SUPPLEMENTAL FILE:
"Second-Log Branch Size Comparison Between Even-aged and Multiaged Douglas-fir Stands in Coastal Northern California"

Part I. Auxiliary Models

Height and live crown base height models

The predictor variables considered for the height and LCBH models are listed in Table S1. Trees with broken tops or that were leaning severely (i.e. > 15^{o}) were removed from the data set since their abnormally large DBH-to-height relationship had high leverage within the model. Correlated variables such as BA and SDI could not be included in the same model so the best fitting variable was chosen prior to application of the model selection methods. In addition to the Box-Cox testing on the response variable, transformations on the predictor variables and interactions between continuous variables and the categorical variable "plot type" (i.e., multiaged or even-aged) were considered.

Table S1: Candidate variables tested for inclusion in height and live crown base height models.

Variable	Description	Type
Plot.type	Multiaged plot (A) or even-aged plot (B)	Categorical
Tpha	Number of trees per hectare	Continuous
SDI	Stand density index (metric)	Continuous
BA	Basal area (m^2 ha^{-1})	Continuous
DBH	Diameter at breast height (cm)	Continuous
HT	Total height of tree (m)	Continuous
LCBH	Height of live crown base (m)	Continuous
Slope	Slope of plot	Percentage
Aspect	Cardinal direction of the downhill plot slope	Range (0-20)
Flow acum.	Number of 10 m cells draining into the plot	Continuous
Health	Code (broken top (BT), lean (LN), and forked (FK))	Categorical

Douglas-fir trees in the understory of multiaged stands were taller on north-facing aspects than trees of equivalent size 'DBH' in even-aged stands of Douglas-fir on north-facing slopes. The plot type B and slope interaction was positive for even-aged stands. This indicated that trees in even-aged stands were taller on steeper slopes. The Douglas-fir height model was improved by taking the natural log of DBH (Table S2). Douglas-fir total height was best predicted using the step AIC method of model selection. This model had an AIC= 2614.2 which was better than Mallows cp method AIC= 2660.7 or 0 times as likely using "Akaike weight". The adjusted R^2 method had an AIC= 2661.0 or 0 times as likely. The model predicts height in meters and was fit with 493 observations.

Table S2: Douglas-fir height model coefficients (s.e. as percent of coefficient in parentheses) (Plot type A = multiaged; B = even-aged).

Model selection	Step AIC	
Intercept	15.3100	(12%)
Plot type B	-6.3660	(16%)
ln(DBH) (cm)	11.5900	(4%)
Trees ha^{-1}	-0.0030	(48%)
SDI (metric)	0.0053	(17%)
Aspect	0.2012	(21%)
Slope %	-0.0881	(27%)
Plot type B × aspect	-0.2055	(25%)
Plot type B × slope	0.1648	(16%)
AIC	2614.2	
Adjusted R^2	0.74	

The predictions of LCBH could be used to make inferences about crown rise. For example, we may infer that growth had less effect on the rate of crown rise for trees in even-aged stands, as indicated by an interaction between plot type and height which had a negative coefficient for the even-aged stands (Table S3). However the positive coefficient for plot type B indicated crown rise was in general faster in even-aged stands. The Douglas-fir LCBH model was fit to the same data set as the Douglas-fir height model. The best Douglas-fir LCBH model was selected using the adjusted R^2 model selection method.

Table S3: Douglas-fir live crown base height model coefficients (s.e. as percent of coefficient in parentheses) (Plot type A=multiaged; B=even-aged).

Model selection	Adjusted R^2	
Intercept	-0.8379	(155%)
Plot type B	1.4949	(98%)
DBH (cm)	-0.1716	(10%)
Height (m)	0.7033	(7%)
Trees ha^{-1}	—	—
SDI (metric)	0.0011	(69%)
Slope %	-0.0234	(51%)
Aspect	0.0415	(57%)
Plot type B × HT	-0.1297	(43%)
AIC	2616.4	
Adjusted R^2	0.54	

Live Crown Radius (LCr) Model

Crown radius taken at the widest part of the living crown (LCr) in the four radial quadrants was measured on focal trees. Table S4 lists candidate predictor variables. The variables BAL and SDI were removed from the LCr model selection process because they were only significant together and caused the model to over fit the data.

