FIREMON Reference Materials – Combined Documents

These documents were combined to provide a single resource for all of the most up-to-date FIREMON Reference materials.

Combined: 9/19/2005

Reference Materials

Glossary

The FIREMON Glossary includes terms that are used in the FIREMON protocol but that may be unfamiliar to some readers. The source of each definition is provided in parenthesis at the end of each definition. In some cases words will use the FIREMON documentation as a source. These terms were defined specifically for use in some part of FIREMON and the definition given may or may not be applicable outside the FIREMON protocol. The term Fire Severity is an example. It was specifically defined for use in the Landscape Assessment methods.

1000-Hour Fuel: Dead fuels consisting of roundwood 3.0 to 8.0 inches in diameter, estimated to reach 63 percent equilibrium moisture content in one thousand hours. (Fire Effects Guide)

100-Hour Fuel: Dead fuels consisting of roundwood in the size range from 1.0 to 3.0 inches in diameter, estimated to reach 63 percent of equilibrium in one hundred hours. (Fire Effects Guide)

10-Hour Fuel: Dead fuels consisting of roundwood 0.25 to 1.0 inches in diameter, estimated to reach 63 percent of equilibrium moisture in ten hours. (Fire Effects Guide)

1-Hour Fuel: Dead fuels consisting of dead herbaceous plant material and roundwood less than 0.25 inches in diameter, estimated to reach 63 percent of equilibrium moisture content in one hour or less. (Fire Effects Guide)

Abiotic: Non-living components of an ecosystem such as air, rocks, soil, water etc. Compare to biotic. Compare to Biotic. (Wildland Planning Glossary, A Glossary of Terms Used In Range Management, Jacoby)

Aerial Plant Component: The upper portion of a plant including branches, leaves, and flowering parts. Compare to Basal Vegetation.

Alluvium: A general term for all detrital material deposited or in transit by streams, including, gravel, sand, silt, clay, and all variations and mixtures of these. (Glossary of Landscape & Vegetation Ecology for Alaska)

Alpine: That vegetation occurring between the upper limit of trees (timberline), and the lower limit of snow (snowline) on mountains high enough to possess both of these features. (Glossary of Landscape & Vegetation Ecology for Alaska)

Ash: The incombustible matter remaining after a substance has burned. (McGraw-Hill Dictionary of Scientific and Technical Terms)

Aspect: A position facing or commanding a given direction; exposure. Aspect is the compass direction of the prevailing slope with respect to true north. (FSVeg)

Azimuth: A horizontal angular measure from true north to an object of interest. (FSVeg)

Basal Area: The area of ground surface covered by the stem or stems of a plant; for trees, measured at 4.5 feet above the ground, for forbs and grasses, measured at the root crown. (FSVeg)

Basal Vegetation: In FIREMON, the area of the cross-section of the plant stem where it enters the ground surface; often expressed as a percent of the plot cover. Compare to Aerial Plant Component. (FIREMON)

Baseline: A permanent line from which all vegetation transects are oriented. Usually, used with the FIREMON CF, PO, LI, DE and RS sampling methods. (FIREMON)

Belt Transect: A two-dimensional transect with width and length. Compare to Transect and Quadrat. (FIREMON)

Biophysical Setting: Describes the physical environment of the FIREMON plot relative to the organisms that grow there. The site characteristics included in a description are topography, geology, soils, and landform. (FIREMON)

Biotic: Applied to the living components of the biosphere or of an ecosystem, as distinct from the abiotic physical and chemical components. Compare to Abiotic. (The Concise Oxford Dictionary of Ecology)

Biotic Plant Community: Any assemblage of populations (plants) living in a prescribed area or physical habitat; an aggregate of organisms which form a distinct ecological unit. (Wildland Planning Glossary)

Bole Char Height: A fire severity measurement that is used to quantify potential tree mortality. In FIREMON, it is height of the top of continuous char measured above the ground on the downhill side of the tree, or if on flat ground the top of the lowest point of continuous char. (FIREMON)

Breaklands: The steep to very broken land at the border of an upland summit that is dissected by ravines. (Landforms For Soil Surveys in the Northern Rockies)

Breakpoint Diameter: In FIREMON the tree diameter above which all trees are tagged and measured individually and below which trees are tallied to species-diameter or species-height classes. Selection of the breakpoint diameter must account for fire monitoring objectives along with sampling limitations and efficiency. (FIREMON)

Broadleaf Species: Deciduous and evergreen trees and shrubs that have seeds within a closed pod or ovary, Compare to Conifer Species. (Glossary of Landscape & Vegetation Ecology for Alaska, Webster's New World Dictionary)

Burn Severity: The degree of environmental change caused by fire, or the result, is the cumulative effect of fire on ecological communities comprising the landscape; the physical and chemical changes to the soil, conversion of vegetation and fuels to inorganic carbon, and structural transformations that bring new microclimates and species assemblages. An analogy to burn severity would be storm severity, which refers to the damage or outcome left in the wake of the storm. Compare to Fire Severity. (FIREMON Landscape Assessment Sampling Methods)

Caliper: An instrument for determining tree and log diameters by measurement of their rectangular projection on a straight graduated rule via two arms at right angles (and one of them sliding along the rule itself). (Timber Cruising in the Pacific Northwest)

Canopy Cover: The percentage of ground covered by the vertical projection of the outermost perimeter of the natural spread of foliage of plants. Small openings within the canopy are included. Some sources differentiate canopy cover (with the spaces and small openings included) and foliar cover (with the spaces and small openings excluded). In FIREMON we suggest sampling foliar cover rather than canopy cover. Compare Foliar Cover. (SRM 1989, NRCS 1997, FIREMON)

Canopy Fuel Base Height: In FIREMON, a subjective assessment of the lowest live or dead fuels attached to the stem of a tree that are sufficient to move fire to the burnable material above. Used to assess crown fire potential. (FIREMON)

Casket Tag: Tags made of high-grade steel that will not melt in a prescribed burn or wildfire. (FIREMON)

CBI (Composite Burn Index): This method uses a field sampling approach on a relatively large plot to determine severity ratings for individual strata, and a synoptic rating for a whole plot area. (FIREMON Landscape Assessment Sampling Methods)

CC (Crew costs): The cost of outfitting one sampling crew including, transportation, supplies and salary. (FIREMON)

CF (Cover Frequency): Methods used to assess changes in plant species cover and frequency for a macroplot. These methods use quadrats to sample within plot variation and quantify statistically valid changes in plant species cover, height and frequency over time. This method is primarily suited for grasses, forbs, and shrubs less than 3 feet in height. (FIREMON)

Char: The blackened charcoal left from incomplete combustion of organic matter.

Clay: Fine grained-material which develops plasticity when mixed with a limited amount of water; composed primarily of silica, alumina, and water, often with iron, alkalis, and alkaline earths. As a soil textural class, soil that is 40% or more clay, less than 45% sand, and less than 40% silt. (McGraw-Hill Dictionary of Scientific and Technical Terms, Glossary of Landscape & Vegetation Ecology for Alaska)

Clinometer: An instrument for measuring angles of slope or inclination. (Webster's New World Dictionary)

Cluster Sampling: A method of locating plots in which a group of polygons are sampled in a cluster around an easily accessible point rather than polygons sampled throughout the landscape. (FIREMON)

Conifer Species: A plant belonging to the class Pinatae of cone-bearing gymnospermous trees and shrubs, mostly evergreen, including the pine, spruce, fir, cedar, yew, and cypress. Generally needle-leaved, cone-bearing plants having naked seeds not enclosed in an ovary. Compare to Broadleaf Species. (Glossary of Landscape & Vegetation Ecology for Alaska, Webster's New World Dictionary)

Cover: See Canopy Cover, Crown Cover and Foliar Cover.

Crown Biomass: The total quantity (weight) of a tree crown including live and dead branches and foliage.

Crown Class: A code used to describe the position in the canopy of the tree relative to the trees around it and to describe how much light is available to that tree in. In FIREMON there are six categories describing crown class: 1) Open Grown, 2) Emergent, 3) Dominant, 4) Codominant 5) Intermediate, and 6) Suppressed. (Based on The Practice of Silviculture)

Crown Cover: An estimate of tree cover on a plot. Generally, it includes the small openings and spaces in the crown. Sometimes called canopy closure. In FIREMON we suggest sampling foliar cover rather that crown cover, however project objectives may suggest using crown cover. If crown cover data is collected be sure to note in the Metadata table the fields where it was applied. (Forest Measurements)

Cryptogam: A plant that reproduces by spores or gametes rather than seeds (i.e. an alga, bryophyte, or pteridophyte). (The Concise Oxford Dictionary of Ecology)

Cryptogamic Crust: Cryptogams such as mosses, algae, lichens or liverworts growing in a thin crust.

Culm Groups: Stalks or stems in grasses. (Webster's New World Dictionary)

CWD (Coarse Woody Debris): Generally pieces greater than 10 cm or 3 inches in diameter and longer than 2 meters or 6 feet in length, however definitions vary widely. In FIREMON, dead woody debris larger or equal to 3 inches in diameter, also called 1000-hour and greater fuels. (Ecology of Coarse Woody Debris in Temperate Ecosystems, FIREMON)

Damage Description: A code which refers to biotic (insects, disease, or browsing) or abiotic (wind, snow or fire), damage in trees. This code describes the damaging agent. Compare to Severity Description (FIREMON).

DBH (Diameter at Breast Height): A measure of a tree taken at breast height (4.5 feet), outside the bark of the tree bole, perpendicular to the bole from the uphill side of the tree. (FSVeg)

DE (Density): A FIREMON method used to assess changes in plant species density and height for a macroplot. This method uses quadrats and belt transects to sample within stand variation and quantifies statistically valid changes in plant species density and height over time. (FIREMON)

Decay Class: A method used in FIREMON to determine the degree of decay present in Coarse Woody Debris. Compare snag class. (Ecology of coarse woody debris in temperate ecosystems)

Deciduous: Plants that shed their leaves annually; as opposed to evergreens. (Webster's New World Dictionary)

Declination: The angle between the magnetic and geographical meridians, expressed in degrees and minutes east or west to indicate the direction of magnetic north from true north; also known as magnetic declination; variation. (McGraw-Hill Dictionary of Scientific and Technical Terms)

DEM (Digital Elevation Model): United States Geologic Survey geographic elevation data distributed in raster form. A digital representation of the shape of the earth's surface. Typically digital elevation data consists of arrays of values that represent topographic elevations measured at equal intervals on the earth's surface. (FSVeg)

Diameter Tape: A spring wound tape measure which has one side in linear units which are converted to diameter and the other side in units for measuring feet and inches. Also called a D-tape or loggers tape. (Measurements for Terrestrial Vegetation)

Dot Tally: A method which uses a series of dots, lines and boxes to tabulate numbers when sampling. This method is particularly useful when counting many small items.

Duff: The partially decomposed organic material of the forest floor that lies beneath the freshly fallen needles, twigs and leaves and above the mineral soil. This is the fermentation and humus layer where the vegetative material is broken down, and the individual pieces are no longer identifiable. (FSVeg, Fire Effects Guide)

Duff/Litter Profile: The cross-sectional view of the litter and duff layers. It extends vertically from the top of the mineral soil to the top of the litter layer. (FIREMON)

DWD (Dead and Down Woody Debris): Dead woody pieces of trees and shrubs that have been broken, uprooted, or severed from their root system, not self supporting, and are lying on the ground. (No longer supporting growth) DWD are categorized in size classes of 1-hour, 10-hour, 100-hour and, 1000-hour. (FSVeg).

ECODATA: Land planning inventory package including sampling methods, field forms, database software and analysis software. Many FIREMON sampling methods are based on the ECODATA protocols.

Ecotone: The area influenced by the transition between plant communities or between successional stages or vegetative conditions within a plant community. (Fire Effects Guide)

Epicormic Branching: A branches that arises from latent, adventitious or dormant buds within the bark of the tree. Epicormic branch development is often initiated by crown damage such as breakage or fire injury (The Practice of Silviculture).

FARSITE (Fire Area Simulator): A fire growth model that uses fuels, topography and weather to predict fire spread.

Fern: A nonflowering embryophyte having roots, stems, and fronds, and reproducing by spores instead of by seeds. (Webster’s New World Dictionary)

Fire Behavior: The manner in which a fire burns in response to the variables of fuel, weather, and topography. A fire may be described as hot or cool, running or creeping, flaming or smoldering, or perhaps, torching or crowning. Compare to Fire Effects. (Fire Effects Guide, Glossary of Wildland Fire Management Terms Used in the U.S.)

Fire Behavior Fuel Model: Mathematical descriptions of fuel properties (e.g. fuel load and fuel depth) that are used in conjunction with environmental conditions to predict certain aspects of fire behavior. (FSVeg, Intro. to Wildland Fire Behavior Glossary)

Fire Effects: Any consequence neutral, detrimental, or beneficial resulting from fire. Examples of First order fire effects are tree mortality, emissions, and fuel consumption. Examples of Second order fire effects are trees damaged by fire that latter succumb to insect infestations, sedimentation in streams from eroding soils, and plant succession. Compare to Fire Behavior. (Glossary of Landscape, Vegetation Ecology for Alaska)

Fire Severity: A qualitative indicator of the effect of fire on the ecosystem, whether it affects the forest floor, canopy, or some other part of the system. It is sometimes assessed based on post-fire attributes such as char height or crown scorch. (Glossary of Landscape, Vegetation Ecology for Alaska, FIREMON) Compare to Burn Severity.

FL (Fuel Load): Methods used to sample dead and down woody debris, depth of the duff/litter profile, estimate the proportion of litter in the profile, and estimate total vegetative cover and dead vegetative cover. Down woody debris is sampled using the planar intercept technique. (Handbook for Inventorying Downed Woody Material, FIREMON)

Flame Height: The average height of flames as measured on a vertical axis. It may be less than flame length if flames are angled. Compare to Flame Length. (Glossary, Intro. To Wildland Fire Behavior Calculations)

Flame Length: The distance measured from the tip of the flame to the middle of the flaming zone at base of the fire. It is measured on a slant when the flames are tilted due to effects of wind and slope. Compare to Flame Height. (Glossary, Wildland Fire Behavior Calculations)

FOFEM (First Order Fire Effects Model): Model for predicting tree mortality, fuel consumption, emissions and soil heating from pre-burn calculations.

Foliar Cover: The percentage of ground covered by the vertical projection of the aerial portion of the plants (foliage and supporting parts). Small openings in the canopy and intraspecific overlap are excluded. This is the cover assessment recommended in FIREMON. (SRM1989, FIREMON)

Forb: A plant with a soft, rather than permanent woody stem, that is not a grass or grass-like plant. Compare to Graminoid. (Fire Effects Guide)

FWD (Fine Woody Debris): Dead woody debris less than 3 inches in diameter, including 1-hour, 10- hour, and 100-hour fuels. (FIREMON)

GIS (Geographic Information System): Integrated software, hardware and data to store and manipulate information that combines thematic and locational attributes about geographic features. (Landscape Assessment Sampling Methods)

Go/no-go gauge: A tool used to classify fuels into one of three classes; 1-hour, 10-hour, and 100-hour. (Handbook for Inventorying Down Woody Debris)

GPS (Geographic Positioning System): A network of radio-emitting satellites from which your position can be triangulated in three dimensions (North, East and Elevation) to within 3-50 meters of accuracy. (FSVeg, FIREMON)

Graminoid: Grass-like plants, including grasses, sedges, rushes, reeds and cattails. (Fire Effects Guide)

Grid Frame: Used with the PO method a grid frame is a frame of any shape or size where cross-hairs formed by perpendicularly oriented strings are considered sampling points. Interceptions of cross-hairs with plant parts are considered hits. (FIREMON)

Ground Cover: This includes cover of basal vegetation, moss/lichens, litter, rocks, gravel and so forth on a site. (FIREMON)

Herb: A small non-woody, seed bearing plant in which aerial parts die back at the end of each growing season. Compare to shrub. (The Concise Oxford Dictionary of Ecology)

Igneous: Rocks that crystallized from molten magma; such as basalt, andesite, diorite to gabbro, latice, quartz monzonite, trachyte & syenite, rhyolite, granite, welded tuff (tufa), and scoria (porcellanite). (Roadside Geology of Montana, FIREMON)

Increment Borer: An instrument used to bore into the pith of the tree and extract a core which can be used for determining age and growth rate by counting the rings in the extracted core. (Forest Measurements)

LA (Land Assessment): A method which identifies and quantifies fire effects over large areas, at times involving many burns by using satellite derived Normalized Burn Ratio (NBR) together with a ground based indicator of fire severity, Composite Burn Index (CBI). (FIREMON)

Ladder Fuel: Fuels that provide vertical continuity between strata, thereby allowing fire to carry from surface fuels into the crowns of trees and shrubs with relative ease. (Glossary of Wildland Fire Management Terms Used in the U.S.)

Landsat: A satellite that carries a Thermatic Mapper sensor which records 30-meter data in specific spectral bands, and 60-meter data in one band. The bands measure reflected energy and heat. (Landscape Assessment Sampling Methods)

Landscape: All of the natural features, such as hills, forest, and water which distinguish one part of the earth's surface from another. A landscape can be any size and shape but it spatially defines stands. Compare to stand. (Glossary of Landscape, Vegetation Ecology For Alaska, FIREMON)

Layered Canopy Structure: The vertical structural components of a community consisting of plants of approximately the same stature or height, e.g., tree layer, shrub layer, herb layer, cryptogam layer. Compare Strata, Vertical (Glossary of Landscape & Vegetation Ecology for Alaska)

LCP (Live Crown Percent): The percent of the total length of tree bole that is supporting live crown. This is assessed from the highest live foliage (i.e., tree height) to the lowest live foliage or the base of the crown. Estimated by visually redistributing the live tree crown evenly around the tree so the branches are spaced at the same branch density as seen along the bole and form the typical conical crown. (FIREMON)

LI (Line Intercept): The FIREMON Line Intercept method is used to assess changes in plant species cover for a macroplot. This method uses line transects to sample plot variation and quantify statistically valid changes in plant species cover and height over time. This method is especially useful for quantification of shrub cover greater than 3 feet tall. Canopy cover is recorded as the number of inches intercepted along a transect. Percent canopy cover is calculated by dividing the number of inches intercepted by each item by the total length of the transect. Compare to planar intercept. (FIREMON)

Lichen: A non-vascular small plant composed of a particular fungus and a particular alga growing in an intimate symbiotic association and forming a dual plant, commonly adhering in colored patches to rock, wood, and soil. (Webster's New World Dictionary)

Litter: The top layer of the forest floor composed of loose debris such as branches, twigs, and recently fallen needles and leaves; little altered by decomposition and still identifiable. This layer may also include debris from shrubs, grasses and forbs that have recently died. The litter layer is directly above the duff layer. (Fire Effects Guide, FIREMON)

Live Canopy Base Height: In a stand, an estimate of the typical or common height of the lowest live branch having live foliage. (FIREMON)

Live Crown Base Height: For individual trees, the height of the lowest live branch whorl with live branches in two quadrant exclusive of epicormic branching and of whorls not continuous with the main crown. (R1 CSE)

Loam: Soil mixture of sand, silt, clay and humus. (McGraw-Hill Dictionary of Scientific and Technical Terms)

Loggers Tape: A spring wound tape measure which has one side in linear units which are converted to diameter and the other side in units for measuring feet and inches. Also, called a diameter tape or D-tape. (Measurements for Terrestrial Vegetation)

Macroplot: A term defining the greater sampling area in which all other sampling methods are nested. The size and shape of the macroplot is determined by sampling objective and available resources, but most macroplots are rectangular or circular encompassing about 0.04-0.1 hectares. (FIREMON)

Mature Tree: In FIREMON a tree greater than breakpoint diameter. This class includes SAF (Society of American Foresters) standard Pole trees, Medium trees, Large trees, and Very Large trees. (FIREMON)

Mean Height: In FIREMON, an estimate of the average height in meters for all individuals of a species or a species by size/age class; estimated by visualizing a plastic sheet draped over the vegetation in the class and recording the average height of the sheet above ground. (FIREMON)

Metadata: Data about the data. In data processing, meta-data is definitional data that provides information about documentation of the data managed within an application environment. Meta-data may include descriptive information about the context, quality and condition, or characteristics of the data. In FIREMON this includes, among other things, specific details regarding the sampling design, approach, and particulars describing the application of methods. (www.dictionary.com)

Metamorphic: Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat and pressure. Nearly all such rocks are crystalline such as; argillite, siltite, quartzite, slate, phyllite, schist, and gneiss. (Glossary of Landscape & Vegetation Ecology for Alaska)

Meter Stick: A metric measuring stick that is one meter, equal to 39.37 inches.

Microplot: A sampling area which is smaller than the macroplot used for measuring small scale phenomenon, such as ground cover or individual plant or species attributes. Often square and about 1 m^2 in size. Microplots are usually located in a grid pattern nested within the macroplot. Compare quadrat and subplot. (FIREMON)

Mineral Soil: Soil composed principally of mineral matter, the characteristics of which are determined more by the mineral than the organic content. This soil is often gravelly or sandy and lighter than the duff layer. (The Concise Oxford Dictionary of Ecology)

Mode/Modal: The value that occurs most often in a frequency distribution. (Measurements for Terrestrial Vegetation)

Moss: A non-vascular small, green bryophyte growing in velvety clusters on rocks, trees and moist ground. (Webster's New World Dictionary)

NBR (Normalized Burn Ratio): A methodology involving remote sensing; this uses Landsat 30-meter data and a derived radiometric value. The Normalized Burn Ratio is temporally differenced between pre-and post-fire datasets to determine the extent and degree of detected change from burning. (Landscape Assessment Sampling Methods)

NEXUS: Algorithm package for predicting fire behavior for assessing crown fire hazard.

Non-Vascular Plants: Plants without an internal vascular system (xylem and phloem) for the transport of nutrients; such as mosses and lichens. (Webster's New World Dictionary)

NRCS Plant Database: The Natural Resources and Conservation Service supported plants database. It is used in FIREMON for consistent naming and coding of plant species. (http://plants.usda.gov/)

NRF (Nested Root Frequency): Used when sampling plant frequency. NRF balances plant density and size by assigning frequency values based on the plant's presence in a nested set of plots corresponding to, usually, 1, 25, 50 and 100 percent of the quadrat.

NRP (Number of Required Plots): This is the number of plots required per stand per stratification category needed to meet different statistical objectives. (FIREMON)

PCS (Percent Crown Scorched): A fire severity measurement that relates directly to tree mortality; an estimate of the amount of crown volume that was consumed or damaged by fire. (FIREMON)

PD (Plot Description): Methods used to describe general characteristics of the FIREMON macroplot to provide ecological context for data analyses. The PD data characterize the topographical setting, geographic reference point, general plant composition and cover, ground cover, fuels and soils information. The PD method contains the only required fields in FIREMON. (FIREMON)

Peak Canopy Cover: A method in FIREMON for estimating cover at peak phenological development of a plant. For example if leaves have fallen off the plant and are on the ground, the projected cover mentally reconstructed with leaves on the plant. (FIREMON)

PF (Project Funds): The amount of money available to conduct the entire monitoring project. (FIREMON)

Phenological Stage: A specific phase within the cycle (usually annual) of a plant's leafing, flowering, fruiting, etc. (The Concise Oxford Dictionary of Ecology)

Pixel: Literally, "picture element"; the smallest area for which data values are assigned. Pixels generally are all the same size, and arranged in a contiguous rectangular grid of rows and columns. Spatial orientation of the grid can be registered to a map projection, so that individual pixels may be located on the ground. (Landscape Assessment Sampling Methods)

Plain: An extensive, level and usually treeless area of land. (www.dictionary.com)

Planar-Intercept: A method in which the sampling area is an imaginary plane extending from the ground, vertically from horizontal (not perpendicular to the slope) to a height of six feet above the ground. Pieces of DWD (down woody debris), that intercept the sampling plane are measured and recorded. Frequently the term "line transect sampling" is used when discussing the planar intercept method. (FIREMON) Compare to Line Intercept.

Plot: The basic sampling unit. This is an area of ground where FIREMON methods will be implemented. The plot is spatially defined by the macroplot.(FIREMON)

PO (Point Cover): This method is used to estimate vegetation and/or ground cover for a macroplot. Point estimates of cover are collected at fixed locations along randomly located line transects. Individual pins, pin frames, or point grids are placed at systematic intervals along a transect. Pins are lowered and plant species and/or ground cover categories are recorded as the number of "hits" encountered along a transect. Cover is calculated by dividing the number of "hits" by the total number of points along a transect. (FIREMON)

Point Frame: Used with the PO method a point frame is a wooden or metallic frame with two legs and two cross arms typically containing 10 pins. Steel rods or wire pins are lowered through the holes. (FIREMON)

Polygon: Generally a discrete area defined by vectors or pixels electronically mapped in a Geographical Information system (GIS). In FIREMON polygons define areas with similar stratification attributes. A polygon can define a stand if the polygon boundaries are based on differences in vegetation characteristics. (FIREMON)

Potential Lifeform: A code which describes the community lifeform that would eventually inhabit the FIREMON plot in the absence of disturbance. (FIREMON)

PPR (Plots per day): The number of plots that can be sampled by one crew, if unknown, estimate the rate of four plots per day (FIREMON)

Prism (Wedge Prism): A tapered wedge of glass that bends or deflects light rays at a specific offset angle. When a tree stem is viewed through such a wedge, the bole appears to be displaced. All tree stems not completely offset when viewed through the wedge are counted. Trees that appear borderline should be measured and checked with the appropriate plot radius factor. (Forest Measurements)

Quadrat: A small clearly demarcated plot or sample area of known size on which ecological observations are made. Quadrats may be square, rectangular, or circular and are usually no more than one square meter. Compare microplot and subplot. (Glossary of Landscape, Vegetation Ecology for Alaska)

RS (Rare Species): This FIREMON method is used specifically for monitoring rare plants such as threatened and endangered species. Plants are located using measurement along and perpendicular to the sampling baseline.

Raster: A digital image stored in one of many grid cell formats, where the cells (that is, pixels) are represented as binary numeric values referenced by byte position within the file. Byte position can be translated into pixel row and column, such that the grid models some two-dimensional space. (Landscape Assessment Sampling Methods)

Releve` Approach: A sampling method in which one plot is placed in a representative portion of a stand “without preconceived bias”. The assumption in releve` sampling is that the plot is representative of a larger area (i.e., stand or polygon) and therefore, conditions measured at the plot can be used to describe the stand or polygon as a whole. (Measurements for Terrestrial Vegetation, FIREMON)

Rhizomatous Plants: A plant that has a stem, generally modified, that grows below the surface of the ground and produces roots, scale leaves, and suckers irregularly along its’ length. (Glossary of Landscape, Vegetation Ecology for Alaska)

Riparian: 1) Pertaining to streamside environment. 2) Vegetation growing in close proximity to a watercourse, lake, or spring and often dependent on its roots reaching the water table. (Glossary of Landscape & Vegetation Ecology for Alaska)

SA (Sample Area): The established area used for sampling. This can be all of the stands on a selected landscape or targeted stands. For example monitoring plots may only be needed on steep areas where rehabilitation efforts were prevalent. Or, it may be only forested areas need to be sampled to monitor tree establishment after wildfire.

Sampling Plane: Used in the FIREMON FL sampling. The imaginary plane is defined by a measuring tape laid on or near the ground and extends from the top of the litter layer, duff layer or mineral soil – whichever is the highest layer - to a height of six feet. (Handbook for Inventorying Downed Woody Material, FIREMON)

Sapling: A tree greater than 4.5 feet and less than the established breakpoint diameter. (FIREMON)

SC (Species Composition): This is a method used to provide ocular estimates of canopy cover and height for plant species on a macroplot. The SC sampling methods are suited for a wide variety of vegetation types and are especially useful in communities of tall shrubs or trees. (FIREMON)

Sedimentary: Rocks made up of particles deposited from suspension in water. The main kinds of sedimentary rock are limestone, dolomite, sandstone, siltstone, shale and conglomerate. (Glossary of Landscape & Vegetation Ecology for Alaska)

Seedling: A tree less than 4.5 feet. (FIREMON)

Severity Description: A code used to quantify the degree of damage by biotic (insects, disease, browsing) and abiotic (wind, snow, fire) agents. Compare to Damage Severity. (FIREMON)

Shrub: A woody plant which branches below or near ground level into several main stems, so has no clear trunk. It may be deciduous or evergreen. At the end of each growing season there is no die-back of the axes. Compare to herb. (The Concise Oxford Dictionary of Ecology)

Silt: As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80% or more silt and less than 12% clay. (Glossary of Landscape & Vegetation Ecology for Alaska)

Slope: Defined in FIREMON as the inclination of the land surface, measured in degrees, from the horizontal. (Glossary of Landscape & Vegetation Ecology for Alaska, FIREMON)

Slope Shape: Slopes may be characterized as uniform (linear or planar), concave, convex, undulating, flat, or patterned. (FSVEG).

Snag Class: A code used to describe the condition of a dead tree. (FSVeg).

Soil Colloid: Soil substance of very small particle size, mineral or organic. (The Concise Oxford Dictionary of Ecology)

SP (Sampling Potential): In general, sampling potential describes the number of standard plots that can be installed during the sampling effort. This statistic integrates most sampling resources into one index that describes the capacity to perform the monitoring project. The sampling potential (SP-number plots) is the project funds (PF-dollars) divided by crew costs (CC-dollars per day) multiplied by plot production rate (PPR-plots per day). (FIREMON)

Spread Rate: Relative activity of a fire in extending its horizontal dimensions, expressed as rate of increase of the perimeter, rate of increase in area, or rate of advance of its head, depending on the intended use of the information; generally in chains or acres per hour. (Glossary of Wildland Fire Management Terms Used in the U.S.)

SRF (Stand Replacing Fire): Fire which kills all or most living overstory trees in a forest and initiates secondary succession or regrowth. (Glossary of Wildland Fire Management Terms Used in the U.S.)

Stand: A spatially continuous group of trees and associated vegetation having similar vertical and spatial structure and species composition (e.g., pole, seedling, sapling, mature) usually growing under similar soil and climatic conditions. Compare to strata, horizontal. (FSVeg).

Stand Height: The estimate of the height of the highest stratum that contains at least 10 percent crown cover measured across a stand. (FIREMON)

Statistical Approach: A method using random sampling, which is utilized in most natural resource inventories. The emphasis is on gaining a statistically sound estimate of variation and mean that can be used to make inference. (FIREMON)

Status: In FIREMON this is a classification for the general health of a plant. There are four tree status codes: 1) Healthy, 2) Unhealthy, 3) Sick, and 4) Dead. (FIREMON)

Strata, Horizontal: In FIREMON these are areas with similar stratification attributes. Compare polygon. (FIREMON)

Strata, Vertical: Referring to one or more layers of a community, arranged vertically and having a continuous sequential order from below-ground to ground-level, and from ground-level to the uppermost vegetative canopy. Strata typically are based on within-stratum similarities of physical organization, species composition, and/or microclimate (Landscape Assessment Sampling Methods)

Stratification Factor: Biotic or abiotic attribute such as fuel load, tree density or treatment type used to stratify or divide a landscape into like polygons or strata. (FIREMON)

Stratified Random Sample: Method of locating plots within a stratum used with the statistical approach to establish plots randomly across the landscape stands or based on some land type stratification factor; using any technique that distributes plots so that probability of all possible plot locations is equal. (FIREMON)

Stratified Systematic Sample: Method of locating plots within a stratum used with the statistical approach. Establishes the first plot randomly where the probability of all possible locations are equal. Then all other macroplots are located with reference to the first, usually along a grid or network of, usually, equal spacing. (FIREMON)

Structural Characteristics: In FIREMON the five important tree characteristics are: DBH, height, live crown length, crown fuel base height and crown class. These characteristics are used to compute properties such as crown biomass, vertical ladder fuels, and potential fire-caused mortality. (FIREMON)

Structural Stage: Describes a stand in terms of the primary elements of vegetation structure, which are growth form, vertical structure and coverage. (Glossary of Landscape & Vegetation for Alaska)

Subplot: A subplot is a microplot nested inside the macroplot for the purpose of measuring numerous individuals or other attributes that would be difficult to assess over the entire macroplot. In FIREMON, generally associated with the TD method. Compare quadrat and microplot. (FIREMON)

Surficial Geology: The description of the rock type on the surface of the earth.

TD (Tree Data): Methods used to sample individual trees in a fixed-area plot to estimate tree density, size, and age class distributions before and after fire so that tree survival and mortality rates can be assessed. This method allows the measurement of diameter, height, age, growth rate, crown length, pathogen evidence, fire severity, and snag description for each tree above a user-specified diameter. (FIREMON)

Topography: The configuration of the earth’s surface, including its relief and the position of its natural and manmade features. (Introduction to Wildland Fire Behavior Calculations)

Transect: A theoretically non-dimensional line that is located within the macroplot. Ecological attributes that intersect or cross the transect are tallied or measured. Compare to Belt transect. (FIREMON)

Treatment: Procedures applied on the landscape or stand level where the effects can be compared to other applied procedures. Examples include a fall burned prescribed fire, an unburned 'control', or an area burned with a specific ignition method or pattern, or a harvested and burned area. (Fire Effects Guide)

UTM (Universal Transverse Mercator): A two-dimensional (flat-map) projection widely used in natural resource applications, suitable for maps of 1:100,000 and greater scale, e.g.1:24,000. Each hemisphere of the world is divided into 60, 6-degree, zones by longitude. Within each zone, the reference is an X, Y equidistant grid in meters, with origin at the lower-left zone corner (western most point on the equator). Coordinate pairs are given in meters northing and easting (e.g. 5437689N, 278334E), increasing from the origin to the north and to the east, respectively. (Landscape Assessment Sampling Methods)

Vascular Plants: A plant having specialized tissues (xylem and phloem) that conduct water and synthesized foods; such as a fern or seed plant. (Webster's New World Dictionary)

Vector: Geographic data represented as numeric X, Y coordinates, and usually some attribute identifier. Vector data define features by point, line, or polygon topology, and are displayed as such on maps or graphics (Landscape Assessment Sampling Methods)

WD (Work Days): The number of 8-hour workdays available to finish the monitoring project. (FIREMON)

Whorl:

How To…
Guide

HOW TO CONSTRUCT A UNIQUE PLOT IDENTIFIER

This is probably the most critical phase of FIREMON sampling because this plot ID must be unique across all plots that will be entered in the FIREMON database. The plot identifier is made up of three parts: Registration Code, Project Code and Plot Number.

The FIREMON Analysis Tools program will allow summarization and comparison of plots only if they have the same Registration and Project Codes. This restriction is set because typically each monitoring project has unique objectives with the sample size and monitoring methods developed for specific reasons intimately related to each project. Comparisons made between projects with dissimilar methods may not be appropriate.

Registration Code ID **–** The Registration Code is a 4-character code determined by you or assigned to you. The Registration Code should be used to identify a large group of people such, as all the people at one district of a National Forest or a number of people working under one monitoring leader. You are required to use all four characters. Chose your Registration Code so that the letters and numbers are related to your business or organization. For example:

MFSL = Missoula Fire Sciences Lab
MTSW = Montana DNRC, Southwest Land Office
CHRC = Chippewa National Forest, Revegetation Crew
RMJD = Rocky Mountain Research Station, John Doe

Project Code – The Project Code is an 8-charcter code used to identify project work that is done within the group. You are not required to use all eight characters. Some examples of Project Codes are:

TCRESTOR = Tenderfoot Creek Restoration
BurntFk = Burnt Fork Project
SCF1 = Swan Creek Prescribed Fire, Monitoring Crew 1
BoxCkDem = Box Creek Demonstration Project

It will be easier to read the sorted results if you do not include digits in the left most position of the project code. For instance, if two of your projects are 22Lolo and 9Lolo, then when sorted 22Lolo will come before 9Lolo. The preferred option would be to name the projects Lolo09 and Lolo22, although Lolo9 and Lolo22 will sort in the proper order, also.

Plot Number **-** Identifier that corresponds to the site where sampling methods are applied. Integer value.

HOW TO LOCATE A FIREMON PLOT

The FIREMON plot describes the area where the FIREMON methods are applied. Each plot location is determined by the sampling approach – relevé or statistical - then its location is identified with written directions to the plot center and, finally, monumented with a permanent marker.

Identifying the appropriate place for a FIREMON plot

FIREMON plot location procedures differ by sampling approach. If a relevé approach is used, then FIREMON plots are located by traversing the strata to be sampled to find the range of vegetation and biophysical conditions that exist within the strata. When a location is found that has the conditions that comprehensively represent conditions across the entire stand the crew boss will identify the plot center. Representative conditions should be assessed from a wide range of ecological attributes. First, the macroplot should represent the vegetation conditions of the strata. This includes species composition, vertical stand structure (e.g. canopy layers), plant size (e.g., DBH, height), and plant health. Next, use the biophysical environment to judge representativiness of the macroplot. The macroplot should represent modal topography conditions or average slope, aspect, slope position, and elevation attributes. The disturbance history should then be taken into account by making sure that the disturbance evidence in the macroplot (i.e., insect, disease, fire, browsing) represents the entire strata. Lastly, make sure the fuel characteristics are representative in the macroplot. Be sure to judge to fuels individually (FWD, CWD and vegetation) and as a group (e.g., fire behavior fuel model) to make sure the macroplot is not located in an atypical fuel condition. Locating a plot in a representative portion of the stand without preconceived bias is somewhat unrealistic and mostly wishful thinking. Most plot locations will contain some element of sampler bias. However, in complex ecosystems with high spatial and temporal variability when many attributed must be measured it appears to be the most simple, efficient, and tenable sampling approach available. One we to minimize bias and subjectivity is to mark a plot location, then randomly choose a direction (e.g., use the second hand on a watch) and place the plot center 100 feet (30 meters) away along the randomly selected direction. There are a few rules that must be followed for relevé plot location. First, establish the plot at least 150 feet (50 meters) from any major change in vegetation or ecosystem conditions, such as a roadway, ecotone, or watercourse, and 150 feet (50 meters) from the edge of the strata. Next, be sure the macroplot does not contain any atypical features such a brush piles, trails, or camp spots.

If a statistical approach is used, then you must randomly locate the plots within the strata or across the landscape using one of three techniques: systematic, random or clumped. The systematic method is usually preferred because most of the FIREMON plots are located a set distance and azimuth from one another making them easier to relocate. The random method uses some process that allows plots to be located at any point within the strata with equal probability. This means that two or more plots may be directly adjacent to one another. Plot locations can be picked by overlaying a map of the strata with a clear plastic sheet marked with random points or using randomly determined x- and y-coordinates. Clumped sampling is used to randomly locate plots around a point of origin. In FIREMON we suggest placing the point of origin near the intersection of multiple strata. This will reduce travel and sampling times and may allow you to increase the number of plots per strata. Unfortunately, cluster sampling usually involves some sort of bias because areas near the point of origin are more likely to be sampled than parts farther away. Also, the plots are, more often than not, near the boundary edges and may not be located to give the best description of typical conditions. These biases may lead to debate over the validity of statistical results. There is a more extensive description of the statistical, random and clumped plot location techniques in the **Integrated Sampling Strategy** document.

Once the plots have been marked on a map the distance and azimuth to each one must be calculated. This can be done using the map scale and plotter or, more easily, using a GIS.

FIREMON Plot center

The center of the FIREMON macroplot is a marked, discreet point around which the sampling methods are applied. FIREMON plots that will be re-sampled must have this point permanently identified. The plot center should be identified by two means: 1) written directions including, at least, latitude/longitude or UTM coordinates and 2) a physical monument. Additionally, plot photos can be quite useful in relocating the FIREMON plot center. See the section, Documenting Plot Location and Fire Effects with Photos in the Plot Description (PD) method.

Written directions to the FIREMON plot

Directions should be kept in the FIREMON notebook and/or the Metadata Table in the FIREMON database. They should carefully describe the directions to the plot from some well-known location that is not likely to change. Instead of, “Travel two miles from the big boulder in Pat Firemon’s pasture…” use, “Turn right at the junction of Highway 87 and Forest Service Road 829, then travel two miles…”
Give more specific directions as you get closer to the plot. The final leg should include distance and azimuth to the plot center. For instance, “…travel 2 miles up FS Rd 829. At Orion Park turn left on FS Rd 73 and go 3.1 miles. On left (north) side of road, are two blazed DF (10.3” and 14.4”) – if you go over culvert for Johnson’s Springs you’ve gone 0.1 mile too far. Trees should also be marked with flagging. Between the two trees is a red stake. The first plot is 245 ft at 330 degrees true north (17.5 degrees E declination) from the stake. Plot center is marked with flagging and 1-foot red wood stake. The stake is 18.2 ft@155 degrees from a 12.4” DF (tag number #33), 25.8 ft@200 degrees from a 9.0” DF (#34) and 23.0 ft@050 degrees from a 18.1” PP (#35). Tags are at 1-foot height facing plot center. The other five plots are in a line spaced two chains apart on an azimuth of 330 true north, starting from the first plot.” The written directions should always include latitude/longitude or UTM coordinates averaged over 200 readings, along with the associated location error.

The directions should be accompanied by a USGS 7.5 minute quadrangle map or aerial photo showing all of the plot locations and, if needed, a hand drawn map showing features not on the quad map such as, side roads and log landings. Be sure to record any unique characteristics that might help locate the plot such as, a group of blow down trees or a spring.

Monumenting the FIREMON plot

The actual method of marking the plot center depends on the land use, distance from roads, vegetation and the type of treatment that will be applied at the plot. We suggest using the most permanent marker possible for the situation. In areas not frequented by the public, domestic livestock, hoofed wildlife or areas that won't see the use of rubber tired skidders; brightly painted steel fence posts or reinforcing bar (rebar) that extend above the understory vegetation make good choices. Rebar is heavy so you don't want to use it if you are traveling long distances on foot. In such cases metal electrical conduit might be a better choice. If the unit is going to be burned the best identification is by stamping or using casket tags. At the other end of the spectrum, a short wooden 2 x 2 in. (5 x 5 cm) post pounded down to ground level may be the best way to go. Relocation of wooden stakes can be made more easily if two or three bridge spikes are pounded around the stake, below ground level, so that the plot center can be relocated with a metal detector. Generally spikes below ground level are not disturbed by or do damage to rubber tired skidders. Identify the plot center marker in some way (paint color, tag, stamped identification, etc.) so that it not confused with other markers on the plot such as the ones used to identify the fuels transects or the vegetation baseline. Each project is unique and it is up to the crew boss to determine the best method for permanently marking the plot center. When used in combination, good written directions, GPS locations, flagging and tree tags you should be able to locate all plot centers with minimal effort.

HOW TO PERMANENTLY ESTABLISH A FIREMON PLOT

FIREMON macroplots can be located permanently by driving a 3-foot (1-meter) long 1-inch (2.5 cm) diameter piece of concrete reinforcement steel bar (rebar) down 1 to 2 feet (0.3 to 0.5 m) into the ground. Use a heavy hammer if possible. Sometimes it's not possible to drive the rebar into the ground because of rocks or hard soil. If so, drive the rebar in as deep as possible and then hacksaw off top leaving about 6 inches (15 cm) of rebar showing. Tie a tag around the rebar about 4 inches (10 cm) from the top. The tag should be hard gauge steel (e.g., casket steel) if the plot will be burned in the near future. Aluminum tags may melt. Use aluminum tags if the plot has already been burned. This tag should have an ID number stamped on it. Write the ID tag down in your notebook. Try to make the ID number part of the plot number. It is highly recommended that an orange or colorful cap be put on the exposed rebar for two reasons. First, it will be easy to relocate and find on the ground. And, most importantly, it will be highly visible so that no one gets hurt by tripping over it or falling on it.

The location of the plot must be documented using three methods. First, stand over the rebar and estimate the longitude and latitude of the plot location using a GPS unit. Average at least 200 instantaneous readings to get the most accurate geo-position. Second, take photos of the plot by following the recommendations in **How To Take Plot Photos.** Third, the rebar should be benchmarked by referencing it to at least three semi-permanent monuments. A monument can be a large, healthy tree (>8 in. DBH), large rock (>6 ft diameter), or stump. Don't use logs, snags, or objects that can easily be moved. Measure the distance and direction (degrees azimuth) from the plot center to the monument and write in a field notebook. Be sure to describe the monument in detail including unique attributes of the monument. For example, record the approximate species, DBH, and height of a tree monument, or describe the type and size of a rock monument.

If possible, permanently mark a monument so that it is more easily identified. For example, blaze a tree monument or scar a rock monument.

HOW TO DEFINE THE BOUNDARIES OF A MACROPLOT

The boundaries of a macroplot are defined by tying flagging on branches or vegetation at a fixed distance away from the plot monuments accounting for slope of the plot. For circular plots a spring loaded logger's tape makes flagging the plot boundaries easier because it automatically rewinds itself as you walk back toward plot center to get around trees. Tie or hook a cloth or logger's tape to the plot center monument, walk out a distance equal to the plot radius and tie a flag to a semi-permanent structure such as a branch, grass bunch or downed log (figure HT-1). Flagging should be placed near eye level along the boundary of the macroplot at intervals that allow the field crew accurate measures of plant cover or tree measurement. It is suggested that at least eight points along the plot perimeter be flagged, but dense undergrowth, high tree densities, or severe topography might require additional flagging. Err on the conservative side and put more flag perimeter points when in doubt. It is important that the distances be adjusted for the slope of the ground by multiplying the fixed distances by a slope correction factor. See **How to Adjust for Slope** for the correction factors. It is very important that the flagging identify which plants are inside or outside the macroplot boundaries.

If the macroplot is rectangular, then cloth tapes are stretched to form the boundaries with all of the corners marked stakes or rebar. Tie flagging on branches that cross over the tape. The tape may not be visible from all parts of the plot and the flags will make it easier to identify the plot boundaries.

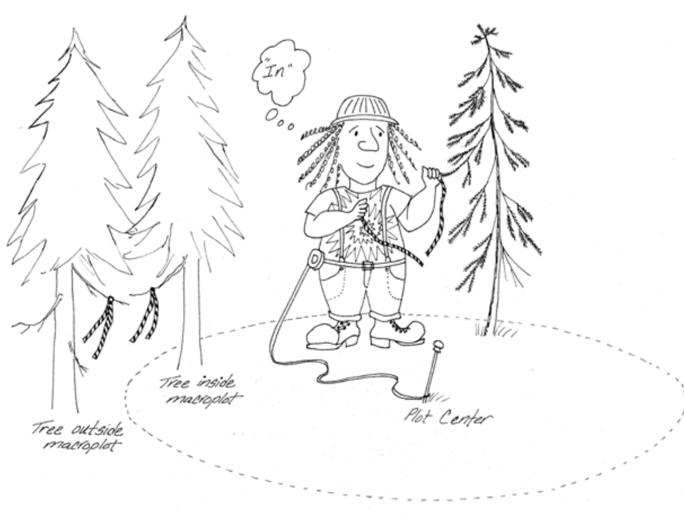

Figure HT-1. Mark the macroplot boundary with flagging.

Selection of the flag color seems trivial but it can be an important phase in this sampling effort. Be sure the flag color is not used by other resource groups at your agency or district office. Select a color that is easy to see and unique. For monitoring plots, it is often helpful if the flags stay up for at least three to five years so that the same boundaries can possibly be used for the second measurement. It is also good practice to write the plot number on the flagging.

HOW TO ESTABLISH PLOTS WITH MULTIPLE METHODS

Plot Layout

Typically, the FIREMON sampling will be done using more than one method. If so, this may mean more than one plot type will be used to gather all of the data. In FIREMON there are four general recommended plot types used for sampling: A 0.1 acre (0.04 ha) circular plot for the Plot Description (PD), Species Composition (SC) and Tree Data (TD) methods, a 66 x 66 foot (20 x 20 meter) vegetation sampling plot for the Cover/Frequency (CF), Point Intercept (PO), Line Intercept (LI) and Density (DE) methods, a hexagonal path defined by the 75-foot (25-meter) Fuel Loading (FL) sampling planes and a 300 x 300 foot (90 x 90 meter) sampling plot for the Composite Burn Index (CB) method. Of course FIREMON allows you to use almost any plot size and shape but the point is, when you lay out the different plot types they should, as much as possible, cover the same area (figure HT-2).

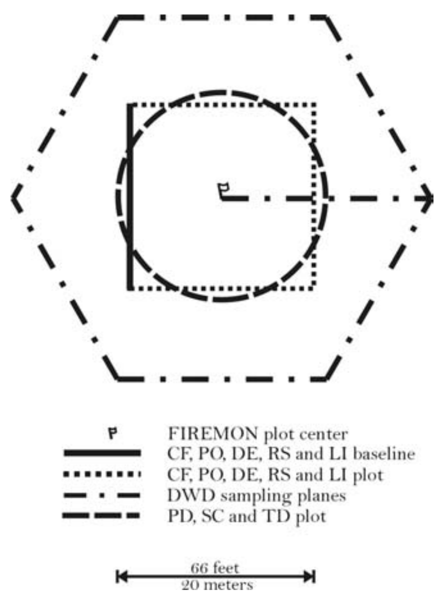

Figure HT-2. Three general plot shapes are used when sampling with the recommended protocols. Often more than one of these plots will be used and if so, the different plots should be laid out so they overlay each other as much as possible.

The FIREMON plot center coincides with the start of the first sampling plane of the FL method as well as the center of the PD, SC and TD methods so it is not difficult to lay them out. The CF, PO, LI and DE methods use transects and quadrats oriented perpendicular to a baseline so it is not intuitive where to start the baseline in order for the vegetation plot to be positioned appropriately. If you are using the recommended plot size for the CF, PO, LI or DE methods then, from the FIREMON plot center, measure 33 feet (10 meters) down slope, then 33 feet (10 meters) across slope to the right and locate the start of the baseline at that point. If the plot is located on flat ground the starting point for the baseline is located 33 feet (10 meters) true south and 33 feet (10 meters) due west from the plot center. To locate the baseline when using a different plot size, measure one half the plot width down slope from plot center then one half the plot height across the slope and locate the start of the transect there. For instance, the CB plot corner would be down 150 feet (45 meters) and across 150 feet (45 meters). If you are using a rectangular plot the longer dimension will generally go across the slope.

Sampling Order

Each sampling method will impact the sampling area to some extent and the impact from one method may negatively influence the ability to sample with another method. For instance, tree sampling often leads to lots of trampling because the samplers are moving back and forth across the plot to mark the boundary, then sampling small and mature trees. If you try to measure herbaceous vegetation heights after tree sampling you won't get a true representation because of the trampling.

Use the table below to order the sampling on your plot (table HT-1). Look for the method(s) that you will be using on each FIREMON plot and sample them in the order you find them in the table. For example, if you using the TD and CF methods complete the CF protocol before moving on to the TD protocol. The first three methods are equally sensitive to plot disturbance, however, rarely would more than one be used on a particular plot.

Table HT-1.Order your sampling by applying the protocols in the order they are listed below.

Order	**Method**
1	RS
2	SC
3	PO
4	CF
5	DE
6	LI
7	TD
8	FL
9	CB
10	PD

HOW TO DETERMINE SAMPLE SIZE

Plotting Graphs of Mean Values for Varying Sample Sizes

It may be necessary to sample more than the recommended number of transects or quadrats in order to sufficiently capture the plant species variation within the macroplot. The FIREMON Line Intercept, Point Intercept-Transect and Density-Belt Transect sampling methods are transect based methods that may require adding more transects or making the existing transect length longer in order to capture the variability of the attribute of interest. The FIREMON Cover/Frequency (CF), Point Intercept-Frame, and Density-Quadrat methods are quadrat based sampling methods the may require installing more quadrats on a longer transects or installing more quadrats on additional transects in order to capture the variability of the attribute of interest.

The following example uses the FIREMON CF method to determine a sufficient sample size for estimating plant species canopy cover. Begin by laying out the minimum number of transects and quadrats. See **How to Locate Transects and Quadrats** for more details. Then record plant species canopy cover for each quadrat. Using a calculator and graph paper or a spreadsheet program such as Microsoft Excel, plot the average canopy cover of selected plant species for varying number of quadrats (table HT-2). Start with averaging canopy cover for the first quadrat and end with averaging canopy cover over all quadrats. It may be necessary to plot average plant species cover values on more than one plot if some plant species have low cover values and some plant species have high cover values. Plotting cover values at different scales will allow you to see fluctuations in the graphs for all species, regardless of the absolute cover values. In this example, three species with high relative cover values were plotted on one graph (figure HT-3) and two species with low relative cover values were plotted on a second graph (figure HT-4).

Table HT-2 Average canopy cover values for selected plant species. Average values are calculated for successively larger numbers of quadrats.

Agropyron spicatum	Agropyron smithii	Bromus japonicus	Achillea millefolium	Koelaria cristata
0	0	0	0	0
20.5	20.4	0.5	0	0
23.3	23.3	1.3	0	1
23.4	23.3	6	0.25	1.5
18.4	18.5	5.4	0.2	1.2
15.2	14.9	5	0.17	1
13.6	14.5	5.7	0.14	1
11.1	14.4	5.4	0.25	1
10.7	13.4	5.1	0.22	1.22
9.5	12.5	5.6	0.3	1.1
9.1	12.5	4.5	0.27	1
8.4	11.2	5.2	0.25	0.92
7.4	10	5	0.46	1.1
7.3	9.2	4.8	0.5	1.2
7.2	9.2	4.5	0.47	1.1
6.3	9.2	4.4	0.63	1.06
6.3	7.8	4.3	0.59	1.06
6.3	7.8	4.1	0.56	1.17
5.6	7.1	4	0.68	1.26
5.4	7.1	4	0.65	1.35
5.3	7.1	3.8	0.67	1.29
5.4	7.1	3.8	0.64	1.3
4.3	6.2	3.5	0.62	1.3
4.3	6.2	3.5	0.62	1.3
4.3	6.2	3.5	0.62	1.3

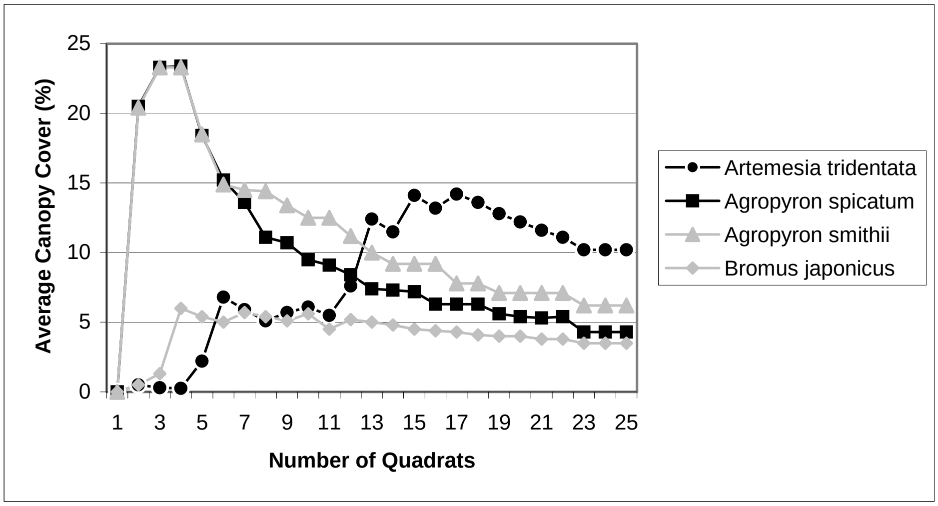

Figure HT-3. Plot of average canopy cover vs. number of quadrats for four plant species on a plot having approximately 5 percent cover or more.

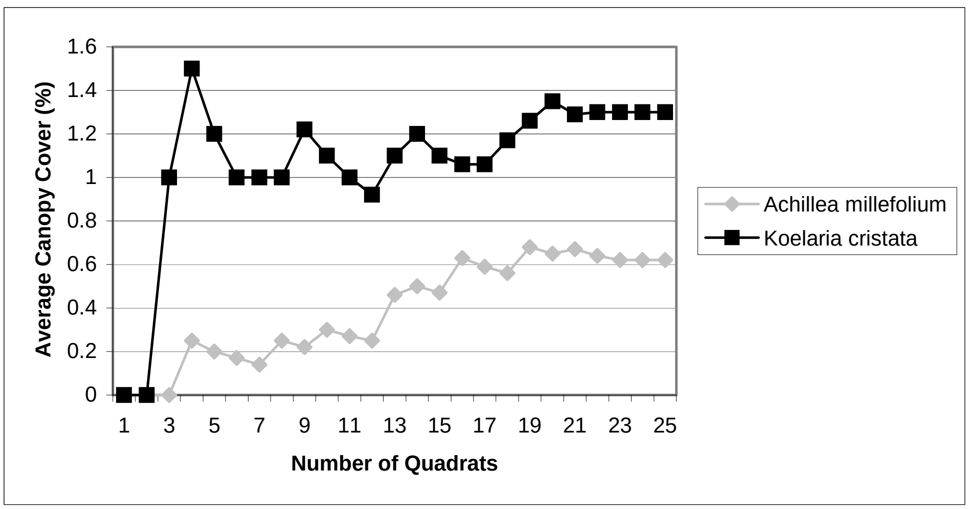

Figure HT-4. Plot of average canopy cover vs. number of quadrats for two plant species on a plot having approximately 1 percent or less cover.

Fluctuations in the graph will level out at a sufficient number of quadrats for sampling the attribute plotted; canopy cover in this example. More quadrats should be sampled if the line graphs do not level out. If more quadrats need to be sampled, add more transects with the same number of quadrats as the other transects or make the existing quadrats longer and add more quadrats. A third option would to place additional quadrats on the existing transects however this can lead to question about the spatial correlation of some attributes so we recommend using this option only if the first two are not feasible. Record plant species canopy cover for the new quadrats and then plot the graphs again with the additional cover values. These graphs can be plotted for other attributes such as frequency, density, and height. The basic idea is to plot a graph for the attribute you are interested in measuring and adjust the sample size appropriately. This method can be used to plot mean attribute values by transect for the transect sampling methods. The number of transects sampled may be adjusted accordingly.

HOW TO ESTIMATE COVER

General Cover Estimation Techniques

Depending on the objectives of your monitoring project you may be estimating cover using the Plot Description (PD), Fuel Load (FL), Cover/Frequency (CF), Line intercept (LI), Point Intercept (PO) and Species Composition (SC) methods. In FIREMON cover estimation is generally made at one of two general scales. In the PD and SC methods estimation is over the entire FIREMON macroplot; for the other methods – except the LI - the cover plot is usually a point, 0.25-meter square or 2-meter diameter cylinder. Cover is measured using a measuring tape when using the Line Intercept (LI) method, however the cover estimation is much more straightforward in the LI method and is described in the LI documentation.

Cover is usually defined one of two ways. First, cover may be defined by the outside edge or drip line of the plant crown being assessed with all of the spaces within the crown included in the estimate. Although there is no standard definition this cover assessment is sometimes called canopy cover, or if tree cover is being estimated, crown cover. Second, cover may be estimated as the vertical projection of the plant foliage and supporting parts with all of the spaces within the crown excluded from the estimate. Again, there is no standard definition however this cover assessment is sometimes called foliar cover. Since the foliage of overstory trees is dense the two assessments are nearly synonymous for that component. Apart from FIREMON, it is common for cover of overstory trees to be estimated using the canopy cover definition and the cover of other components to be estimated using foliar cover definition.

In FIREMON, all the methods suggest using foliar cover for the cover estimates. Figures HT-7 and HT-8 were developed to help users estimate foliar cover. The other figures are presented to help users visualize concepts, such as subdividing and grouping, to make better cover estimations. If user's want to estimate canopy cover rather than foliar cover for any cover assessment it should be noted in the Metadata table.

Of the two types, foliar cover is a better measure of vegetation change over time. If you estimate cover based on plant perimeter you are purposely disregarding the open spaces in the canopy. These spaces are likely locations for new growth to occur so it would be possible for foliar cover to increase over time without any associated increase in canopy cover. Changes in foliar cover are often important to fire monitoring projects so we suggest sampling that characteristic rather than just canopy cover.

The biomass equations used in the FIREMON Analysis Tools package are based on foliar cover, but this is not always the case. If you are collecting species specific cover data to derive biomass outside of the FIREMON Analysis Tools be sure that you sample cover the same way that it was sampled when the equations were developed or your biomass estimations will be incorrect.

You may need to make cover estimates for a number of ecosystem components. The most common estimates are for living vegetation, such as individual species, structural layer, or life form. Other components include cover of dead vegetation such as fine and coarse woody debris and dead herbaceous material. Finally, bare ground, rocks and ash are examples of non-vegetation components that may need to be sampled.

In FIREMON, "cover" is the vertically projected cover of the component being sampled. Vertically projected cover is best described as the cover of the sampling entity if it were compressed straight to the ground. In order to make good estimations of cover, field samplers will need to visualize this compression for each component. This might not be hard to visualize if samplers are estimating the cover of logs, lichen or some other low entity but as the vegetation gets taller and occupies more layers the task becomes more difficult. Experience will help samplers be less intimidated by it. Sometimes a plant that is rooted outside the sampling area has vegetation – branches and leaves primarily - growing within the sampling area. This vegetation should be included in the cover estimate you make.

The cover classes used in FIREMON are relatively broad, typically 10 percent (table HT-3), so the precision of cover estimates are secondary to accuracy.

Table HT-3. Cover classes used in FIREMON.

Code	Cover Class
0	Zero percent cover
0.5	0-1 percent cover
3	>1-5 percent cover
10	>5-15 percent cover
20	>15-25 percent cover
30	>25-35 percent cover
40	>35-45 percent cover
50	>45-55 percent cover
60	>55-65 percent cover
70	>65-75 percent cover
80	>75-85 percent cover
90	>85-95 percent cover
98	>95-100 percent cover

The easiest way to get a cover estimate in the field is through an iterative process where you first note that cover is between two cover classes, then use the midpoint of those two classes and try to determine which half the cover is in. Continue this until you have narrowed cover down to one class. For instance, say you are looking at a sampling area and you know for certain that cover is between 15 and 55 percent (cover classes 20 and 60). Next, try and determine if cover is between 15 and 35 percent or between 35 and 55 percent. If you think cover is lower than 35 percent then try to determine if cover is between 15 and 25 percent or of it is between 25 and 35 percent. Cover class will be 20 if you choose the lower half or 30 if you choose the upper half.

Experienced field samplers usually get accurate estimations of cover using two methods: grouping or subdividing. On smaller plots many samplers mentally group the plants to one corner of the sampling area and then estimate the cover. Cover estimates are easier when you group using a marked quadrat like the one described in the CF methods. The subdivision method uses our natural ability to estimate cover on small areas better than large areas and is typically used on large plots, like the FIREMON macroplot. Also, because samplers may not be able to see the entire plot from one location, subdivision is required in order to get accurate estimates.

When using the subdivision method, divide the sampling area into quadrants or some other easily determined area, and estimate the cover in each part. It may be useful to use the grouping technique on each quadrant also. In figure HT-5, A, illustrates how plants, represented by the circles, might be distributed across a plot. B shows the plot divided into quadrants and plants being mentally combined within the quadrant then the combined cover is shown using circles in C or as squares in D. The areas of all the circles in A make up 10 percent cover. In C, percent cover for quadrants 1, 2, 3 and 4 is 12, 4, 16 and 8 percent, respectively. Percent cover, then, is (12 + 4 + 16 + 8)/4 = 10 percent. Usually you will also be developing a species list for the plot, so as you walk around the perimeter looking at the cover within each quadrant you can record the species at the same time.

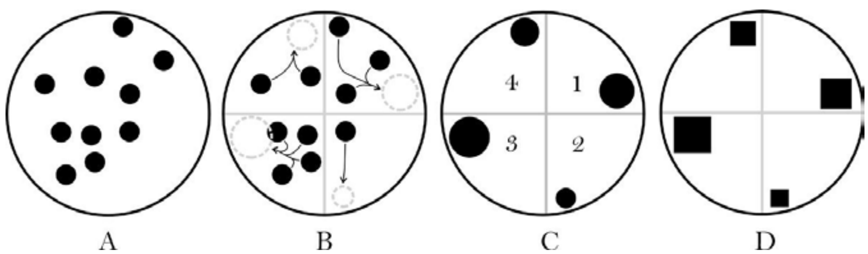

Figure HT-5. The subdivision and grouping technique for estimating cover. Average the cover in quadrants to get the cover class estimation.

The dimensions of the imaginary item groups can be used by the field sampler to estimate cover on the entire plot. For instance, if you visually group all of the herbaceous cover on the 0.10 acre macroplot and find that it would fit in a circle about 24 feet across, that group would constitute a cover of about 10 percent (table HT-4). This method can be used at the individual species level, for estimating cover in layers or for a composite estimation of cover.

Table HT-4. Percent cover for different radius areas on a 0.10 acre (400 m^2) circular macroplot.

Radius (feet)	Radius (meters)	Percent of 0.10 acre (400 m^2) macroplot
37.2	11.28	100
26.3	7.98	50
18.6	5.64	25
11.8	3.57	10
8.3	2.52	5
3.7	1.13	1

Regardless of the technique used for estimating cover, samplers will need to calibrate their eye in order to make an accurate assessment of cover. Field crews should develop a plan so that samplers can calibrate their eyes periodically throughout the field season. The best way to do this is by visually estimating cover on a FIREMON plot sized area where the "true" value has been verified using either PO for ground cover, CF for herbaceous cover, and/or LI for shrub cover. Below are some illustrations that are designed to help samplers as they begin to calibrate their eye.

The illustrations in figure HT-6 represent a circular plot of any size. Before reading the figure caption try to estimate the area inside each large circle that is covered by the smaller circles. As a hint, people tend to overestimate.

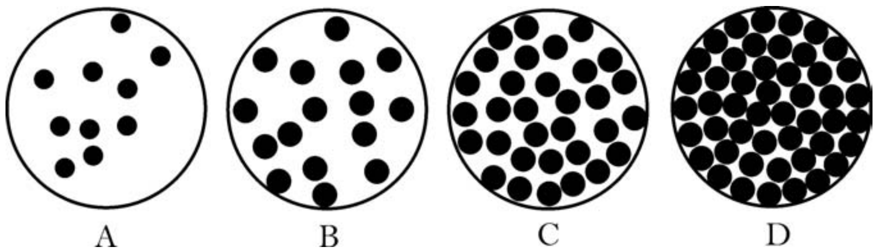

Figure HT-6. Cover illustrations showing different levels of cover. