

Valles Caldera National Preserve



Forest Monitoring Objectives and Methods

2013

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The methods used to conduct forest monitoring include a modified National Park Service Fire Effects Monitoring method based on Forest Treatment Plot design by Laura Trader (Bandelier National Monument Fire Ecologist). The original FM plots were double in size and had 4 quarters. These plots are 20x25 m and are divided into 2 quarters, Q1 & Q2.

FIELD DATA COLLECTION OBJECTIVES

	OBJECTIVES	METHOD
1	HERBACEOUS VEGETATION AND GROUND COVER Document changes in species composition, community structure, species diversity, and percent cover through time and provide predictions of successional trajectories Basal cover Shrub species, density, mortality, recruitment Bare soil estimates Land cover information for comparison to aerial photos and mapping	Line-Point Intercept transects shrub density belts
2	STAND CHARACTERISTICS AND HEALTH General stand characteristics such as forest type, demography, disturbance Estimated tree densities: overall and by species Track tree mortality, colonization, seedling regeneration Live Tree Health: disease classes, damage type/severity	Standing & Downed/dead inventory Relative percent tree species cover
3	PLOT BURN SEVERITY Overall burn severity of plot and variability within plot	Modified Burn Severity Index
4	BASAL SUBSTRATE MEASUREMENTS Litter and duff depths Fuel load Slope and aspect Habitat potential	Modified Browns lines
5	JMS Habitat Habitat log inventory	JMS Habitat transects (Brown's Lines) Large diameter log inventory (Q1)

FOREST PLOT MONITORING DESIGN

These plots are 20x25 m and are divided into 2 quarters, **Q1** & **Q2**. The basic protocols (number of quarters sampled for trees, number of vegetation transects, etc.) are outlined below.

OVERSTORY trees (DBH ≥ 15.1 cm) are measured in **Q1 & Q2**

POLE trees (DBH 2.5 – 15.0 cm) are measured in **Q1**

SEEDLING trees (DBH < 2.5 cm) are counted by category in **Q1**

SHRUBS: 2 X 2 m belt transect **P1** to **Q1** & **P2** to **Q2**

SALAMANDER LOGS (DBH > 30.5 cm) are measured in **Q1**

HERBACEOUS VEGETATION: *Set-up varies by project.* Line-point intercept transects. "0" starts 5 m from Origin and is read every 0.5 m.

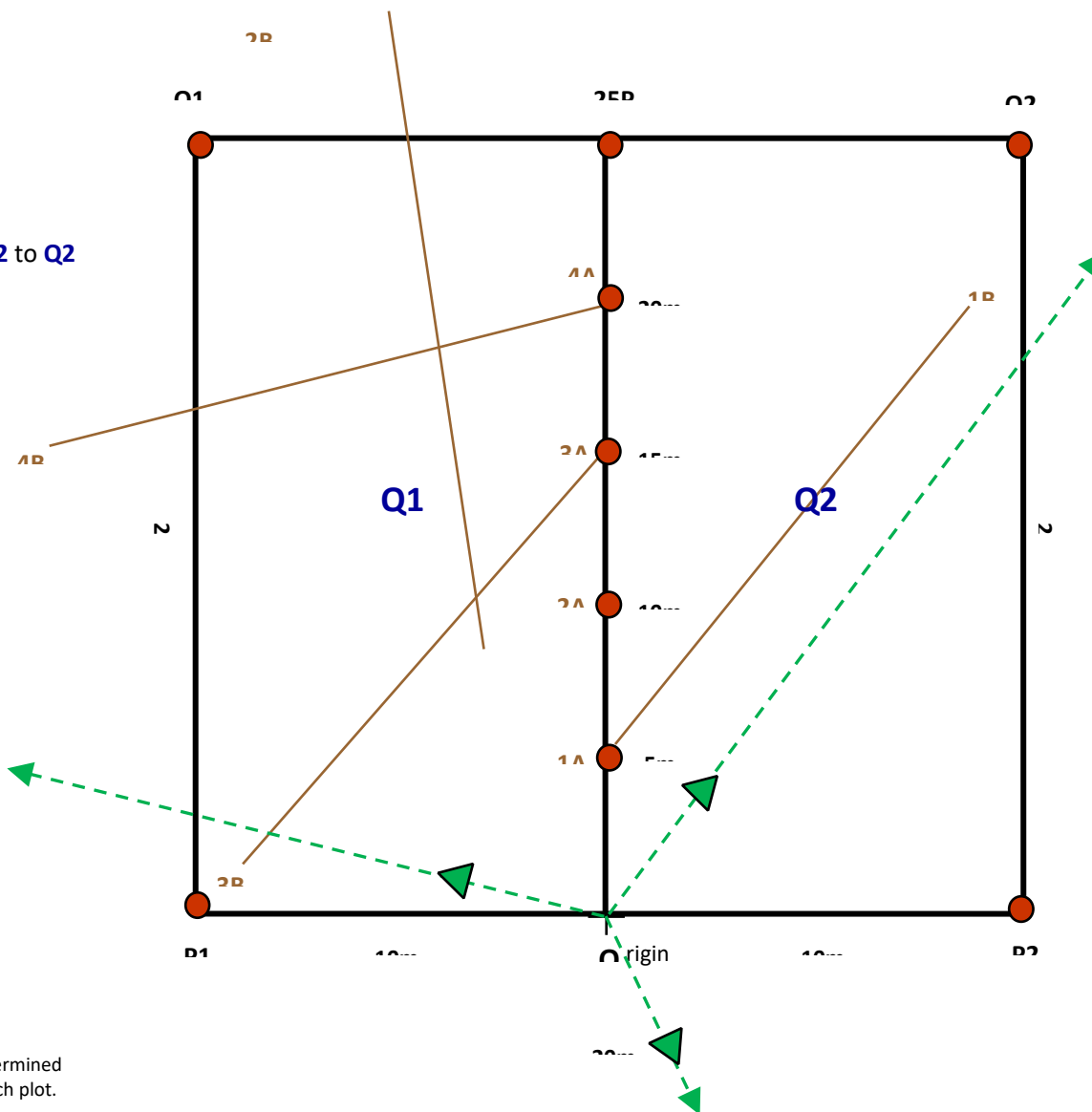
TREE CANOPY DENSITY measured at 5, 10, 15, & 20 m **O** to **25P**.

