

NMFWRI FFI/CSE-Based Sample Protocols

In use in current form since 2016

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Crews, Navigation & Plot Setup

Plots are most efficiently accomplished with a **3-person crew** but can also be taken with 2 people. More detailed plots, presented here as options, are most efficient with a 4- to 5-person crew. All crews need basic knowledge of monitoring methods and rationale, equipment, plant species and common tree pests and diseases.

Plots are established using a random point location with project-specific boundaries e.g. stand boundaries, treatment areas, vegetation types, etc. In our office, maps and plot locations are generated with ArcGIS utilities and are loaded onto a Trimble and Garmin GPS units. Unit maps, driving maps and driving directions are created and sent with the field crew. Once in the project area, navigation to a plot is typically accomplished through paper maps and the Garmin GPS units. Paper maps can be easily marked with Sharpies to indicate sequence of plot collection, dates, and teams at work; this information can be stored with the datasheets and may help answer questions that arise later. We use Garmin GPS units because they are user-friendly and can run on AA batteries which are easily replaced in the field. We use the Trimble unit to more accurately determine plot location and collect updated plot location coordinates which can later be post-processed for greater location accuracy with GPS Pathfinder Software. Plots must be moved one chain (66 ft) at a random azimuth from their original, intended location if they are within 75 feet of a road.

A marker (we typically use a 1-foot piece of ½ inch rebar with a mushroom cap) is installed at plot center. Where plots are being re-visited, a good metal detector may be of use to locate the center stake. Copies of the previous plot photos can also be useful.

Plots are set up using 8 pin flags in addition to the center stake. Crew members walk cardinal azimuths (N, E, S, W) from plot center and place pin flags at 11.78ft (11' 9") and 37.24ft (37' 3") to give visual aids for the two plots (1/10th ac and 1/100th ac) whose purposes are described below.

Photographs, Witness Trees & Other Plot data

Seven **photographs** are taken per plot. If more than one Brown's transect is collected, additional photographs are taken in the same format. Typically, a white board with marker is used to tag each photo. The first photo taken at each plot is of the white board on the ground at plot center ("PC"). This ensures the data technicians are able to read the plot name and number and correctly identify the photos that follow. It is helpful if the camera used can record GPS coordinates.

Additional photos include:

- "C," taken from 75 feet along the North azimuth looking at a crew member holding the white board at plot center
- Brown's transect photo, "B_degrees" taken from the 75-foot mark of each fuels azimuth looking towards a crew member holding the white board at plot center

- “N,” “E,” “S,” and “W” photos taken from plot center facing a crew member holding the white board 37.2’ at each of the four cardinal azimuth flags. Additional photographs may be taken, but we recommend these be taken after the mandatory seven plot photos, and noted on the data sheets, so that there is no confusion for the data technicians.

A **witness tree** or trees should be near plot center to assist with finding plot center and ideally should be expected to survive any future thinning, fire, or other disturbance. For example, mature yellow-bark pines near plot center are easy to find and not likely to be thinned. Any healthy tree will work. The tree should be flagged, noted in the overstory data, and described on the Plot Description datasheet.

Photo order, hill slope, dominant aspect, coordinates, elevation, date, and time are recorded for each plot. **Comment fields** are available on all datasheets and we encourage all observations, including species, land use impacts, fire history, challenges in taking plot, etc. to be documented here.

