623
(40,50]	213	1131	5024	8054	6429
(50,60]	46	295	1806	3957	4655
(60,70]	18	90	647	1738	2975
(70,80]	8	37	227	847	2025
(80,90]	0	20	77	377	1413
(90,100]	0	3	32	173	961
(100,110]	0	4	18	70	398
(110,120]	0	0	6	36	513
(120,130]	0	0	1	17	192
(130,140]	0	0	0	8	141
(140,150]	0	2	0	16	240
(150,160]	0	1	0	0	90
(160,170]	0	0	0	2	50
(170,180]	0	0	1	3	64
(180,190]	0	0	0	0	8
(190,200]	0	0	1	10	38

Table S 6. Observations of crown exposure classes versus tree height classes (h_{allom}) across all censuses except the last. The last census is excluded because we use the height and crown exposure classes from the beginning of each census interval in our models.

	1	**2**	**3**	**4**	**5**
[0,5]	1668	1361	921	307	73
(5,10]	11066	16558	16213	5674	1587
(10,15]	4748	12975	23814	15760	6949
(15,20]	1018	3672	11441	14489	12793
(20,25]	31	187	1039	3235	7016
(25,30]	1	9	75	557	2508
(30,35]	0	0	21	66	328
(35,40]	0	0	0	0	36

Table S 7. Mean coefficients for all models fit in this study across the entire dataset (i.e. that did not fit separate models to logged and unlogged plots). File available as a separate attachment.

FIGURES

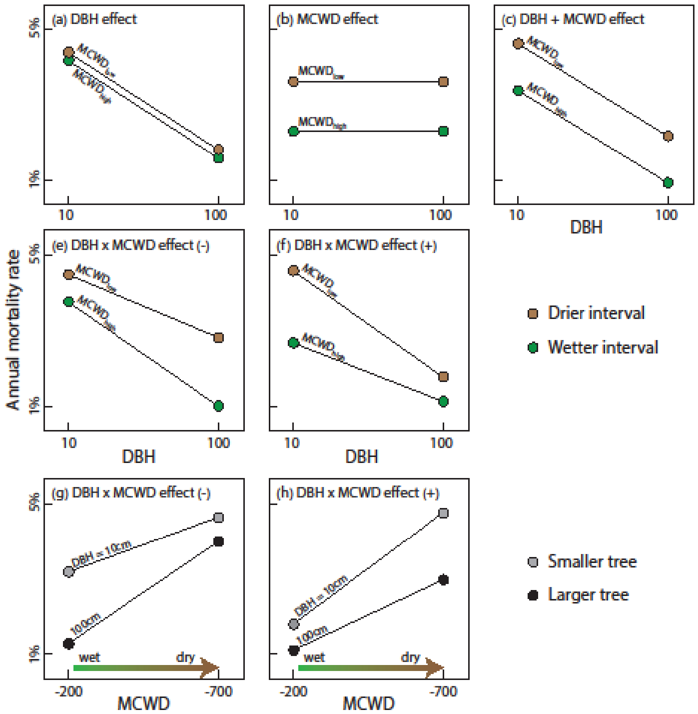

Figure S 1. Conceptual illustration of interaction plots for potential directions of DBH, MCWD, and DBH:MCWD interaction effects.

DESCRIPTIVE FIGURES

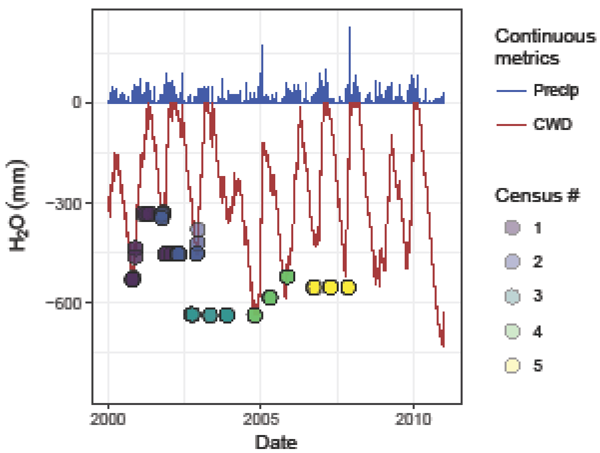

Figure S 2. Precipitation (blue bars), Climatological Water Deficit (CWD, red line), and the MCWD (dots) experienced by trees during the interval between consecutive censuses. Dot color indicates census number.

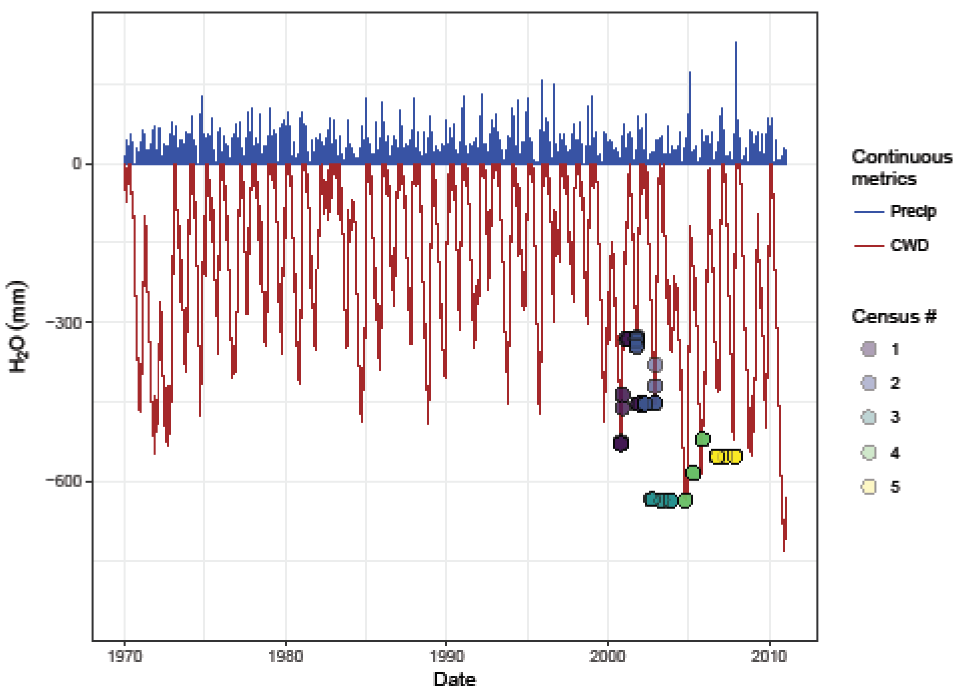

Figure S 3. As in Figure S 2, but with an expanded date range to illustrate the historical context of soil moisture conditions.