SURFACE FUELS & SALAMANDER HABITAT ASSESSMENT: **four 50 ft. transects** (Brown's Line Transects)
1A to 1B, 2A to 2B,
3A to 3B, 4A to 4B

POSTBURN SEVERITY is measured along **four 50 ft. transects** (aka Brown's Line Transects),
1A to 1B, 2A to 2B,
3A to 3B, 4A to 4B



The Brown's Line Transect azimuths are randomly determined when the plot is installed. They will be different for each plot.



METHODS

OVERSTORY TREES

An overstory tree is defined as living and dead trees with a diameter at breast height (DBH) of 15.1 cm or greater. Diameter at breast height is measured at breast height (BH) 1.37m (4.5 ft) from ground level. Trees are not tagged. Information collected for overstory trees includes species identification, DBH, diameter at root crown (DRC), live/dead status, crown position and height, damage codes, wildlife codes, and log/snag decay class codes.

Tree Status:

CODE	DESCRIPTION
L	Live – includes all standing trees that have at least one green point of growth. This includes deciduous trees that have lost their foliage for the season, and trees that have recently lost their leaves to defoliators, but will re-flush.
D	Dead – standing trees 4.5 feet or taller, without a green point of growth. Note: many of the tree fields are not used if the tree is a dead tree. If dead trees are recorded, a snag decay class is required for extensive and intensive exam levels.

Measuring DBH:

For a tree on a slope, determine the DBH while standing at the midslope side of the tree. Measure the DBH of a leaning tree by leaning with the tree and measuring perpendicular to the bole (trunk or main stem of tree). Measure DBH (in centimeters) to the nearest mm. Include trees on the plot boundary line if >50% of their bases are within the plot. Wrap a diameter tape (not a standard tape) around the tree in the plane of the BH making sure the tape does not sag, and read the diameter. Take care to read at the measurement line, not at the end of the tape.

Measuring DBH without a Diameter Tape: If you do not have a diameter tape, you can use a standard tape to measure circumference, and then calculate diameter as follows:

$$DBH = \frac{\text{circumference}}{\pi}$$

For non-sprouting tree species forked below BH, individually measure each overstory-size bole (Figure 26). For sprouting tree species, measure only the largest bole (in diameter) of the cluster in order to determine size class. For clonal tree species, e.g., aspen, treat each bole as an individual tree. Tally seedling-size sprouts as re-sprout class seedlings until they grow into the pole tree size class. **Note:** If the main bole of a sprouting species has died, but the tree is sprouting from the base, consider the main bole dead.

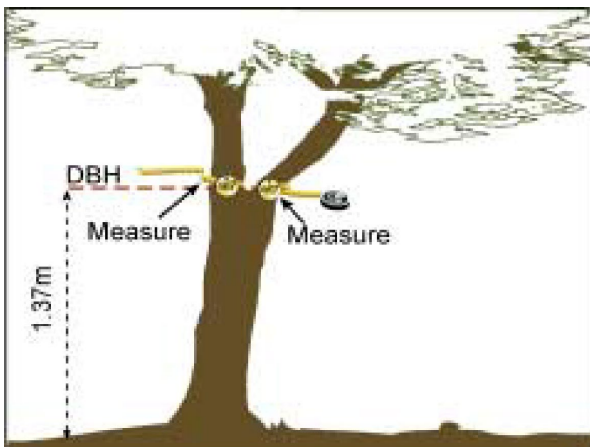


Figure 26. DBH measurement for non- sprouting trees forked below BH.

If the bole of a fallen tree is below BH, and the individual is re-sprouting, treat the sprouting branches as individuals and place them in the appropriate size class (seedling, pole, or overstory). Include clarifying comments on the data sheet, especially for re-sprouting trees.

Sampling Problems with DBH:

***Note:** The following tips are additions to the FMH handbook and must be incorporated with caution.*

Swelling at BH (Figure 27): If a swell or other irregularity occurs at the standard 1.37 m height for DBH, measure above or below the swell. Make every attempt to keep the measurement between 1 and 2 m above the ground, trying above the obstruction first. If you do not measure DBH at BH, note this on the *Overstory Tree Data Form* in the *Tree Remarks* Section.

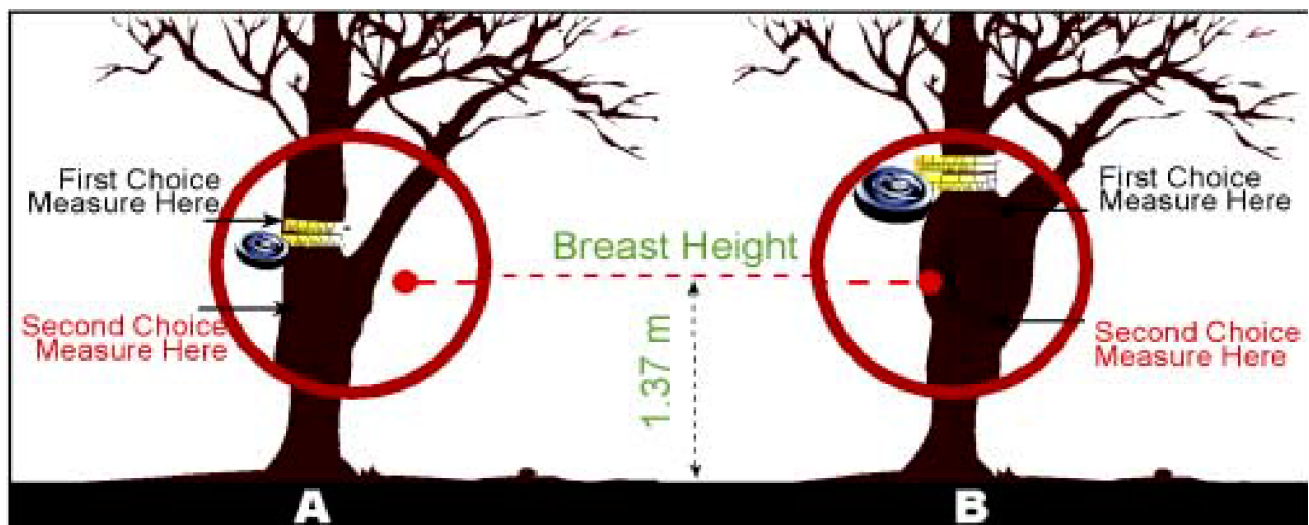


Figure 27. Handling irregularities at BH.

A) A tree with a branch at BH

B) A tree with a swell at BH.

Void at BH (Figure 28): If you find a void caused by a fire scar or other abnormality, and a large part of the bole is missing at BH, and it would be impractical to simply measure above or below it, it may be necessary to estimate what the DBH would be, were the bole intact. If this is done, be sure to note this on the *Overstory Tree Data Form* in the *Tree Remarks* Section.

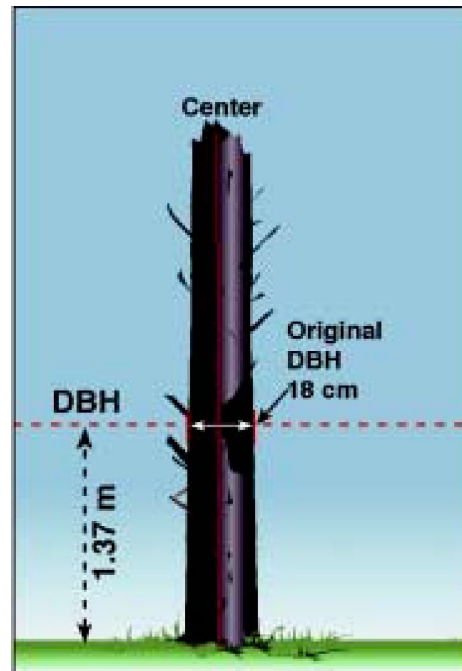


Figure 28. Reconstruct DBH when it would provide a better estimate of the regular bole of the tree.

Measuring DRC (Diameter at Root Crown):

Measurement of a tree's diameter at root crown is an alternative to DBH measurements for tree species that are typically highly forked. **Note:** Do not use this method for unusual individual trees that have many boles. With this method, trees with stems that fork underground, or with several stems clumped together that appear to be from the same root origin, are treated as a single tree. The single diameter of the root crown should be measured directly if branching occurs above ground and the single diameter accurately reflects the cumulative volume of the stems it supports. Alternatively, if the stems fork below ground level, or the base is deformed and its diameter would grossly overestimate the volume of the individual stems, the DRC should be calculated from the individual stem diameters (see page 214, Appendix D for this equation).

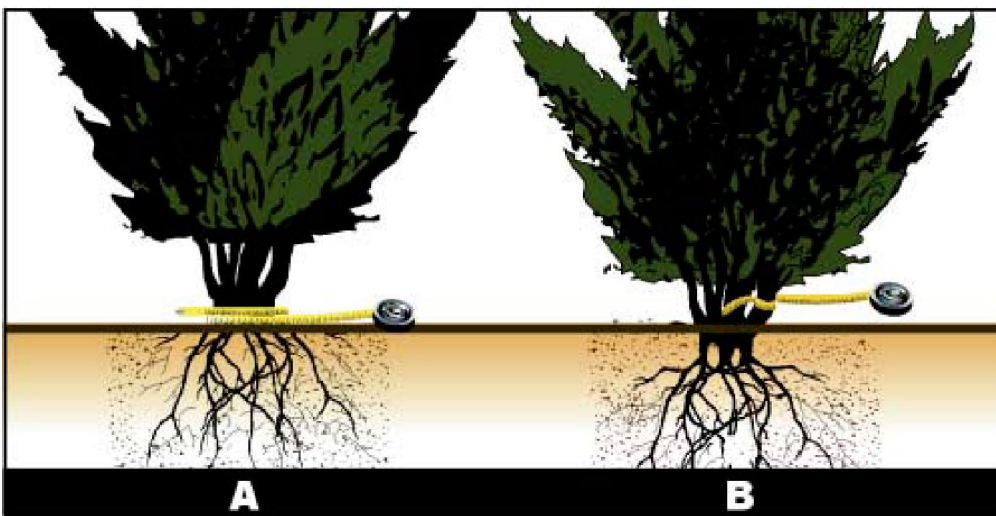


Figure 31. Measuring multiple stems forked above ground with DRC.

Measure just above the fork, and above any swells.

Measurement of: **A)** multiple stems forked above ground, **B)** single stems, or stems forked underground.

Diameter Groupings

Overstory trees. This includes single-stemmed trees >15 cm DRC and multi-stemmed trees with a cumulative DRC >15 cm (though you can modify this definition; see page 44).

Pole-size trees. This includes single-stemmed trees between 2.5 cm and 15 cm DRC, and multi-stemmed trees with a cumulative DRC between 2.5 cm and 15cm (though you can modify this definition; see page 44).

Table 20. Guidelines to determine whether a tree is considered an overstory tree.

Approximate Stem Size (cm)	Approx. Number of Stems Needed to Exceed 15.0 cm DRC
10.5	2
8.5	3
5.0	9
3.5	18
2.5	35

Crown Position (Crown Class)

Crown position is assigned a numeric code 1–5 as described in Table 17. Codes for dead trees can also be recorded using numeric snag classes 6–12 as described in Table 18. Crown Position Codes (CPC) are recorded in the *Crown Class* column of the *Overstory Tree Data form*.

During the immediately post-burn visit use the “Live” column on FMH-20 for CPC codes (10–12). Use (C) for dead and down or completely consumed (CPC 10), (B) for broken below DBH (CPC 11), and (S) for cut stump (CPC 12). Note that these three codes are used only once during data collection.

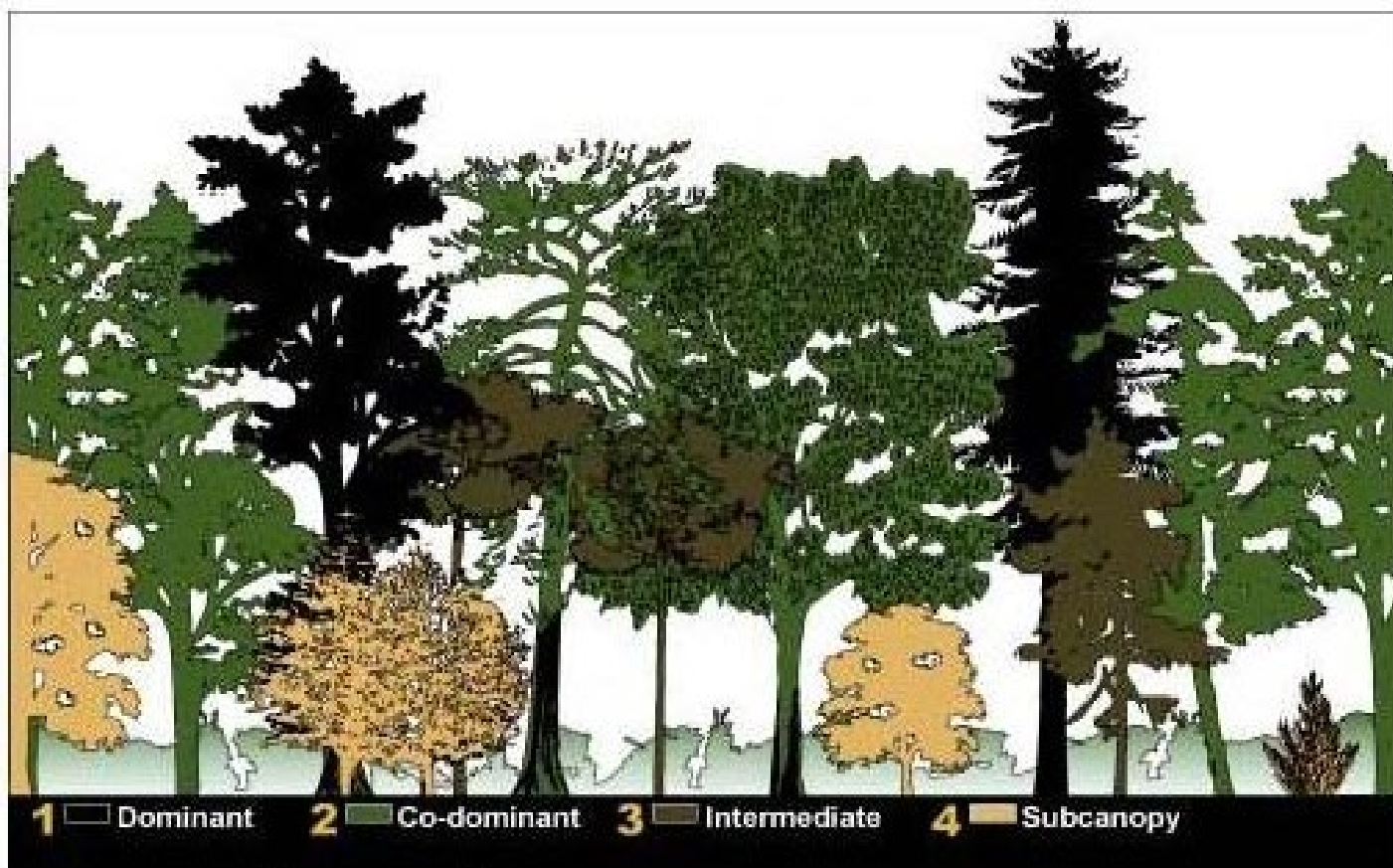


Figure 29. Crown position codes for live trees.

A fifth code (5) is used for isolated trees.

Table 17. Descriptions of live tree crown position codes.

1 Dominant	Trees with crowns extending above the general level of the crown cover, and receiving full light from above and at least partly from the side; these trees are larger than the average trees in the stand and have well-developed crowns, but may be somewhat crowded on the sides.
2 Co-dominant	Trees with crowns forming the general level of the crown cover and receiving full light from above, but comparatively little from the sides; these trees usually have medium-size crowns, and are more or less crowded on the sides.
3 Intermediate	Trees shorter than those in the two preceding classes, but with crowns either below or extending into the crown cover formed by co-dominant and dominant trees, receiving little direct light from above, and none from the sides; these trees usually have small crowns and are considerably crowded on the sides.
4 Subcanopy	Trees with crowns below the general level of the crown cover and receiving no direct light from above or from the sides.
5 Open Growth/ Isolated	Trees receiving full sunlight from above and all sides. Typically, these are single trees of the same general height and size as other trees in the area, but where the stand is open and trees are widely separated so dominance is difficult to determine.

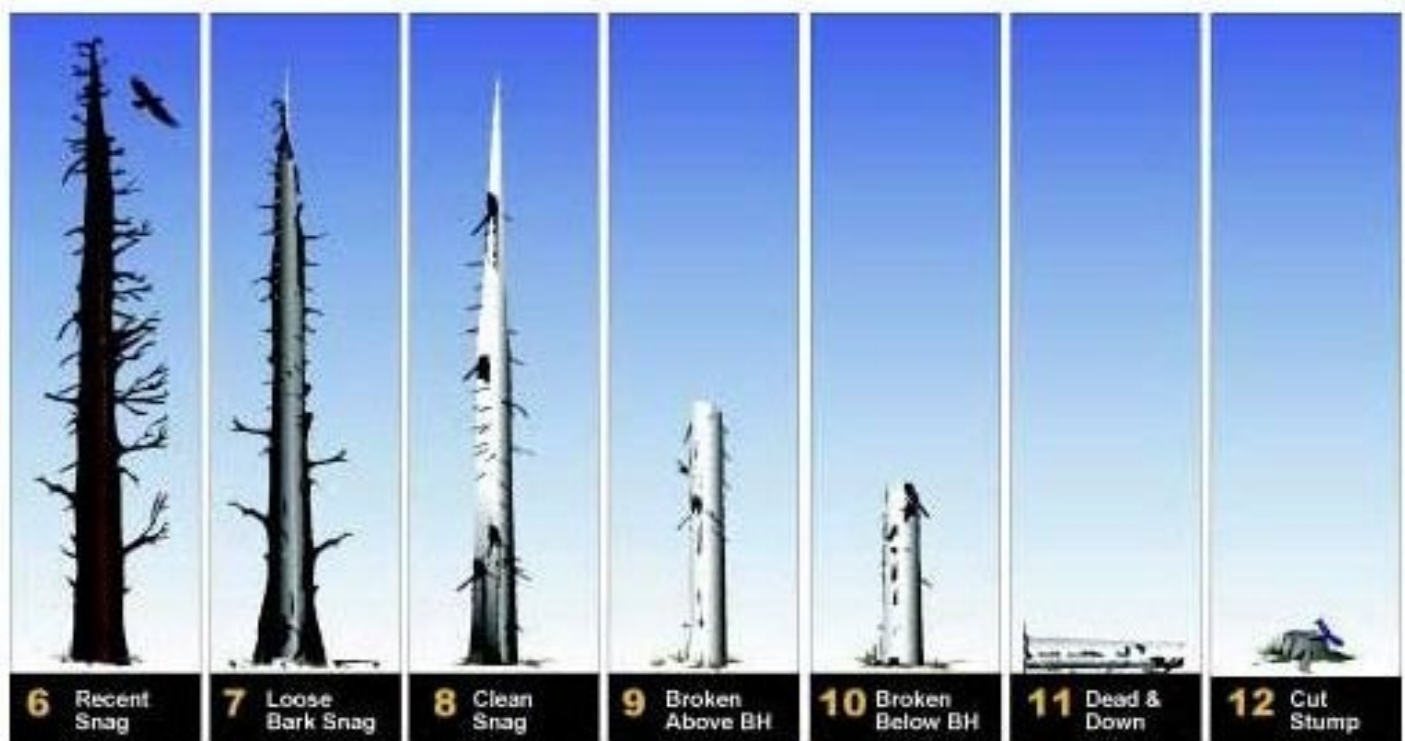


Figure 30. Crown position codes for dead trees.

Table 18. Descriptions of dead tree crown position codes.

6 Recent Snag	Trees that are recently dead with bark intact. Branches and needles may also be intact.
7 Loose Bark Snag	Trees that have been dead several years on which the bark is partially deteriorated and fallen off; tops are often broken.
8 Clean Snag	Trees that have been dead several years with no bark left. Usually most of the branches will be gone as well; tops are often broken.
9 Broken Above BH	Trees that have been dead a long time with no bark, extensive decay, and that are broken above BH.
10 Broken Below BH	Postburn trees that extended above BH preburn, but no longer do. Note: Only record data for a tree the first time you find it broken.

11 Dead and Down	Postburn trees that stood preburn and have since fallen or been consumed. Note: Only record data for a tree the first time you find it down.
12 Cut Stump	Postburn trees that stood preburn and has been cut as a result of fire operations. Note: Only record data for a tree the first time you find the stump.

Tree Damage

It is useful to identify living overstory trees exhibiting signs of stress before they burn. By doing this we can infer that if those trees die relatively soon following the fire, their death may not be wholly attributable to the fire, but to a combination of factors. Table 19 provides a list of structural defects and signs of disease that will serve as a guideline. Categories may be added to add damage of local importance that is not already listed in the table. These damage codes will be recorded for living overstory trees only. Any given tree may possess more than one type of damage therefore the number of damage codes used may vary.

Some damage codes may not be applicable to all species. For example, some species of oak are characterized by complex forking above BH, so the FORK code would not indicate damage or abnormality and would not be of use.