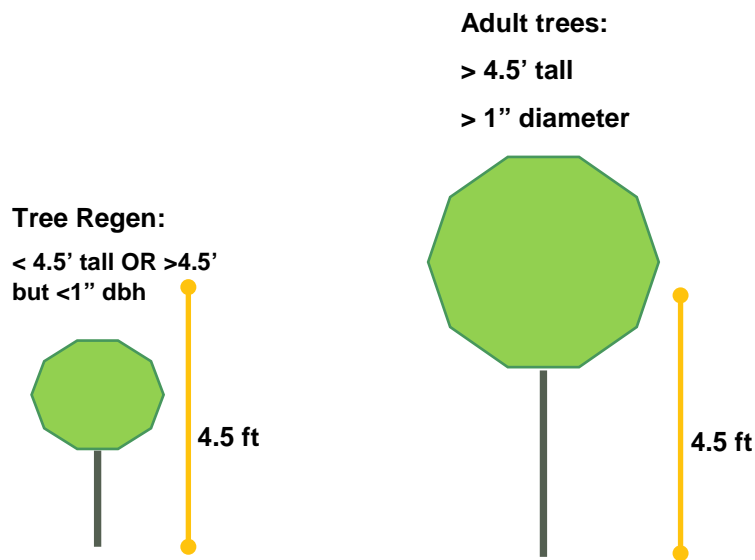
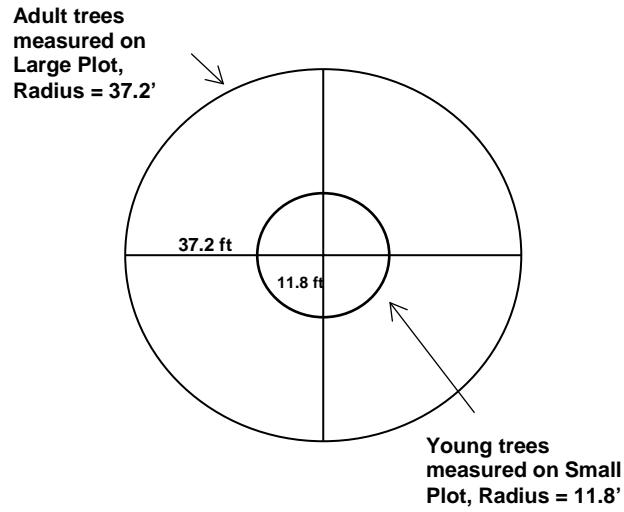
Overstory

All **trees and snags** are measured within the 1/10th acre plot (37.24 ft. radius) circular, fixed area sample plot. We typically define a tree as ≥ 4.5 ft. and > 1.0 in dbh or drc, although other cutoffs may be used depending on objectives. Species, condition, dbh or drc, number of stems, total height, and live crown base height are recorded for each tree located within the plot. Most trees are measured at dbh with exception of those multi-stem species with more than two stems at dbh (i.e. *Quercus* spp., *Juniperus* spp.). Be aware that other trees/large shrubs with multiple stems, such as mountain mahogany or chokecherry, cannot be processed if they are measured at drc since their conversion formulas are unavailable. Depending upon the project, other information may be collected including damage and severity, scorch height, snag decay class, crown ratio, and crown class. Trees are recorded starting from the north azimuth line and moving clockwise, like spokes of a wheel from plot center. In dense stands, we find it helpful to flag the first tree measured to keep the crew oriented. If appropriate, this first tree may also serve as the **witness tree**. Do not forget to flag and record your witness tree.

Tree regeneration is measured on the nested 1/100th acre circular plot (11.78 ft. radius) and species, condition, and height class ($>0-0.5$ ft; $>0.5-1.5$ ft; $>1.5-2.5$ ft; $>2.5-3.5$ ft.; $>3.5-4.5$ ft) are recorded for each **seedling** or sprout. **Saplings** (>4.5 ft but <1.0 in dbh/drc) are also recorded in this way. **Shrubs** are measured on the same nested subplot and species, condition and height/diameter class are recorded for each stem just as with tree species; we typically record cacti as well. Other cutoffs may be used for height and diameter classes depending upon objectives.

Trees and shrubs are typically recorded using their **USDA PLANTS code**, which is commonly a four letter code defined by the first two letters of the genus and first two letters of the species name (e.g. PIPO, ABCO, PIFL, PIED, JUDE, JUSC, QUGA, etc). Note that upon entry into a database, it is common for these codes to be followed by various numbers in order to differentiate between other species whose names would create the same code. These symbols can be found on the USDA PLANTS website, <https://plants.usda.gov/>

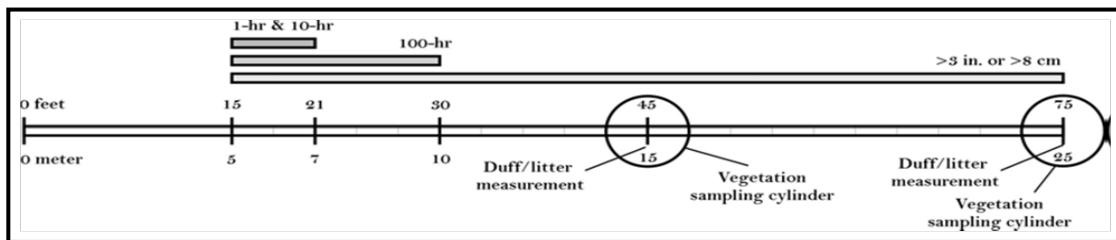
Canopy cover (density) is an average of four measurements from a spherical densiometer. These four measurements are taken facing out at the four small-plot pin flags along the perimeter of the nested subplot. In this way, each reading is spaced 90 degrees apart.



Fuels (Brown's)

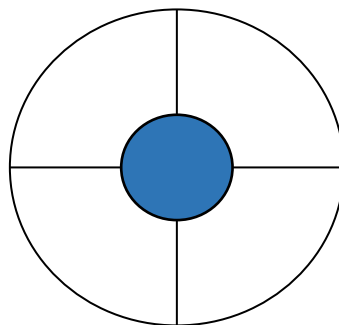
Dead woody biomass and forest floor depth are measured using a planar Brown's transect or transects. These transects may be at fixed or random azimuths. To select a random azimuth, one crew member spins a compass and another decides when to stop. Typically in our protocol, a fiberglass tape is run from the plot center stake out 75 feet and fuels are measured from 15 to 75 feet to account for the expected foot traffic disturbance around plot center. Parameters measured include **1, 10, 100, and 1,000 hour fuels** ("time-lag fuels"). Other lengths of transects, including variable lengths for each fuel size, may be used. For more information, see Brown 1974 and subsequent guidelines. Note that in our protocol, a piece of coarse woody debris (CWD) must be >3" in diameter and at least 3 feet long to count as a 1000-hour fuel; if it is >3" in diameter, but under 3 feet long, we count it as a 100-hour fuel. Decay class (1 to 5) and sometimes length is collected for each 1000-hour fuel.

Percent cover and height of **herbaceous live and dead material**, percentage cover and height (up to 6 ft.) of **woody live (excluding boles of trees) and dead material** are estimated using 6-foot diameter cylinders per Brown's planar intersect method at 45 and 75 ft (Brown 1974). **Litter and duff depths** are measured at 45 and 75 ft. The location, offset, and frequency of these measurements is flexible.



Understory

Vegetation and ground cover are estimated within the nested 1/100th acre plot; some project managers may request these measurements are conducted across the entire 1/10th acre area. Vegetation measurements include **aerial percent cover** of seedling/saplings, shrubs, graminoids, and forbs, and may not necessarily total 100%. Depending upon objectives, aerial percent cover may be further stratified by individual species greater than 1% cover. **Ground cover measurements** include percent cover of plant basal area (including cacti), boles, litter, bare soil, rock, and gravel, and must total 100%.



Data processing and reporting

At this time, we use **FFI software**, as well as Excel spreadsheets, to enter and analyze our data. FFI is able to export to FVS and FuelCalc. FFI software and User Guides are available for download here: <https://www.frames.gov/partner-sites/ffi/software-and-manuals/>

In order to process individual piñons, junipers and oaks with more than 2 stems or whose branch structure made access difficult and were therefore measured at root collar (DRC) instead of breast height (DBH), we use the **equations developed by Chojnacky and Roger (1999)**.

All our results are typically reported to two significant digits, with exceptions for those metrics we know were measured with either more or less precision.

Sample reports can be found on our website: <http://nfwri.org/resources/restoration-information/cfrp/cfrp-long-term-monitoring/cfrp-long-term-monitoring>

SAMPLE DATASHEETS – BASIC PLOT

Plot Description

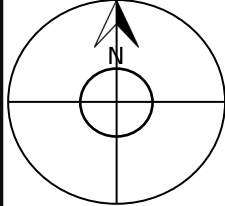
Observer: _____
 Recorder: _____
 Latitude (dd.dddddd): _____
 Longitude (ddd.dddddd): _____
 Elevation: _____

Administrative Unit: _____
 Project Unit: _____
 Macroplot: _____
 Date (MM/DD/YYYY): _____
 Time: _____

Photo _____
 Azimuths: (1) of whiteboard at PC. (1) from 75 feet N looking south to PC (4) from PC in all four cardinal directions; (1) from each Brown's transect looking toward PC.
 ORDER TAKEN: _____

Hill Slope (% where steepest): _____ %
 Aspect (circle one): **N E S W**
 Aspect azimuth (degrees): _____ °
 Mag Declination: _____ °

Comments: _____

Describe Witness Tree(s): _____

 Draw location of tree on plot
 Color of Flagging/Marker Used: _____

Aerial cover (%) (1/100th acre plot)			
Tree regen.	Shrubs	Graminoids	Forbs

Macroplot Sizes		
Size (Acres)	1/100	1/10
Radius (Feet, Decimal Feet)	11.78	37.24
Radius (Feet, Inches)	11' 9"	37' 3"

