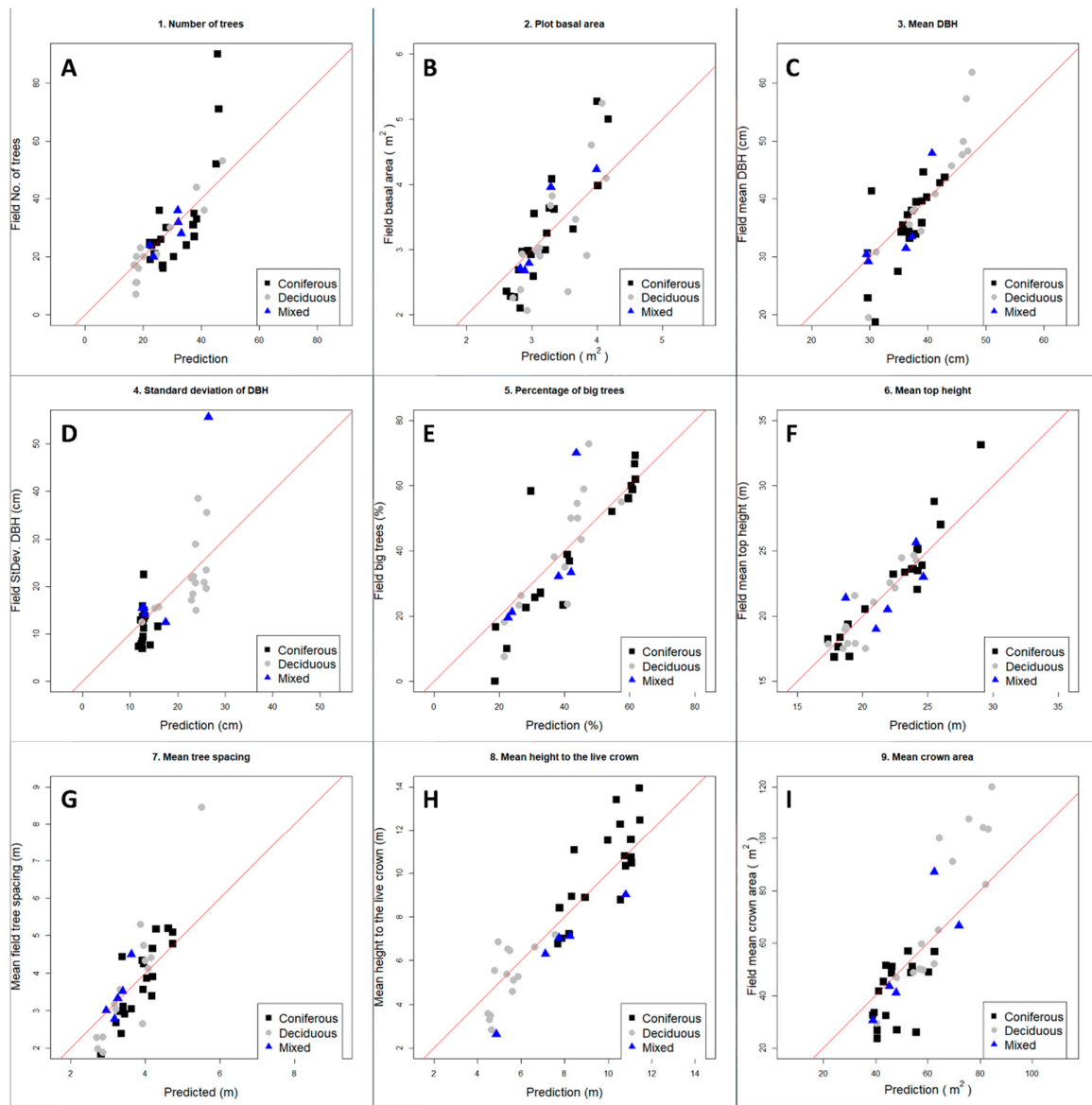
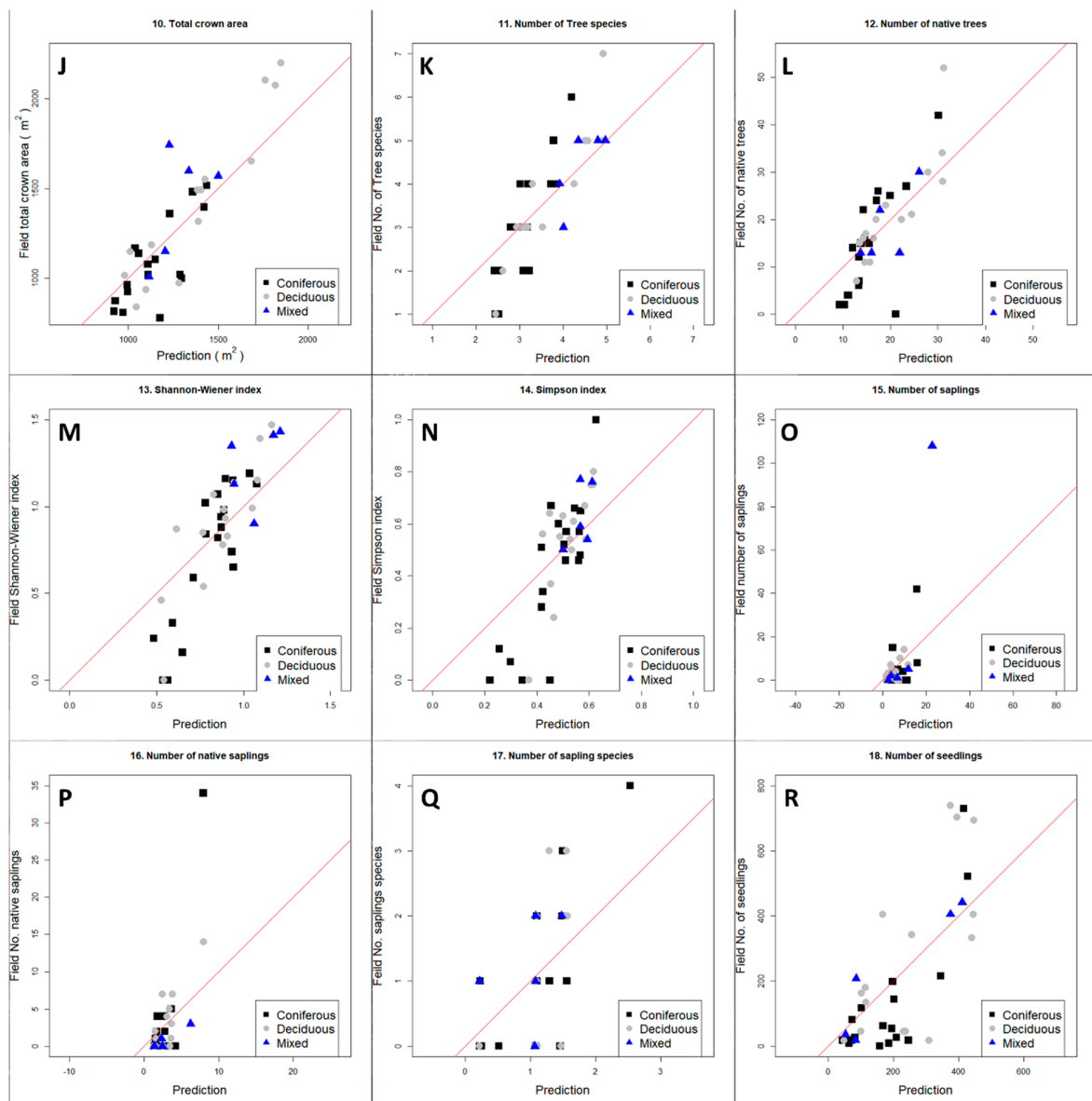
