

Appendix E: Explanation of posterior tail probability and parameter estimates for all models for all species

This appendix gives details on the model selection strategy, including how the posterior tail probability is calculated, and summarizes the parameter estimates for all models tested for each species. We also provide code for calculating the posterior tail probability, which is based on `HPDinterval` (Plummer et al. 2010).

Explanation of the posterior tail probability

Controversy has developed around model selection for Bayesian estimation methods (Celeux et al. 2006 and discussants), and in particular for hierarchical models and the deviance information criterion (DIC) (Celeux et al. 2006, Millar 2009). The DIC was derived “heuristically” for models without random effects (Spiegelhalter et al. 2002), based on asymptotic (large sample) results, specifically for a normal posterior. The caveats discussed by Plummer (2008) for spatial disease models also apply to our time-series models, which contain a large number of latent unmeasured states as well as random effects. The lack of a clear choice among possible random-effects versions of DIC (Celeux et al. 2006) has added to concerns about its behavior in real applications (Millar 2009, Kery and Schaub 2012). Spiegelhalter et al. (2014) remark that they were always aware of the limitations of the DIC and are surprised it has held up this well.

As described in the main text, we prefer to refer to the a posterior tail probability as a way to rank potential variable additions and to determine when to stop adding variables. The posterior tail probability indicates how strong the support of the posterior is away from zero, complementary to the 95% credible interval which indicates how broad the posterior is in parameter space, i.e. how many parameter values are highly supported. We give a basic example in Figure E1, and in tables E1-E8 we give the posterior mean, posterior tail probability, and 95 % credible interval for each parameter in each model for each species. Mathematically, the tail probability is two times the minimum of the area under the curve (posterior density) less than zero or greater than zero:

$$2 \cdot \min \left(\int_{-\infty}^0 p(\beta^k | \cdot) d\beta^k, \int_0^{\infty} p(\beta^k | \cdot) d\beta^k \right) \quad (\text{E.1})$$

where $p(\beta^k | \cdot)$ is the posterior distribution of β^k .

The posterior tail probability, practically speaking, is calculated by using `HPDinterval` to check a grid of possible credible interval probabilities (including 95), and choosing the credible interval probability with one bound as close to zero as possible (see code at the end of this section). For example, the posterior tail probability for a parameter might be 0.20. This means that zero is at the edge of the 80 % most supported values (highest values of the posterior).

In this Bayesian context, a posterior tail probability of 0.001 would indicate that the credible interval with one bound at 0 is a 99.9% credible interval, containing the 99.9% most highly supported parameter values in the posterior. The reader may evaluate whether the posterior tail probability is high enough to warrant that variable’s selection; compare a parameter with a posterior tail probability of 0.066 with a parameter with a posterior tail probability of 0.535. The latter parameter has only 46.5 % of the posterior within a credible interval with one

bound at zero; we would say that zero has substantial support. The former parameter, while it has not met the 5 % threshold, it may be judged to be important based on context (e.g. has a higher posterior tail probability in most other models).

This metric is justified for the case of comparing single variable additions to a model, as opposed to model selection with non-nested models. When comparing models differing by a single variable, the AIC difference and the p-value associated with a likelihood ratio test are monotonically related (Murtaugh 2014). For a Bayesian analysis where the likelihood dominates the prior (see appendix C for details on flat priors for our models), the posterior tail area for a parameter that is away from zero will be very similar to the analogous p-value because of large-sample likelihood theory. Therefore, at each variable selection step, we select the variable with the highest posterior weight of differing from zero. Since this will be similar to the p-value, which varies monotonically with the AIC, we should have similar results to AIC model selection.

To examine whether our AIC-motivated approach would have differed from a DIC approach, we compared DIC values for models from the species with the fewest random effects: tanoak, for which we did not include plot effects. These models are closest to the case that the DIC was derived for. For our tanoak models, although not every comparison among specific variables would have had the same result, our final model did have the lowest DIC among all the models we calculated as part of the forward selection. In Tables E1-E8, we list parameter estimates (posterior means), tail probabilities, and 95 % credible intervals for all models used in the forward selection strategy for each species.

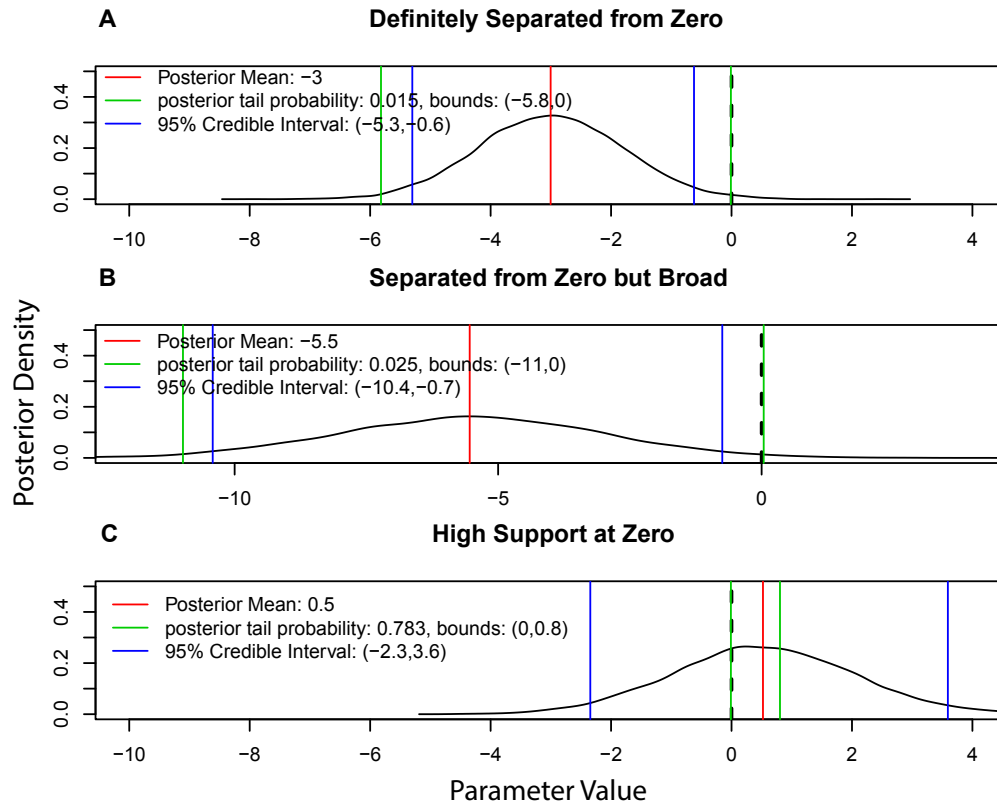


Figure E1: Demonstration of posterior tail probability, 95% credible interval, and posterior mean. A) A case where the posterior is clearly separated from zero, with a posterior tail probability close to zero. B) A case with the same mean, but a wider posterior; the posterior tail probability is lower, but the 95 % credible interval helps to see just how much broader the posterior is and how uncertain the parameter estimate is. C) In this case, the posterior is close to zero; only the 78.3 % most probable values fall between zero and 2.4.