Tree Canopy (%) _____

Ground cover (%) (1/100th acre plot) (total 100 %)						
Plant basal	Bole	Litter	Bare soil	Rock (>2.5in)	Gravel (< 2.5 in)	Total (%)

Species	Condition (Live, Dead, Sick)	Small Plot—Tree Regen & Shrubs					Small Plot—Tree Regen & Shrubs		
		Height classes—Seedlings (<4.5', <1" dbh/drc)					Species	Condition (Live, Dead, Sick)	Saplings >4.5', < 1"
		> 0 - 0.5	> 0.5—1.5'	> 1.5' - 2.5'	>2.5 - 3.5	>3.5 - 4.5			



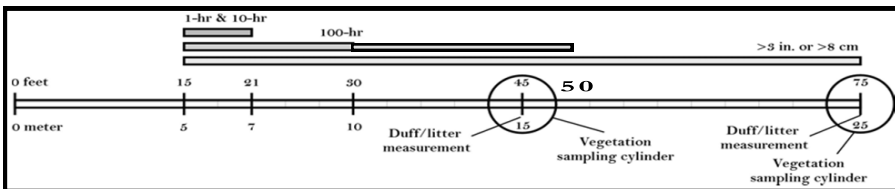
Surface Fuels

Sheet 1 of 2: Fine Woody Debris—Coarse Woody Debris

Observer	_____
Recorder	_____
Number of Transects	_____

Administrative Unit:	_____
Project Unit:	_____
Macroplot:	_____
Date (DD/MM/YYYY):	_____
Time:	_____

1-hour Transect Length - 6'	10-hour Transect Length - 6'	100-hour Transect Length - 35'	1000-hour Transect Length - 60'
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Class		Diameter (in)
FWD	1-hr 10-hr 100-hr	0 to 0.25 0.25 to 1.0 1.0 to 3.0
CWD	1000-hr and greater	3.0 and greater

Fine Woody Debris (1, 10, 100 hr fuels)	Transect	Azimuth	Slope	1 - Hr Count	10 - Hr Count	100 - Hr Count	Comment
	1	* Random for CFRP or (0°)					
	2	135°					
	3	270°					

Coarse Woody Debris (1000 hr fuels)	Transect	Slope	Log No.	Log Diameter	Decay Class	Comment	

Precisions: Diameter: ±0.5 in ; decay class ±1 class ; Slope ±5 percent

Decay Class Description

- All bark is intact. All but the smallest twigs are present. Old needles probably still present. Hard when kicked
- Some bark is missing, as are many of the smaller branches. No old needles still on branches. Hard when kicked
- Most of the bark is missing and most of the branches less than 1 in. in diameter also missing. Still hard when kicked
- Looks like a class 3 log but the sapwood is rotten. Sounds hollow when kicked and you can probably remove wood from the outside with your boot. Pronounced sagging if suspended for even moderate distances
- Entire log is in contact with the ground. Easy to kick apart but most of the piece is above the general level of the adjacent ground. If the central axis of the piece lies in or below the duff layer then it should not be included in the CWD sampling as these pieces act more like duff than wood when burned.



Surface Fuels

Sheet 2 of 2: Duff, Litter, and Vegetation

Observer	_____
Recorder	_____
Number of Transects	_____
Transect Length: 75'	

Administrative Unit:	_____
Project Unit:	_____
Macroplot:	_____
Date (DD/MM/YYYY):	_____
Time:	_____

Transect	Sample Location	Litter Depth	Duff Depth	Veg Item	% Veg Cover	Veg Hgt (d.d')	Surface Fuels-Vegetation Item Code and Description
1	45'			HD			HD dead non-woody vegetation
				HL			HL Live non-woody vegetation
				SD			SD Dead woody vegetation
				SL			SL Live woody vegetation
1	75'			HD			
				HL			
				SD			
				SL			
2	45'			HD			
				HL			
				SD			
				SL			
2	75'			HD			
				HL			
				SD			
				SL			
3	45'			HD			
				HL			
				SD			
				SL			
3	75'			HD			
				HL			
				SD			
				SL			

% Veg cover	
Code	Cover
0	No cover
0.5	>0-1 % cover
3	>1-5 % cover
10	>5-15 % cover
20	>15-25 % cover
30	>25-35 % cover
40	>35-45 % cover
50	>45-55 % cover
60	>55-65 % cover
70	>65-75 % cover
80	>75-85 % cover
90	>85-95 % cover

Comments:



SAMPLE DATASHEETS – DETAILED CSE PLOT

CSE Surface Fuels

Observer	_____
Recorder	_____

Macroplot:	_____
Date (DD/MM/YYYY):	_____
Time:	_____

CSE Brown's Transects are 50 feet long, starting at PC.