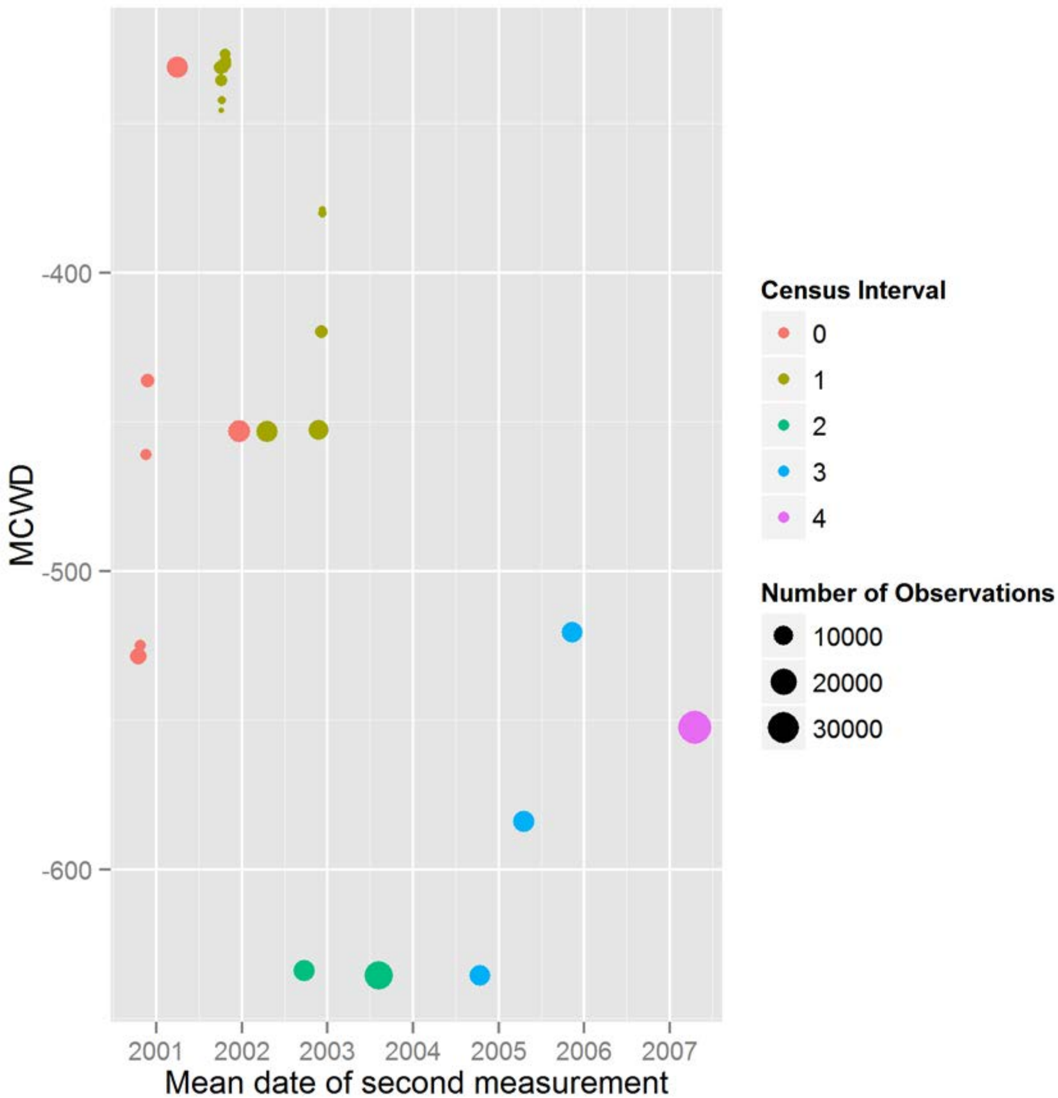

Figure S 4. MCWD values across censuses. Multiple MCWD values occur for each census interval due to census intervals extended across significant periods of time. Overall, conditions became drier over the course of the study.

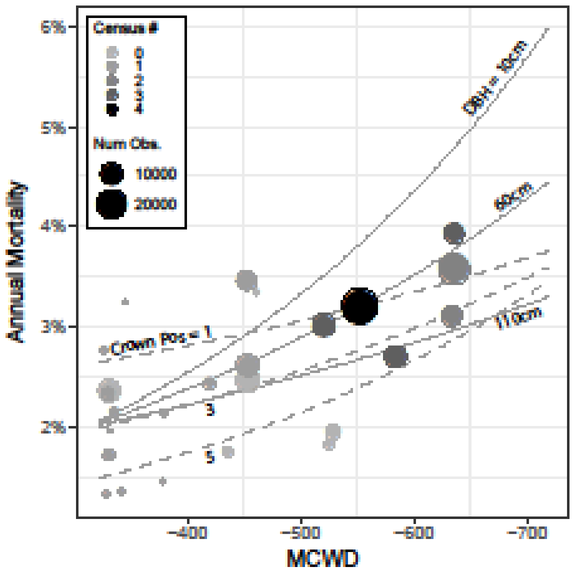

Figure S 5. Mortality rates as a function of MCWD in observed data and modelled predictions. Trees in burned areas or that died as a direct result of forestry operations were removed. Solid lines are mean predictions of the full DBH model (Model 1) for 10, 60, and 110 cm DBH trees averaged across exposure classes; dashed lines are mean predictions for trees with crown exposure classes of 1, 3, and 5 averaged across DBH classes 10 – 200 cm. Conditions go from wet to dry along the x-axis from left to right.

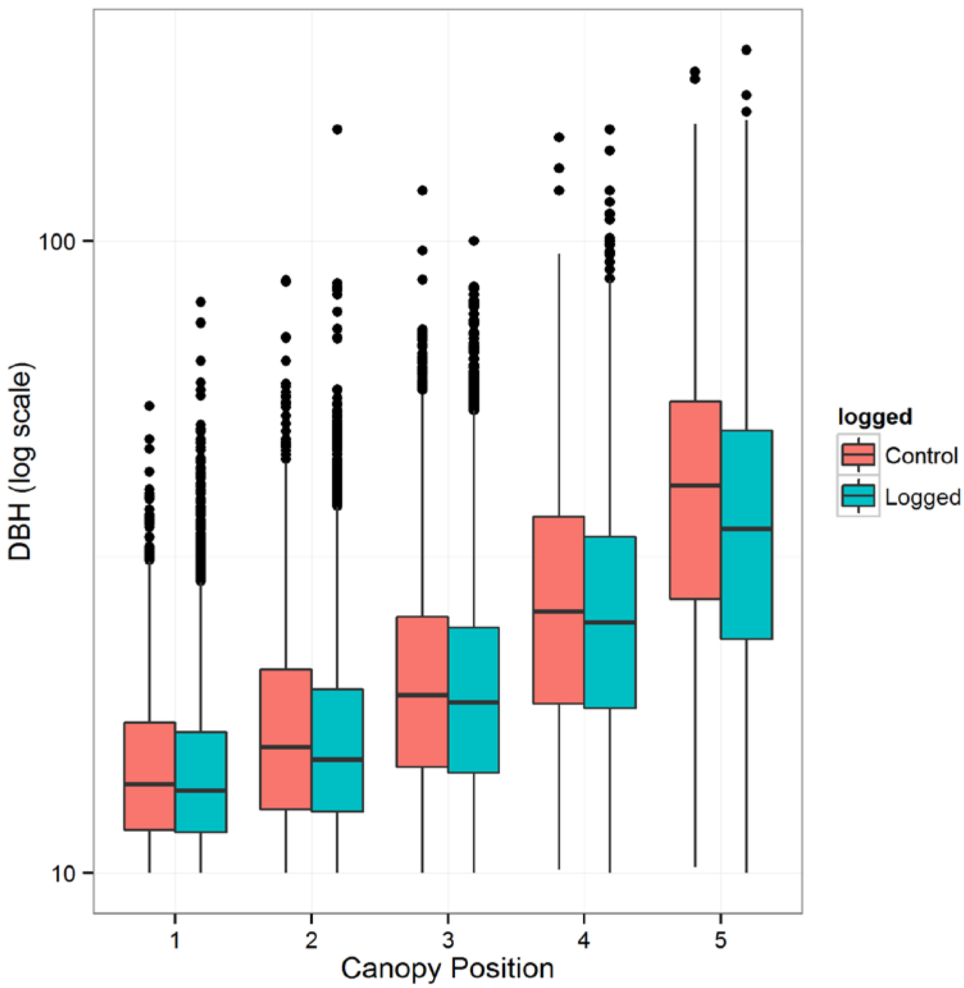

Figure S 6. Box plot of DBH vs. canopy position (following Clark and Clark [48]: 1 (no direct light), 2 (some lateral light), 3 (10-90% overhead light), 4 (>90% overhead light), and 5 (full overhead and later light)) for all subplots in which trees >10 cm DBH were measured in all post-logging censuses.

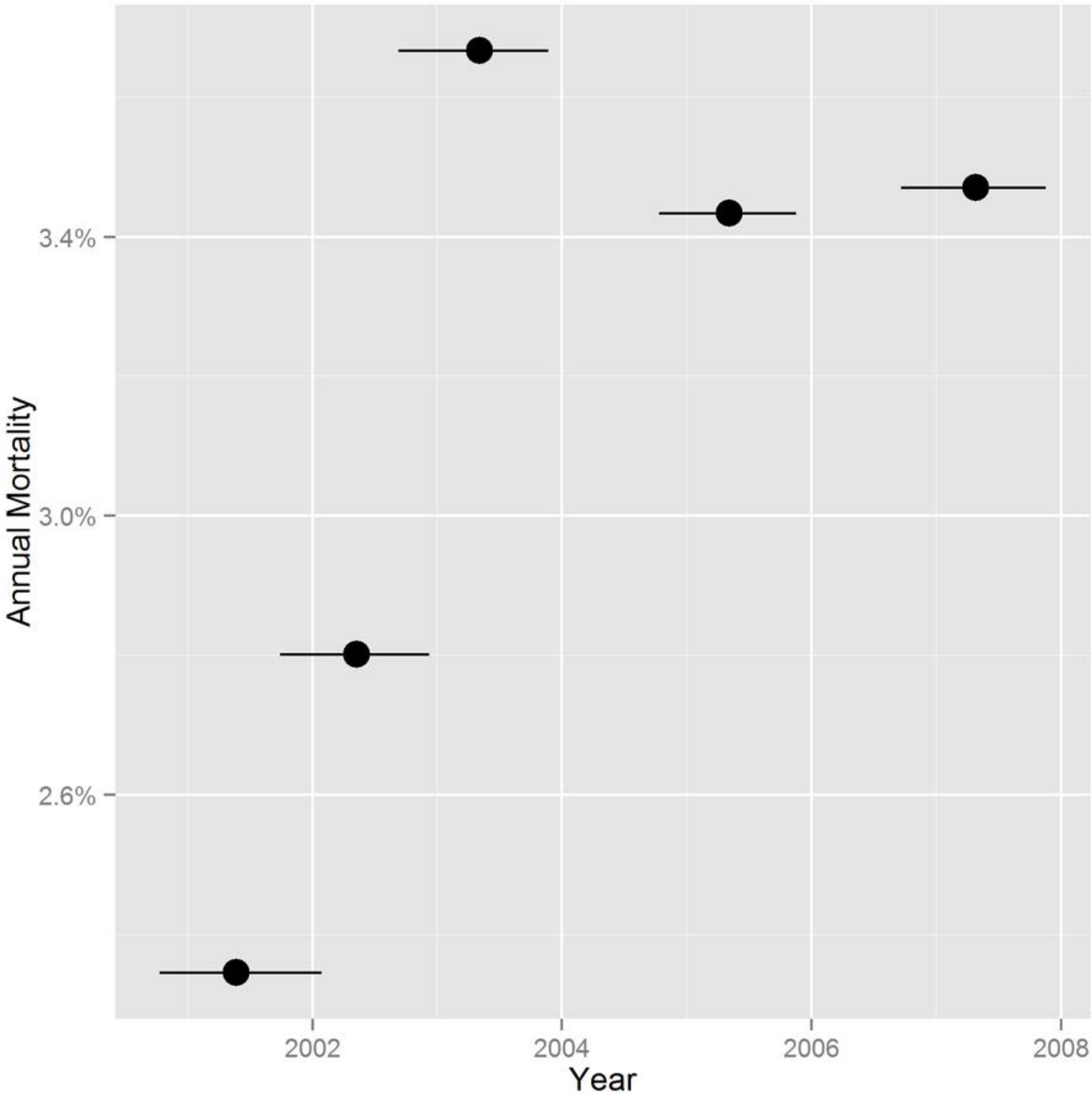

Figure S 7. Large tree mortality rates for each census interval. Tree were removed that died due to logging, silvicultural treatments, and a wildfire. Horizontal lines indicate the time periods over which each census was conducted.

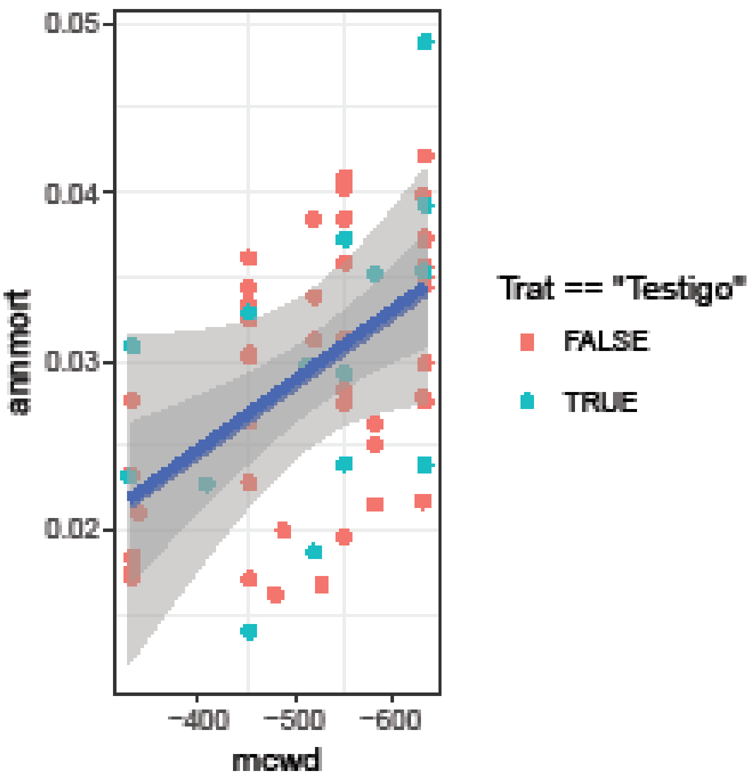

Figure S 8. Annual mortality rates for logged (orange) and unlogged (green) plots. Each point indicates a census in a plot.

COEFFICIENT PLOTS

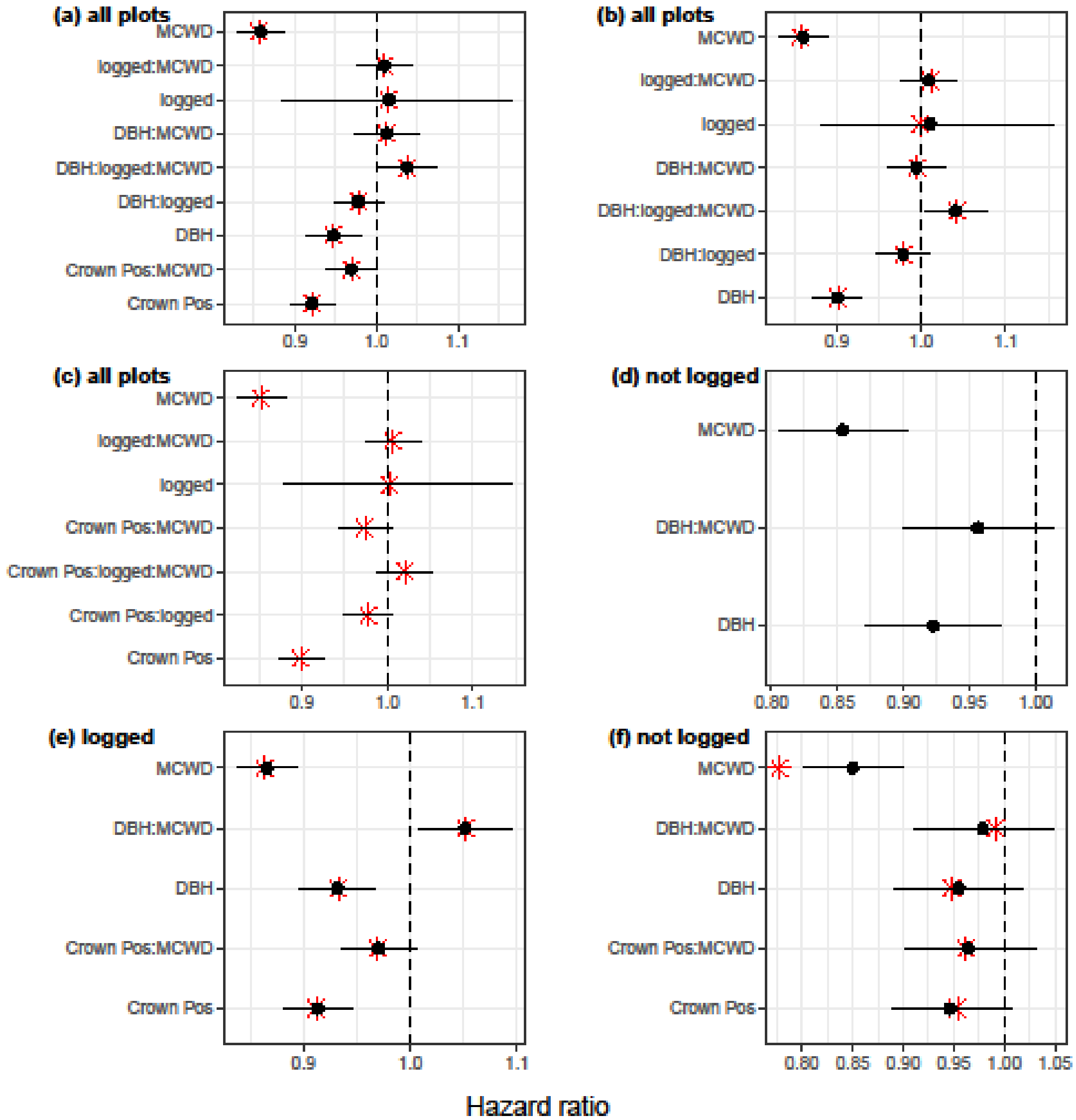

Figure S 9. Hazard ratios (exponentiated coefficients) of selected DBH-based models: (a) The most parsimonious DBH-based model (Model 15, DBH * logged * MCWD + CP * MCWD), (b) simple DBH logging model (Model 12, DBH * logged * MCWD), (c) crown exposure-only model (Model 23, CP * logged * MCWD), (d) simple DBH logging model fit with unlogged data only (DBH * MCWD), and the full DBH model (DBH * MCWD + CP * MCWD) fit in (e) logged and (f) unlogged plots. Black points are the 0.5 quantiles and horizontal bars are the 95% credible intervals fit with a Bayesian INLA algorithm, and red stars are the mean parameter estimates of the corresponding GLMM fit. Intercept and random effects are removed for readability. When black points are missing, the GLMM model converged sufficiently, and the 95% confidence intervals are derived from Wald approximations.

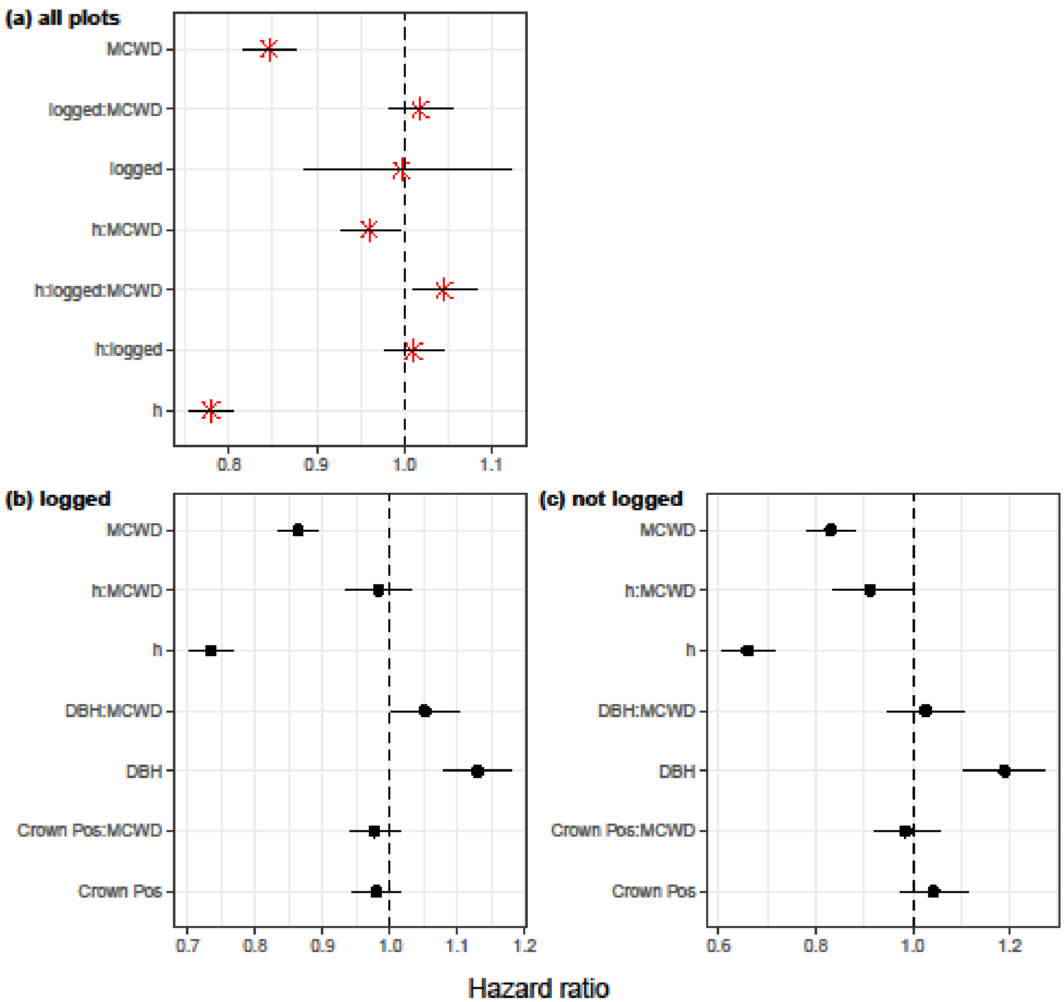

Figure S 10. Hazard ratios (exponentiated coefficients) of selected height-based models not included in the main text: (a) simple height logging model (Model 22, h * logged * MCWD), and the model including both height and DBH (h + DBH + CP) * MCWD fit in (b) logged (Model 30) and (c) unlogged (Model 31) plots. Black points are the 0.5 quantiles and horizontal bars are the 95% credible intervals fit with a Bayesian INLA algorithm, and red stars are the mean parameter estimates of the corresponding GLMM fit. Intercept and random effects are removed for readability. When black points are missing, the GLMM model converged sufficiently, and the 95% confidence intervals are derived from Wald approximations.

PREDICTION PLOTS

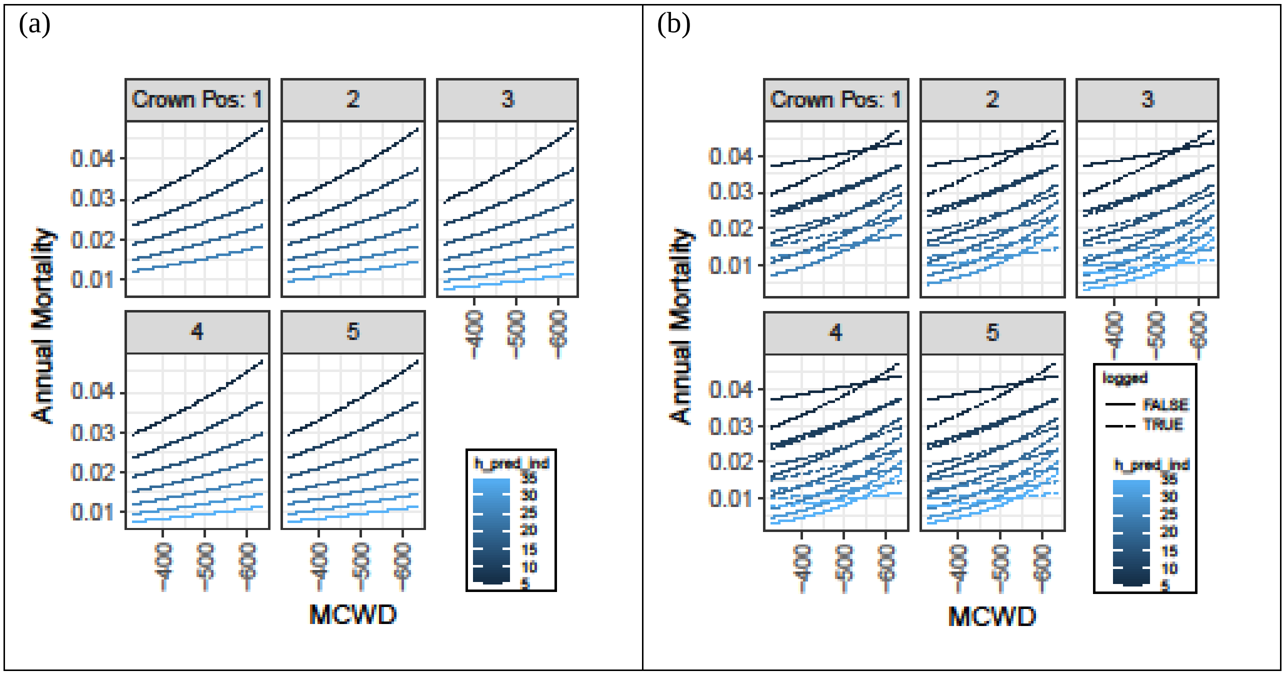

Figure S 11. Predictions of annual tree mortality rates across crown exposure, tree height, and MCWD according to (a) the full height model (Model 5) and (b) preferred logging model (Model 26). Combinations of height and crown exposure for which few data were available were removed from panel (b) (see Table S 6).

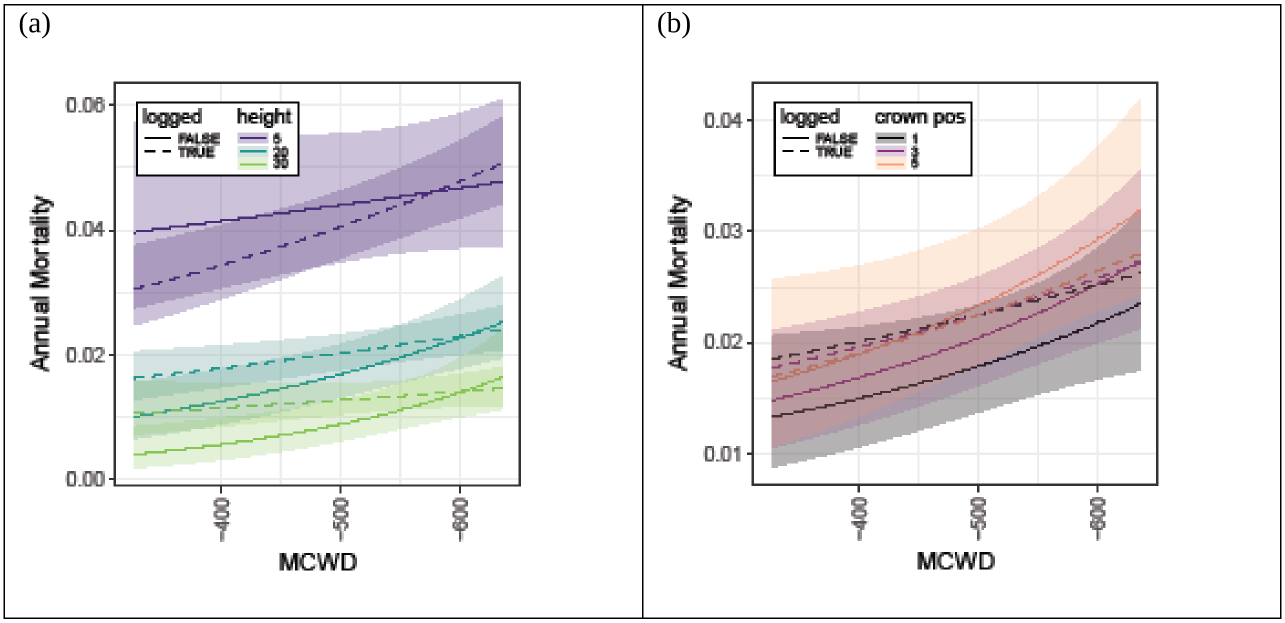

Figure S 12. Annual mortality rates and 95% mean Wald confidence intervals (a) for trees 5, 20, and 30m tall, averaged across crown exposure classes, and (b) for crown exposure classes averaged across trees 5 – 30m tall, as predicted by the most complex height model (Model 29). Confidence intervals removed from logging predictions in panel (b) for readability.

(a) (b)

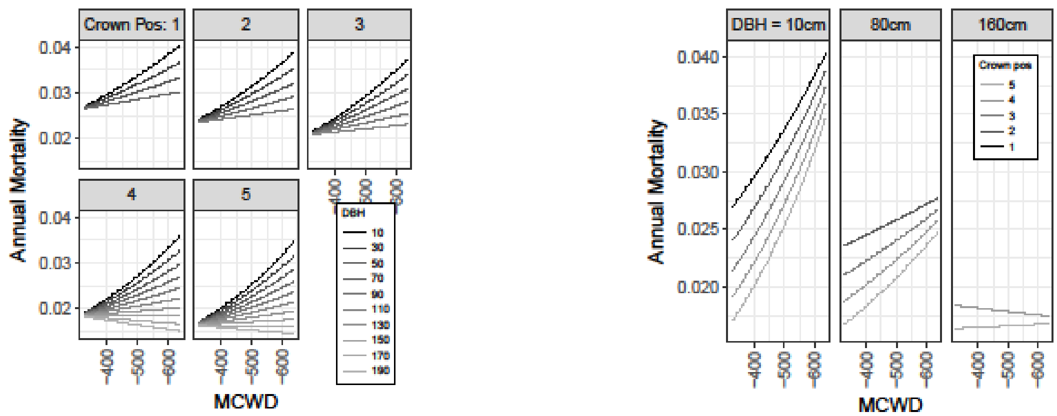

Figure S 13. Annual mortality rates as predicted by the full DBH model (Model 1, Table S 7) across (a) crown exposure and (b) DBH classes.

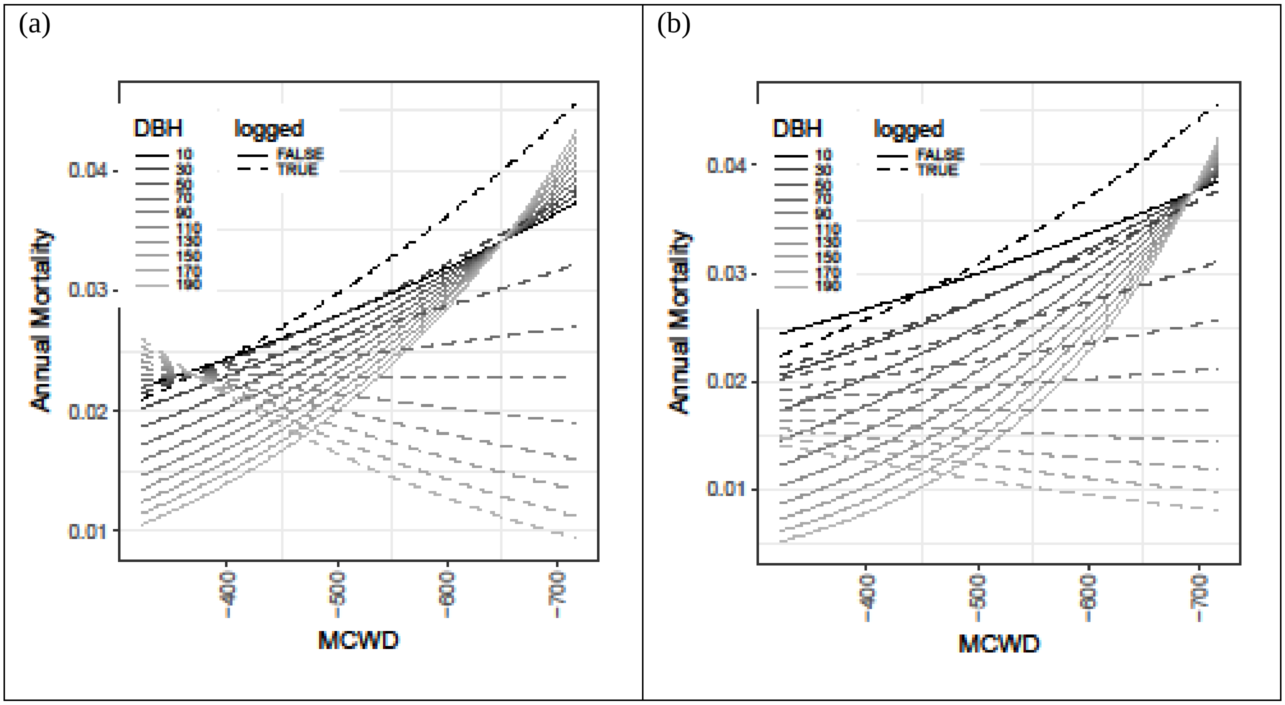

Figure S 14. Annual mortality rates of logged vs unlogged plots across DBH sizes according to (a) the most parsimonious DBH-based logging model (Model 14) and (b) the simple DBH logging model (Model 12). Canopy position had no interactions in this model, so was set to 3 here.

OTHER FIGURES

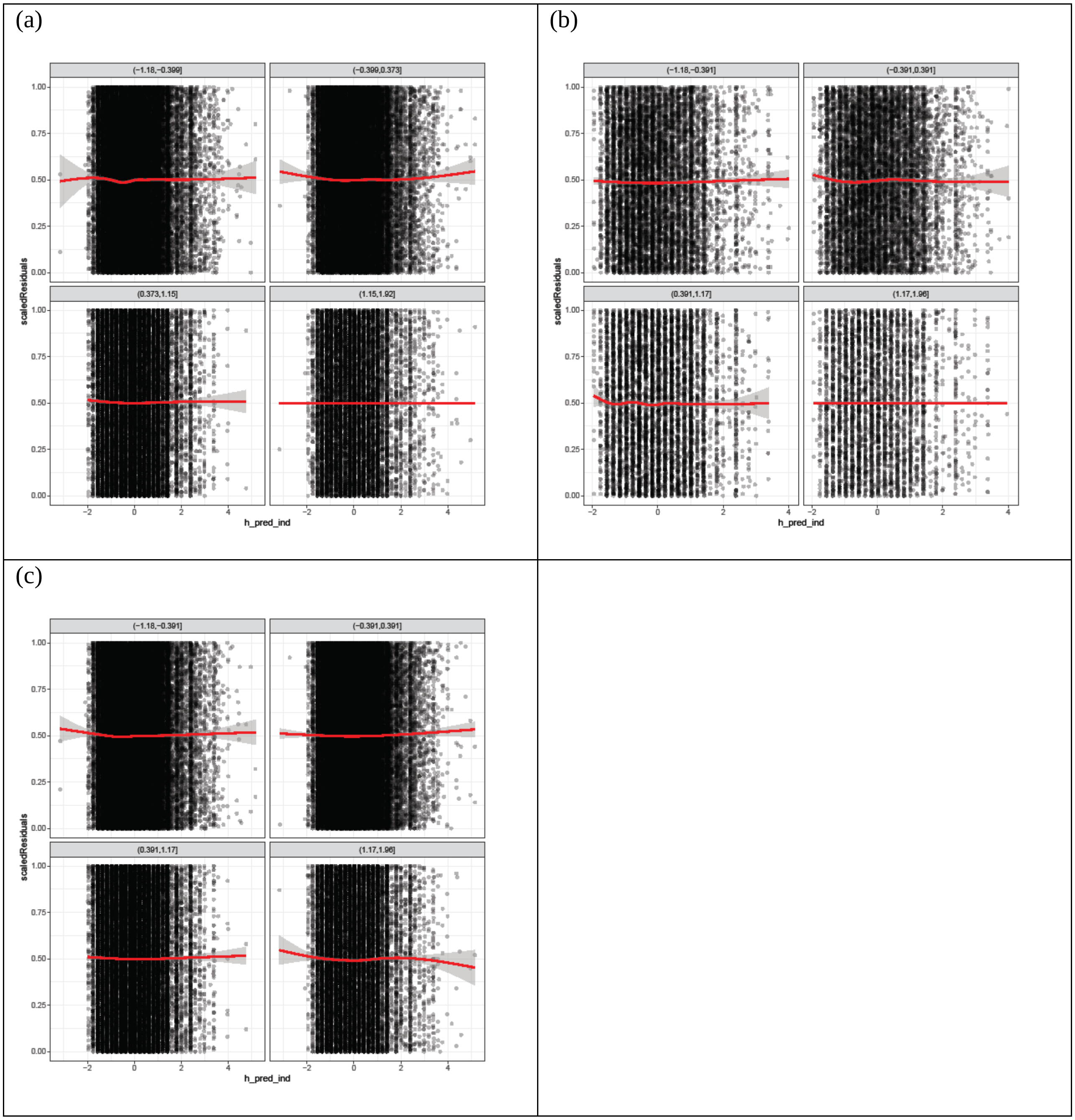

Figure S 15. Scaled residuals of the full height models versus tree height binned across MCWD in (a) logged plots (Model 19), (b) unlogged plots (Model 20), and (c) across all plots (Model 29). Panel titles indicate scaled MCWD range, going from dry conditions in the upper left panels, to wet conditions in the lower right.

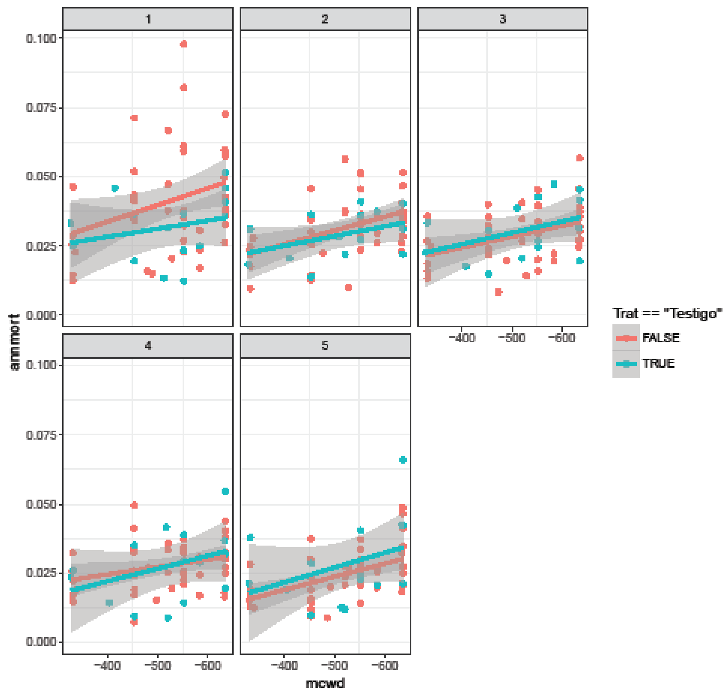

Figure S 16. Annual mortality rates versus MCWD across crown exposure classes for logged (orange) and unlogged (green) plots. Lines are OLS fits.

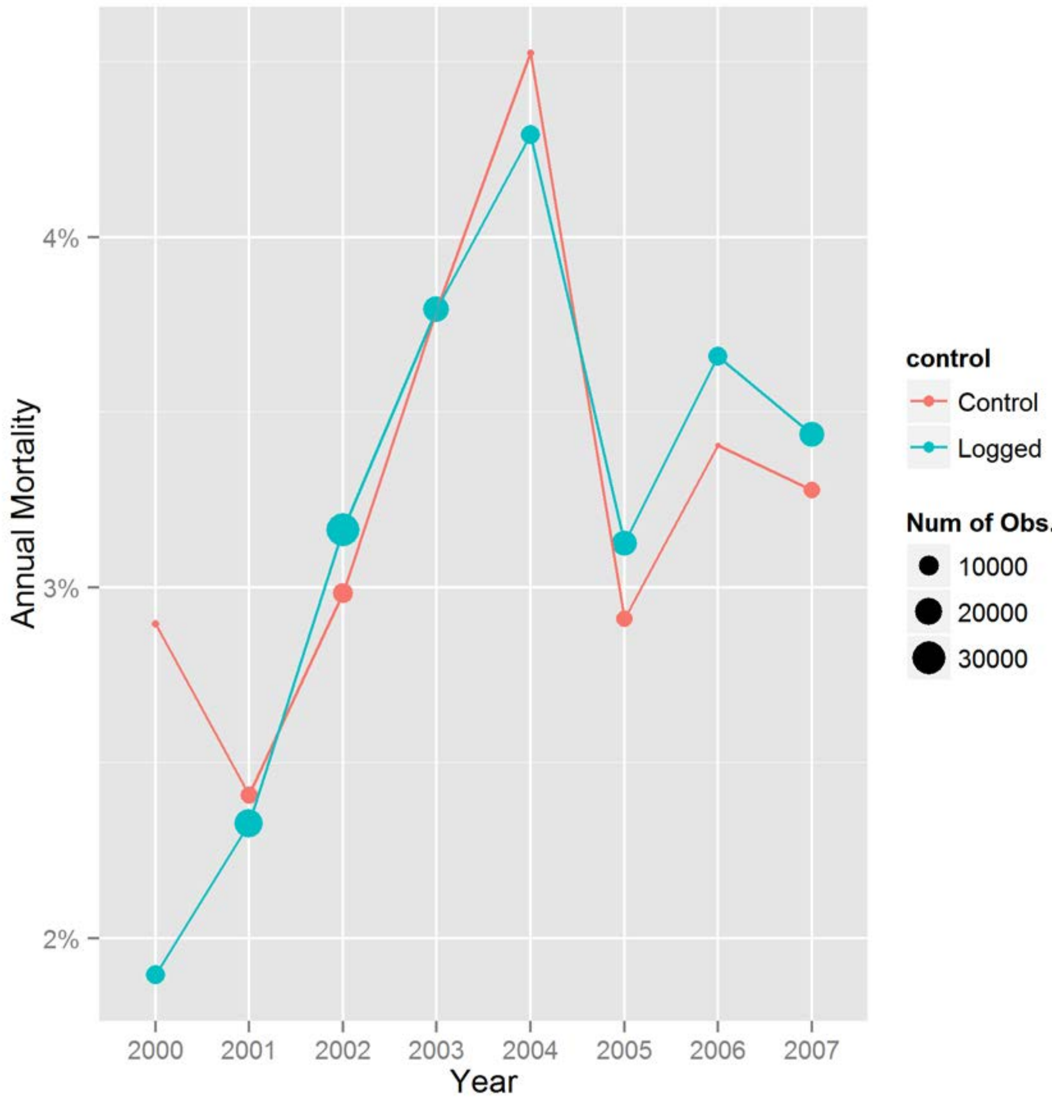

Figure S 17. Mortality rates of trees >10 cm DBH versus year of the census. Tree directly killed by logging and silviculture treatments as well as all trees in burned areas were removed. Dot size represents number of survival and mortality events observed.

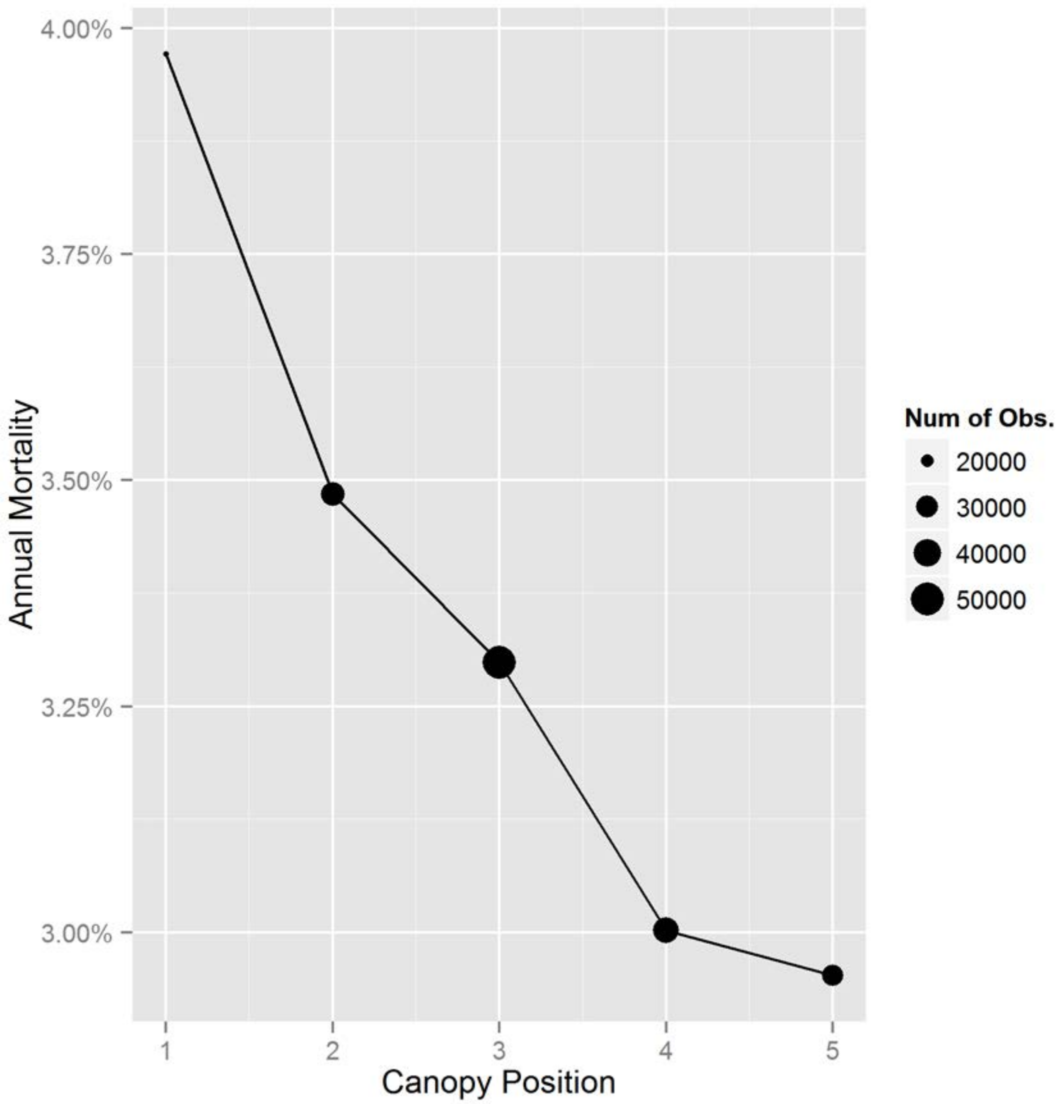

Figure S 18. Adult mortality per crown class (canopy position; Clark and Clark 1992). Tree deaths due to logging and silviculture as well as all trees in burned areas were removed. Dot size represents number of survival and mortality events observed.

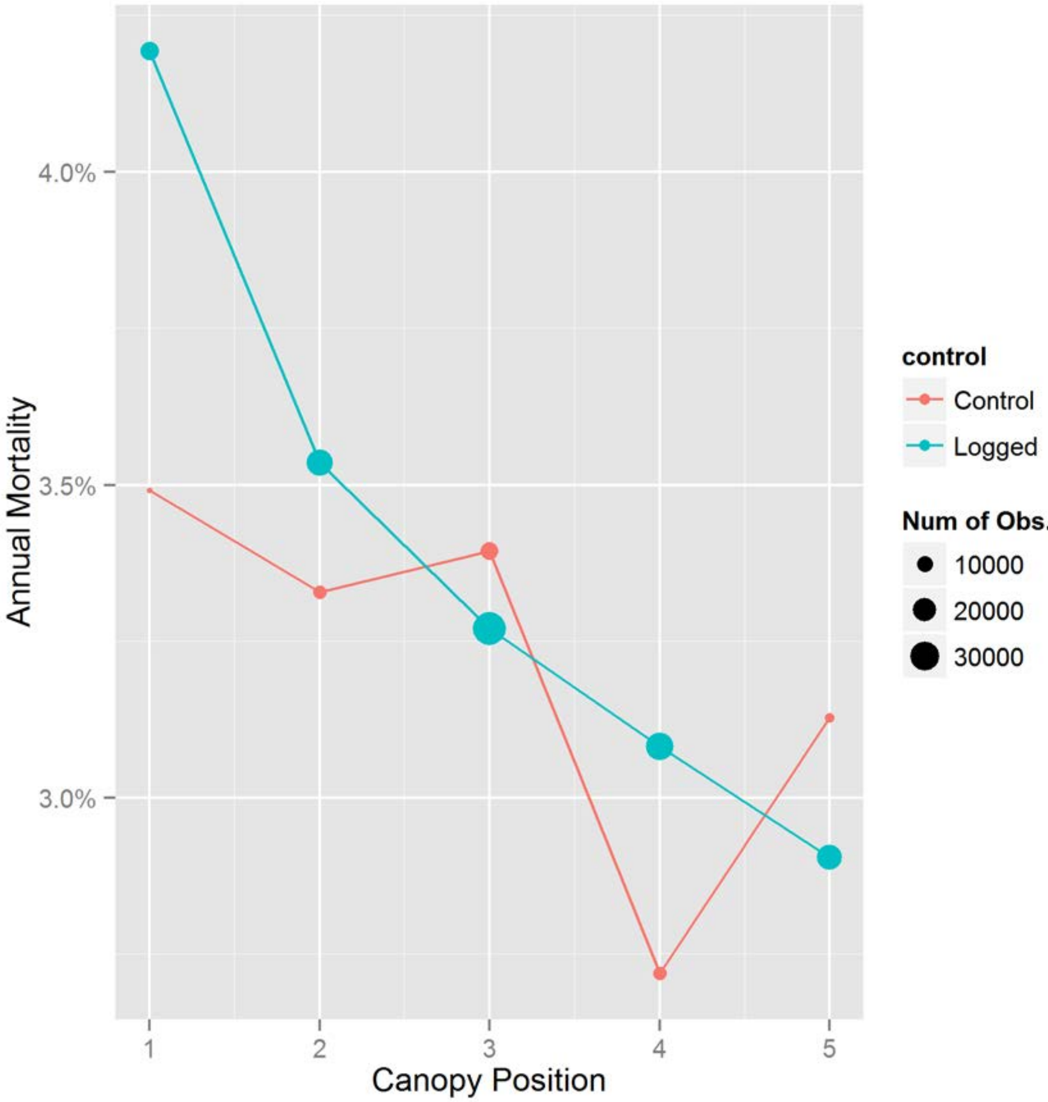

Figure S 19. Adult mortality per crown exposure class for logged and control plots. Tree deaths due to logging and silviculture as well as all trees in burned areas were removed. Dot size represents number of survival and mortality events observed.