ABGR	Abnormal growth pattern for the species of concern. This category would include a range of physical deformities not included in the remainder of the damage codes.
BIRD	Bird damage such as woodpecker or sapsucker holes.
BLIG	Blight is generally defined as any plant disease or injury that results in general withering and death of the plant without rotting. Blight can result from a wide variety of needle, cone, and stem rusts, as well as canker diseases, and is often species- or genus-specific. Consultation with local plant pathologists may assist in identifying specific blight conditions.
BROK	Broken top of the tree.
BROM	Witches' broom diseases are characterized by an abnormal cluster of small branches or twigs on a tree as a result of attack by fungi, viruses, dwarf mistletoes, or insects. Brooms caused by dwarf mistletoe and from yellow witches' broom disease are common in the west.
BURL	A hard, woody, often rounded outgrowth on a tree. This occurs naturally in some tree and shrub species, and is a sign of an infection or disease in other species.
CONK	The knobby fruiting body of a tree fungal infection visible on a tree bole, such as a shelf fungus.
CROK	Crooked or twisted bole for species in which this is uncharacteristic.
DTOP	Dead top.

EPIC	Epicormic sprouting, adventitious shoots arising from suppressed buds on the stem; often found on trees following thinning or partial girdling.
EPIP	Epiphytes present.
FIRE	Fire scar or cambial damage due to fire.
FORK	Forked top of a tree or multiple primary leaders in a tree crown for species in which this is uncharacteristic. Forks assume vertical growth and should be distinguished from branches, which assume horizontal growth.
FRST	Frost crack or other frost damage.
GALL	Galls found on stems, leaves or roots. Galls are formed by infection of the plant by bacteria or fungi, or by an attack by certain mites, nematodes, or insects, most notably wasps.
HOLW	Hollowed-out trees. Repeated hot fires can burn through the bark and the tree's core may then rot out, especially in trees with tough bark, but soft heartwood, e.g., sequoia, coast redwood. These hollowed-out trees are sometimes called "goose pens" because early settlers kept poultry in them.
INSE	Visible insects in the tree bole or the canopy, or their sign, such as frass, pitch tubes or bark beetle galleries.
LEAN	Tree is leaning significantly. If on a slope, tree deviates considerably from plumb.
LICH	Lichens present.
LIGT	Lightning scar or other damage to the tree caused by lightning.
MAMM	Damage caused by mammals, such as bear claw marks, porcupine or beaver chewings, and deer or elk rubbings.
MISL	Mistletoe is visible in the tree (as opposed to signs of mistletoe, such as broom, without visible mistletoe).
MOSS	Moss present.
OZONE	Ozone damage. Ozone injury is often seen in the form of stippling or speckling on the leaves or needles of trees. This discoloration varies among species and ranges in color from red or purple to yellow or brown. Susceptible species often drop their leaves prematurely.
ROOT	Large exposed roots.
ROTT	A rot of fungus other than a conk, often associated with a wound or crack in a tree.

SPAR	Unusually sparse foliage for that species and size of tree.
SPRT	Basal sprouting; new shoots arising from the root collar or burl.
TWIN	A tree that forks below BH and has two or more boles. Use this code for tree species that typically have single boles.
UMAN	Human-caused damage such as axe marks, embedded nails or fence wire, or vandalism.
WOND	A wound to a tree that cannot be identified by one of the other damage codes, including wounds or cracks of unknown cause.

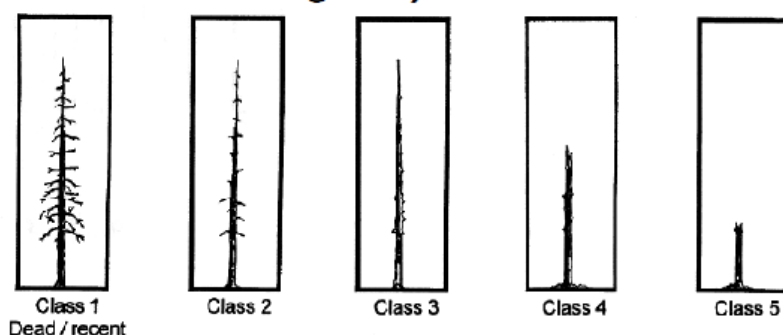
Log/Snag Decay Class

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 ½	Losing form, soft	>5 years
5	75%+ missing	Advanced to crumbly	50%+ advanced	Absent	Approx. ½+	Form mostly lost	>5 years

*Implies recent mortality, within the last 5 years.

Snag Decay Classes

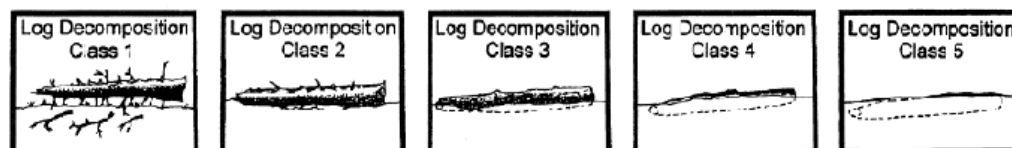


Log Decay

Code	Bark	Twigs	Texture	Shape	Wood Color	Portion of log on ground
1*	Intact	Present	Intact	Round	Original	None, elevated on supporting points
2	Intact	Absent	Intact to soft	Round	Original	Parts touch, still elevated, sagging slightly
3**	Trace	Absent	Hard large pieces	Round	Original to faded	Bole on ground
4**	Absent	Absent	Soft blocky pieces	Round to oval	Light brown to faded brown	Partially below ground
5**	Absent	Absent	Soft, powdery	Oval	Faded light yellow or gray	Mostly below ground

* Implies recent mortality, within the last 5 years.

** Only down trees in decay class 1 or 2 should be recorded on the tree form. Logs in decay classes 3-5 should be recorded on the down woody material form.



POLE SIZED TREES

A pole sized tree is defined as any tree within a defined area in the plot that has a DBH ranging from 2.5 - 15.0 cm. **All pole sized trees are tallied in the Q1 section only.** Data that are to be recorded on the *Pole-Size Tree Data Sheet* and includes the quarter of the plot it is located in, species, DBH, live or dead status, and height.