Class	Count From	Total Length
1-hr, 10-hr	44' to 50'	6
100-hr	38' to 50'	12
1000-hr	0' to 50'	50

Class		Diameter (in)
FWD	1-hr	0 to 0.25
	10-hr	0.25 to 1.0
	100-hr	1.0 to 3.0
CWD	1000-hr and greater	3.0 and greater

Decay Class Description

- All bark is intact. All but the smallest twigs are present. Old needles probably still present. Hard when kicked
- Some bark is missing, as are many of the smaller branches. No old needles still on branches. Hard when kicked
- Most of the bark is missing and most of the branches less than 1 in. in diameter also missing. Still hard when kicked
- Looks like a class 3 log but the sapwood is rotten. Sounds hollow when kicked and you can probably remove wood from the outside with your boot. Pronounced sagging if suspended for even moderate distances
- Entire log is in contact with the ground. Easy to kick apart but most of the piece is above the general level of the adjacent ground. If the central axis of the piece lies in or below the duff layer then it should not be included in the CWD sampling as these pieces act more like duff than wood when burned.

Fine Woody Debris (1, 10, 100 hr fuels)	Transect	Azimuth	Slope	1 - Hr Count	10 - Hr Count	100 - Hr Count	Comment
	1	0°					
	2	180°					

Coarse Woody Debris (1000 hr fuels)	Transect	Log No.	Log Diameter	Decay Class	Length (feet)	Comment	

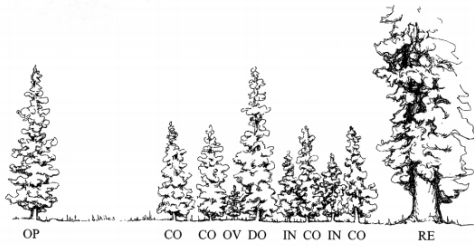
Litter & Duff	Transect 1	15'	30'	38'	44'	45'
	Litter Depth (in)			N/a	N/a	
	Duff Depth (in)	N/a	N/a			N/a
	Transect 2	15'	30'	38'	44'	45'
	Litter Depth (in)			N/a	N/a	
	Duff Depth (in)	N/a	N/a			N/a



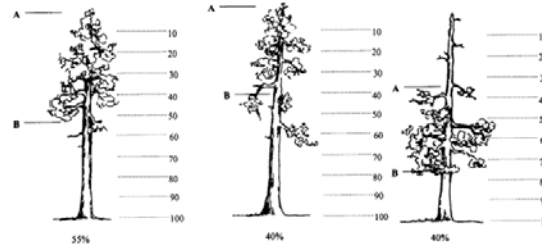
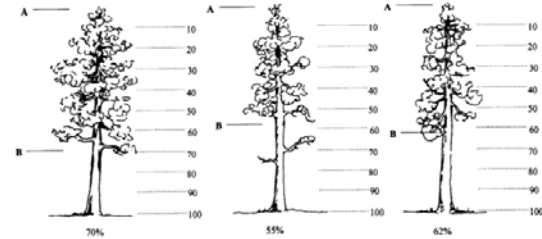
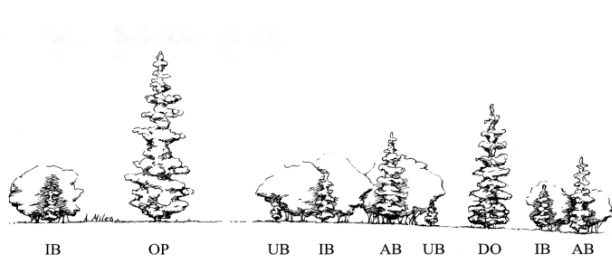
CSE Tree Sheet Column	Description	Examples	Warnings
Tree #	Order of trees in plot, starting clockwise from N line, moving around plot like spokes of a wheel	1, 2, 3	Stay in order!
Condition	Condition of tree	L, D, S	If sick, identify why; If dead, record decay class of snag
Species	Species of tree, recorded using USDA PLANTS code	PIED, PIPO, JUSC, POTR	
DBH (in)	Diameter at breast height (4.5 feet); used for single-stem species	10.1, 4.2	CSE Plots only record trees over 4.5 ft, with DBH \geq 5 inches, if tree would be measured at DBH
DRC (in)	Diameter at root crown (close to ground); use only on PIED, JUXX, or QUXX with <2 stems	7.4, 5.5	CSE Plots only record trees over 4.5 ft, with DRC \geq 5 inches, if tree would be measured at DRC
Number of stems	Order of the stems measured	1, 2, 3, 4	
Total Tree Ht (ft)	Height of tree from ground to top of tree (whether top is live or dead); use rangefinder or clinometer	70, 15, 5	
LiCrBht, Live Crown Base Ht (ft)	Height from ground to base of live crown (not necessarily on bole of tree)	6, 21, 50	Live trees only
Crown Ratio	Length of live crown divided by the total tree height	50%, 65%	Live trees only
Crown Class	Two-letter code that describes the relative position of the tree crown with respect to the competing vegetation	CO, DO, OP	See Reference Sheet for Classes
Damage/Disease	Recorded using categories in reference sheet in the following format: Category/Agent/Tree Part/Severity	10/000/BO/1	See Reference Sheet for Categories
Decay Class	A number between 1 and 5, similar to the decay classes used for CWD	Class 2, Class 3	Snags only; See Reference Sheet for Decay Classes
Comment	Otherwise observation about the tree, including whether or not it is a witness tree	<i>Nest in tree</i>	Note if this is your witness tree