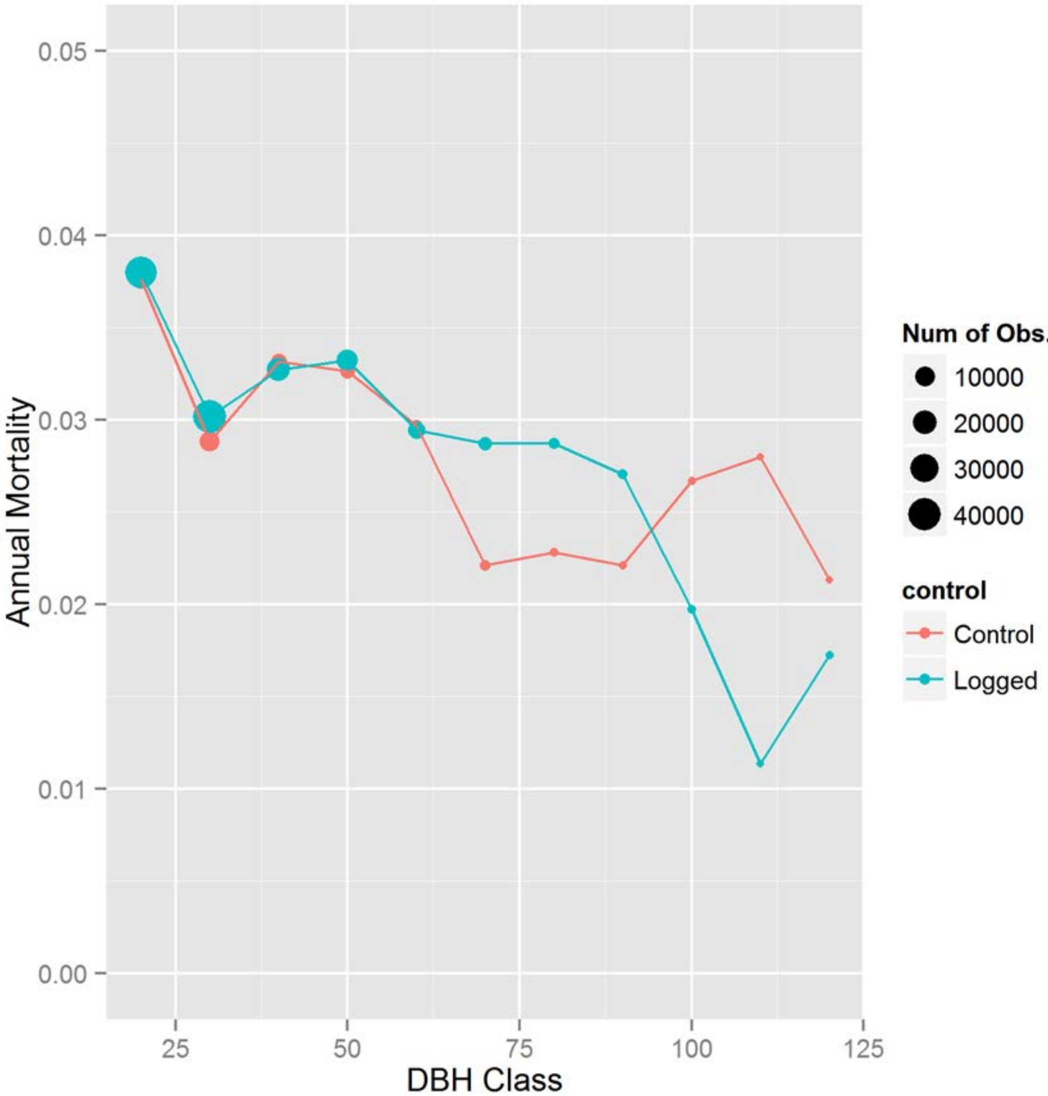

Figure S 20. Adult mortality per DBH class for logged and un-logged plots. Tree deaths due to logging and silviculture as well as all trees in burned areas were removed. Dot size represents number of survival and mortality events observed.

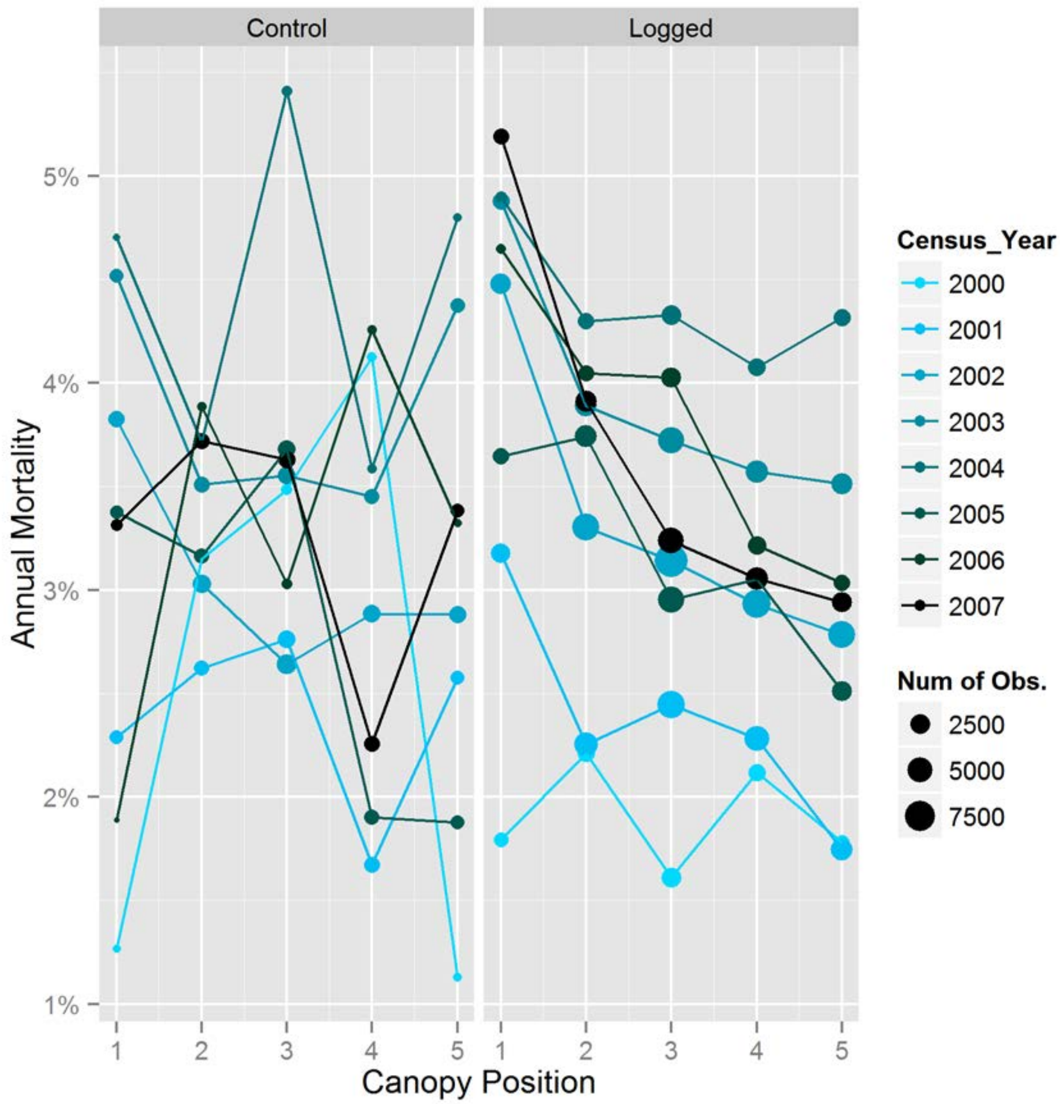

Figure S 21. Adult mortality per crown class for logged and control treatments. Tree deaths due to logging and silviculture as well as all trees in burned areas were removed. Dot size represents number of survival and mortality events observed. Each line represents a different years' census.

R ENVIRONMENT

```
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Running under: Windows 7 x64 (build 7601) Service Pack 1

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attached base packages:
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 [8] datasets  methods   base

other attached packages:
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