SEEDLING TREES

A seedling tree is defined as any tree within a defined area in the plot that has a DBH less than 2.5 cm. **All tree seedlings are tallied in the Q1 section only.** Data that are to be recorded on the *Seedling Tree Data Sheet* includes quarter, species, live or dead status, height, and tally of individuals.

SHRUBS

Shrubs are counted along the exterior perimeter of each plot for a total of 2 shrub belts. Each shrub belt is 25 m long by 2 m in width, the 2-meter width wholly contained within the plot boundary. Data are to be recorded using the *Alternate Shrub Density Data Sheet* which includes the quarter, species, age class, number of individuals, and live or dead status.

FUEL TRANSECTS (BROWN'S LINE INVENTORY FOR DEAD AND DOWN FUEL LOAD)

On all forest monitoring plots, measure dead and detached woody fuel as well as duff and litter depths. These measurements are taken along fuel inventory transects or "Brown's Lines", which must be relocatable to allow evaluation of post-burn fuel load. All measurement are taken in English, not metric. All data are recorded on datasheet.

The Brown's Line (Brown, 1974) is a standard method used to assess accumulations of dead and down fuels on the forest floor. Parameters measured include 1, 10, 100, and 1,000 hour fuels (also called "time-lag fuels") and litter and duff depths. The term "hour" refers to an estimate of how long it takes for the moisture percentage of the particular fuel (i.e. 1 hour) to equilibrate to ambient air temperature. All time-lag fuels are defined by diameters: 1 hour fuels are 0-0.25 in. in diameter; 10 hour fuels are 0.25 - 1.0 in. in diameter; 100 hour fuels are 1.0 - 3.0 in. in diameter; and 1,000 hour fuels are 3.0+ in. in diameter.

There are four Brown's Lines per plot which originate from the centerline at 5, 10, 15, and 20m (see *Plot Design*). Each transect extends 50 ft. in a random azimuth. Count intercepts along the transect plane up to 6 ft. from the ground. Count dead and down woody material, but not cones, bark, needles and leaves. Do not count stems and branches attached to standing shrubs or trees (Brown 1974; Brown and others 1982).

Size Class	Suggested Length
0–0.25" (0–0.62 cm) diameter (1 hour)	tally from 0–6 ft
0.25–1" (0.62–2.54 cm) diameter (10 hour)	tally from 0–6 ft
1–3" (2.54–7.62 cm) diameter (100 hour)	tally from 0–12 ft
>3" (>7.62 cm) diameter (1,000 hour)	measure each log from 0–50 ft

For the first 6 ft. of a transect: every 1 hour and 10 hour fuel is recorded.

For the first 12 ft. of a transect: every 100 hour fuel is recorded.

Entire length of transect: All 1,000 hour fuels are recorded.

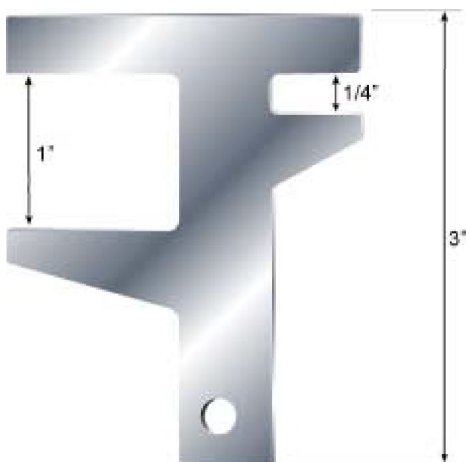


Figure 33. Graphic of a go-no-go gauge. A go-no-go gauge with openings (0.25, 1, and 3in) works well for separating borderline particles into size classes and for training the eye to recognize these size classes.

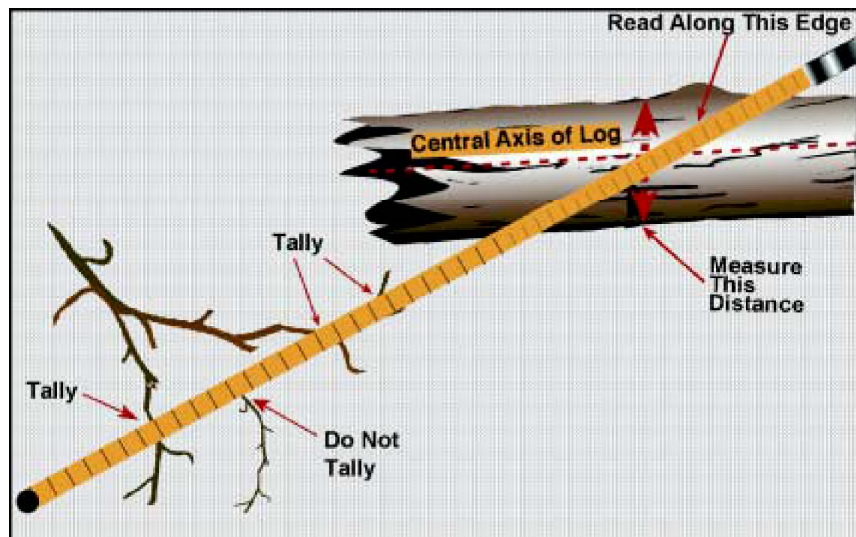


Figure 34. Tally rules for dead and down fuel. Count all intersections, even curved pieces. All intersections must include the central axis in order to be tallied. Measurement of all particles is taken perpendicular to the point where the tape crosses the central axis.

1,000 Hour Fuel

Diameter: The diameter of each 1,000 hour fuel is taken in three places:

1. Where the tape crosses the log
2. Smallest diameter - not smaller than 3 in.
3. Largest diameter

Length: The total length of the log is measured from 3 in. (or the smallest diameter point if greater than 3 in.) to the opposite end of the log.

