

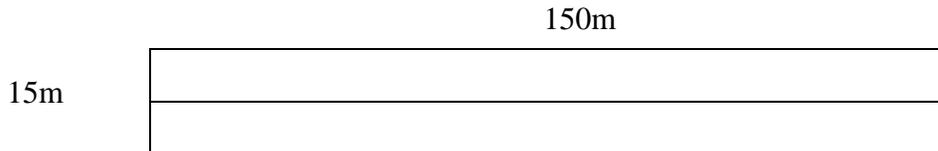
Stand Level Measurements

Measurements Recorded the First Visit

Stem Map—

For all stems within the plot area greater than 5 cm in diameter at breast height (DBH), X and Y coordinates and DBH are recorded. The plot area is defined as 3 by 0.3 times the mean height of canopy dominants. (If canopy dominants have a mean height of 50m, the plot area would be 150m by 15m.) A one hundred meter tape is stretched down the center of the plot and staked at either end with re-bar. For each stem, the perpendicular distance between the center of the stem and the meter tape is recorded as the Y value. The value on the meter tape perpendicular to the center of the stem is recorded as the X-value. DBH is measured at 1.37m from the root collar and recorded (See Appendix A). Additionally, the species, status (live or dead), and a unique identification number is recorded for each stem.

Measurement	Units	Significant digits	Example	Max-Min Value
x-value	meters	1	25.1	0-270
y-value	meters	1	10.9	0-27
DBH	centimeters	1	6.7	5-500



Shrub Transect—

The shrub transect runs down the center, is the entire length of the plot, and is 0.1 times the width of the plot (0.03 times the mean height of canopy dominants). While the tape is stretched, we use a height pole (a piece of PVC cut to 1.37m in length) to measure plot width to the right and left of plot center. Species, x-value, basal diameter, and height is recorded for tree species with DBH less than 5 cm and all woody shrubs. For woody shrubs greater than 5cm DBH, DBH is recorded.

Measurement	Units	Significant digits	Example	Max-Min Value
x-value	meters	1	25.1	0-270
Basal Diameter	centimeters	1	0.8	0.1-25
DBH	centimeters	1	6.7	5-25
Height	meters	1	4.5	0.1-25

Course Woody Debris Line Intercept—

Any piece of dead wood whose central axis crosses a line running down the center of the plot and whose diameter (at point of intersect with center of transect) is greater than 5cm is measured. Measurements include beginning and end points for where log intersects the transect, species, decay class (See Appendix B), and diameter. Diameter is measured perpendicular to the central axis of the log where the central axis intersects the transect. (See Appendix C).

<u>Measurement</u>	<u>Units</u>	<u>Significant digits</u>	<u>Example</u>	<u>Max-Min Value</u>
Begin x-value	meters	2	25.14	0-270
End x-value	meters	2	25.87	0-270
Diameter	centimeters	0	63	1-500

Vegetation Sampling—

Vegetation micro plots are circular plots one meter in diameter and are located every meter along the center of the transect starting at 1.0 meter. In each micro plot a percent cover is estimated for each of three life forms. The three life forms are bryophytes and lichen, deciduous herbaceous plants, and evergreen herbaceous plants. The data set includes “+”, which mean the life form is present but less than 1% cover. All other values are 1, 2, 5, 10, 15, etc. in increments of 5. Maximum value is 100% for each life form. For all tree seedlings less than 0.1 meter in height a tally is recorded by species.