Table S4: Candidate variables used to create the Douglas-fir live crown radius (LCr) model.

Variable	Description	Type
Plot.type	Multiaged plot (A) or even-aged plot (B)	Categorical
Tpha	Number of trees per hectare	Continuous
SDI	Stand density index (metric)	Continuous
BAL	Basal area of trees larger (m^2 ha^{-1})	Continuous
Slope	Slope of plot	Percentage
Aspect	Cardinal direction of the downhill plot slope	Range (0-20)
DBH	Diameter at breast height (cm)	Continuous
HT	Total height of tree (m)	Continuous
LCBH	Live crown base height (m)	Continuous
HDR	Height divided by DBH	Ratio
DBH.p	Target tree DBH divided by plot mean DBH	Ratio
Age	Age of tree at breast height (years)	Continuous
BL	Length of selected branch (m)	Continuous
BD	Branch diameter (cm)	Continuous
B.Azi	Azimuth of branch away from tree center	Range (0-20)
N.dist	Distance to the most influential neighbor	Continuous
Num.N	Number of influential neighbors	Continuous
Overlap	Length of branch covered by its neighbor (m)	Continuous

Douglas-fir LCr was influenced mostly by tree-level variables. The LCr was not influenced by the number of influential neighbors. LCr was wider on larger trees in terms of both DBH and height. Douglas-fir LCr was narrower on the north side of the tree (i.e., reduced crown radius; shorter branches on the north side). The LCr was not affected by the difference between multiaged and even-aged stand types (Table S5). The best Douglas-fir live crown radius (LCr) model was derived using the adjusted R^2 method. The model was fit with 229 observations.

Table S5: Douglas-fir live crown radius (LCr) model coefficients (and s.e. as percent of coefficient in parentheses). Model predicts crown radius in meters.

Model selection	Adjusted R^2	
Intercept	0.7529	(50%)
DBH (cm)	0.0291	(32%)
HT (m)	0.0448	(33%)
BL (m)	0.6417	(7%)
B.Azi	-0.0174	(43%)
Num.N	-0.0900	(73%)
Overlap (m)	-0.2567	(19%)
AICc	538.7	
AIC	538.0	
Adjusted R^2	0.59	

Part II. Geospatial Representation of Tree Branches and Crowns

ArcMap was used to determine crown projection area of focal trees and neighboring trees. Focal tree crown shape and area were derived as follows: distance and azimuth data for tree locations were converted into longitude and latitude. The focal tree locations were then used to obtain location data for the tip of the largest branch in each quadrant. These locations defined crown extent. To convert the crown extent points into polygons with realistic rounded shapes, the four points were aggregated and converted to a straight sided quadrilateral, then smoothed using the Bezier Interpolation tool (Figure S1).

Neighboring crowns were represented by circles with radius (LCr) predicted by an auxiliary regression, and assigned to one of two categories: crowns above and crowns below the focal trees (i.e., taller and shorter neighbor trees). These crown areas were summed, giving total area of crowns above the focal trees and area of crowns below the focal trees. Example visual representations are provided in Figure S2 & S3.