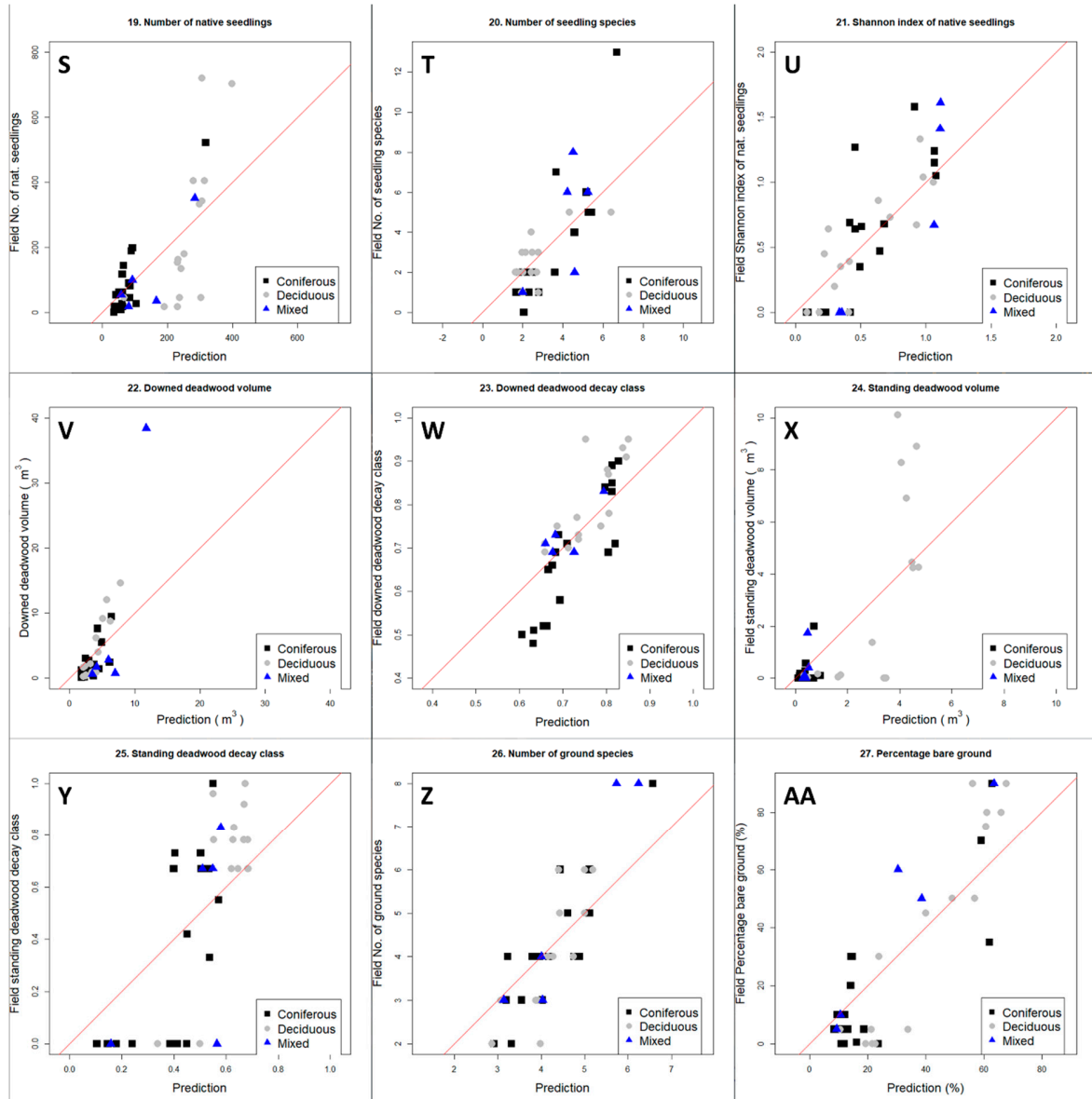


