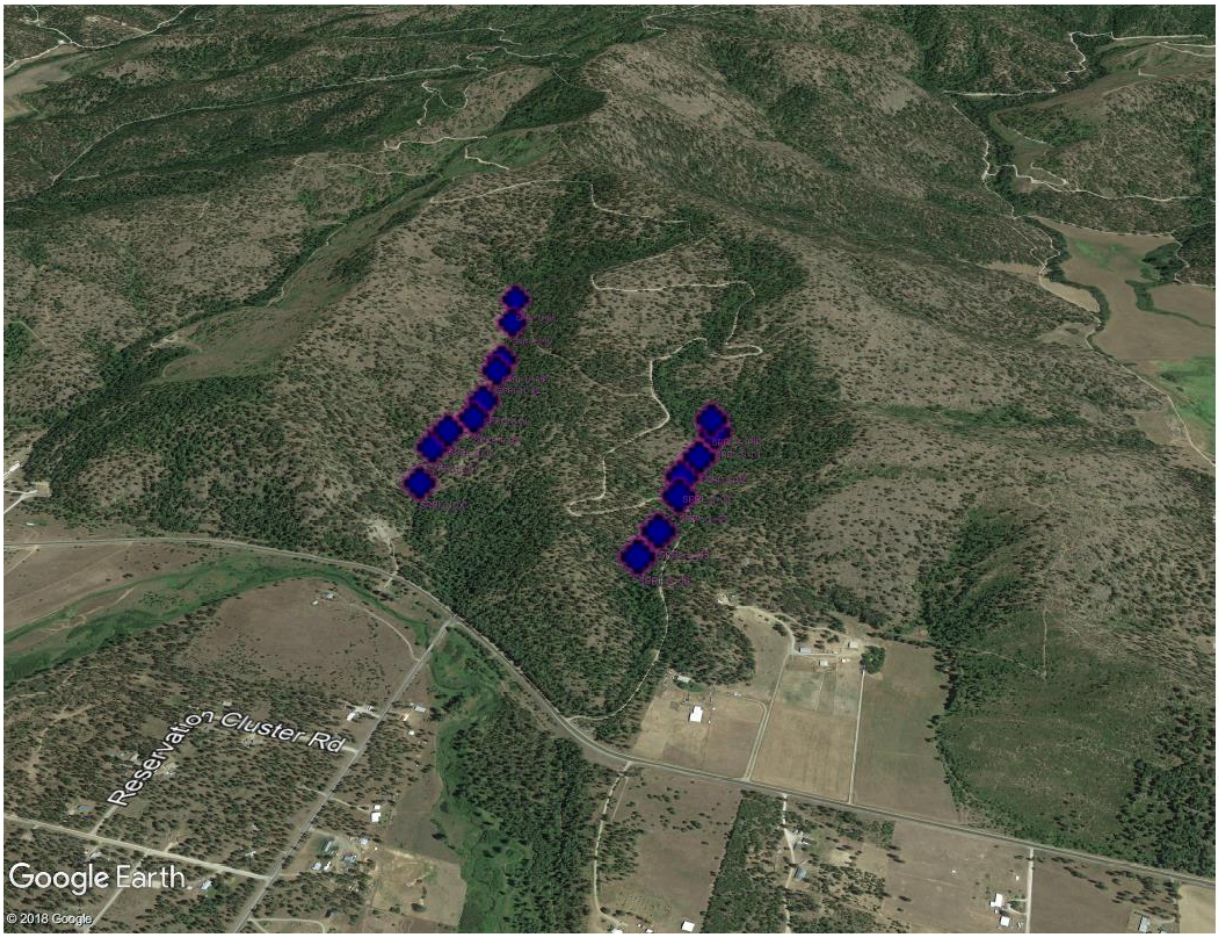
ENREP RIPARIAN SURVEYS

PRE-HARVEST FIELD DATA COLLECTION PROTOCOLS



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PURPOSE AND OBJECTIVE

The overall purpose of the ENREP project is to determine the extent to which the prescriptions found in Washington's eastside Type N Riparian Prescriptions Rule Group are effectively achieving performance targets, particularly as they apply to sediment and stream temperature and their effects on aquatic life. The objective is to inform CMER Policy of the quantitative changes in 2012 Forest Practices Habitat Conservation Plan (FPHCP) covered resources, water quality and aquatic life coincident with forest harvest activities in eastern Washington, and to determine if and how observed changes are related to activities associated with forest management.

The ENREP experimental layout emphasizes evaluation of shade loss. Therefore, a major purpose and objective of riparian vegetation plots is to measure stand conditions with the potential to directly affect stream shade—before and after harvest—within the riparian management zones (RMZs) implemented by the study. Stream shade will be monitored as a separate component of the ENREP study, however, the potential effect of stand conditions on in-stream shade levels will be of interest. Shade can be affected by several factors, including buffer width, canopy density, and tree height, and can vary with species composition (Groom et al. 2011; Teply et al. 2014) and crown geometry (Seyednasrollah and Kumar, 2013).

Wood, sediment, and food delivery are also of interest to the ENREP study. Timber harvest can affect wood recruitment by changing the number of trees with recruitment potential (Beechie 1998) or the frequency of mortality-inducing events including windthrow (Grizzel and Wolff, 1998; Jackson et al. 2001). Harvest-related windthrow can increase near-stream sediment delivery from windthrow-pits (Gomi et al. 2005; Liquori et al. 2008; Schuett-Hames et al. 2015). Generally, timber harvest can increase sediment delivery, but the effects can be mitigated by riparian buffers depending on hillslope gradient, number of obstructions, volume generated, and lithology (Castelle et al. 1994; CH3MHill and Western Watershed Analysts 1998; Castelle and Johnson 2000; Decker 2003; Gomi et al. 2005; Liquori et al. 2008; Sweeney and Newbold 2014).

Alteration of the riparian corridor can also affect benthic invertebrates and other aquatic life by not only affecting light, wood, and sediment delivery, but by also influencing leaf and litterfall (Hawkins et al. 1983; Gregory et al. 1991; Davies and Nelson 1994; Kiffney et al. 2003). Harvest can affect the amount of terrestrial-derived detritus reaching the channel by changing the number of trees, size of trees, species composition, and exposure to wind (Hetrick et al. 1998; Kiffney and Richardson 2010; Bisson et al. 2013; Bilby and Heffner 2016; Estrella et al. 2018). Overall, in addition to measuring stand metrics that may explain shade loss, the purpose and objective of riparian vegetation plots is to measure stand conditions with potential to influence wood recruitment, sediment delivery, sediment filtration, and leaf and litterfall.

STUDY BASIN DESCRIPTIONS

Field protocols cover establishment and measurement of pre-harvest riparian vegetation in the six (6) northeast Washington basins selected by CMER: the Springdale, Blue Grouse, and Tripps installations in Stevens, Pend Oreille, and Spokane Counties, respectively (Figure 1 and Figure 2). As described in the Final Study Plan: "The first pair of basins (Springdale) is approximately 27 miles northwest of Spokane, average 196 acres in size, are east facing and are dominated by second growth ponderosa pine. Both basins are isolated (or hanging) Np with no channel

connection to downstream fish-bearing waters. They average about 2800 feet of channel that is mostly dry by late summer. The second pair of basins (Blue Grouse) is approximately 34 miles due north of Spokane, average 84 acres, are east facing and composed of second-growth mixed conifers. The northern treatment basin has about 2400 feet of channel, half of which is likely to be dry in late summer while the reference is flowing through most of its length. The third set of basins (Tripps) is approximately 24 miles northeast of Spokane (just east of Mount Spokane), averages 111 acres, are north facing and are dominated by Douglas fir and western redcedar. These sites each have over 4000' of channel that is largely perennial."