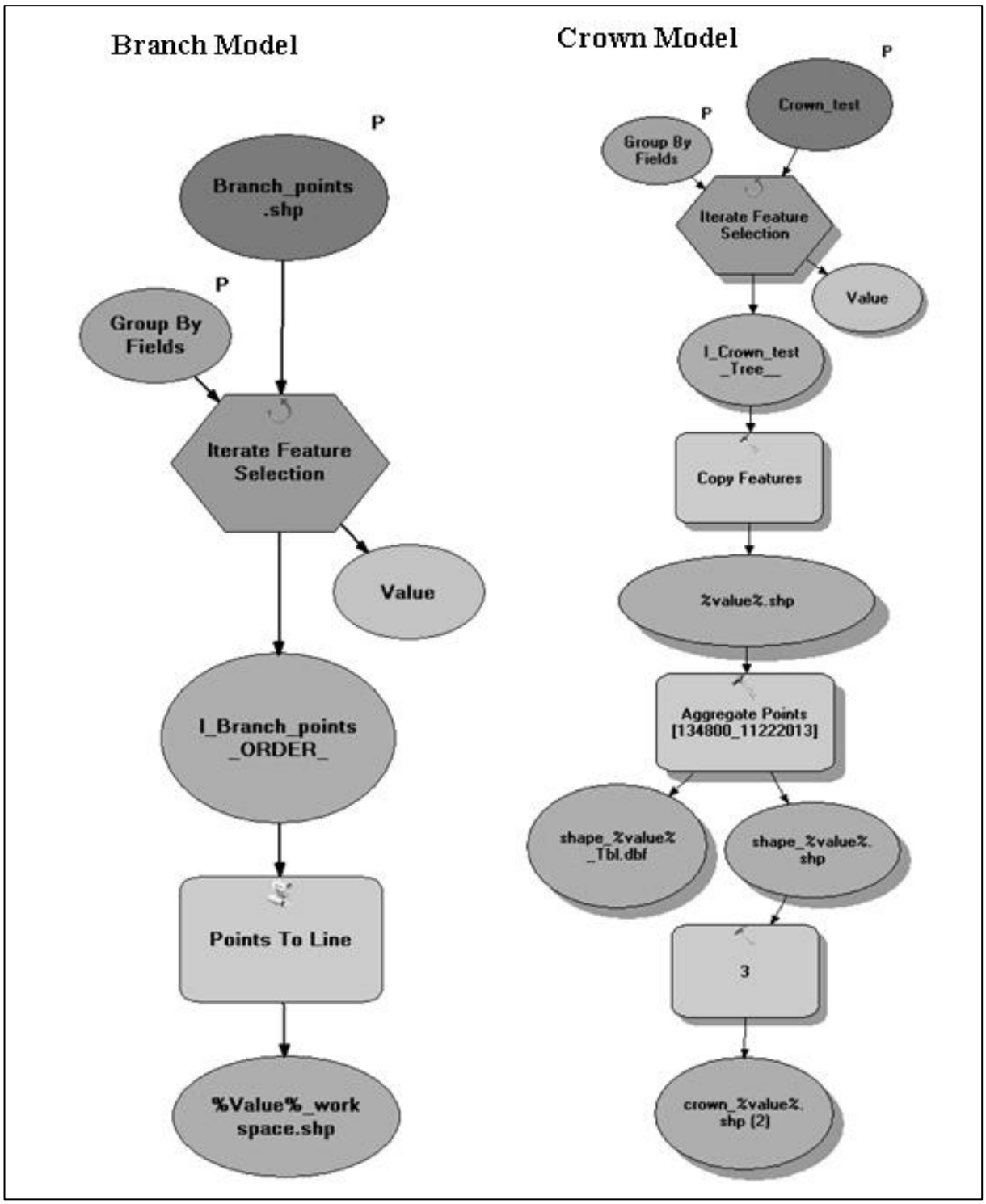

Figure S1: Branch and crown models used to display branches and crowns which can be seen in Figures S2 & S3 below. The models select point data grouped so that they represent a branch or crown area. The model then runs the system of tools as displayed. When a selection is completed it then returns to the start and selects the next group of points and repeats this process until all data has been run through the model.