# Towards Forest Condition Assessment: Evaluating Small-Footprint Full-Waveform Airborne Laser Scanning Data for Deriving Forest Structural and Compositional Metrics

## Supplementary Materials







**Figure S1.** Plots of predicted values from RF models against field measurements produced from the most accurate models (which could be sourced from leaf-on (LON), leaf-off (LOF) or combined leaf-on and leaf-off (COM) models). The models presented are as follows: Number of trees (A) (COM); Basal area (B) (LON); Mean DBH (C) (LON); Standard deviation of tree diameters (D) (LOF); Percentage of big trees (E) (COM); Mean tree height (F) (LON); Mean tree stem spacing (G) (LOF); Mean height to the living crown (H) (LOF); Mean crown horizontal area (I) (LON); Sum of crown horizontal area (J) (LON); Number of tree species (K) (LOF); Number of native tree stems (L) (COM); Shannon-Wiener index for native trees (M) (LOF); Simpson index of diversity (N) (LOF); Number of saplings (O) (LOF); Number of native saplings (P) (LON); Number of sapling species (Q) (LON); Number of seedlings (R) (COM); Number of native seedlings (S) (LON); Number of seedling species (T) (LOF); Shannon-Wiener index for native seedlings (U) (COM); Volume of downed deadwood (V) (LOF); Downed deadwood decay class (W) (LOF); Volume of standing deadwood (X) (COM); Standing deadwood decay class (Y) (COM); Number of ground vegetation species (Z) (LOF); and Percentage bare ground cover (AA) (LON).

**Table S1.** A summary of field measured values for each of the 27 metrics across all 41-plot locations.

No.	Metric	Minimum	Maximum	Mean	Standard deviation
1	Number of trees (plot <sup>-1</sup> )	7.00	90.00	28.44	15.64
2	Mean DBH (cm)	18.72	61.84	36.97	9.11
3	Standard deviation of tree diameters (cm)	6.91	55.67	16.98	9.37
4	Basal area (m <sup>2</sup> plot <sup>-1</sup> )	2.06	5.27	3.27	0.83
5	Percentage of big trees (DBH > 40 cm)	0.00	85.72	40.47	20.26
6	Mean tree height (m)	12.83	33.12	21.78	3.94
7	Mean tree stem spacing (m)	1.84	8.45	3.67	1.27
8	Mean height to the living crown (m)	2.63	13.94	7.89	3.11
9	Mean crown horizontal area (m <sup>2</sup> )	13.03	119.91	53.80	26.49
10	Total crown horizontal area (m <sup>2</sup> )	590.17	2198.75	1227.31	388.36
11	Number of tree species	1.00	7.00	3.49	1.33
12	Number of native tree stems	0.00	52.00	17.71	11.20
13	Shannon-Wiener index for native trees	0.00	1.47	0.86	0.39
14	Simpson index of diversity	0.00	1.00	0.49	0.24
15	Number of saplings (plot <sup>-1</sup> )	0.00	108.00	7.02	18.49
16	Number of native saplings (plot <sup>-1</sup> )	0.00	38.00	3.39	7.99
17	Number of sapling species	0.00	4.00	1.00	1.10
18	Number of seedlings (plot <sup>-1</sup> )	0.00	1053.00	240.12	270.30
19	Number of native seedlings (plot <sup>-1</sup> )	0.00	1053.00	171.32	230.72
20	Shannon-Wiener index for native seedlings	0.00	1.61	0.56	0.52
21	Number of seedling species	0.00	13.00	3.20	2.52
22	Volume of downed deadwood (m <sup>3</sup> plot <sup>-1</sup> )	0.09	38.42	3.98	6.58
23	Downed deadwood decay class	0.48	0.95	0.73	0.13
24	Volume of standing deadwood (m <sup>3</sup> plot <sup>-1</sup> )	0.00	10.12	1.42	2.71
25	Standing deadwood decay class	0.00	1.00	0.50	0.37
26	Number of ground vegetation species	2.00	8.00	4.20	1.62
27	Percentage bare ground cover (%)	0.00	95.00	32.33	34.03

**Table S2.** List of ecological indicators for the New Forest. The acronym DBH stands for diameter at breast height. Thresholds values that constitute ‘favourable status’ are recorded (Adapted from Cantarello and Newton, 2008 - derived from: Ferretti *et al.* 2006; Keddy and Drummond, 1996; Mountford *et al.* 1999; Van den Meererschaut and Vanderkerkhove, 1998)

Key Factor	Indicator	Indicator threshold value	Value relative to plot scale
Forest Stand Structure	Number of trees (ha <sup>-1</sup> )	222	24.67
	Shannon-Wiener index for native trees	0.87	0.87
	Basal area (m <sup>2</sup> ha <sup>-1</sup> )	23	2.56
	Mean DBH (cm)	32	32
	Standard deviation of tree diameters (cm)	14	14
	Percentage of big trees (DBH > 40cm) (%)	7	7
Larger tree Regeneration	Mean tree height (m)	17	17
	Number of saplings (ha <sup>-1</sup> )	91	10.11
	Number of native saplings (ha <sup>-1</sup> )	91	10.11
Deadwood	Volume of downed deadwood (m <sup>3</sup> ha <sup>-1</sup> )	26	2.89
	Downed deadwood decay class (0-1)	0.5	0.5
	Volume of standing deadwood (m <sup>3</sup> ha <sup>-1</sup> )	16	1.78
	Standing deadwood decay class (0-1)	0.4	0.4
Tree Regeneration	Number of seedlings (ha <sup>-1</sup> )	63219	7024.33
	Number of native seedlings (ha <sup>-1</sup> )	63219	7024.33
	Shannon-Wiener index for native seedlings	0.89	0.89
Ground vegetation	Number of ground vegetation species (ha <sup>-1</sup> )	33	3.67

**Table S3.** A summary of random forest model tuning parameters for models using metrics from the leaf-on acquisition. MTRY is the number of features to consider at each split in the tree; maxnodes is the maximum number of end nodes that trees in the forest can have, and ntrees is the maximum number of trees to create.