Code to obtain posterior tail probability

```
> #workhorse piece of HPDinterval, coded separately so I can use apply
> evaluate.interval<-function(gap1,vals1){
+   nsamp1<-length(vals1)
+   temp1<-nsamp1-gap1
+   init1<-1:temp1
+   #starting point for each interval to evaluate
+   inds1<- which.min(vals1[init1 + gap1,drop=FALSE]
+     - vals1[init1,drop=FALSE])
+   #how long is the interval & pick smallest one
+   ans1 <- c(vals1[inds1],vals1[inds1 + gap1])
+   #return the endpoints of that interval
+   return(ans1)
+ }
> # a version of HPDinterval which can handle a vector of
> # probabilities, prob; obj is the vector of posterior samples
> HPDintervalMVE <- function(obj, prob){
+   nprob<-length(prob) # number of probabilities to do the calc for
+   vals <- sort(obj) # sort chain to get ecdf
+   nsamp <- length(vals) # number of samples in chain
+   gap <-round(nsamp * prob)
+   # length of credible interval in samples
+   gap[gap==nsamp]<-nsamp-1
+   # must have more than one gap to calculate
+   gap[gap==0]<-1 # cannot do the calc with a gap of 0
+   gap<-as.array(gap)
+   # for apply
+   ans<-apply(gap,1,evaluate.interval,vals) # get the interval based on the gap
+   ans<-as.data.frame(t(ans)) #make it a dataframe
+   names(ans)<-c("lower","upper") #rename columns
+   ans$prob<-prob #add probability for convenience
+   return(ans)
+ }
> # function that calls HPDintervalMVE
> # nodechain is the chain for the node of interest, a
> # numeric variable containing all the posterior samples
> get.credible.level<-function(nodechain){
+   lgrid<-seq(0,1,length.out=10000)
+   #hard-code in how fine a grid to use of probs
+   CIs<-HPDintervalMVE(as.numeric(nodechain),lgrid)
+   #get the data frame of intervals
+   CIs$min<-apply(abs(CIs[,c("lower","upper")] ),1,min)
+   #find the upper or lower bound closest to zero
+   res<-mean(CIs$prob[CIs$min==min(CIs$min)])
+   #pull out the prob corresponding to the closest to zero bound closest to zero
+   return(1-res)
+ }
>
```

Model results for all species, variables, and models

Tables E1-8 summarize model results for explanatory variables for each species. Variables included are: Mean survival, $expit(b)$; Plot standard deviation, σ_p ; Linear size, β^{DBH} ; Quadratic size, β^{DBH^2} ; Plot Basal Area, β^{ba} ; Insolation, β^{insol} ; Elevation, β^{elev} ; Topographic Slope, β^{slope} ; time trend, β^t ; annual climatic water deficit, β^{def} . All variables are standardized (See Appendix C), therefore these parameters correspond to centered and scaled covariates. This means they can be directly compared across models and between variables but not between species. Beta parameters which have tail probability less than 0.05% (alternatively, 95% credible interval does not overlap zero) are highlighted in **bold text**. Empty cells indicate that the variable was not included in the model depicted in a given row.

Table E1: Model Parameter Estimates for All Species Aggregated

$expit(b)$	σ_p	β^{DBH}	β^{DBH^2}	β^{slope}	β^{elev}	β^{insol}	β^{def}	β^{ba}	β^t
0.99 (0) (0.98, 0.99)	0.82 (0.213) (0, 1.07)	0.72 (0) (0.53, 0.86)							
0.99 (0) (0.99, 0.99)	0.94 (0) (0.76, 1.12)	0.86 (0) (0.75, 0.97)	-0.15 (0) (-0.2, -0.1)						
0.98 (0) (0.98, 0.99)	0.7 (0.219) (0, 0.93)		0.12 (0) (0.07, 0.17)						
0.98 (0) (0.98, 0.99)	0.73 (0.012) (0.58, 0.95)			0.16 (0.085) (-0.01, 0.34)					
0.98 (0) (0.98, 0.99)	0.72 (0.209) (0, 0.91)				-0.03 (0.75) (-0.19, 0.12)				
0.98 (0) (0.98, 0.99)	0.68 (0.309) (0, 0.89)					0.13 (0.077) (-0.02, 0.29)			
0.99 (0) (0.98, 0.99)	0.63 (0.202) (0, 0.92)						-0.46 (0.13) (-1.01, 0.11)		
0.99 (0.286) (0.98, 0.99)	0.77 (0) (0.61, 0.94)							-0.38 (0) (-0.59, -0.18)	
0.99 (0) (0.98, 0.99)	0.78 (0) (0.62, 0.95)								-0.13 (0.035) (-0.25, -0.01)
0.99 (0) (0.99, 0.99)	0.93 (0) (0.76, 1.12)	0.86 (0) (0.74, 0.96)	-0.15 (0) (-0.19, -0.1)	0.13 (0.216) (-0.07, 0.34)					
0.99 (0) (0.98, 0.99)	0.87 (0.344) (0, 1.11)	0.84 (0.375) (0.64, 0.98)	-0.14 (0) (-0.19, -0.09)		-0.05 (0.986) (-0.27, 0.14)				
0.99 (0) (0.98, 0.99)	0.72 (0.238) (0, 1.08)	0.81 (0) (0.57, 0.97)	-0.14 (0) (-0.19, -0.08)			0.13 (0.145) (-0.06, 0.35)			
0.99 (0.001) (0.98, 0.99)	0.77 (0.232) (0, 1.11)	0.81 (0) (0.59, 0.97)	-0.14 (0) (-0.19, -0.08)				-0.26 (0.76) (-0.93, 0.39)		
0.99 (0) (0.99, 0.99)	0.97 (0.001) (0.79, 1.17)	0.85 (0) (0.74, 0.96)	-0.14 (0) (-0.19, -0.09)					-0.41 (0.001) (-0.66, -0.16)	
0.99 (0) (0.99, 0.99)	0.97 (0.001) (0.79, 1.16)	0.86 (0) (0.74, 0.97)	-0.14 (0) (-0.19, -0.09)						-0.16 (0.01) (-0.29, -0.04)
0.99 (0) (0.99, 0.99)	0.9 (0.385) (0, 1.14)	0.83 (0) (0.62, 0.98)	-0.14 (0) (-0.19, -0.09)	0.08 (0.494) (-0.13, 0.28)				-0.39 (0) (-0.61, -0.17)	
0.99 (0) (0.99, 0.99)	0.97 (0) (0.79, 1.17)	0.85 (0) (0.73, 0.95)	-0.14 (0) (-0.18, -0.08)		0.02 (0.901) (-0.19, 0.26)			-0.4 (0) (-0.65, -0.19)	
0.99 (0) (0.99, 0.99)	0.97 (0) (0.78, 1.17)	0.85 (0) (0.73, 0.95)	-0.14 (0) (-0.19, -0.09)			0.11 (0.27) (-0.1, 0.29)		-0.41 (0.002) (-0.66, -0.16)	
0.99 (0) (0.99, 0.99)	0.97 (0) (0.79, 1.19)	0.85 (0.25) (0.75, 0.97)	-0.14 (0) (-0.19, -0.09)				-0.14 (0.947) (-0.68, 0.37)	-0.4 (0.004) (-0.63, -0.14)	
0.99 (0) (0.99, 0.99)	0.92 (0.023) (0, 1.15)	0.84 (0) (0.69, 1)	-0.14 (0) (-0.19, -0.09)					-0.4 (0.003) (-0.67, -0.09)	0 (0.892) (-0.17, 0.18)