Measurements Recorded the Second Visit

Tree Heights and Crown Projections—

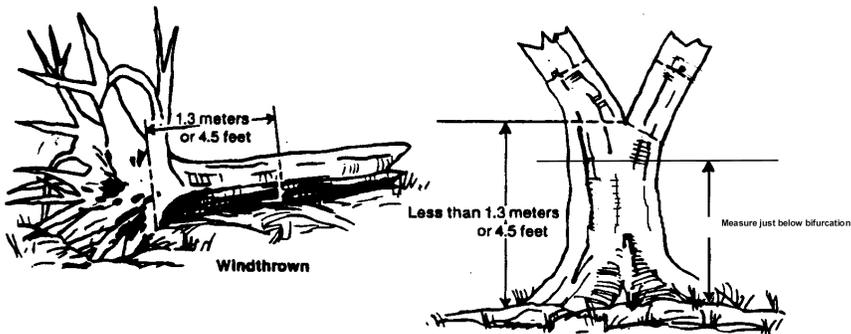
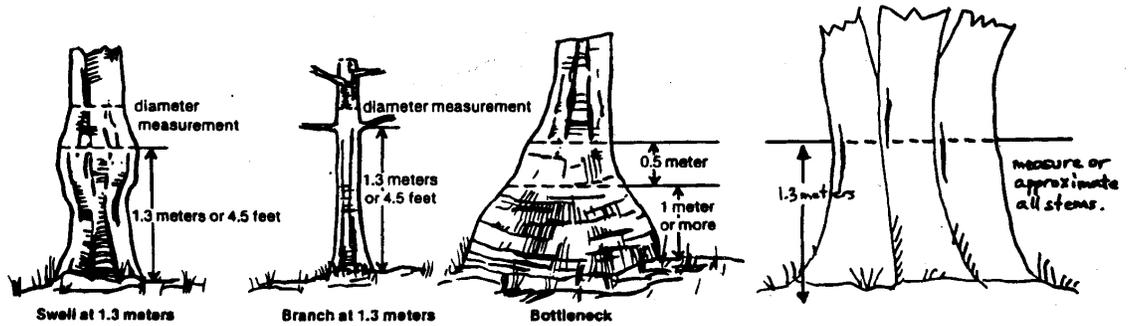
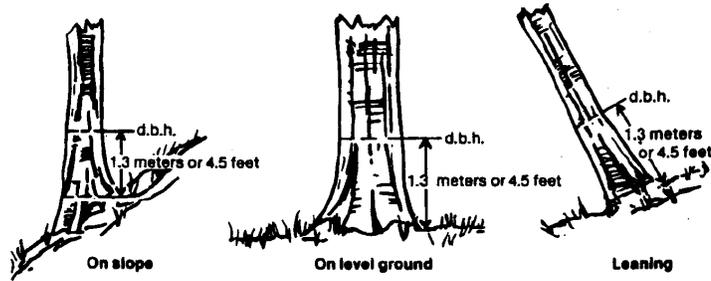
The impulse laser is used to measure tree heights and the height of the crown base. The crown base location where a minimum of 120 degrees of living foliage begins. The height routine is used on the impulse whenever possible. Otherwise the vertical distance to top and bottom of the tree is measured with the impulse.

Four crown radii are measured from the center of the bole to the end of the longest living branch in four cardinal directions. One individual stands due north of the tree bole at the outer edge of the tree crown. The individual uses a clinometer to find the spot that is directly below the outer edge of the crown. The distance from that spot to the center of the bole is then measured (outliers are ignored) using an impulse laser or the back side of a diameter tape.

<u>Measurement</u>	<u>Units</u>	<u>Significant digits</u>	<u>Example</u>	<u>Max-Min Value</u>
Height	meters	1	25.1	0-100
Crown Base	meters	1	25.87	0-100
Crown Radii(E,S,W,N)	meters	0	4.3	1-25

Appendix A. Standards for Measuring Tree Diameters

Measure diameter at 1.37 meters above the root collar or ground level. If the bole has a swell at 1.37 meters, measure it above or below the swell, which ever is closest height to 1.37m. If the bole splits before 1.37 meters, measure it below the split.



Appendix B. Log and Snag Decay Classes

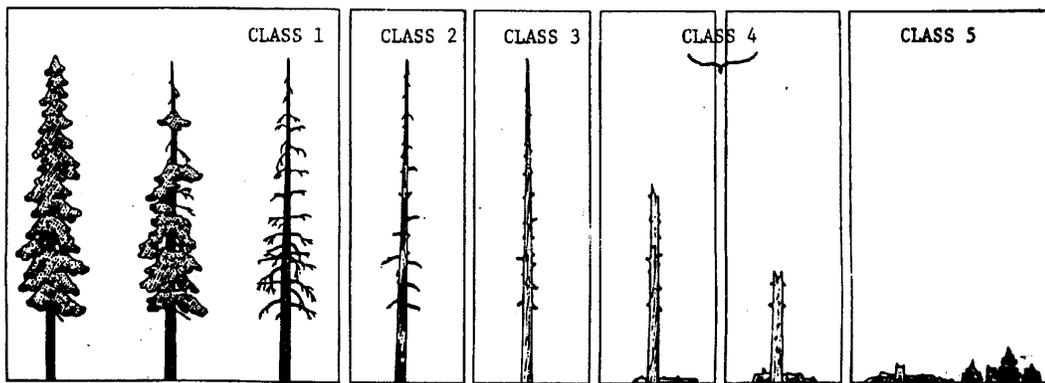
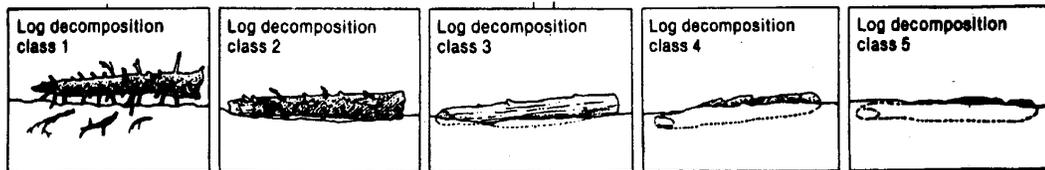
1= bark intact; twigs <3cm in diameter present; texture-wood intact; log cross-section round; wood original color; log elevated on support points.

2= Bark intact; twigs < 3cm in diameter absent; texture- wood intact to partly soft; log cross-section round; wood original color; log elevated on support points but sagging slightly

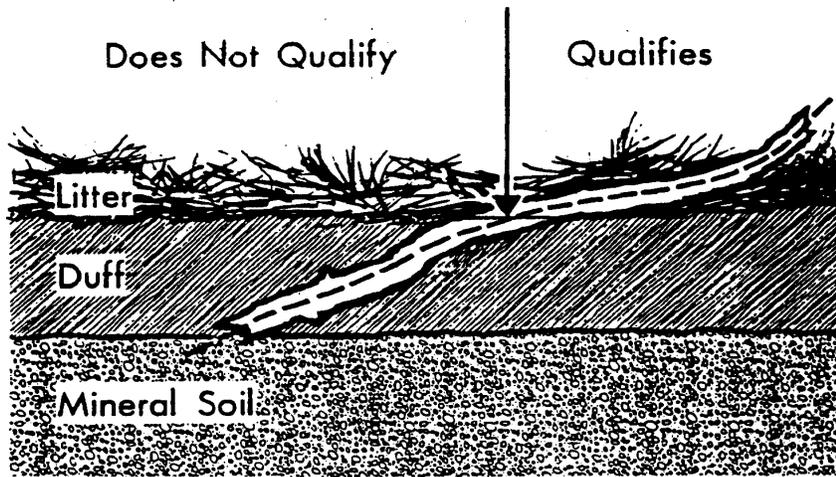
3= Bark loose and missing in places; twigs < 3 cm in diameter absent; texture- wood hard but in large pieces; log cross-section round; wood original color to faded; log sagging and near ground

4= Bark absent; twigs < 3 cm in diameter absent; texture- wood chunks small. Soft, and blocky; log cross-section round to oval; wood color light to faded brown or yellow; all of log on ground

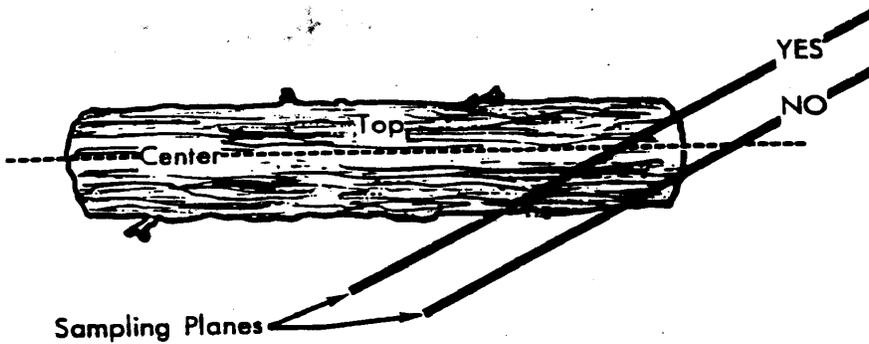
5= Bark and twigs <3 cm in diameter absent; texture-wood soft and powdery; log cross-section oval; wood color faded to light yellow or gray; all of log on ground



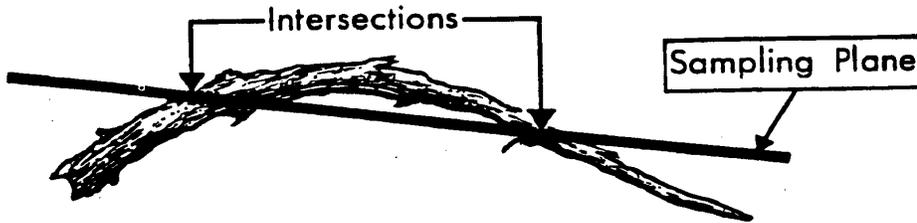
Appendix C. Coarse Woody Debris



--Regardless of size, pieces are tallied only when intersection lies in and above the litter (right of arrow).



--An intersection at the end of a branch or log must include the central axis to be tallied.



--Count both intersections for a curved piece.

Include stems, branches, chunks of the bole, and uprooted stumps or roots. Do not include chunks of bark. Only include CWD whose central axis crosses the measuring tape. For heavily decayed logs attempt to visually reconstruct the original shape of log

and measure that. If the central axis of the log is elevated of the forest floor only count it if it is less than 2 meters above the ground. If two pieces of the same log are separated by more than 5 cm measure them as separate pieces.

Within Tree Measurements

Branch System Measurements for *Pseudotsuga menziesii* at Trout Creek, Cedar Flats, Ohanapecosh, and Chinook Creek

When sampling a tree, the first task is to establish ground level. Old-growth trees often have a vegetated mound of bark and debris near the base of the tree that can deceive the researcher. Standing back away from the tree is a better way to assess what true ground level is. Once ground level is established, a 100 m tape is stretched from the ground to a spot near the top of the tree. The tape usually cannot be anchored at ground level, so it usually attached to a nearby tree at the proper height, accounting for lean, etc. Metal height tags are attached to the bole a 5 m increments, excluding the 5 m tag. At each tag, the trunk diameter is measured and recorded. In addition, the total tree height is recorded to the nearest decimeter. Near the ground, several diameters are measured to aid in modeling the convex tree base.

A branch system is defined as one or more individual branches originating from the same location on the tree bole. Each branch system receives a unique branch number on a per tree basis. Branch systems are permanently marked with a metal tag nailed on the tree bole directly above the branch system. Within a branch system unique measurements are taken for each branch greater than 4cm in diameter and that originate from the bole. Multiple branches within a single branch system all have the same branch number. Measurements include: height above the forest floor, diameter at point of insertion, straight line distance from tree center to the furthest tip of the branch (extent), azimuth from tree center to the furthest tip of the branch, the length of the live portion of branch and branchlets greater than 4cm in diameter, and the length of the dead portion of branch and branchlets greater than 4cm in diameter. A spray is a collection of small branches (less than 4cm in diameter) that originate from the same location on the bole. Only branch height and number of foliar units (see foliar measurements) are recorded for a spray. If the branch is 100% dead, no further information is collected.