No.	Metric	MTRY	maxnodes	ntrees
1	Number of trees (ha <sup>-1</sup> )	7	5	250
2	Mean DBH (cm)	2	4	350
3	Standard deviation of tree diameters (cm)	8	6	400
4	Basal area (m <sup>2</sup> ha <sup>-1</sup> )	1	7	450
5	Percentage of big trees (DBH > 40 cm)	1	5	300
6	Mean tree height (m)	4	7	300
7	Mean tree stem spacing (m)	1	6	250
8	Mean height to the living crown (m)	1	4	300
9	Mean crown horizontal area (m <sup>2</sup> )	1	4	600
10	Total crown horizontal area (m <sup>2</sup> )	1	9	250
11	Number of tree species	1	3	250
12	Number of native tree stems	1	5	300
13	Shannon-Wiener index for native trees	1	6	350
14	Simpson index of diversity	2	4	550
15	Number of saplings (ha <sup>-1</sup> )	16	6	250
16	Number of native saplings (ha <sup>-1</sup> )	1	5	350
17	Number of sapling species	9	3	800
18	Number of seedlings (ha <sup>-1</sup> )	4	5	250
19	Number of native seedlings (ha <sup>-1</sup> )	1	8	250
20	Shannon-Wiener index for native seedlings	8	6	300
21	Number of seedling species	1	7	300
22	Volume of downed deadwood (m <sup>3</sup> ha <sup>-1</sup> )	1	7	250
23	Downed deadwood decay class	7	7	350
24	Volume of standing deadwood (m <sup>3</sup> ha <sup>-1</sup> )	1	6	300
25	Standing deadwood decay class	1	3	250
26	Number of ground vegetation species	1	5	300
27	Percentage bare ground cover (%)	1	4	350

**Table S4.** A summary of variable inputs to each random forest model using metrics from the leaf-on acquisition, as determined by Boruta variable selection. Each variable, per model, is ranked by importance. Importance was determined by assessing the mean decrease in accuracy of the variable when it was removed. The acronyms Stdev and AbsDev represent standard deviation, absolute deviation respectively.

<b>Metric</b>	<b>Predictor variables</b>	<b>Importance</b>
Number of trees (ha <sup>-1</sup> )	Mean return width	14.10
	Variance of return height	6.48
	StDev. of return heights	4.70
	AbsDev.of return height	4.43
	StDev. of return width	4.40
	Variance of return width	3.32
Mean DBH (cm)	Sum of return amplitude	8.30
	AbsDev. of return heights	8.09
	StDev. of return heights	7.56
	Variance of return heights	7.18
	60 <sup>th</sup> percentile of width	6.01
	20 <sup>th</sup> percentile of width	5.25
Standard deviation of tree diameters (cm)	55 <sup>th</sup> percentile of width	5.16
	Canopy cover	9.93
	Mean return width	9.83
Basal area (m <sup>2</sup> ha <sup>-1</sup> )	25 <sup>th</sup> percentile of return height	5.89
	20 <sup>th</sup> percentile of return height	9.00
	Canopy cover	7.56
	Variance of return amplitude	7.42
	15 <sup>th</sup> percentile of return heights	7.07
	30 <sup>th</sup> percentile of return heights	6.50
Percentage of big trees (DBH > 40cm)	Minimum non-ground height	5.36
	StDev. of return heights	7.69
	AbsDev. of return heights	6.21
	Variance of return heights	6.08
	AbsDev. of return width	5.86
	20 <sup>th</sup> percentile of return width	5.47
Mean tree height (m)	Variance of return width	5.31
	StDev. of return width	4.02
	Maximum of return heights	16.37
	StDev. of return heights	5.72
	Variance of return heights	4.87
	Dominant height	3.71
Mean tree stem spacing (m)	Median of return amplitude	3.59
	95 <sup>th</sup> percentile of return height	3.41
	70 <sup>th</sup> percentile of return height	2.80
	StDev. of return width	6.13
	AbsDev. of return height	6.03
	StDev. of return heights	5.69
	Variance of return width	4.88
	AbsDev. of return width	4.49
	Variance of return height	4.48
	Kurtosis of return height	4.12

Mean height to the living crown (m)	25 <sup>th</sup> percentile of return height	6.35
	AbsDev. of return height	5.64
	Canopy cover	5.46
	25 <sup>th</sup> percentile of amplitude	5.01
	Kurtosis of return width	4.96
	90 <sup>th</sup> percentile of width	4.94
Mean crown horizontal area (m <sup>2</sup> )	Mean of return width	10.43
	Median of return width	9.16
	Sum of return amplitude	7.97
	Kurtosis of return amplitude	7.55
	StDev. of return height	5.37
Total crown horizontal area (m <sup>2</sup> )	95 <sup>th</sup> percentile of amplitude	8.32
	Mean of return amplitude	5.59
	90 <sup>th</sup> percentile of amplitude	5.04
	Mean of return height	4.45
	Variance of return width	4.37
	AbsDev. of return width	3.95
	StDev. of return width	2.72
Number of tree species	45 <sup>th</sup> percentile of return heights	3.19
	10 <sup>th</sup> percentile of return heights	2.65
	40 <sup>th</sup> percentile of return heights	2.57
	55 <sup>th</sup> percentile of return heights	2.21
	Variance of return amplitude	0.48
Number of native tree stems	AbsDev. of return width	8.07
	AbsDev. of return height	7.07
	StDev. of return width	5.36
	Variance of return width	5.00
	StDev. of return height	4.34
Shannon-Wiener index for native trees	80 <sup>th</sup> percentile height	7.30
	Variance of return height	7.04
	StDev. of return height	6.13
Simpson index of diversity	70 <sup>th</sup> percentile of amplitude	8.63
	Median of amplitude	7.19
	65 <sup>th</sup> percentile of amplitude	6.86
	60 <sup>th</sup> percentile of amplitude	6.67
	55 <sup>th</sup> percentile of amplitude	6.26
	45 <sup>th</sup> percentile of amplitude	6.16
	80 <sup>th</sup> percentile of amplitude	5.06
Number of saplings (ha <sup>-1</sup> )	Sum of return amplitude	3.27
Number of native saplings (ha <sup>-1</sup> )	Maximum of return width	3.39
	5 <sup>th</sup> percentile of return width	2.48
	40 <sup>th</sup> percentile of return height	1.79
	75 <sup>th</sup> percentile of return width	1.05
	55 <sup>th</sup> percentile of return width	0.30
Number of sapling species	Median of return width	13.35
Number of seedlings (ha <sup>-1</sup> )	Variance of return heights	11.87
Number of native seedlings (ha <sup>-1</sup> )	95 <sup>th</sup> percentile of return heights	5.43
	20 <sup>th</sup> percentile of return width	2.00
	5 <sup>th</sup> percentile of return width	1.82
	90 <sup>th</sup> percentile of return width	1.59