Crown Class Illustration



Brush Cover Crown Class Illustration



Crown Ratio →

Code	Name	Description
OP	Open-grown or Isolated	Tree crowns receive full light from above and from all sides. In even-aged stands, these trees have their crowns well above the general canopy.
DO	Dominant	Tree crowns receive full light from above and partly from the sides. Crowns extend above the general level of the crown cover of others of the same stratum and are not physically restricted from above, although possibly somewhat crowded by other trees on the sides. In even-aged stands, dominant trees rise somewhat above the general canopy.
CO	Codominant	Tree crowns receive full light from above, but comparatively little from the sides. Crowns form a general level of crown stratum, are not physically restricted from above and are crowded by other trees from the sides. In even-aged stands, codominants form the general canopy level.
IN	Intermediate	Tree crowns occupy a definitely subordinate position and are subject to strong lateral competition from crowns of dominants and codominants. They receive little direct light from above through small holes in the canopy, but no light from the sides.
OV	Overtopped	Tree crowns receive no direct light from above or from the sides and are entirely below the general level of dominant and codominant trees.
RE	Remnant	Trees that remain from a previous management activity or catastrophic event. The tree is significantly older than the surrounding vegetation. Remnant trees do not form a canopy layer and are usually isolated individuals or small clumps. This definition is from the Region 6 Inventory and Monitoring System field procedures for the Current Vegetation Survey.
AB	Leader Above Brush	The terminal leader of the tree is above the surrounding brush while the middle or lower crown may be within the brush canopy.
IB	Leader Within Brush	The terminal leader and upper crown of the tree is within the brush canopy.

Code	Name	Description
UB	Leader Overtopped by Brush	The crown of the tree is completely overtopped by the surrounding brush. Brush cover crown classes only apply to isolated or dominant trees with brush competition; therefore, brush cover crown class codes are used as modifiers for open-grown or dominant trees. Competition from adjacent trees is more important than competition from shrubs if they both occur. Generally, brush cover crown codes are used in stands where overstory tree competition is absent.

Snag Decay

Code	Bark	Heartwood Decay	Sapwood Decay	Limbs	Top Breakage	Bole Form	Time Since Death
1*	Tight, intact	Minor	None to incipient	Mostly Present	May be present	Intact	≤5 years
2	50% loose or missing	None to advanced	None to incipient	Small limbs missing	May be present	Intact	>5 years
3	75% missing	Incipient to advanced	None to 25%	Few remain	Approx. 1/3	Mostly intact	>5 years
4	75% missing	Incipient to advanced	25%+	Few remain	Approx. 1/3 to 1/2	Losing form, soft	>5 years
5	75%+ missing	Advanced to crumbly	50%+ advanced	Absent	Approx. 1/2+	Form mostly lost	>5 years

*Implies recent mortality, within the last 5 years.

Snag Decay Classes