Table E2: Model Parameter Estimates for Incense-cedar

$expit(b)$	σ_p	β^{DBH}	β^{DBH^2}	β^{slope}	β^{elev}	β^{insol}	β^{def}	β^{ba}	β^t
1 (0)	1.35 (0.338)	0.69 (0)							

(0.99, 1)	(0, 1.9)	(0.3, 1.02)							
1 (0) (0.99, 1)	1.44 (0.006) (0.96, 2.08)	0.7 (0.002) (0.32, 1.04)	0.04 (0.938) (-0.13, 0.23)						
1 (0.4) (0.99, 1)	1.32 (0) (0.89, 1.79)		0.26 (0.155) (0.08, 0.46)						
1 (0) (0.99, 1)	1.25 (0.001) (0.85, 1.75)			0.41 (0.08) (-0.01, 0.87)					
1 (0) (0.99, 1)	1.1 (0.295) (0, 1.68)				-0.15 (0.532) (-0.52, 0.17)				
1 (0) (0.99, 1)	1.26 (0.002) (0.83, 1.79)					0.05 (0.876) (-0.35, 0.5)			
1 (0) (1, 1)	1.65 (0.01) (1.15, 2.37)						2.21 (0.4) (1.65, 2.85)		
1 (0.4) (1, 1)	1.82 (0) (1.28, 2.43)							-2.65 (0) (-3.28, -2.01)	
1 (0) (1, 1)	1.9 (0.001) (1.34, 2.51)								-1.28 (0) (-1.62, -0.97)
1 (0) (0.99, 1)	1.44 (0.012) (0.96, 2.15)	0.71 (0.001) (0.34, 1.11)	0.03 (0.912) (-0.13, 0.21)	0.46 (0.112) (-0.07, 1.03)					
1 (0) (0.99, 1)	1.31 (0.321) (0, 1.93)	0.65 (0.007) (0.18, 1.03)	0.05 (0.977) (-0.13, 0.25)		-0.19 (0.685) (-0.66, 0.18)				
1 (0) (0.99, 1)	1.18 (0.236) (0, 1.9)	0.63 (0.011) (0.12, 1.07)	0.05 (0.873) (-0.13, 0.27)			-0.01 (0.941) (-0.41, 0.4)			
1 (0) (1, 1)	1.94 (0) (1.37, 2.53)	0.86 (0) (0.46, 1.21)	0.02 (0.788) (-0.15, 0.24)				2.38 (0) (1.81, 3.05)		
1 (0) (1, 1)	2.26 (0.001) (1.57, 2.96)	0.86 (0) (0.51, 1.22)	0.06 (0.643) (-0.13, 0.27)					-3.11 (0) (-3.9, -2.31)	
1 (0) (1, 1)	2.26 (0) (1.65, 2.98)	0.88 (0) (0.54, 1.23)	0.04 (0.846) (-0.13, 0.25)						-1.45 (0) (-1.8, -1.13)
1 (0) (1, 1)	2.3 (0) (1.61, 3.05)	0.84 (0) (0.49, 1.21)	0.06 (0.963) (-0.14, 0.27)	0.05 (0.902) (-0.62, 0.75)				-3.12 (0) (-3.88, -2.37)	
1 (0) (1, 1)	2.3 (0) (1.58, 3.05)	0.84 (0) (0.49, 1.18)	0.05 (0.814) (-0.13, 0.27)		0.02 (0.874) (-0.58, 0.58)			-3.13 (0) (-3.95, -2.33)	
1 (0) (1, 1)	2.24 (0.278) (1.53, 3.23)	0.84 (0.005) (0.4, 1.3)	0.05 (0.854) (-0.15, 0.27)			-0.08 (0.92) (-0.81, 0.6)		-3.04 (0.001) (-4.11, -2.19)	
1 (0) (1, 1)	2.04 (0.001) (1.41, 2.7)	0.9 (0) (0.55, 1.3)	0.07 (0.854) (-0.13, 0.31)				1.92 (0.01) (0.98, 2.91)	-2.25 (0.002) (-2.88, -1.54)	
1 (0) (1, 1)	2.06 (0) (1.48, 2.71)	0.86 (0) (0.51, 1.22)	0.06 (0.7) (-0.13, 0.26)					-1.75 (0) (-2.75, -0.75)	-0.77 (0.001) (-1.26, -0.25)
1 (0) (1, 1)	1.92 (0.24) (0, 2.68)	0.8 (0.025) (0.11, 1.25)	0.07 (0.764) (-0.12, 0.31)	0.26 (0.502) (-0.39, 0.98)				-1.54 (0) (-2.8, -0.61)	-0.8 (0.003) (-1.35, -0.16)
1 (0) (1, 1)	2.09 (0) (1.49, 2.78)	0.86 (0) (0.5, 1.23)	0.05 (0.786) (-0.13, 0.25)		-0.09 (0.717) (-0.7, 0.47)			-1.72 (0) (-2.63, -0.72)	-0.78 (0.001) (-1.3, -0.32)
1 (0) (1, 1)	2.08 (0) (1.47, 2.73)	0.85 (0) (0.5, 1.19)	0.06 (0.583) (-0.13, 0.27)			-0.01 (0.807) (-0.55, 0.54)		-1.78 (0) (-2.7, -0.91)	-0.75 (0.001) (-1.2, -0.3)
	2.06 (0) (1.45, 2.75)	0.88 (0) (0.51, 1.26)	0.06 (0.803) (-0.13, 0.27)				0.73 (0.36) (-1.37, 2.63)	-1.89 (0) (-3, -0.84)	-0.46 (0.271) (-1.23, 0.26)