	Canopy cover	0.26
Shannon-Wiener index for native seedlings	Maximum return height	17.96
	Maximum of return width	14.62
	5 <sup>th</sup> percentile of return width	8.44
Number of seedling species	Maximum of return width	9.05
	5 <sup>th</sup> percentile of return width	7.91
	Maximum return height	7.28
	Median of return amplitude	5.32
Volume of downed deadwood (m <sup>3</sup> ha <sup>-1</sup> )	45 <sup>th</sup> percentile of return width	4.43
	Skewness of return width	4.22
	65 <sup>th</sup> percentile of return width	2.56
	15 <sup>th</sup> percentile of return width	1.48
	20 <sup>th</sup> percentile of return heights	0.05
Downed deadwood decay class	Maximum height	14.25
Volume of standing deadwood (m <sup>3</sup> ha <sup>-1</sup> )	Sum of amplitude	9.40
	30 <sup>th</sup> percentile of return width	5.77
Standing deadwood decay class	85 <sup>th</sup> percentile of amplitude	5.80
	Kurtosis of return amplitude	5.71
	80 <sup>th</sup> percentile of amplitude	5.62
Number of ground vegetation species	Maximum return height	6.48
	Minimum non-ground height	6.27
	75 <sup>th</sup> percentile of return heights	6.03
	95 <sup>th</sup> percentile of return heights	5.31
	Skewness of return height	4.96
	90 <sup>th</sup> percentile of return heights	4.86
Percentage bare ground cover (%)	25 <sup>th</sup> percentile of return heights	8.68
	30 <sup>th</sup> percentile of return heights	7.01
	Canopy cover	6.41
	Variance of return amplitude	6.06
	95 <sup>th</sup> percentile of amplitude	5.64
	AbsDev. of amplitude	5.58
	20 <sup>th</sup> percentile of return heights	5.47

**Table S5.** A summary of random forest model tuning parameters for models using metrics from the leaf-off acquisition. MTRY is the number of features to consider at each split in the tree; maxnodes is the maximum number of end nodes that trees in the forest can have, and ntrees is the maximum number of trees to create.

No.	Metric	MTRY	maxnodes	ntrees
1	Number of trees (ha <sup>-1</sup> )	4	6	400
2	Mean DBH (cm)	16	5	350
3	Standard deviation of tree diameters (cm)	1	3	600
4	Basal area (m <sup>2</sup> ha <sup>-1</sup> )	1	3	300
5	Percentage of big trees (DBH > 40 cm)	1	8	500
6	Mean tree height (m)	1	8	400
7	Mean tree stem spacing (m)	2	6	250
8	Mean height to the living crown (m)	8	5	250
9	Mean crown horizontal area (m <sup>2</sup> )	1	7	250
10	Total crown horizontal area (m <sup>2</sup> )	1	3	250
11	Number of tree species	3	7	300
12	Number of native tree stems	10	3	300
13	Shannon-Wiener index for native trees	1	8	550
14	Simpson index of diversity	1	3	300
15	Number of saplings (ha <sup>-1</sup> )	1	5	300
16	Number of native saplings (ha <sup>-1</sup> )	1	3	250
17	Number of sapling species	1	3	250
18	Number of seedlings (ha <sup>-1</sup> )	1	6	400
19	Number of native seedlings (ha <sup>-1</sup> )	1	4	300
20	Shannon-Wiener index for native seedlings	2	7	250
21	Number of seedling species	1	5	300
22	Volume of downed deadwood (m <sup>3</sup> ha <sup>-1</sup> )	1	3	250
23	Downed deadwood decay class	1	7	250
24	Volume of standing deadwood (m <sup>3</sup> ha <sup>-1</sup> )	1	3	450
25	Standing deadwood decay class	1	5	250
26	Number of ground vegetation species	1	8	300
27	Percentage bare ground cover (%)	1	4	500

**Table S6** A summary of variable inputs to each random forest model using metrics from the leaf-off acquisition, as determined by Boruta variable selection. Each variable, per model, is ranked by importance. Importance was determined by assessing the mean decrease in accuracy of the variable when it was removed. The acronyms Stdev and AbsDev represent standard deviation and absolute deviation.