Measurement	Units	# of decimal points	Example	Max-Min Value	Null Values
Height	meters	1	67.8	0-100	no
Diameter	centimeters	1	6.7	4-300	yes
Extent	meters	1	5.8	0-20	yes
Azimuth	degrees	0	217	0-360	yes
Live Axis	meters	half meter	1.5	0-20	yes
Dead Axis	meters	half meter	0.5	0-20	yes

Foliar Measurements for *Pseudotsuga menziesii*

The foliage centroid is the center of mass, in three dimensional space, of all foliage associated with a single branch. Centroid measurements include: height above forest floor, azimuth between the center of the bole and the centroid, and the distance from the outer surface of bole to the centroid. The spread and depth of foliage is also measured. Spread is the greatest width of foliage associated with a branch in a horizontal plane. Depth is the greatest length of foliage in a vertical plane. Spread is measured perpendicular to the centroid azimuth and depth is measured parallel to the tree bole.

A foliar unit is a subjective estimate of needle quantity based on a visual assessment of naturally occurring sub-branches on a tree. Each species will be different as to what defines a foliar unit. Foliar units will also vary upon height within the tree. The density of foliage at the top of a tree is different than shaded branches near the base of the crown. On a daily basis each technician collects a sample of one foliar unit and then calibrates with the other technicians. . For each measured branch the number of foliar units is counted and recorded to the nearest half-unit by each technician if possible. Climbing partners are frequently switched to maintain a fairly consistent calibration between all technicians.

<u>Measurement</u>	<u>Units</u>	<u># of decimal points</u>	<u>Example</u>	<u>Max-Min Value</u>	<u>Null Values</u>
Height	meters	1	67.8	0-100	yes
Azimuth	degrees	0	217	0-360	yes
Distance	meters	half meter	1.5	0-20	yes
Spread	meters	half meter	2.0	0-20	yes
Depth	meters	half meter	3.5	0-20	yes
Foliar Units	FU	one half	2.5	0-100	no

Within Tree Measurements 2

Branch System Measurements for *Tsuga heterophylla*, *Thuja plicata*, *Abies* spp., and *Pseudotsuga menziesii* only at PL, MC, PC, and OH.

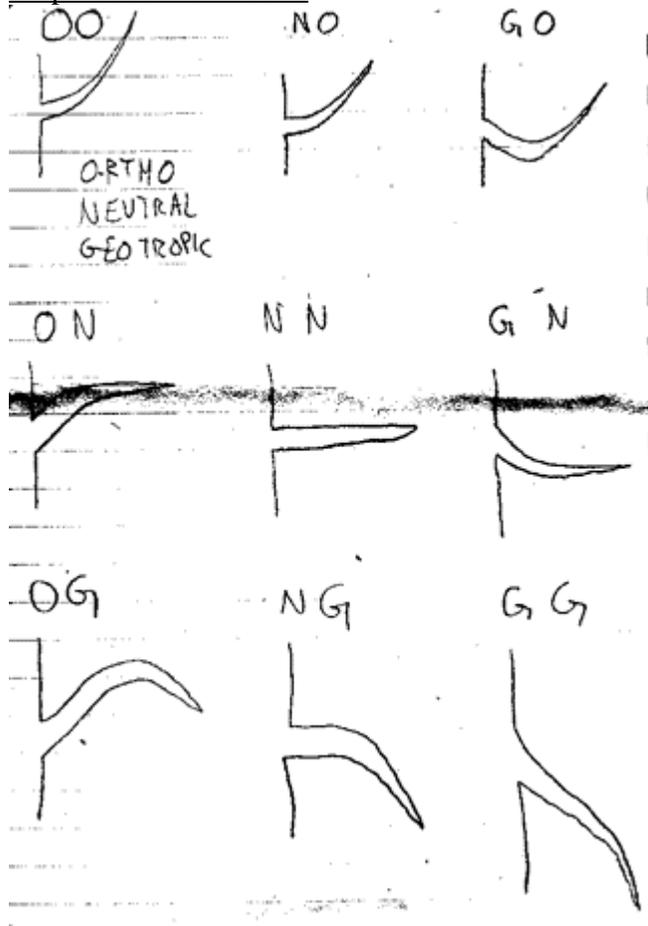
When sampling a tree, the first task is to establish ground level. Old-growth trees often have a vegetated mound of bark and debris near the base of the tree that can deceive the researcher. Standing back away from the tree is a better way to assess what true ground level is. Once ground level is established, a 100 m tape is stretched from the ground to a spot near the top of the tree. The tape usually cannot be anchored at ground level, so it usually attached to a nearby tree at the proper height, accounting for lean, etc. Metal height tags are attached to the bole a 5 m increments, excluding the 5 m tag. At each tag, the trunk diameter is measured and recorded. In addition, the total tree height is recorded to the nearest decimeter. Near the ground, several diameters are measured to aid in modeling the convex tree base.

A branch system is defined as one or more individual branches originating from the same location on the tree bole. Each branch system receives a unique branch number on a per tree basis. Within a branch system unique measurements are taken for each branch greater than 2cm in diameter and that originate from the bole. Multiple branches within a single branch system all have the same branch number. Measurements include: height above the forest floor, diameter at point of insertion, straight line distance from tree center to the furthest tip of the branch (extent), azimuth from tree center to the furthest tip of the branch, the overall branch slope, and a two letter code describing the curvature of the branch. If the branch is 100% dead, no further information is collected.

The overall branch slope is measured in degrees, positive (up) or negative (down), in five-degree increments. This is to represent the overall general tendency of the branch and not a maximum or minimum. The two letter code is used to further describe the shape of the branch. The first letter refers to the first part of the branch (the way it emerges from the bole), and the second letter refers to the shape of the end of the branch. There are three different letters – resulting in nine possible two-letter codes of branch shape. And upward tending branch is orthotropic, and is given the letter O. A down sloping branch is geotropic and is given the letter G. Branches that are neither (generally perpendicular to the trunk are termed neutral, and given the letter N.

Measurement	Units	Decimal digits	Example	Max-Min Value	Null Values
Height	meters	1	67.8	0-100	no
Diameter	centimeters	1	6.7	4-300	yes
Extent	meters	1	5.8	0-20	yes
Azimuth	degrees	0	217	0-360	yes
Slope	degrees	0 (increments of 5)	15	0-90	yes

Slope Code Definitions



Foliar Measurements

Live branches 0-1 cm diameter and 1-2 cm diameter are tallied in 5 m increments. Most of these end up being near the top of a tree.

Each branch greater than 2 cm diameter is estimated for the total percent of the branch that is foliated. This is done in 5% increments with the exception of allowing 2% and 98%. For most branches, this completes the measurement sequence.

For very large (> ~10 cm) or complex branches (a somewhat subjective distinction) three additional measurements are taken. These include the spread and depth of foliage. Spread is the greatest width of foliage associated with a branch in a horizontal plane. Depth is the greatest length of foliage in a vertical plane. Spread is measured perpendicular to the branch azimuth and depth is measured parallel to the tree bole. Finally, the number of bifurcations (branching) in which both branches exceed 4 cm, is tallied. These are estimated when not measurable, but represent only forks in which *both* sides of the fork are greater than 4 cm.

<u>Measurement</u>	<u>Units</u>	<u>decimals digits</u>	<u>Example</u>	<u>Max-Min Value</u>	<u>Null Values</u>
% foliated	degrees	0 (5° increment)	15	0-90	yes
Spread	meters	1 (0.5 m increment)	2.5	0-20	yes
Depth	meters	1 (0.5 m increment)	3.5	0-20	yes
Bifurcations	#	0	5	0-50	yes

Stem table descriptions

Field Name	Data Type	Description
Stem_id	AutoNumber	primary key
Plot_id	Number	primary key
Study_Area	Text	Locality of field research
Location_name	Number	Transect #1-4
Stem_name	Number	Tag number assigned to stem for particular transect
Species_Code	Text	Four letter United States Forest Service species code. First two letters of genus and first two letters of species
X	Number	Distance from point of origin measured parallel to transect in meters
Y	Number	Distance from point of origin measured perpendicular to transect in meters
Z	Number	Elevation of ground where stem originates. Measured in meters
Diameter	Number	Diameter of stem measured at 1.37 meters. Measured in centimeters
Reiteration	Yes/No	Defines stem as a reiteration or original stem
Ecosystem_Component	Text	Tree or small tree
Living	Text	Status of stem. Living=Yes, Dead=No
Height	Number	Measured vertically from soil to highest portion of tree. Measured in meters
Decay	Number	Decay class rated 1 through 5
Crown_Base	Number	
N	Number	Greatest extent of living branch
E	Number	Greatest extent of living branch
S	Number	Greatest extent of living branch
W	Number	Greatest extent of living branch
Comment	Memo	
Initial_Survey_date	Date/Time	Day of Month-Abbreviation of Month-Two digit Year
Comes_from_Branch	Number	
Comes_from_Stem	Number	
Reit_name	Text	The tag or field id for this reiteration
B_ht	Number	The height from the ground at which the base of this reiteration forms, measured in meters.
B_diam	Number	The diameter of the stem or branch from which this reiteration forms, measured in centimeters.
B_azi	Number	The azimuth of the base of the reiteration forming from the stem, measured in degrees.
B_dist	Number	The distance from the center of the main stem to the center of the base of the reiteration, measured in meters.
Top_ht	Number	The highest point of the reiteration, measured in meters.
Top_azi	Number	The azimuth of the top of the reiteration, measured in degrees.
Top_dist	Number	The distance to from the center of the main stem to the top of the reiteration, measured in degrees.
Top_diam	Number	The diameter at the top of the reiteration, measured in centimeters.
Fuzz<1	Number	Fuzz, or branchlets with diameter smaller than 1cm, tallied
Fuzz>1	Number	Fuzz, or branchlets with diameter greater than 1cm, tallied
Age	Number	Number of annual growth rings at 1.37 meters

Branch table subscriptions

Field Name	Data Type	Description
Branch_tag	Number	Number of aluminium tag or other number assigned by researcher to track branches.
Height	Number	Height at point of insertion. Measured in meters
Diameter	Number	Diameter at point of insertion. Measured in centimeters
Azimuth	Number	Azimuth of branch radiating from stem. Measured in degrees
Extention	Number	Distance from center of stem to furthest tip of branch. Measured in meters
Slope	Number	Slope of branch from point of insertion. Measured in degrees
SlopeCode	Text	Two letter code denoting branch growth form
Bifurcation	Text	Number of bifurcations of branches >4cm in diameter
Bifur_spread	Number	Spread of the bifurcation measured perpendicular to the branch azimuth in meters.
Bifure_depth	Number	Depth of the bifurcation measured parallel to the bole in meters.
Axis	Number	Combined length of all branches and branchlets greater than 4cm diameter. Measured in meters
Live Axis	Number	Combined length of all live branches and branchlets greater than 4cm diameter. Measured in meters
Dead Axis	Number	Combined length of all dead branches and branchlets greater than 4cm diameter. Measured in meters
Percent_foliage	Number	Percent of total axis from which live foliage originates.
C_height	Number	Height of centroid. Measured in meters
C_azimuth	Number	Azimuth of centroid radiating from stem. Measured in degrees
C_distance	Number	Distance from center of stem to the centroid. Measured in meters
C_spread	Number	Width of foliage spheroid in a horizontal plane. Measured in meters
C_depth	Number	Length of foliage spheroid in a horizontal plane. Measured in meters
Foliar_Units	Number	Subjective estimate of needle quantity based on a visual assessment of foliage volume and density.
Reiterations	Text	Reiterations forming off of the branch or the reiteration from which the branch sprouts from
Epicormic	Text	Epicormic bud or original bud
Comment	Memo	
Date_of_measure	Date/Time	