Species: If unknown record "UNKT"

Ground Contact: Yes or No if >50% of the log is touching the ground.

Decay Class: Class 1, 2, and 3 are solid, Class 4 and 5 are rotten.

Large Logs

All Logs with a diameter >12 inches are recorded in Q1 of the plot, a 25x10 meter area. The 12 in. diameter point must be rooted within Q1 in order to be counted.

Diameter: The diameter of each large log is taken in three places:

1. Smallest diameter - not smaller than 3 in.
2. Mid-point
3. Largest diameter

Length: The total length of the log is measured from 3 in. (or the smallest diameter point if greater than 3 in.) to the opposite end of the log.

Species: If unknown record "UNKT"

Ground Contact: Yes or No if >50% of the log is touching the ground.

Decay Class: Class 1, 2, and 3 are solid, Class 4 and 5 are rotten.

SOUTH PALIZA SAMPLING: Down/dead trees in decay class 1 and 2 were recorded on overstory tree data form, even when originally rooted outside plot. Total length was measured, and DRC of stump recorded.

Litter & Duff*

The amount of litter and duff found on the forest floor is measured at 1, 5, 10, 15, 20, 25, 30, 35, 40, and 45 ft. along the fuel inventory transect. Unlike herbaceous transects, fuel load transects can cross each other (Brown 1996). Measure the percent slope of each transect from the start to end point in percent.

TREE CANOPY DENSITY

Canopy density will be measured at 5, 10, 15, & 20 m along the Origin to 25P centerline. A spherical densiometer will be used to take these measurements. Four readings, each spaced 90 degrees apart, will be taken at each spot and recorded on the *Tree Canopy Density Data sheet*.

IMMEDIATE POSTBURN VEGETATION AND FUEL OBSERVATIONS

In addition to the 25 m brush transects, seedling, pole, and overstory tree inventories, and fuel transects, visual assessments of *burn severity* on the organic substrate and vegetation are recorded during the immediate postburn visit to each plot. Burn severity observations are taken on the four fuels transects at the same ten points (1, 5, 10, 15, 20, 25, 30, 35, 40, and 45 ft.) where litter and duff are measured. A 4dm² area is delineated around each point and two burn severity ratings are determined, one for organic substrate and one for above ground vegetation. There are 40 points evaluated for burn severity on each plot, with a total of 80 ratings (one for substrate and one for vegetation at each point).

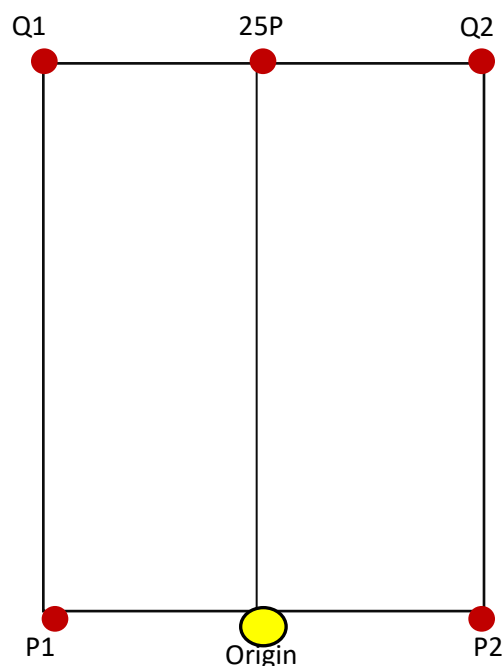
The other FMH measurements of foliar postburn condition for overstory trees on the immediate postburn visit (*Scorch Height*, *Char Height* and *Percent Crown Scorched*) were not collected on the post-Las Conchas Fire plots. For other monitoring locations such as San Juan and Paliza, the FMH protocols (beginning on page 108 of the FMH Handbook) will be used, with the exception that trees are not tagged so individual tree data cannot be tracked. Post-burn information for each untagged tree will include scorch height, char height, and percent crown scorched will be collected.

Summary of Information collected for burn severity: Visual assessments of burn severity of vegetation and substrate at points along fuel transects and of all standing trees (pole and overstory).

PHOTO POINTS

Photos are taken in landscape orientation to capture the transect line and horizon. A whiteboard labeled with the plot ID, corresponding photo label, and date must also be captured in the frame. Photos are taken and labeled in the following manner:

#	PHOTO	PHOTO LABEL
1	Origin to 25P	Origin
2	P1 to Origin	P1→O
3	P1 to Q1	P1→Q1
4	Q1 to P1	Q1→P1
5	Q1 to 25P	Q1→25P
6	25P to Origin	25P→O
7	Q2 to 25P	Q2→25P
8	Q2 to P2	Q2→P2
9	P2 to Q2	P2→Q2
10	P2 to Origin	P2→O



DATASHEETS:

TITLE	NPS Fire Monitoring Handbook Forms (or other)	FMH Page #
Forest Plot Data Sheet	FMH-7	164
Forest Plot Fuels Inventory Data Sheet	FMH-19	186-187
Overstory Tree Data Sheet	NA (see VALL datasheet)	
Pole-size Tree Data Sheet	FMH-9	168-169
Seedling Tree Data Sheet	FMH-10	170
Alternate Shrub Density Data Sheet	FMH-17A	183
Forest Plot Burn Severity Data Sheet	FMH-21	190-191
Tree Canopy Density	NA (see VALL datasheet)	
50 m. Vegetation Transect Data Sheet	NA (see VALL datasheet)	
Tree Postburn Assessment Data Sheet	FMH-20	188-189
Salamander Habitat Datasheet	NA (see VALL datasheet)	