0.99 (0) (0.99, 1)	1.28 (0) (0.97, 1.62)	1.02 (0) (0.81, 1.24)	-0.09 (0.017) (-0.16, -0.02)	0.21 (0.224) (-0.14, 0.55)			-0.19 (0.826) (-1.23, 0.81)	-0.41 (0.105) (-0.9, 0.07)	-0.23 (0.116) (-0.53, 0.05)
0.99 (0) (0.99, 1)	1.28 (0) (0.92, 1.59)	1.02 (0) (0.81, 1.23)	-0.1 (0.018) (-0.16, -0.02)		0.01 (0.967) (-0.32, 0.34)		-0.14 (0.957) (-1.2, 0.79)	-0.48 (0.037) (-0.94, -0.02)	-0.2 (0.164) (-0.47, 0.08)
0.99 (0) (0.99, 1)	1.26 (0) (0.94, 1.6)	1.01 (0) (0.78, 1.22)	-0.09 (0.023) (-0.16, -0.01)			0.15 (0.367) (-0.17, 0.47)	-0.03 (0.672) (-1.12, 0.88)	-0.51 (0.021) (-0.94, -0.06)	-0.17 (0.208) (-0.42, 0.11)

Table E3: Model Parameter Estimates for White Fir

$expit(b)$	σ_p	β^{DBH}	β^{DBH^2}	β^{slope}	β^{elev}	β^{insol}	β^{def}	β^{ba}	β^t
0.98 (0) (0.98, 0.99)	0.94 (0) (0.67, 1.22)	0.61 (0) (0.42, 0.81)							
0.98 (0) (0.97, 0.99)	0.95 (0) (0.69, 1.23)	0.57 (0) (0.35, 0.79)	0.29 (0.008) (0.08, 0.52)						
0.98 (0) (0.97, 0.98)	0.84 (0.209) (0, 1.17)		0.39 (0) (0.2, 0.58)						
0.98 (0) (0.98, 0.99)	0.93 (0.003) (0.66, 1.24)			0 (0.862) (-0.28, 0.27)					
0.98 (0) (0.98, 0.99)	0.94 (0) (0.68, 1.21)				-0.06 (0.684) (-0.32, 0.17)				
0.98 (0) (0.98, 0.99)	0.91 (0) (0.64, 1.18)					0.18 (0.162) (-0.1, 0.43)			
0.98 (0) (0.98, 0.99)	0.93 (0.001) (0.67, 1.22)						0.15 (0.565) (-0.52, 0.82)		
0.98 (0) (0.98, 0.99)	0.94 (0.001) (0.68, 1.24)							-0.17 (0.318) (-0.49, 0.14)	
0.98 (0) (0.98, 0.99)	0.91 (0.004) (0.65, 1.21)								0.05 (0.706) (-0.19, 0.29)
0.98 (0) (0.97, 0.99)	0.95 (0) (0.7, 1.24)	0.57 (0) (0.36, 0.8)	0.3 (0.005) (0.08, 0.54)	-0.08 (0.513) (-0.37, 0.17)					
0.98 (0) (0.97, 0.99)	0.95 (0.002) (0.68, 1.28)	0.56 (0) (0.35, 0.8)	0.3 (0.003) (0.08, 0.52)		-0.04 (0.86) (-0.29, 0.21)				
0.98 (0) (0.97, 0.98)	0.58 (0.343) (0, 1.12)	0.55 (0) (0.34, 0.77)	0.28 (0.007) (0.06, 0.51)			0.26 (0.035) (0.02, 0.49)			
0.98 (0) (0.97, 0.99)	0.86 (0.368) (0, 1.2)	0.56 (0) (0.35, 0.8)	0.29 (0.006) (0.08, 0.53)				0.21 (0.469) (-0.48, 0.87)		
0.98 (0) (0.98, 0.99)	0.97 (0) (0.7, 1.25)	0.56 (0) (0.34, 0.77)	0.31 (0.006) (0.08, 0.53)					-0.22 (0.177) (-0.53, 0.1)	
0.98 (0) (0.97, 0.99)	0.95 (0) (0.67, 1.22)	0.57 (0) (0.35, 0.8)	0.29 (0.008) (0.07, 0.53)						0.04 (0.999) (-0.22, 0.28)
0.98 (0) (0.97, 0.99)	0.93 (0) (0.68, 1.22)	0.58 (0) (0.36, 0.8)	0.31 (0.004) (0.09, 0.52)	-0.01 (0.92) (-0.28, 0.27)		0.24 (0.091) (-0.01, 0.51)			
0.98 (0) (0.97, 0.99)	0.64 (0.287) (0, 1.15)	0.55 (0) (0.34, 0.77)	0.29 (0.008) (0.07, 0.54)		-0.09 (0.55) (-0.37, 0.12)	0.28 (0.026) (0.04, 0.54)			
0.98 (0) (0.97, 0.99)	0.93 (0) (0.68, 1.21)	0.58 (0) (0.37, 0.81)	0.31 (0.002) (0.09, 0.55)			0.27 (0.061) (-0.02, 0.55)	0.34 (0.269) (-0.43, 0.97)		
0.98 (0) (0.98, 0.99)	0.82 (0.227)	0.56 (0)	0.32 (0.003)			0.25 (0.055)		-0.22 (0.185)	

(0.97, 0.99)	(0, 1.18)	(0.34, 0.79)	(0.1, 0.56)			(0, 0.52)		(-0.54, 0.1)	
0.98 (0)	0.9 (0.002)	0.59 (0)	0.29 (0.007)			0.27 (0.049)			0.08 (0.539)
(0.97, 0.99)	(0.62, 1.2)	(0.37, 0.82)	(0.06, 0.53)			(0, 0.52)			(-0.16, 0.35)

Table E4: Model Parameter Estimates for Douglas-fir

$expit(b)$	σ_p	β^{DBH}	β^{DBH^2}	β^{slope}	β^{elev}	β^{insol}	β^{def}	β^{ba}	β^t
0.99 (0)	0.62 (0.005)	0.83 (0)							
(0.99, 0.99)	(0.13, 1.04)	(0.48, 1.15)							
0.99 (0)	0.65 (0.001)	0.85 (0)	-0.04 (0.375)						
(0.99, 0.99)	(0.26, 1.06)	(0.52, 1.17)	(-0.22, 0.17)						
0.99 (0)	0.37 (0.333)		0.09 (0.376)						
(0.98, 0.99)	(0, 0.91)		(-0.05, 0.26)						
0.99 (0)	0.53 (0.037)			0.29 (0.105)					
(0.99, 0.99)	(0, 0.97)			(-0.06, 0.64)					
0.99 (0)	0.68 (0.001)				0.13 (0.489)				
(0.98, 0.99)	(0.26, 1.08)				(-0.22, 0.47)				
0.99 (0)	0.51 (0.376)					-0.39 (0.043)			
(0.99, 0.99)	(0, 0.95)					(-0.77, -0.01)			
0.99 (0)	0.68 (0.003)						0.32 (0.434)		
(0.99, 1)	(0.27, 1.15)						(-1.12, 1.55)		
0.99 (0)	0.74 (0)							-0.42 (0.121)	
(0.99, 0.99)	(0.35, 1.16)							(-0.98, 0.06)	
0.99 (0)	0.67 (0.012)								-0.23 (0.239)
(0.98, 0.99)	(0.15, 1.2)								(-0.59, 0.15)
0.99 (0)	0.56 (0.002)	0.84 (0)	-0.04 (0.456)	0.29 (0.107)					
(0.99, 0.99)	(0.09, 0.95)	(0.51, 1.15)	(-0.21, 0.17)	(-0.06, 0.65)					
0.99 (0)	0.61 (0.084)	0.84 (0)	-0.04 (0.453)		0.11 (0.49)				
(0.99, 0.99)	(0, 1.02)	(0.54, 1.19)	(-0.2, 0.16)		(-0.23, 0.44)				
0.99 (0)	0.59 (0.014)	0.83 (0.001)	-0.04 (0.373)			-0.33 (0.091)			
(0.99, 1)	(0.1, 1.06)	(0.52, 1.18)	(-0.2, 0.16)			(-0.74, 0.03)			
0.99 (0)	0.66 (0.001)	0.87 (0)	-0.04 (0.441)				0.59 (0.211)		
(0.99, 1)	(0.24, 1.08)	(0.53, 1.21)	(-0.21, 0.16)				(-0.84, 1.75)		
0.99 (0)	0.74 (0.023)	0.86 (0.001)	-0.04 (0.389)					-0.53 (0.064)	
(0.99, 1)	(0, 1.16)	(0.53, 1.2)	(-0.21, 0.17)					(-1.08, 0.07)	
0.99 (0)	0.65 (0.298)	0.86 (0)	-0.03 (0.448)						-0.32 (0.104)
(0.99, 1)	(0, 1.11)	(0.54, 1.19)	(-0.21, 0.19)						(-0.71, 0.06)
0.99 (0)	0.71 (0.016)	0.87 (0)	-0.04 (0.369)	0.22 (0.256)				-0.48 (0.139)	
(0.99, 1)	(0.18, 1.28)	(0.53, 1.21)	(-0.21, 0.17)	(-0.16, 0.62)				(-1.11, 0.09)	
0.99 (0)	0.8 (0.003)	0.87 (0)	-0.04 (0.363)		0.24 (0.28)			-0.63 (0.029)	
(0.99, 1)	(0.39, 1.28)	(0.55, 1.21)	(-0.21, 0.17)		(-0.17, 0.67)			(-1.17, -0.05)	
0.99 (0)	0.76 (0.002)	0.86 (0)	-0.04 (0.403)			-0.3 (0.167)		-0.52 (0.082)	
(0.99, 1)	(0.25, 1.29)	(0.53, 1.19)	(-0.22, 0.18)			(-0.74, 0.11)		(-1.11, 0.06)	
0.99 (0)	0.73 (0.009)	0.9 (0)	-0.03 (0.429)				0.85 (0.127)	-0.56 (0.027)	
(0.99, 1)	(0.21, 1.33)	(0.56, 1.21)	(-0.19, 0.18)				(-0.62, 1.97)	(-1.1, -0.03)	
0.99 (0)	0.74 (0.105)	0.88 (0)	-0.03 (0.472)					-0.44 (0.115)	-0.27 (0.17)
(0.99, 1)	(0, 1.16)	(0.56, 1.21)	(-0.21, 0.2)					(-0.96, 0.08)	(-0.67, 0.12)

0.99 (0) (0.99, 1)	0.66 (0.007) (0.13, 1.16)	0.88 (0.001) (0.53, 1.22)	-0.03 (0.439) (-0.2, 0.21)	0.26 (0.19) (-0.09, 0.67)			0.86 (0.143) (-0.79, 1.9)	-0.45 (0.109) (-0.97, 0.12)	
0.99 (0) (0.99, 1)	0.76 (0.002) (0.31, 1.25)	0.9 (0) (0.54, 1.25)	-0.04 (0.425) (-0.22, 0.19)		0.21 (0.285) (-0.13, 0.59)		0.82 (0.129) (-0.47, 1.87)	-0.63 (0.029) (-1.16, -0.08)	
0.99 (0) (0.99, 1)	0.73 (0.003) (0.2, 1.25)	0.86 (0) (0.54, 1.21)	-0.05 (0.405) (-0.22, 0.15)			-0.24 (0.233) (-0.71, 0.18)	0.74 (0.177) (-0.6, 1.82)	-0.56 (0.047) (-1.14, -0.01)	
0.99 (0) (0.99, 1)	0.74 (0.011) (0.22, 1.32)	0.88 (0) (0.55, 1.21)	-0.04 (0.472) (-0.21, 0.16)				0.61 (0.333) (-0.69, 1.95)	-0.52 (0.071) (-1.11, 0.02)	-0.09 (0.624) (-0.56, 0.38)

Table E5: Model Parameter Estimates for Ponderosa Pine

$expit(b)$	σ_p	β^{DBH}	β^{DBH^2}	β^{slope}	β^{elev}	β^{insol}	β^{def}	β^{ba}	β^t
0.99 (0) (0.98, 0.99)	1.05 (0.001) (0.56, 1.57)	0.86 (0) (0.58, 1.14)							
0.99 (0) (0.99, 1)	0.93 (0.331) (0, 1.44)	0.84 (0.286) (0.57, 1.1)	-0.43 (0) (-0.61, -0.23)						
0.99 (0) (0.98, 0.99)	0.86 (0.004) (0.34, 1.35)		-0.25 (0.004) (-0.41, -0.1)						
0.99 (0) (0.98, 0.99)	0.89 (0.001) (0.37, 1.41)			0.29 (0.07) (-0.04, 0.6)					
0.99 (0) (0.98, 0.99)	1.01 (0) (0.57, 1.51)				-0.01 (0.999) (-0.35, 0.36)				
0.99 (0) (0.98, 0.99)	0.99 (0) (0.54, 1.49)					0.14 (0.423) (-0.24, 0.5)			
0.99 (0) (0.98, 1)	1.02 (0) (0.56, 1.51)						0.28 (0.56) (-1.22, 1.63)		
0.99 (0) (0.98, 0.99)	1.05 (0.001) (0.58, 1.56)							-0.27 (0.287) (-0.75, 0.18)	
0.99 (0) (0.98, 0.99)	1 (0) (0.56, 1.48)								-0.26 (0.161) (-0.61, 0.09)
0.99 (0) (0.99, 1)	0.87 (0.003) (0.32, 1.43)	0.85 (0) (0.58, 1.1)	-0.43 (0) (-0.62, -0.24)	0.37 (0.01) (0.08, 0.67)					
0.99 (0) (0.99, 1)	1.07 (0.001) (0.6, 1.61)	0.86 (0) (0.61, 1.1)	-0.43 (0) (-0.62, -0.24)		0.03 (0.835) (-0.34, 0.38)				
0.99 (0) (0.99, 1)	1.01 (0.001) (0.51, 1.56)	0.86 (0) (0.6, 1.11)	-0.43 (0) (-0.61, -0.24)			0.26 (0.213) (-0.12, 0.69)			
1 (0) (0.99, 1)	1.1 (0.085) (0, 1.69)	0.9 (0) (0.63, 1.24)	-0.44 (0) (-0.63, -0.23)				0.29 (0.459) (-2.01, 2.29)		
0.99 (0) (0.99, 1)	1.07 (0.199) (0, 1.68)	0.92 (0) (0.62, 1.21)	-0.45 (0) (-0.64, -0.25)					-0.65 (0.008) (-1.21, -0.12)	
0.99 (0) (0.99, 1)	1.23 (0) (0.67, 1.79)	0.94 (0) (0.67, 1.24)	-0.43 (0) (-0.62, -0.24)						-0.5 (0.01) (-0.91, -0.12)
0.99 (0) (0.99, 1)	0.92 (0.001) (0.4, 1.47)	0.85 (0) (0.59, 1.1)	-0.43 (0) (-0.62, -0.25)	0.37 (0.034) (0.05, 0.72)	0 (0.968) (-0.33, 0.33)				
0.99 (0) (0.99, 1)	0.67 (0.247) (0, 1.28)	0.83 (0) (0.59, 1.11)	-0.42 (0) (-0.6, -0.24)	0.35 (0.02) (0.05, 0.65)		0.24 (0.112) (-0.08, 0.56)			
1 (0) (0.99, 1)	0.85 (0.327) (0, 1.46)	0.89 (0) (0.62, 1.19)	-0.43 (0) (-0.63, -0.2)	0.4 (0.007) (0.11, 0.71)			0.57 (0.267) (-2.39, 2.32)		

0.99 (0) (0.99, 1)	1.07 (0) (0.51, 1.7)	0.93 (0) (0.66, 1.19)	-0.45 (0) (-0.63, -0.25)	0.26 (0.168) (-0.13, 0.65)				-0.51 (0.04) (-1.09, -0.03)	
0.99 (0) (0.99, 1)	1.06 (0.001) (0.51, 1.66)	0.94 (0) (0.68, 1.2)	-0.42 (0) (-0.6, -0.24)	0.43 (0.019) (0.08, 0.81)					-0.5 (0.015) (-0.9, -0.09)
0.99 (0) (0.99, 1)	1.12 (0.001) (0.6, 1.73)	0.94 (0) (0.66, 1.2)	-0.43 (0) (-0.62, -0.23)	0.41 (0.039) (0.03, 0.79)	-0.02 (0.904) (-0.38, 0.41)				-0.52 (0.007) (-0.94, -0.12)
0.99 (0) (0.99, 1)	1.07 (0.001) (0.57, 1.64)	0.95 (0) (0.67, 1.21)	-0.42 (0) (-0.6, -0.24)	0.4 (0.024) (0.06, 0.75)		0.24 (0.219) (-0.13, 0.65)			-0.5 (0.015) (-0.9, -0.12)
0.99 (0) (0.99, 1)	1.06 (0.016) (0.42, 1.78)	0.94 (0) (0.65, 1.21)	-0.43 (0) (-0.62, -0.23)	0.43 (0.012) (0.1, 0.77)			0.05 (0.876) (-1.85, 1.62)		-0.4 (0.052) (-0.83, 0.01)
0.99 (0) (0.99, 1)	1.11 (0) (0.57, 1.69)	0.96 (0) (0.68, 1.24)	-0.44 (0) (-0.61, -0.24)	0.36 (0.077) (-0.05, 0.75)				-0.29 (0.346) (-0.85, 0.19)	-0.4 (0.077) (-0.86, 0.04)