Metric	Predictor variables	Importance
Number of trees (ha <sup>-1</sup> )	95 <sup>th</sup> percentile of amplitude	11.94
	Skewness of return width	8.64
	90 <sup>th</sup> percentile of amplitude	8.39
	AbsDev. of return width	7.10
	Kurtosis of return width	5.17
	StDev. of return width	6.02
	Variance of return width	3.53
Mean DBH (cm)	Minimum non-ground height	8.16
	70 <sup>th</sup> percentile of return height	6.59
	AbsDev. of return width	6.45
	Skewness of return width	6.22
	95 <sup>th</sup> percentile of amplitude	5.81
	Mean of return amplitude	4.28
	90 <sup>th</sup> percentile of amplitude	4.07
Standard deviation of tree diameters (cm)	Kurtosis of return width	8.33
	Mean of return width	7.12
	Skewness of return width	6.48
	Variance of return width	6.20
	AbsDev. of return width	6.06
	StDev. of return width	5.89
Basal area (m <sup>2</sup> ha <sup>-1</sup> )	Variance of return amplitude	7.58
	Skewness of return height	6.81
Percentage of big trees (DBH > 40cm)	Variance of return height	10.16
	AbsDev. of return height	8.61
	StDev. of return height	8.45
	Skewness of return width	8.27
	90 <sup>th</sup> percentile of amplitude	8.01
	95 <sup>th</sup> percentile of amplitude	6.62
	Mean of return amplitude	6.45
Mean tree height (m)	Maximum return height	7.94
	60 <sup>th</sup> percentile of return heights	7.43
	AbsDev. of return heights	7.20
	StDev. of return heights	7.01
	Variance of return heights	6.99
	65 <sup>th</sup> percentile of amplitude	6.57
	60 <sup>th</sup> percentile of amplitude	6.13
Mean tree stem spacing (m)	Variance of return height	5.67
	Sum of amplitude	4.90
	30 <sup>th</sup> percentile of return height	4.38
	35 <sup>th</sup> percentile of amplitude	4.25
	30 <sup>th</sup> percentile of amplitude	3.72
	StDev. of return height	3.49
	80 <sup>th</sup> percentile of return height	3.48
Mean height to the living crown	Maximum of ground width	13.72

(m)	Mean of return width	11.46
	Variance of return width	5.17
	Kurtosis of return width	5.09
	StDev. of return width	4.42
	AbsDev. of return width	3.04
Mean crown horizontal area (m <sup>2</sup> )	Kurtosis of return width	6.74
	Variance of return width	6.22
	Mean of return width	5.86
	StDev. return width	5.85
	AbsDev. of return width	5.77
	Skewness of return width	4.14
Total crown horizontal area (m <sup>2</sup> )	15 <sup>th</sup> percentile of amplitude	6.05
	30 <sup>th</sup> percentile of amplitude	5.90
	25 <sup>th</sup> percentile of amplitude	5.81
	35 <sup>th</sup> percentile of amplitude	5.15
	40 <sup>th</sup> percentile of amplitude	4.87
	45 <sup>th</sup> percentile of amplitude	4.53
	20 <sup>th</sup> percentile of amplitude	4.12
Number of tree species	80 <sup>th</sup> percentile of return width	5.76
	Skewness of return heights	5.73
	35 <sup>th</sup> percentile of return width	5.57
	40 <sup>th</sup> percentile of return heights	5.40
	85 <sup>th</sup> percentile of return width	5.12
	Median of return heights	2.94
Number of native tree stems	95 <sup>th</sup> percentile of amplitude	11.72
	70 <sup>th</sup> percentile of return width	5.57
	75 <sup>th</sup> percentile of return width	1.48
Shannon-Wiener index for native trees	75 <sup>th</sup> percentile of amplitude	7.37
	Skewness of return height	6.97
	45 <sup>th</sup> percentile of return height	6.92
	55 <sup>th</sup> percentile of return height	6.75
	80 <sup>th</sup> percentile of amplitude	6.67
	Median of return height	6.53
Simpson index of diversity	Skewness of return height	7.99
	55 <sup>th</sup> percentile of return height	5.65
	Median of return height	5.25
Number of saplings (ha <sup>-1</sup> )	40 <sup>th</sup> percentile of return heights	7.90
	Maximum of ground width	4.37
	90 <sup>th</sup> percentile of return width	3.15
Number of native saplings (ha <sup>-1</sup> )	15 <sup>th</sup> percentile of return width	3.29
	5 <sup>th</sup> percentile of return width	3.22
	Maximum of ground width	1.30
	StDev. of return width	0.23
Number of sapling species	10 <sup>th</sup> percentile of amplitude	4.39
	5 <sup>th</sup> percentile of amplitude	1.66
Number of seedlings (ha <sup>-1</sup> )	Variance of return height	6.93
	25 <sup>th</sup> percentile of return width	5.82
	95 <sup>th</sup> percentile of return heights	5.17
	90 <sup>th</sup> percentile of return heights	4.92

	StDev. of return heights	4.32
	85 <sup>th</sup> percentile of return heights	3.95
	AbsDev. of return heights	3.60
Number of native seedlings (ha <sup>-1</sup> )	AbsDev. of return width	20.76
	Kurtosis of return width	4.48
	Variance of return width	2.62
Shannon-Wiener index for native seedlings	Maximum return height	8.04
	Dominant height	7.46
	15 <sup>th</sup> percentile of return width	6.64
	10 <sup>th</sup> percentile of return width	6.59
	5 <sup>th</sup> percentile of return width	5.71
	5 <sup>th</sup> percentile of amplitude	5.19
Number of seedling species	60 <sup>th</sup> percentile of amplitude	5.94
	Kurtosis of return amplitude	5.53
	Maximum return height	5.07
	65 <sup>th</sup> percentile of amplitude	4.89
	15 <sup>th</sup> percentile of return width	4.86
	Skewness of return amplitude	4.85
	70 <sup>th</sup> percentile of amplitude	4.54
Volume of downed deadwood (m <sup>3</sup> ha <sup>-1</sup> )	95 <sup>th</sup> percentile of amplitude	6.96
	Dominant height	5.35
Downed deadwood decay class	15 <sup>th</sup> percentile of return width	10.61
	Sum of return amplitude	7.31
Volume of standing deadwood (m <sup>3</sup> ha <sup>-1</sup> )	StDdev. of return width	5.70
	Variance of return width	5.09
	Sum of amplitude	4.82
	AbsDev. of return width	4.63
	Kurtosis of return width	4.45
	Mean of return width	3.88
	Maximum of ground width	3.34
Standing deadwood decay class	AbsDev. of return width	6.13
	StDev. of return width	5.93
	Variance of return width	5.55
	70 <sup>th</sup> percentile of return width	3.57
Number of ground vegetation species	80 <sup>th</sup> percentile of amplitude	6.63
	Skewness of return height	5.90
	80 <sup>th</sup> percentile of return heights	5.81
	Maximum return height	5.31
	90 <sup>th</sup> percentile of return heights	5.03
Percentage bare ground cover (%)	20 <sup>th</sup> percentile of amplitude	12.32
	30 <sup>th</sup> percentile of amplitude	7.42

**Table S7.** A summary of random forest model tuning parameters for models using metrics from both the leaf-on and leaf-off acquisitions. MTRY is the number of features to consider at each split in the tree; maxnodes is the maximum number of end nodes that trees in the forest can have, and ntrees is the maximum number of trees to create.