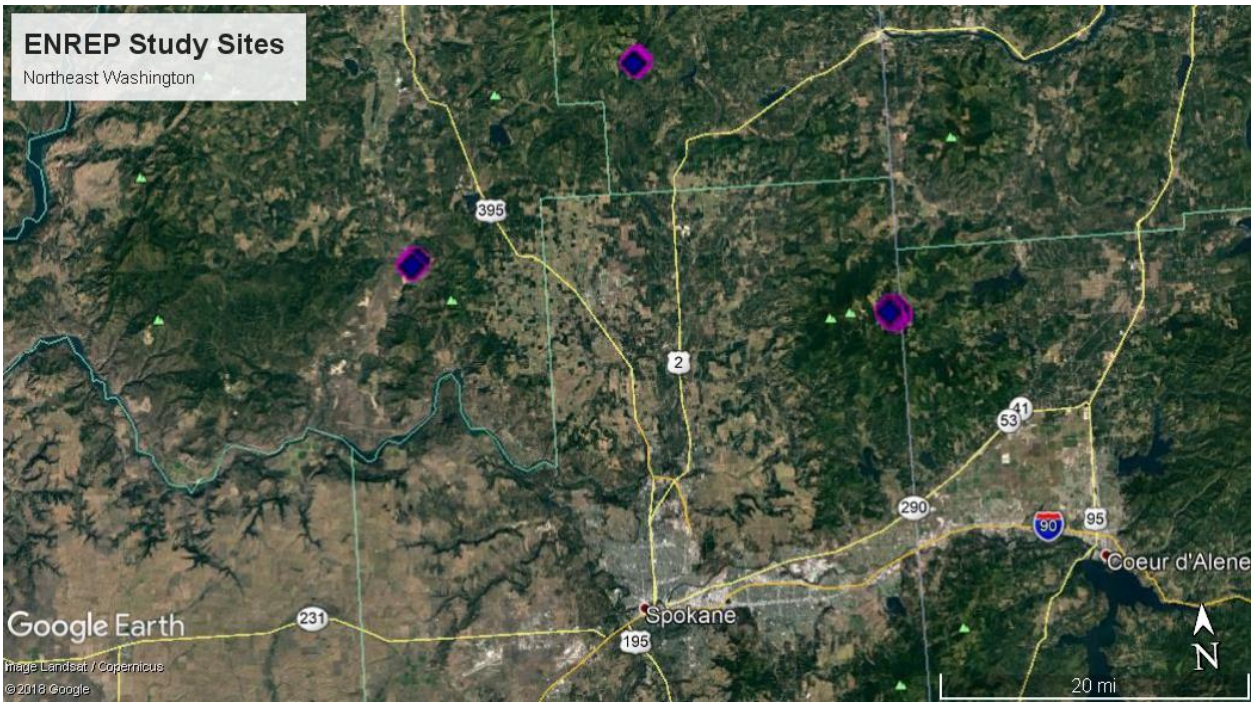

Figure 1. Location of northeast Washington NREP study basins selected by CMER.

FIELD DATA COLLECTION PROTOCOLS

As described in the Final Study Plan: "Riparian stand data will be collected at a series of fixed-area strip plots within each Np reach. Plots will be distributed so that the riparian vegetation within each basin is systematically sampled with a minimum of 10 plots per basin and a maximum of 50 plots. Guidelines for transect spacing in Teply et al. (2013) will be followed to minimize autocorrelation among observations. Each plot will extend 7.6 m (25 ft) parallel to the channel azimuth and 15.24 – 22.86 m (50 -75 ft) out in a perpendicular direction on each side of the stream, corresponding to the width of the RMZ buffer. All live and dead standing trees ≥ 4 in diameter breast height (DBH) will be counted in each plot, along with their distance to the streambank, condition (live/dead), species, DBH, and live crown ratio."

This general approach is amended in the following protocol to: co-locate plots with stream stations used to measure instream shade; synchronize the perpendicular extent of plots with that

(50 ft) used by Schuett-Hames and Roorbach (2010) in the Hardrock Study (CMER 2018); establish and measure two plots at the perennial initiation point; collect tree measurements on a subsample of saplings; measure total height and crown height on a subsample of standing trees; and record fallen trees. All measurements will be taken in English units to be consistent with implementation of the Washington Forest Practices Rules, later converted to metric.

This plot layout and sampling intensity is consistent with guidance by Marquadt et al. (2010) for 20 percent sampling via perpendicular strip plots in riparian areas to reduce error and bias in estimates of stand structure. The colocation of plots with Hemiview plots provides the opportunity to examine relationships between instream shade and stand structure (an emphasis of the study). Other design elements seek consistency with procedures used in the Hardrock Study.

The tree measurement schedule is generally consistent with the Hardrock Study schedule in that two pre-harvest measurements are taken. Like the Hardrock Study, the first pre-harvest measurement will occur about 2 years prior to harvest (i.e., 2019). However, unlike the Hardrock Study which takes the second measurement 1 year prior to harvest, ENREP will take the second measurement immediately before harvest in order to fully capture pre-harvest mortality/tree fall.

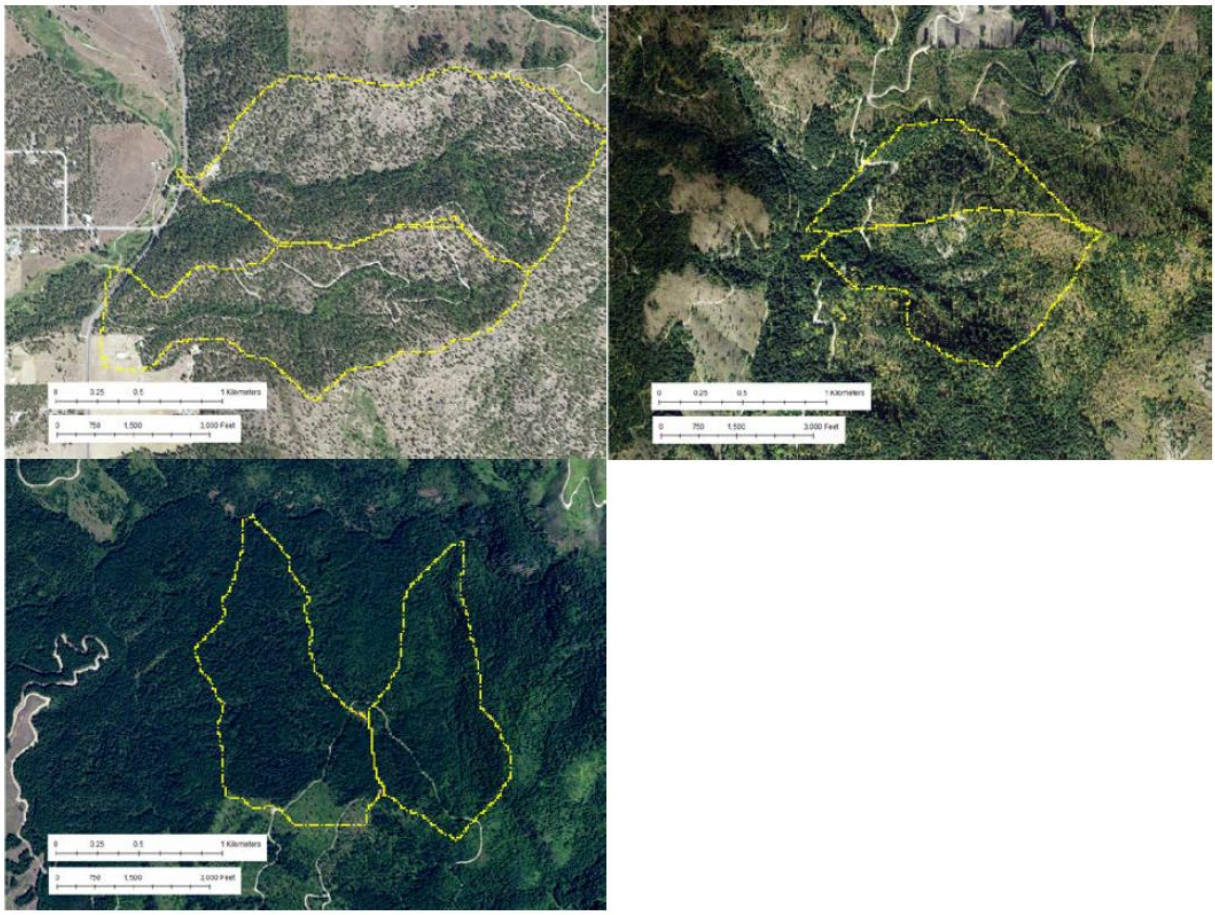

Figure 2. Northeast Washington NREP study basins selected by CMER: Springdale North and South (upper left), Blue Grouse North and South (upper right), and Tripps West and East (lower left).

Field Data Recording, Storage, and QA/QC

Field data will be recorded electronically using a ruggedized hand-held mobile computer (e.g., Juniper Archer 2). Data will be input into voice-intelligent spreadsheets, one spreadsheet per day and one sheet for each plot with plot-level information recorded in the sheet's header and tree-level data recorded one row per tree. Data validation rules will be coded for entry fields to ensure valid field-specific data codes or values. Each spreadsheet will also incorporate slope adjustment factors to help field crew use centerline-based measurement distances for height-related measurements. See Appendix A for the Excel-based sheet layout with example data entry.

Field data will be maintained on the data recorder throughout the project and backed up to internal memory in the field after each station. At the end of each day, field data will be uploaded to a cloud-based repository (e.g. DropBox) for storage and backup. Filenames will be as follows:

[Basin ID]_(Sequence #].xls

QA/QC will occur in three phases. First, all data measurement will be conducted by qualified forest inventory professionals who will follow standard forest inventory protocols and capable of ensuring the data's accuracy, precision, and representativeness fall within project standards. Second, all data entry will be validated in the field, before moving to the next plot, for completeness and to ensure all values were entered and recorded accurately. Any errors or omissions will be resolved on-site. Finally, data entry will be validated in the office, each evening upon data upload, for completeness--i.e., that all plots are accounted for.

Hardcopy field data sheets will be carried in the field, too, to be used as backup in case the electronic field data recorder fails. Data from hardcopy sheets will be hand-entered into a spreadsheet template on a computer and the added step of visually verifying all data entry values will be conducted in the office. All other procedures would apply.

Plot Location, Layout, and Monumentation

In each basin, up to about 20 plot tie-ins will be selected systematically, with a random start, from pre-existing uniformly-spaced stations already located for instream shade measurements (Table 1) plus at the PIP. Following guidance from Teply et al. (2007, 2013), where extent of influence of forest stands riparian function was assessed in Northern Rockies forest types, plot tie-ins will be spaced over 100 ft apart to minimize spatial autocorrelation, reasonably assuring us that instream measurements of shade, wood, etc. will reflect inputs from riparian stands adjacent to the plot tie-in and have minimal influence from stand conditions measured in upstream and downstream plots.

From each tie-in, two plots, each 50 ft horizontal distance from bankfull width (BFW) by 25 ft along BFW, will be located along centerlines located perpendicular to stream flow. Plot centerline azimuths will be measured using a handheld compass, declination 14 deg east. The plot boundaries 50 ft perpendicular to the stream along the centerline will be located with tape measure. Plot boundaries parallel to the centerline, 12.5 ft either side of the centerline for large tree plots and 2.5 feet either side for sapling subplots, will be measured from the centerline using a measuring rod to determine whether trees are "in" the plot or "out" (see below).

Pin flags will be located on the plot centerline at BFW labeled:

[Station ID] ["L"eft | "R"ight (viewed in upstream direction)] ["BFW"]

Overall, plot locations will cover the range of stand conditions affecting riparian function on either side of the stream with minimal autocorrelation while meeting the sample size target. Monumentation and tie-in "stacks on" existing staking and plot spacing can therefore vary slightly. Target plot spacing at Springdale and Blue Grouse will be about 40 meters and plot spacing at Tripps will be about 80 meters. The layout represents a 15 to 20 percent cruise of the 50 ft RMZs--approaching the target coverage recommended by Marquadt et al (2010).

Deviation from plot locations due to unsafe conditions (e.g., cliffs, bee nests, etc.), unrepresentative conditions (e.g., roads, channel migration zones, etc.), project equipment (e.g., flumes), or sensitive areas (e.g, nests, dens, etc.) can be made and will entail moving to the next upstream tie-in, noting changes in the plot header section of the Excel-based spreadsheet. In only two instances will it be necessary to establish new HemiView plots.

Table 1. Instream shade measurement stations selected for riparian plot tie-ins ("X") with deviations from HemiView photography plots denoted in red lettering.

Springdale South			Springdale North			Blue Grouse North			Blue Grouse South			Tripps West			Tripps East		
Station	Reach Break		Station	Reach Break		Station	Reach Break		Station	Reach Break		Station	Reach Break		Station	Reach Break	
0	0		3	0		1			2			1			1		
20		X	20		X	17	0		21	0		12	0		15	0	
40			40			40		X	40		X	40		X	30		X
60		X	60			61			60			78	1		60		
83	1		80		X	79	1	X	73	1	X	119		X	87		
100		X	100			100			100			159			120		X
120			122	1		120		X	124	2	X	200		X	150	1	
140		X	140		X	140			140			226	2		180		
160			160			160		X	158	3	X	240			210		X
180		X	179	2		185	2		180			280		X	240		
200			200		X	200		X	200		X	320			274	2	X
217	2	X	220			219			216	4		360		X	301		
240			245	3		240		X	240			400			330		
250			260		X	251			260			416	3		360		X
278	3		280			264	3		284	5	X	440		X	390		
300		X	300			280		X	300			481			421		
320			319	4	X	300			321		X	520		X	442	3	X
345	4	X	340			320		X	340			543	4		480		
360			360			340			359	6	X	560			510		X
380		X	378		X	360		X	380			601		X	540		
400			400			380			400		X	640			559	4	
420		X	420			400		X	428			680		X	570		
447	5		430	5	X	415	4		440		X	705	5		599		X
460		X	460			427			460			720			630		
480			482	6		450			480		X	760		X	663		
499	6	X	500		X	466	5		497	7		799			689	5	X
			520			480			520		X	840		X	720		
			540			500		X	540			866	6		748		X
			560		X	519	6		560		X	880			782	6	
			580			540		X	580			916		X	810		
			600			561			604	8	X	960			840		X
			620		X	580		X				1000	7	X	870		
			649	7		590	7					1041			903	7	
			660			619		X				1053	8		930		X
			680		X	640						1080		X	959		
			700			666	8	X				1120			971	8	
			720			680						1143	9		990		
			740			700						1160		X	1020		X
			769	8	X	718	9	X				1195			1030	9	
												1237			1050		
												1266	10	X	1085	10	X
												520 taken at 500			599 taken at 580		

Stand Parameters and Tree Measurements

Table 2 summarizes tree measurements that are needed to interpret the potential effects of riparian stand conditions on key riparian functions of interest. The enumeration of overstory trees

(standing trees ≥ 4 in diameter breast height (DBH)) is required for nearly all stand parameters, as is each tree's distance to BFW, species, condition, and DBH. Total height measurements are needed for overstory trees to support interpretations of stream shade, wood recruitment, and leaf and litterfall. Crown measurements will support stream shade and leaf and litterfall interpretations. Information about fallen trees permit evaluation of potential sediment delivery. Understory tree measurements will inform shade, sediment filtration, and leaf and litter fall.

Field parameters will be measured using devices, methods, and measurement tolerances that the contractor finds standard, in their experience, for forest inventory for research purposes (

Table *3*). To achieve desired measurement tolerances, analog devices are opted for in place of production laser measurement devices. Most methods and tolerances follow standard USFS (2018) Forest Inventory and Analysis (FIA) plot protocols used in their nationwide establishment and maintenance of permanent monitoring plots. Extent of BFW will be determined per WaDNR Board Manual 2. Enumeration of fallen trees will occur, noting those exhibiting a root pit, exposed root-wad or associated mound that can potentially deliver sediment to streams (Stewart et al. 2018) and those having recruited wood to the stream.

Table 4 summarizes the tree measurements required for each tree category of interest in this study. Two years prior to harvest, all live trees and saplings and all dead trees ≥ 4 inches DBH will be enumerated and measured within their respective subplot for distance to bankfull width, species, status, standing, and DBH. Immediately before harvest, these same trees will be enumerated, noting any changes in tree status or standing dead and cause of death when applicable. Ingrowth immediately before harvest (those trees becoming 4 inches DBH or saplings within their respective plot since two years prior to harvest) will be enumerated and measured. Tree heights will be measured on a random subset of trees, selection of which will be made after the distribution of species and tree sizes is determined from the first pre-harvest measurement. Appendix B provides excerpts from USFS (2018) describing FIA methods adopted for tree measurement in this study.

Table 2. Riparian function stand parameters and corresponding tree measurements.

	Distance to BFW	Species	Tree Condition	DBH	Total Height	Height to Live Crown Base	Fallen Trees
Stream Shade							
- **Overstory Height**	X	X	X	X	X		
- **Overstory Density**	X	X	X	X			
- **Crown Volume**	X	X	X	X	X	X	
- **Understory Density**	X	X	X	X	X		
Wood Recruitment							
- **Deliverable Wood**	X	X	X	X	X		
- **Fallen Trees**	X	X	X	X			X
Sediment Delivery							
- **Fallen Trees**	X	X	X	X			X
Sediment Filtration							
- **Overstory Density**	X	X	X	X			
- **Understory Density**	X	X	X	X	X		
Leaf and Litterfall							
- **Overstory Height**	X	X	X	X	X		
- **Overstory Density**	X	X	X	X			
- **Crown Volume**	X	X	X	X	X	X	
- **Understory Density**	X	X	X	X	X		

Table 3. Tree measurements and measurement devices, methods, tolerance, and frequency

Tree Measurements	Device	Method	Tolerance	Frequency
Distance to BFW	Tape measure	Slope distance	+/- 1 ft	2 years pre-harvest; pre-harvest (ingrowth only)
Species	Ocular	USFS (2018)	See Species codes	2 years pre-harvest; pre-harvest (ingrowth only)
Tree status	Ocular	USFS (2018)	See Status codes	2 years pre-harvest; pre-harvest (all qualifying)
Standing dead	Ocular	USFS (2018)	See Standing codes	2 years pre-harvest; pre-harvest (all qualifying)
Cause of Death	Ocular	USFS (2018)	See Cause codes	Pre-harvest
DBH	Diameter tape	USFS (2018)	+/- 0.1 in (large); +/- 1.0 in (sapling)	2 years pre-harvest; pre-harvest (ingrowth only)
Total height	Clinometer	USFS (2018)	+/- 1 ft	Pre-harvest sub-sample
Height to Live Crown	Clinometer	USFS (2018)	+/- 1 ft	Pre-harvest subsample

The following general order of operations will be used once the plot tie-in is monumented, BFW established, and stream orientation/plot centerline direction determined as guidelines to measure trees efficiently within each plot:

1) From BFW, measure to the 50 ft outer plot boundary using a tape measure, distance horizontal adjusted for slope, locating a stake painted orange at the 50 ft mark flagged above with double pink ribbon;
2) If on a "height plot," extend the tape measure beyond the 50 ft boundary and hang flagging at 100 ft, a target to which slope measurements for tree heights are made;
3) Start tree enumeration at bank full width, proceeding left to right, then upslope;
4) Determine standing "in" trees using a measuring rod (12.5 ft from centerline for large trees and 2.5 ft from centerline for saplings) and record for each "in" tree the slope distance to stream from stem midpoint, along center line, and distance from centerline;
5) For each standing "in" tree, large tree or sapling, within their respective plots, determine and record the species and tree status, (assumed standing), and measure and record DBH to the nearest 0.1 in (large trees) or 1.0 in (saplings);
6) If a fallen tree greater than 4 in DBH is encountered that would have stood within the large tree plot, record the distance to the stream from the approximate pre-fall tree bole center and the species, status, standing dead, and DBH. Note root pits or mounds and LWD recruitment to BFW.
7) For each large "in" tree, live or dead (standing or fallen), paint an orange stripe about 4 inches tall and 8 inches wide at a point about 6 to 8 feet above ground toward plot center;

8) On height plots, measure sapling (live or dead within 2.5 ft of centerline) total height and height to crown base to the nearest 1 ft with a measuring rod;
9) On height plots, defer measurement of large live standing trees (within 12.5 ft of centerline) heights until distance from tree is at least 50 ft from the tree;
10) On height plots, when distance to large trees is at least 50 ft, measure large live tree heights to the nearest 1 ft using a clinometer, where possible, recording centerline distance and stump, live crown base, and total height clinometer readings (using the percent scale);
11) If it is not possible to measure standing large live tree heights from centerline, take clinometer measurements 1 chain from the tree, recording an "X" in the centerline distance and for the clinometer top and bottom readings, and entering the height directly into the HTCB and THT fields on the data entry spreadsheet;
12) Note that the tape measure may be pulled beyond 100 ft to measure upper slope trees;

Any deviation from these procedures due to tree or site conditions will be noted for the affected tree in the tree's notes section in the Excel-based spreadsheet.

Table 4. Tree measurements required for each tree category of interest

Tree (#)	Distance fr BFW (ft)	Distance fr CL (ft)	Species (Code)	Tree Status	Tree Standing	DBH (in)	CL Stn for HT Meas. (ft)	Stump Reading (%)	HTCB Top Reading (%)	THT Top Reading (%)	HTCB (ft)	THT (ft)
Standing Live > 4 in DBH	*Yes*	*Yes*	*Yes*	*Yes*	*No (Assumed Standing)*	*Yes*	*Yes (Height Plots)*	*Yes (Height Plots)*	*Yes (Height Plots)*	*Yes (Height Plots)*	*Calc (Height Plots)*	*Calc (Height Plots)*
Standing Live < 4 in DBH	*Yes*	*Yes*	*Yes*	*Yes*	*No (Assumed Standing)*	*Yes*	*No*	*No*	*No*	*No*	*Yes (Height Plots)*	*Yes (Height Plots)*
Standing Dead > 4 in DBH	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*No*	*No*	*No*
Fallen Dead > 4 in DBH	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*No*	*No*	*No*

Equipment List

Shovel, ax, and fire extinguisher

GPS unit and satellite PLB

Access Maps

Landowner access agreements

Gate keys

Rugged hand-held mobile computer

Rite-in-the-Rain notebooks and pencils

Field data collection protocols

Blue pin flags and marker

Handheld compass

Tape measure and nail

Clinometer

Swede tool

Orange tree paint

Wooden stakes

Pink flagging

Measuring rod

Diameter tape

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United States Forest Service. 2018. Forest Inventory and Analysis National Core Field Guide. Volume I: Field Data Collection Procedures for Phase 2 Plots. Version 8.0. 439p.

APPENDIX A: EXCEL-BASED PLOT DATA SHEET

ENREP NE WA Riparian Survey, Plot Form, ver. 8/25/19

Basin:	Test	Station:	One	Side:		Azimuth:		Slope:	0	Slope Dist:	50	Crew:		Date:		Ht. Plot?:	Yes
Notes:	25 minute height plot																

Tree (#)	Voice Data xx and yy	Distance fr BFW (ft)	Distance fr CL (ft)	Species (Code)	Voice Data status standing xx.x	Tree Status	Tree Standing	DBH (in)	Voice Data tree notes	CL Stn for HT Meas. (ft)	Voice Data -ss and ccc and ttt	Stump Reading (%)	HTCB Top Reading (%)	THT Top Reading (%)	Distance to Tree	HTCB (ft)	THT (ft)
1	05 and 04	5	4	PSME	e standing 1	Live	Standing	14.3		71	nd 101 and	-5	101	135	66	69	92
2	05 and 05	5	5	PSME	d standing 1	Dead	Standing	14.8		71							
3	10 and 04	10	4	PSME	d standing	Dead	Standing	9.3		76							
4	15 and 03	15	3	PSME	d standing	Dead	Standing	9.8		81							
5	17 in 04	17	4	PSME	d standing 1	Dead	Standing	10.2		83							
6	17 and 01	17	1	ALRU2	e standing 0	Live	Standing	0.5		83						3	8
7	38 and 04	38	4	ALRU2	es standing	Live	Standing	6.5		104	nd 76 and 1	-2	76	101	66	51	67
8	40 and 02	40	2	ALRU2	es standing	Live	Standing	5.1		106	nd 66 and 1	-2	66	101	66	44	67
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

ENREP NE WA Riparian Survey, Plot Form, ver. 8/25/19

Basin:	Test	Station:	Two	Side:		Azimuth:		Slope:	0	Slope Dist:	50	Crew:		Date:		Ht. Plot?:	No
Notes:	10 minute stocking plot																

Tree (#)	Voice Data xx and yy	Distance fr BFW (ft)	Distance fr CL (ft)	Species (Code)	Voice Data status standing xx.x	Tree Status	Tree Standing	DBH (in)	Voice Data tree notes	CL Stn for HT Meas. (ft)	Voice Data -ss and ccc and ttt	Stump Reading (%)	HTCB Top Reading (%)	THT Top Reading (%)	Distance to Tree	HTCB (ft)	THT (ft)
1	10 and 10	10	10	PSME	e standing 1	Live	Standing	17.1		76							
2	17 and 02	17	2	PSME	ad fallen 12	Dead	Fallen	12.2	Down								
3	26 and 03	26	3	PSME	e standing 1	Live	Standing	13.2		92							
4	28 and 04	28	4	PSME	e standing 1	Live	Standing	12.5		94							
5	44 and 09	44	9	ALRU2	e standing 9	Live	Standing	9.5		110							
6																	
7																	
8																	
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20																	

APPENDIX B: FIA (USFS 2018) MEASUREMENT METHODS

Species

Record the appropriate SPECIES code from the list in Appendix 3. If the species cannot be determined in the field, tally the tree, but bring branch samples, foliage, cones, flowers, bark, etc. to the supervisor for identification. If possible, collect samples outside the subplots from similar specimens and make a note to correct the SPECIES code later. Use code 0299 for unknown dead conifer, 0998 for unknown dead hardwood when the genus or species codes cannot be used, and 0999 for other or unknown live tree. The generic code should only be used when you are sure the species is on the species list, but you cannot differentiate among acceptable species. This is often the case with standing dead trees on newly established plots. In this case use the sample collections procedures described earlier in this paragraph. The species code list in Appendix 3 includes all tree species tallied in the Continental U.S., Alaska, and the Caribbean. Species designated East/West are commonly found in those regions, although species designated for one region may occasionally be found in another. Species marked as Woodland designate species where DRC is measured instead of DBH. Species that have an "X" in the Core column are tallied in all regions. All other species on the list are "core optional."

Value	Description
ABGR	grand fir
ABLA	subalpine fir
LAOC	western larch
PIEN	Engelmann spruce
PICO	lodgepole pine
PIMO3	western white pine
PIPO	ponderosa pine
PSME	Douglas-fir
THPL	western redcedar
TSHE	western hemlock
TSME	mountain hemlock
ALRU2	red alder
POTR5	quaking aspen
POBAT	black cottonwood

Status

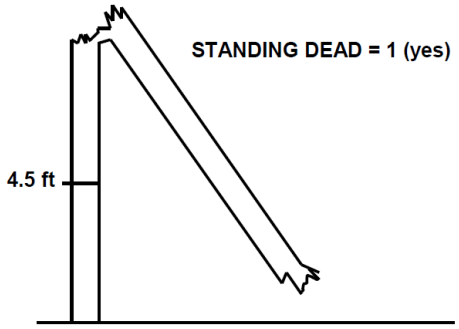
Record a current PRESENT TREE STATUS for each tallied tree; this code is used to track the status of sample trees over time: as they first appear, as ingrowth, as they survive, and when they die or are removed. This information is needed to correctly assign the tree's volume to the proper component of volume change.

Value	Description
0	No status – tree is not presently in the sample (remeasurement plots only). Tree was incorrectly tallied at the previous inventory, currently is not tallied due to definition or procedural change, or is not tallied due to natural causes. Requires RECONCILE code = 5-9.
1	Live tree – any live tree (new, remeasured or ingrowth)
2	Dead tree – any dead tree (new, remeasured, or ingrowth), regardless of cause of death. Includes all previously standing dead trees that no longer qualify as standing dead, trees killed by silvicultural or land clearing activity and assumed not to have been utilized, as well as dead trees that may have been present at the time of plot establishment but only tallied now due to procedural change
3	Removed – a tree that has been cut and removed by direct human activity related to harvesting, silviculture or land clearing (remeasurement plots only). The tree is assumed to have been utilized.

Standing Dead

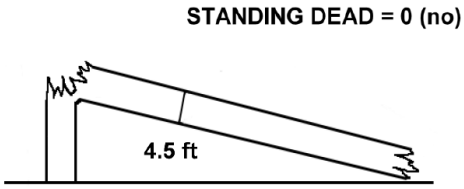
Record the code that describes whether or not a tree qualifies as standing dead. To qualify as a standing dead tally tree, dead trees must be at least 1.0 inch in diameter, have a bole that has an unbroken ACTUAL LENGTH of at least 4.5 feet, and lean less than 45 degrees from vertical as measured from the base of the tree to 4.5 feet. See figures 20-22 for examples. ... Live and dead standing tally trees, and partially separated boles of dead tally trees, do not have to be self-supported. They may be supported by other trees, branches, or their crown.

Value	Description
0	No – tree does not qualify as standing dead.
1	Yes – tree does qualify as standing dead.



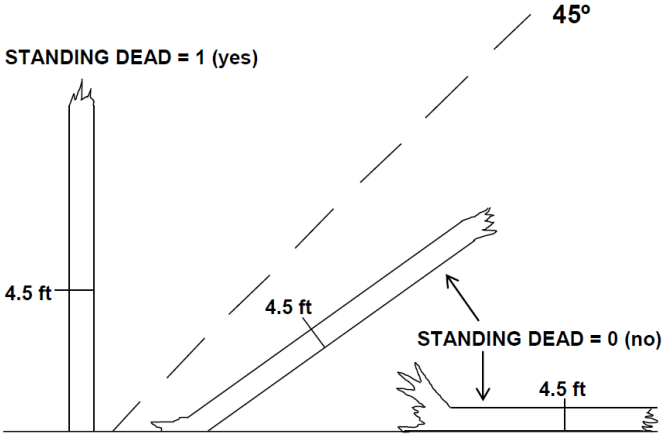
(Tree is at least 1.0 inch at 4.5 feet and is at least 4.5 feet in unbroken ACTUAL LENGTH)

Figure 20. Example of an unbroken bole to 4.5 feet.



(Tree is at least 1.0 inch at 4.5 feet, but does not have 4.5 feet in unbroken ACTUAL LENGTH)

Figure 21. Example of an unbroken length of < 4.5 feet.



(Trees are at least 1.0 inch at 4.5 feet and are at least 4.5 feet in unbroken ACTUAL LENGTH)

Figure 22. Other examples of dead trees

Cause of Death

Record a cause of death for all trees that have died or been cut since the previous survey. If cause of death cannot be reliably estimated, record unknown/not sure/other.

Value	Description
10	Insect
20	Disease
30	Fire
40	Animal
50	Weather
60	Vegetation (suppression, competition, vines/kudzu)
70	Unknown/not sure/other - includes death from human activity not related to silvicultural or landclearing activity (accidental, random, etc.). TREE NOTES required.
80	Silvicultural or landclearing activity (death caused by harvesting or other silvicultural activity, including girdling, chaining, etc., or to landclearing activity)

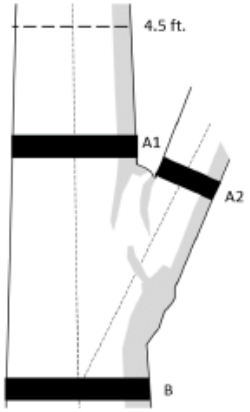
Diameter at Breast Height

5.9.2 DIAMETER AT BREAST HEIGHT (DBH)

Unless one of the following special situations is encountered, measure DBH at 4.5 feet above the ground line on the uphill side of the tree. Round each measurement down to the last 0.1 inch. For example, a reading of 3.68 inches is recorded as 3.6 inches.

Special DBH situations:

1. Forked tree: In order to qualify as a fork, the stem in question must be at least 1/3 the diameter of the main stem and must branch out from the main stem at an angle of 45 degrees or less (figs. 23-26), AND must be judged to have, or have the potential to assume an obvious "tree like" form and function as opposed to an obvious "branch like" form and function. If there is any doubt as to the form and function of a potential fork, call it a fork instead of a branch. Figure 27 provides examples where the form and function are considerations. Forks originate at the point on the bole where the piths intersect. Forked trees are handled differently depending on whether the fork originates below 1.0 foot, between 1.0 and 4.5 feet, or above 4.5 feet.

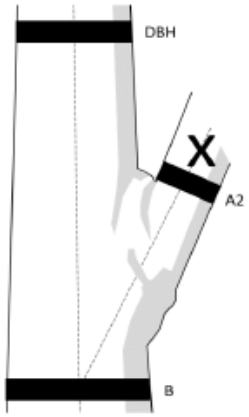


A1, A2 and B represent diameter locations for determining if minimum diameter ratios are met. Diameter ratios are met if:

$$\frac{A1}{B} \geq \frac{1}{3}$$

$$\frac{A2}{B} \geq \frac{1}{3}$$

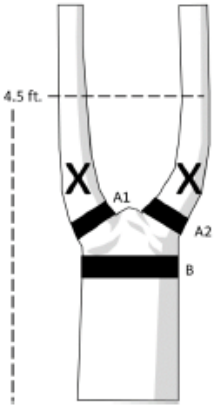
Figure 23. Determining diameter ratio of forks. When determining if a fork meets the 1/3 diameter requirement for qualifying as a fork, the diameter of the potential fork taken at locations A1 and A2 must be 1/3 of the diameter at location B.



If one of the potential forks is less than 1/3 the diameter at B, then no fork exists and the diameter would be placed at 4.5 feet from the ground on the qualifying stem.

$$\frac{A2}{B} < \frac{1}{3}$$

Figure 24. A single non-qualifying fork. If one of the forks does not meet the minimum ratio, then no fork exists and the diameter is placed at the normal location on the dominant stem.



If neither stem above a fork meets the minimum 1/3 diameter requirement, neither stem is tallied.

$$\frac{A1}{B} < \frac{1}{3}$$

$$\frac{A2}{B} < \frac{1}{3}$$

Figure 25. Two non-qualifying stems. If neither stem meets the 1/3 diameter requirement, neither is tallied. This is often associated with broken tops and is consistent with the point at which a stem is considered recovered from a break.

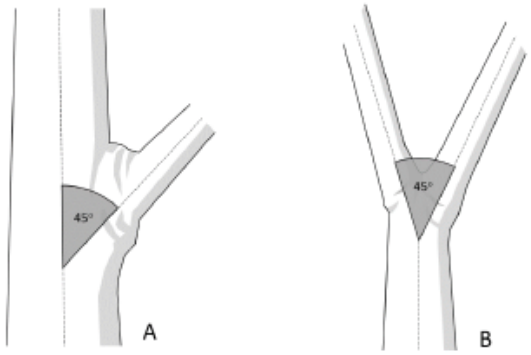


Figure 26. Forking angle. In order to qualify as a fork, the piths must diverge at an angle not exceeding 45 degrees from the main stem (A). In cases where there is no obvious main stem (B), consider the angle of pith separation between the two stems.

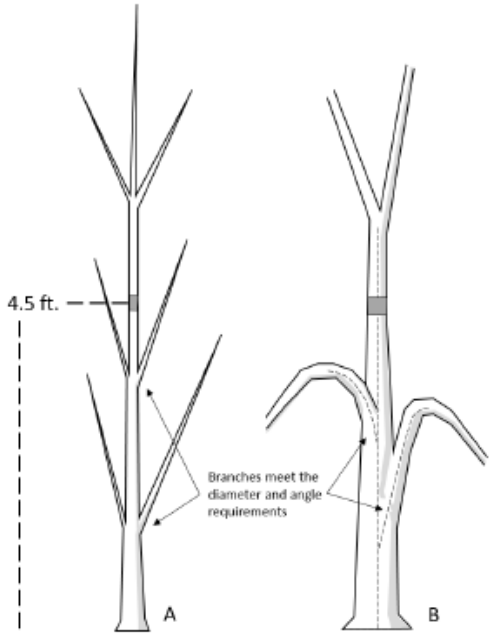


Figure 27. Forks that have branch-like form and function, leading to the tally of a single tree instead of multiple trees. In example A, although the potential fork is currently 1/3 the diameter of the main bole and is within 45 degrees of the main bole at the point of attachment, it appears to be serving as a branch as opposed to an additional independent tree. In addition, as the main bole continues to grow, the "branch" may reach the point where it is no longer 1/3 the main bole, dropping out of the inventory based on definition. Such potential forks would be ignored and the main bole would be tallied as a single tree with diameter measured at 4.5 feet. The tree is evaluated at each future visit and tallied following standard remeasurement procedures. In example B, although the potential fork is 1/3 the diameter of the main bole and is within 45 degrees of the main bole at point of attachment, it deviates drastically beyond 45 degrees about 1 inch from the main bole, taking on the form and function of a branch. This should be tallied as a single tree with diameter measured at 4.5 feet.

- Trees forked below 1.0 foot. Trees forked below 1.0 foot are treated as distinctly separate trees (fig. 28). Distances and azimuths are measured individually to the center of each stem where it splits from the stump (fig. 34 A-C). DBH is measured for each stem at 4.5 feet above the ground. When stems originate from pith intersections below 1 foot, it is possible for some stems to be within the limiting distance of the microplot or subplot, and others to be beyond the limiting distance. If stems originating from forks that occur below 1.0 foot fork

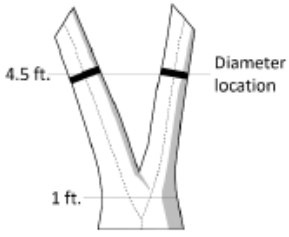


Figure 28. Forked below 1.0 foot.

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again between 1.0 and 4.5 feet (fig. 34-E), the rules in the next paragraph apply.

- Trees forked between 1.0 foot and 4.5 feet. Trees forked between 1.0 foot and 4.5 feet are also counted as separate trees (fig. 29), but only one distance and azimuth (to the central stump) is recorded for each stem (fig. 34 D-F). Although a single azimuth and distance applies to all, multiple stems should be recorded as they occur in clockwise order (from front to back when one stem is directly in front of another). The DBH of each fork is measured at a point 3.5 feet above the pith intersection. When forks originate from pith intersections between 1.0 and 4.5 feet, the limiting distance is the same for all forks--they are either all on, or all off the plot.

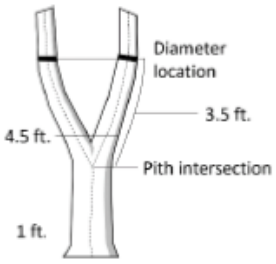

Figure 29. Forked between 1.0 foot and 4.5 feet.

Measure Low Approach

Crews may encounter trees of any species displaying growth forms with multiple forks that make applying traditional forking rules very difficult. In some instances these growth forms are species specific and in others they are the result of either the immediate growing conditions or the fact that the trees have been bred, pruned, or managed in a way that promotes multiple stems resulting in a specific crown shape.

In cases where such multiple forks all originate from approximately the same point on the main stem, follow the **Measure Low Approach**, where the diameter is taken at the highest, most repeatable location between the 1-foot stump and initial pith separation. This approach is applicable in instances where any of the following are present between the 1-foot stump and DBH (4.5 feet):

(1) Multiple forks (fig. 30).

(2) Prolific branching originating from approximately the same location that prevents accurate and repeatable diameter (fig. 31). This is a rare situation that should not be confused with normal branching patterns that allow for accurate diameter placement.

(3) Any combination of multiple forks and prolific branching originating at approximately the same location.

(4) The stems of a forked tree are grown together in such a fashion that an accurate DBH cannot be measured or estimated due to deformation resulting from the presence of the above mentioned criteria (fig. 32).

Figures 30, 31, and 32 illustrate a combination of forks and or branches all originating at the approximate same location will trigger a measure low approach.

Figure 30. Multiple forks originating from the same area. In cases such as this the diameter is taken low and all stems are treated as one tree.

Figure 31. Multiple forks and branches originating from the same area. Similar to having multiple forks, when there are multiple forks and branches, the diameter is taken low and all stems are treated as one tree.

A tree can only fork once. Following are specific procedures to secondary forking:

Once a stem is tallied as a fork that originated from a pith intersection between 1.0 and 4.5 feet, do not recognize any additional forks (or potential forks) that may occur on that stem. When such secondary forks are encountered, measure/estimate the diameter of such stems at the most repeatable location below stem separation but above the first pith separation (fig. 34 F-I) while attempting to avoid measuring double piths (fig. 40) where possible (i.e., do not move the point of diameter the entire 3.5 feet above the first fork).

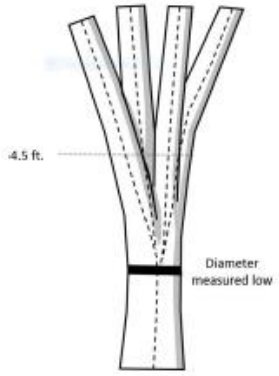

Figure 32. Using pith separation to determine diameter locations. In this example it is clear that all piths appear to separate from approximately the same location; this triggers the "**Measure Low Approach**". In cases where the piths do NOT originate within approximately the same location, normal forking rules are applied as demonstrated in figures 34 A-D and F-I.

- Trees forked at or above 4.5 feet. Trees forked at or above 4.5 feet count as one single tree (fig. 33). If a fork occurs at or immediately above 4.5 feet, measure diameter below the fork just beneath any swelling that would inflate DBH.

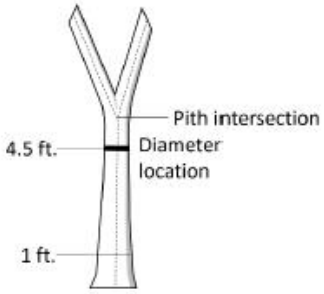

Figure 33. One Tree.

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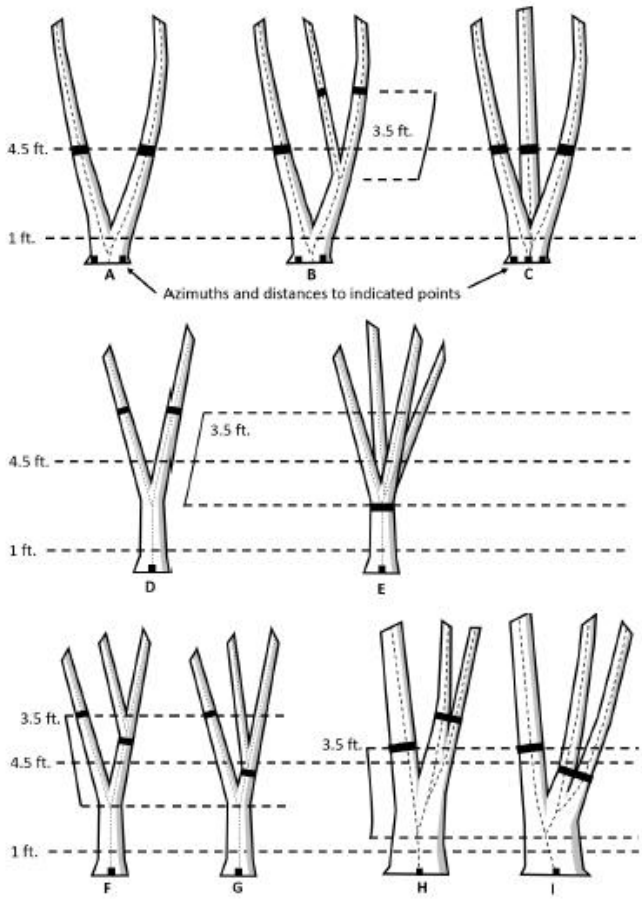

Figure 34 Summary of where to measure diameter, distance and azimuth on trees that fork below 1.0 foot (A, B, C) and trees that fork above 1.0 foot (D, E, F, G, H, I). Figure E represents the "Measure Low Approach". Figures F and G represent secondary forks with abnormal diameters at stem separation. Figures H and I represent secondary forks with normal diameters at stem separation.

2. Stump sprouts: Stump sprouts originate between ground level and 4.5 feet on the boles of trees that have died or been cut. Stump sprouts are handled the same as forked trees, with the exception that stump sprouts are not required to be 1/3 the diameter of the dead bole. Stump sprouts originating below 1.0 foot are measured at 4.5 feet from ground line. Stump sprouts originating between 1.0 foot and 4.5 feet are measured at 3.5 feet above their point of occurrence. As with forks, rules for measuring distance and azimuth depend on whether the sprouts originate above or below 1.0 foot. For multi-stemmed woodland species, treat all new sprouts as part of the same new tree.

3. Tree with butt-swell or bottleneck: Measure these trees 1.5 feet above the end of the swell or bottleneck if the swell or bottleneck extends 3.0 feet or more above the ground (fig. 35).

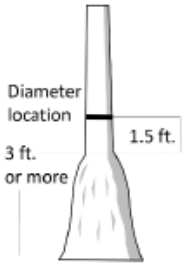

Figure 35. Bottleneck tree.

4. Tree with irregularities at DBH: On trees with swellings (fig. 36), bumps, depressions, and branches (fig. 37) at DBH, diameter will be measured immediately above the irregularity at the place it ceases to affect normal stem form.

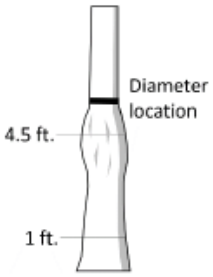

Figure 36. Tree with swelling.

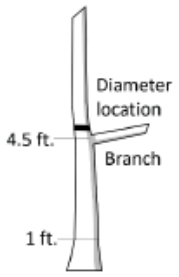

Figure 37. Tree with branch.

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5. Tree on slope: Measure diameter at 4.5 feet from the ground along the bole on the uphill side of the tree (fig. 38).

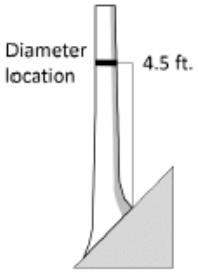

Figure 38. Tree on a slope.

6. Leaning tree: Measure diameter at 4.5 feet from the ground along the bole. The 4.5-foot distance is measured along the underside face of the bole (fig. 39).

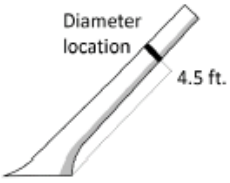

Figure 39. Leaning tree.

7. Turpentine tree: On trees with turpentine face extending above 4.5 feet, estimate the diameter at 10.0 feet above the ground and multiply by 1.1 to estimate DBH outside bark.

8. Independent trees that grow together: If two or more independent stems have grown together at or above the point of DBH, continue to treat them as separate trees. Estimate the diameter of each, set the "DIAMETER CHECK" code to 1, and explain the situation in the notes (fig. 40).

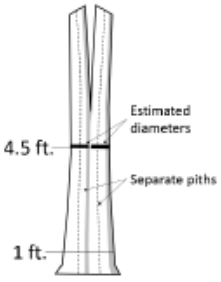

Figure 40. Independent trees grown together.

9. Missing wood or bark: Do not reconstruct the DBH of a tree that is missing wood or bark at the point of measurement. Record the diameter, to the nearest 0.1 inch, of the wood and bark that is still attached to the tree (fig. 41). If a tree has a localized abnormality (gouge, depression, etc.) at the point of DBH, apply the procedure described for trees with irregularities at DBH (fig.36).

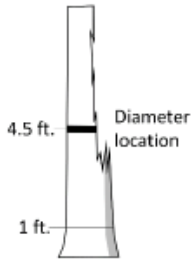

Figure 41. Tree with part of stem missing.

10. Live windthrown tree: Measure from the top of the root collar along the length to 4.5 feet (fig. 42).

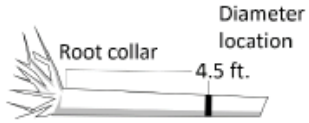

Figure 42. Tree on the ground.

11. Down live tree with tree-form branches growing vertical from main bole: When a down live tree, touching the ground, has vertical (less than 45 degrees from vertical) tree-like branches coming off the main bole, first determine whether or not the pith of the main bole (averaged along the first log of the tree) is above or below the duff layer.

    - If the pith of the main bole is above the duff layer, use the same forking rules specified for a forked tree, and take all measurements accordingly (fig. 43).

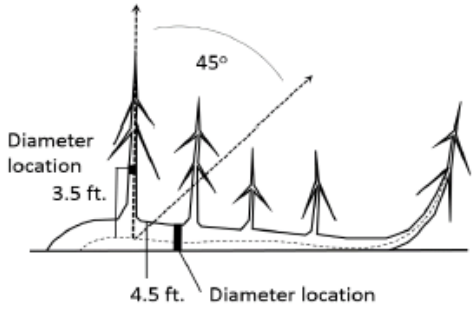

Figure 43. Down tree with pith above the duff.

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- If the pith intersection of the main down bole and vertical tree-like branch occurs below 4.5 feet from the stump along the main bole, treat that branch as a separate tree, and measure DBH 3.5 feet above the pith intersection for both the main bole and the tree-like branch.

- If the intersection between the main down bole and the tree-like branch occurs beyond the 4.5 feet point from the stump along the main bole, treat that branch as part of the main down bole.

- If the pith of main tree bole is below the duff layer, ignore the main bole, and treat each tree-like branch as a separate tree; take DBH and length measurements from the ground, not necessarily from the top of the down bole (fig. 44). However, if the top of the main tree bole curves out of the ground towards a vertical angle, treat that portion of that top as an individual tree originating where the pith leaves the duff layer.

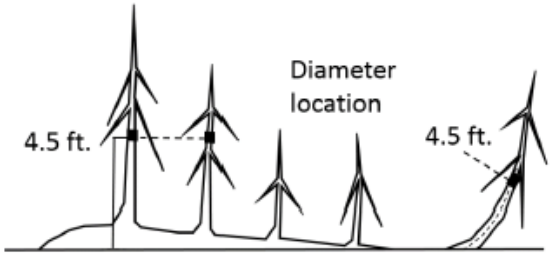

Figure 44. Down tree with pith below the duff.

12. Tree with curved bole (pistol butt tree): Measure along the bole on the uphill side (upper surface) of the tree (fig. 45).

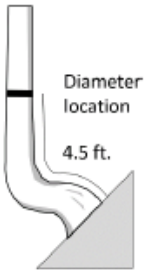

Figure 45. Tree with curved bole (pistol butt tree).

5.9.3 PREVIOUS DIAMETER AT ROOT COLLAR

This is the DRC assigned at the previous survey. It has been downloaded from the previous inventory. Any change made to this field signifies a misclassification at the time of the previous

Total Height

Record the TOTAL LENGTH of the tree, to the nearest 1.0 foot from ground level to the top of the tree. For trees growing on a slope, measure on the uphill side of the tree. If the tree has a missing top (top is broken and completely detached from the tree), … [r]ecord the ACTUAL LENGTH of the tree to the nearest 1.0 foot from ground level to the break. Use the length to the break for ACTUAL LENGTH until a new leader qualifies as the new top for TOTAL LENGTH; until that occurs, continue to record ACTUAL LENGTH to the break. Trees with previously broken tops are considered recovered (i.e., ACTUAL LENGTH = TOTAL LENGTH) when a new leader (dead or alive) is 1/3 the diameter of the broken top at the point where the top was broken (not where the new leader originates from the trunk). Forked trees should be treated the same as unforked trees.

Height to Live Crown Base

The live crown base is an imaginary horizontal line drawn across the trunk from the bottom of the lowest live foliage of the "obvious live crown" for trees and from the lowest live foliage of the lowest twig for saplings. The "obvious live crown" is described as the point on the tree where most live branches/twigs above that point are continuous and typical for a tree species (and/or tree size) on a particular site. Include most crown branches/twigs but exclude epicormic twigs/sprigs and straggler branches that usually do not contribute much to the tree's growth. The base of the live branch/twig bearing the lowest foliage may be above or below this line.

For trees 5.0 inches DBH/DRC or greater, if any live branch is within 5 feet below this "obvious live crown" line, a new horizontal line is established. Create the new line at the base of live foliage on that branch. Continue this evaluation process until no live branches are found within 5 feet of the foliage of the lowest qualifying branch.

Occasionally, all original major crown branches/twigs are dead or broken and many new twigs/sprigs develop. These situations are likely to occur in areas of heavy thinning, commercial clearcuts and severe weather damage:

- Trees that had an "obvious live crown" with live branches now have no crown to measure until the new live twigs become live branches. When these new live branches appear, draw the new live crown base to the live foliage of the lowest live branch that now meets the 5-foot rule.
- Saplings and small trees that had only live twigs should establish the crown base at the base of the live foliage on the new lowest live twig. If no live twigs are present, there is no crown to measure.

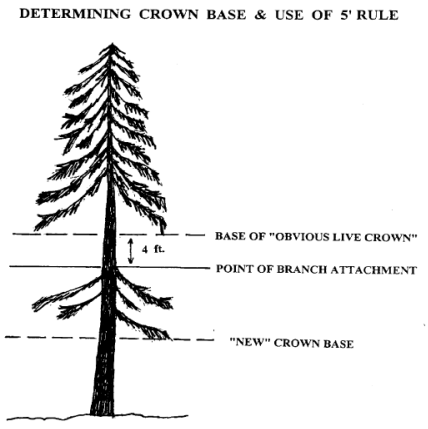

Figure 23-1. Determining the base of the live crown.