Table E6: Model Parameter Estimates for Sugar Pine

$expit(b)$	σ_p	β^{DBH}	β^{DBH^2}	β^{slope}	β^{elev}	β^{insol}	β^{def}	β^{ba}	β^t
0.98 (0) (0.97, 0.99)	1 (0.05) (0, 1.98)	0.75 (0.002) (0.22, 1.3)							
0.98 (0) (0.97, 1)	1.07 (0.022) (0.04, 2.16)	0.8 (0.002) (0.25, 1.41)	-0.07 (0.999) (-0.54, 0.39)						
0.97 (0) (0.96, 0.99)	1.02 (0.033) (0.01, 2.02)		0.15 (0.637) (-0.21, 0.56)						
0.98 (0) (0.97, 0.99)	0.92 (0.01) (0.04, 1.82)			0.17 (0.649) (-0.41, 0.78)					
0.98 (0) (0.97, 0.99)	0.83 (0.018) (0.03, 1.73)				0.11 (0.613) (-0.41, 0.62)				
0.98 (0) (0.97, 0.99)	0.88 (0.007) (0.05, 1.73)					0.13 (0.612) (-0.46, 0.69)			
0.98 (0) (0.97, 0.99)	0.83 (0.005) (0.05, 1.66)						-0.19 (0.992) (-1.2, 0.88)		
0.98 (0) (0.97, 0.99)	0.88 (0.056) (0.02, 1.76)							0.12 (0.725) (-0.57, 0.87)	
0.98 (0) (0.97, 0.99)	0.85 (0.014) (0.04, 1.6)								0.81 (0.015) (0.15, 1.5)
0.98 (0) (0.97, 1)	1.1 (0.011) (0.03, 2.35)	0.84 (0.001) (0.28, 1.44)	-0.1 (0.511) (-0.55, 0.39)	0.31 (0.338) (-0.4, 1)					
0.98 (0) (0.97, 0.99)	0.92 (0.48) (0, 2.12)	0.81 (0.001) (0.29, 1.4)	-0.09 (0.662) (-0.54, 0.36)		0.27 (0.257) (-0.28, 0.83)				
0.98 (0) (0.97, 1)	1.17 (0.14) (0, 2.33)	0.82 (0.003) (0.29, 1.45)	-0.07 (0.684) (-0.51, 0.42)			0.12 (0.75) (-0.53, 0.76)			
0.99 (0) (0.97, 1)	1.09 (0.021) (0.04, 2.22)	0.81 (0.004) (0.25, 1.44)	-0.06 (0.688) (-0.53, 0.39)				-0.21 (0.776) (-1.36, 0.93)		
0.98 (0) (0.97, 1)	1.15 (0.007) (0.07, 2.26)	0.85 (0.003) (0.25, 1.48)	-0.08 (0.784) (-0.55, 0.4)					-0.2 (0.559) (-1.05, 0.6)	
0.99 (0) (0.98, 1)	0.84 (0.012) (0.03, 1.8)	0.7 (0.003) (0.17, 1.23)	-0.13 (0.464) (-0.59, 0.3)						0.71 (0.043) (0.02, 1.42)
0.99	1.02	0.78	-0.15	0.2					0.67

(0) (0.98, 1)	(0.014) (0.05, 2.04)	(0.002) (0.24, 1.37)	(0.49) (-0.63, 0.31)	(0.554) (-0.48, 0.86)					(0.065) (-0.06, 1.35)
0.99 (0) (0.97, 1)	0.83 (0.049) (0.01, 1.86)	0.76 (0.002) (0.25, 1.32)	-0.13 (0.497) (-0.56, 0.37)		0.27 (0.29) (-0.3, 0.81)				0.69 (0.049) (0, 1.37)
0.99 (0) (0.98, 1)	1.02 (0.008) (0.08, 2.01)	0.72 (0.004) (0.17, 1.24)	-0.13 (0.566) (-0.57, 0.33)			0.11 (0.672) (-0.53, 0.83)			0.7 (0.047) (0.02, 1.46)
0.99 (0) (0.98, 1)	0.98 (0.246) (0, 1.99)	0.72 (0.006) (0.22, 1.27)	-0.12 (0.51) (-0.6, 0.33)				-0.64 (0.558) (-2.31, 1.02)		0.86 (0.022) (0.07, 1.62)
0.99 (0) (0.98, 1)	1.02 (0.343) (0, 2.07)	0.83 (0.002) (0.26, 1.45)	-0.19 (0.407) (-0.64, 0.34)					-0.53 (0.369) (-1.54, 0.36)	0.88 (0.026) (0.1, 1.7)

Table E7: Model Parameter Estimates for Black Oak

$expit(b)$	σ_p	β^{DBH}	β^{DBH^2}	β^{slope}	β^{elev}	β^{insol}	β^{def}	β^{ba}	β^t
0.99 (0) (0.97, 1)	2.97 (0.003) (1.09, 5.52)	0.65 (0.105) (-0.17, 1.44)							
1 (0) (0.99, 1)	3.08 (0.291) (0, 5.98)	1.58 (0.017) (0.16, 2.82)	-0.86 (0.005) (-1.65, -0.22)						
0.99 (0) (0.98, 1)	2.72 (0.005) (0.65, 5.24)		-0.29 (0.205) (-0.72, 0.08)						
0.99 (0) (0.98, 1)	2.22 (0.025) (0.02, 4.35)			1.06 (0.999) (-0.17, 2.39)					
0.99 (0) (0.97, 1)	2.88 (0.002) (0.93, 5.6)				-0.23 (0.81) (-1.58, 1.26)				
0.99 (0) (0.97, 1)	2.79 (0.007) (0.64, 5.66)					0.49 (0.477) (-0.95, 1.98)			
0.99 (0) (0.98, 1)	2.6 (0.002) (0.76, 4.97)						-0.04 (0.832) (-1.9, 1.71)		
0.99 (0) (0.97, 1)	2.79 (0.004) (0.81, 5.4)							-0.4 (0.533) (-1.64, 0.94)	
0.99 (0) (0.98, 1)	2.55 (0.005) (0.75, 4.85)								0.03 (0.922) (-0.84, 0.84)
1 (0) (0.99, 1)	3.1 (0.002) (0.87, 5.91)	1.76 (0) (0.57, 2.94)	-0.81 (0.002) (-1.46, -0.26)	1.52 (0.397) (-0.17, 3.38)					
0.99 (0) (0.98, 1)	3.96 (0.004) (1.3, 7.59)	1.78 (0.002) (0.56, 3.05)	-0.93 (0.001) (-1.63, -0.28)		-0.39 (0.646) (-2.17, 1.37)				
1 (0) (0.99, 1)	3.73 (0.002) (1.26, 7.19)	1.76 (0) (0.64, 2.96)	-0.94 (0.002) (-1.65, -0.35)			0.82 (0.381) (-1.13, 2.83)			
1 (0) (0.99, 1)	3.47 (0.2) (0, 6.59)	1.67 (0.005) (0.4, 3.21)	-0.91 (0.004) (-1.79, -0.18)				-0.14 (0.901) (-2.18, 1.52)		
1 (0) (0.99, 1)	3.52 (0.002) (1.21, 6.48)	1.87 (0.001) (0.66, 3.33)	-0.96 (0.002) (-1.7, -0.3)					-0.96 (0.206) (-2.46, 0.61)	
1 (0) (0.99, 1)	3.6 (0.002) (1.27, 6.64)	1.8 (0.001) (0.6, 3.09)	-0.95 (0.001) (-1.67, -0.26)						-0.1 (0.855) (-1.05, 0.88)
1 (0) (0.98, 1)	4.37 (0.006) (0.96, 10.17)	2.01 (0.001) (0.67, 3.28)	-0.94 (0) (-1.72, -0.3)	2 (0.132) (-0.63, 5.07)	-1.11 (0.55) (-4.74, 1.8)				
1 (0) (0.99, 1)	3.27 (0.002) (0.9, 6.5)	1.9 (0) (0.76, 3.28)	-0.92 (0.001) (-1.63, -0.26)	1.61 (0.068) (-0.13, 3.55)			1.03 (0.305) (-0.43, 2.98)		

1 (0) (0.99, 1)	2.4 (0.293) (0, 5.43)	1.64 (0.001) (0.41, 3.05)	-0.78 (0.001) (-1.48, -0.22)	1.5 (0.064) (-0.08, 3.28)			0.02 (0.677) (-1.98, 1.56)		
1 (0) (0.99, 1)	3.55 (0.006) (1, 6.96)	1.99 (0.001) (0.76, 3.39)	-0.9 (0.001) (-1.66, -0.27)	1.51 (0.114) (-0.32, 3.41)				-0.67 (0.422) (-2.2, 1.03)	
1 (0) (0.99, 1)	3.44 (0.004) (0.94, 6.46)	1.92 (0) (0.7, 3.19)	-0.92 (0.001) (-1.61, -0.27)	1.61 (0.089) (-0.24, 3.55)					-0.3 (0.628) (-1.25, 0.59)

Table E8: Model Parameter Estimates for Tanoak

$expit(b)$	σ_p	β^{DBH}	β^{DBH^2}	β^{slope}	β^{elev}	β^{insol}	β^{def}	β^{ba}	β^t
0.99 (0) (0.98, 0.99)		0.45 (0.059) (-0.02, 0.94)							
0.99 (0) (0.98, 1)		0.38 (0.127) (-0.08, 0.88)	-0.12 (0.4) (-0.44, 0.23)						
0.99 (0) (0.98, 1)			-0.2 (0.163) (-0.5, 0.1)						
0.99 (0) (0.98, 1)				-0.58 (0.284) (-1.53, 0.33)					
0.98 (0) (0.97, 0.99)					-0.64 (0.033) (-1.2, -0.07)				
0.99 (0) (0.98, 0.99)						-0.34 (0.547) (-1.13, 0.36)			
0.99 (0) (0.98, 1)							-0.25 (0.94) (-2.01, 1.24)		
0.99 (0) (0.98, 0.99)								-0.28 (0.566) (-1.36, 0.69)	
0.99 (0) (0.98, 0.99)									-0.22 (0.609) (-1.02, 0.58)
0.98 (0) (0.98, 0.99)		0.35 (0.135) (-0.09, 0.81)			-0.54 (0.079) (-1.14, 0.08)				
0.98 (0) (0.97, 0.99)		0.37 (0.136) (-0.11, 0.88)	0.07 (0.88) (-0.36, 0.52)		-0.62 (0.097) (-1.43, 0.1)				
0.99 (0) (0.98, 1)				-0.39 (0.384) (-1.18, 0.37)	-0.59 (0.061) (-1.17, 0.02)				
0.98 (0) (0.98, 0.99)					-0.61 (0.047) (-1.17, -0.01)	-0.18 (0.999) (-0.89, 0.46)			
0.99 (0) (0.98, 1)					-0.64 (0.034) (-1.16, -0.02)		-0.19 (0.914) (-1.75, 1.27)		
0.98 (0) (0.97, 0.99)					-0.63 (0.043) (-1.21, -0.04)			-0.04 (0.901) (-1.12, 0.96)	
0.98 (0) (0.97, 0.99)					-0.63 (0.042) (-1.22, -0.05)				-0.05 (0.882) (-0.86, 0.78)
0.99 (0) (0.98, 1)		0.61 (0.015) (0.1, 1.08)		-0.89 (0.032) (-1.77, -0.07)	-0.54 (0.099) (-1.17, 0.15)				
0.99 (0) (0.98, 0.99)		0.35 (0.14) (-0.1, 0.8)			-0.52 (0.098) (-1.15, 0.07)	-0.18 (0.918) (-0.86, 0.45)			
0.99 (0) (0.98, 1)		0.33 (0.16) (-0.11, 0.79)			-0.55 (0.075) (-1.17, 0.07)		-0.09 (0.872) (-1.66, 1.31)		

0.99 (0) (0.98, 0.99)		0.4 (0.119) (-0.08, 0.91)			-0.6 (0.071) (-1.24, 0.06)			0.32 (0.754) (-0.88, 1.62)	
0.99 (0) (0.98, 0.99)		0.38 (0.146) (-0.09, 0.88)			-0.58 (0.072) (-1.2, 0.05)				0.18 (0.641) (-0.72, 1.06)

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