No.	Metric	MTRY	maxnodes	ntrees
1	Number of trees (ha <sup>-1</sup> )	1	5	250
2	Mean DBH (cm)	2	7	250
3	Standard deviation of tree diameters (cm)	1	3	550
4	Basal area (m <sup>2</sup> ha <sup>-1</sup> )	1	8	250
5	Percentage of big trees (DBH > 40 cm)	1	7	400
6	Mean tree height (m)	9	6	600
7	Mean tree stem spacing (m)	1	6	250
8	Mean height to the living crown (m)	8	5	250
9	Mean crown horizontal area (m <sup>2</sup> )	1	5	300
10	Total crown horizontal area (m <sup>2</sup> )	1	4	550
11	number of tree species	9	5	400
12	number of native tree stems	5	6	250
13	Shannon-Wiener index for native trees	1	7	250
14	Simpson index of diversity	1	3	450
15	Number of saplings (ha <sup>-1</sup> )	16	6	250
16	Number of native saplings (ha <sup>-1</sup> )	1	8	400
17	Number of sapling species	18	3	250
18	Number of seedlings (ha <sup>-1</sup> )	1	7	250
19	Number of native seedlings (ha <sup>-1</sup> )	7	5	300
20	Shannon-Wiener index for native seedlings	4	6	350
21	Number of seedling species	1	5	300
22	Volume of downed deadwood (m <sup>3</sup> ha <sup>-1</sup> )	1	6	250
23	Downed deadwood decay class	1	4	400
24	Volume of standing deadwood (m <sup>3</sup> ha <sup>-1</sup> )	1	4	250
25	Standing deadwood decay class	1	3	350
26	Number of ground vegetation species	3	5	350
27	Percentage bare ground cover (%)	1	5	600

**Table S8.** A summary of variable inputs to each random forest model using metrics from both leaf-on and leaf-off acquisitions, as determined by Boruta variable selection. Each variable, per model, is ranked by importance. Importance was determined by assessing the mean decrease in accuracy of the variable when it was removed. The acronyms Stdev and AbsDev represent standard deviation and absolute deviation.

Metric	Predictor variables	Importance
Number of trees (ha <sup>-1</sup> )	AbsDev. of return heights (leaf-on)	6.55
	Mean of return width (leaf-on)	6.01
	AbsDev. of return width (leaf-off)	5.67
	Skewness of return width (leaf-off)	5.64
	95 <sup>th</sup> percentile of amplitude (leaf-off)	5.30
	Kurtosis of return width (leaf-off)	4.39
	90 <sup>th</sup> percentile of amplitude (leaf-off)	3.47
Mean DBH (cm)	AbsDev. of return heights (leaf-on)	7.24
	Variance of return heights (leaf-on)	7.12
	StDev. of return heights (leaf-on)	6.95
	70 <sup>th</sup> percentile of return heights (leaf-off)	6.45
	Sum of amplitude (leaf-on)	5.95
	AbsDev. of return width (leaf-off)	4.26
	Minimum non-ground height (leaf-off)	3.73
Standard deviation of tree diameters (cm)	Kurtosis of return width (leaf-off)	6.51
	Skewness of return width (leaf-off)	6.41
	Mean of return width (leaf-off)	6.10
	StDev of return width (leaf-off)	5.97
	Variance of return width (leaf-off)	5.94
	AbsDev. of return width (leaf-off)	5.64
Basal area (m <sup>2</sup> ha <sup>-1</sup> )	20 <sup>th</sup> percentile of return heights (leaf-on)	6.72
	Canopy Cover (leaf-on)	5.22
	StDev. of return amplitude (leaf-off)	5.04
	35 <sup>th</sup> percentile of return heights (leaf-on)	4.23
	Skewness of return heights (leaf-off)	2.43
Percentage of big trees (DBH > 40cm)	Variance of return heights (leaf-on)	8.29
	Skewness of return width (leaf-off)	7.82
	Variance of return heights (leaf-off)	7.45
	StDev of return heights (leaf-on)	7.38
	AbsDev. of return heights (leaf-on)	6.69
	StDev of return heights (leaf-off)	6.59
	20 <sup>th</sup> percentile of return width (leaf-on)	5.64
Mean tree height (m)	Maximum return height (leaf-on)	23.91
	Variance of return heights (leaf-on)	8.59
	StDev. of return heights (leaf-on)	8.17
	Dominant height (leaf-on)	7.00
	Maximum of return height (leaf-off)	6.52
	AbsDev. of return heights (leaf-off)	3.76
	StDev. of return heights (leaf-off)	2.10
Mean tree stem spacing (m)	StDev. of return width (leaf-on)	6.13
	AbsDev. of return heights (leaf-on)	6.03
	StDev. of return heights (leaf-on)	5.69
	Variance of return width (leaf-on)	4.88

	AbsDev. of return width (leaf-on)	4.49
	Variance of return heights (leaf-on)	4.48
	Kurtosis of return heights (leaf-on)	4.12
Mean height to the living crown (m)	Maximum of ground width (leaf-off)	13.72
	Mean of return width (leaf-off)	11.46
	Variance of return width (leaf-off)	5.17
	Kurtosis of return width (leaf-off)	5.09
	StDev. of return width (leaf-off)	4.42
	AbsDev. of return width (leaf-off)	3.04
Mean crown horizontal area (m <sup>2</sup> )	Kurtosis of return width (leaf-off)	7.91
	AbsDev. of return width (leaf-off)	6.89
	Variance of return width (leaf-off)	6.35
	StDev. of return width (leaf-off)	6.04
	Mean of return width (leaf-on)	5.97
	Mean of return width (leaf-off)	5.96
	Skewness of return width (leaf-off)	4.85
Total crown horizontal area (m <sup>2</sup> )	20 <sup>th</sup> percentile of amplitude (leaf-off)	9.83
	95 <sup>th</sup> percentile of amplitude (leaf-on)	8.92
	15 <sup>th</sup> percentile of amplitude (leaf-off)	8.80
	90 <sup>th</sup> percentile of amplitude (leaf-on)	8.11
	25 <sup>th</sup> percentile of amplitude (leaf-off)	7.19
	45 <sup>th</sup> percentile of amplitude (leaf-off)	7.00
	Mean of return amplitude (leaf-on)	6.86
Number of tree species	40 <sup>th</sup> percentile of return height (leaf-off)	10.87
	95 <sup>th</sup> percentile of amplitude (leaf-off)	7.44
	AbsDev. of return width (leaf-on)	5.64
Number of native tree stems	85 <sup>th</sup> percentile of return width (leaf-off)	5.41
	AbsDev. return height (leaf-on)	4.03
	Variance of return height (leaf-on)	3.71
	90 <sup>th</sup> percentile of return width (leaf-off)	2.23
	StDev. of return heights (leaf-on)	1.67
Shannon-Wiener index for native trees	55 <sup>th</sup> percentile of return heights (leaf-off)	5.75
	Skewness of return heights (leaf-off)	5.22
	Kurtosis of return heights (leaf-off)	4.22
Simpson index of diversity	55 <sup>th</sup> percentile of return heights (leaf-off)	8.69
	60 <sup>th</sup> percentile of amplitude (leaf-on)	7.35
	45 <sup>th</sup> percentile of amplitude (leaf-on)	7.22
	Median of amplitude (leaf-on)	7.15
Number of saplings (ha <sup>-1</sup> )	Sum of return amplitude (leaf-on)	3.27
	95 <sup>th</sup> percentile of amplitude (leaf-off)	1.63
Number of native saplings (ha <sup>-1</sup> )	StDev. of return amplitude (leaf-off)	1.42
	Mean of return amplitude (leaf-on)	0.71
	15 <sup>th</sup> percentile of return width (leaf-off)	0.37
Number of sapling species	70 <sup>th</sup> percentile of return width (leaf-on)	4.36
	AbsDev. of return width (leaf-off)	7.73
	Variance of return width (leaf-off)	5.51
Number of seedlings (ha <sup>-1</sup> )	Kurtosis of return width (leaf-off)	5.04
	StDev. of return width (leaf-off)	4.73
	Mean of return width (leaf-off)	3.97
Number of native seedlings	AbsDev. of return width (leaf-off)	20.76



(ha <sup>-1</sup> )	Kurtosis of return width (leaf-off)	4.48
	Variance of return width (leaf-off)	2.62
Shannon-Wiener index for native seedlings	Dominant height (leaf-off)	10.61
	Maximum return width (leaf-on)	8.06
	5 <sup>th</sup> percentile of amplitude (leaf-off)	7.96
	Maximum return height (leaf-off)	7.35
	15 <sup>th</sup> percentile of return width (leaf-off)	5.36
	5 <sup>th</sup> percentile of return width (leaf-off)	4.78
	20 <sup>th</sup> percentile of return width (leaf-off)	4.52
Number of seedling species	60 <sup>th</sup> percentile of amplitude (leaf-off)	5.94
	Kurtosis of return amplitude (leaf-off)	5.53
	Maximum return height (leaf-off)	5.07
	65 <sup>th</sup> percentile of amplitude (leaf-off)	4.89
	15 <sup>th</sup> percentile of return width (leaf-off)	4.86
	Skewness of return amplitude (leaf-off)	4.85
	70 <sup>th</sup> percentile of amplitude (leaf-off)	4.54
Volume of downed deadwood (m <sup>3</sup> ha <sup>-1</sup> )	85 <sup>th</sup> percentile of amplitude (leaf-off)	2.24
	40 <sup>th</sup> percentile of return width (leaf-off)	1.20
	Variance of return width (leaf-off)	0.89
	85 <sup>th</sup> percentile of return heights (leaf-on)	0.73
Downed deadwood decay class	Maximum of ground width (leaf-off)	11.88
Volume of standing deadwood (m <sup>3</sup> ha <sup>-1</sup> )	StDev. of return width (leaf-off)	6.87
	Variance of return width (leaf-off)	6.06
	AbsDev. of return width (leaf-off)	5.30
	Sum of return amplitude (leaf-on)	4.72
	Kurtosis of return width (leaf-off)	4.50
	Sum of return amplitude (leaf-off)	3.63
Standing deadwood decay class	30 <sup>th</sup> percentile of return height (leaf-off)	6.45
	80 <sup>th</sup> percentile of amplitude (leaf-on)	6.37
	85 <sup>th</sup> percentile of amplitude (leaf-on)	6.06
	70 <sup>th</sup> percentile of amplitude (leaf-on)	4.81
	70 <sup>th</sup> percentile of return width (leaf-off)	4.50
Number of ground vegetation species	Maximum return height (leaf-on)	12.155
	Maximum return height (leaf-off)	7.309
	95 <sup>th</sup> percentile of return height (leaf-on)	5.485
Percentage bare ground cover (%)	25 <sup>th</sup> percentile of return height (leaf-on)	11.02
	30 <sup>th</sup> percentile of return height (leaf-on)	10.34
	Canopy cover (leaf-on)	9.91
	95 <sup>th</sup> percentile of amplitude (leaf-on)	9.73