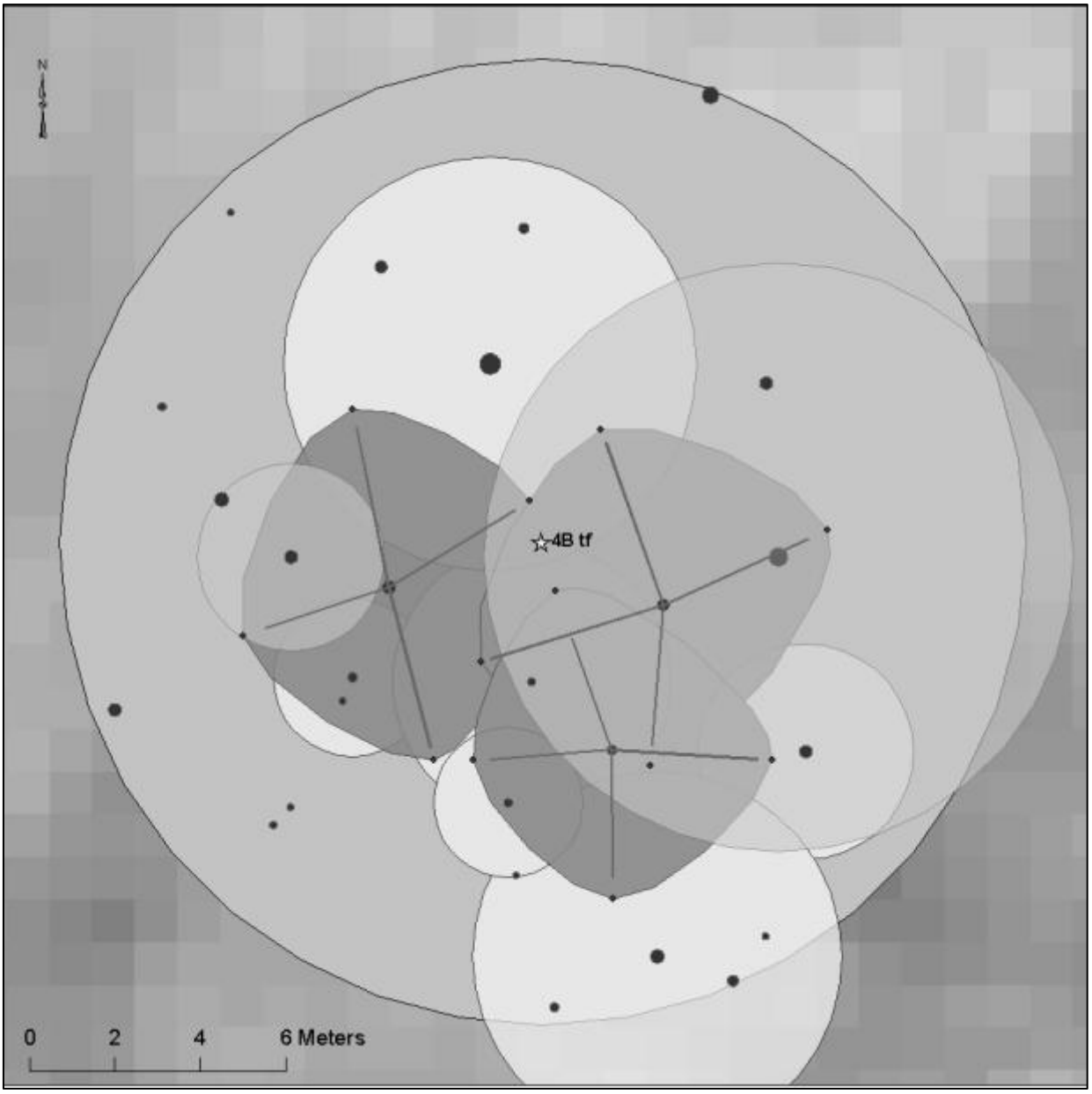

Figure S2: Depiction of even-aged plot number 4B at LWSDTF in Humboldt County, California. The large circle represents the 0.04 ha plot area; the light gray circles are crowns above the target tree crowns represented by the dark irregular shapes in the center of the plot. The white circles are crowns below the target Douglas-fir tree crowns. The dark small circles are the trees within the plot depicting their actual DBH and the lines are the target tree branch length accurately depicted.

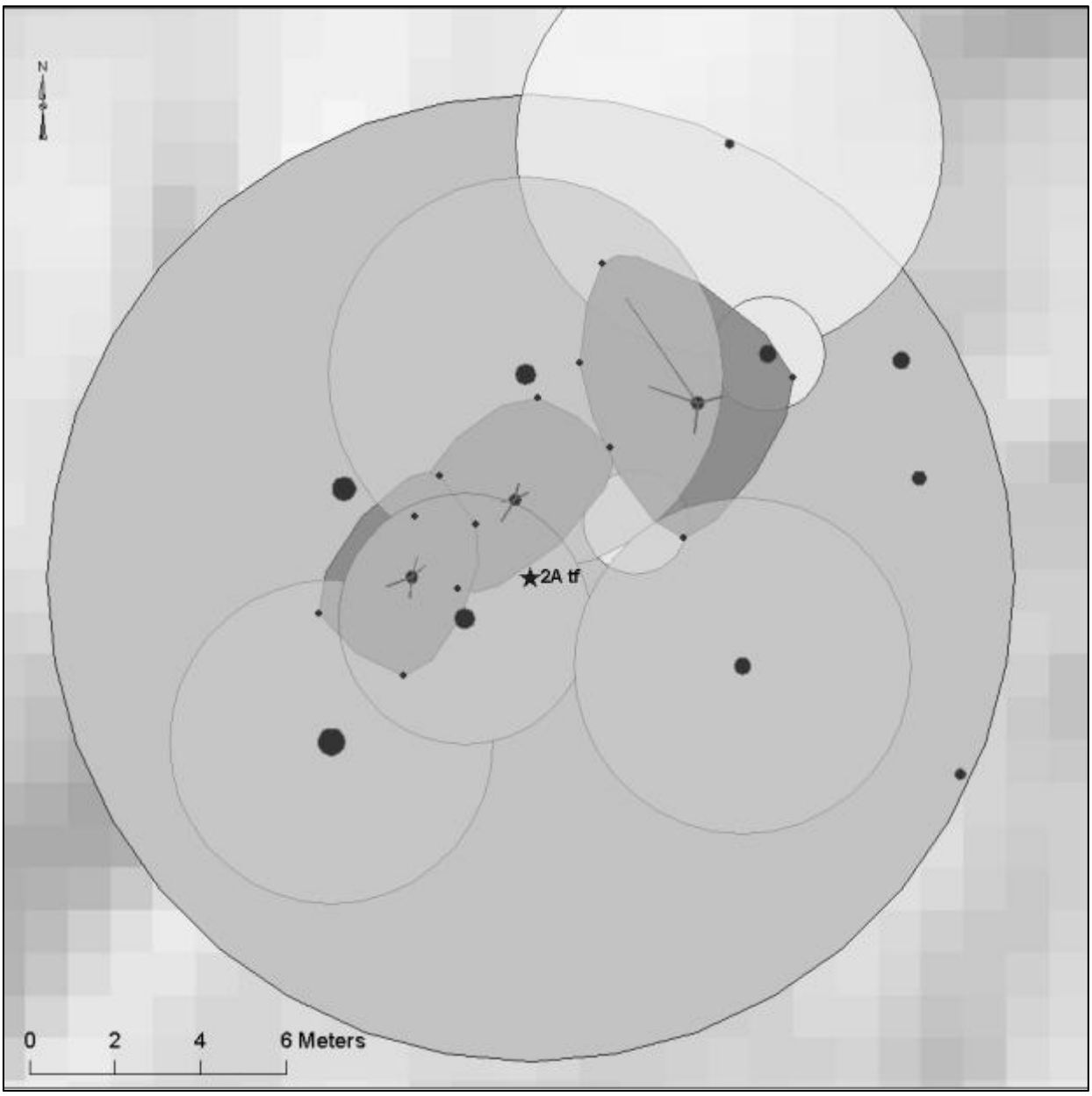

Figure S3: Depiction of multiaged plot number 2A at LWSDTF in Humboldt County, California. The large circle represents the 0.04 ha plot area; the light gray circles are crowns above the target tree crowns represented by the dark irregular shapes in the center of the plot. The white circles are crowns below the target Douglas-fir tree crowns. The dark small circles are the trees with in the plot depicting their actual DBH and the lines are the target tree branch length accurately depicted.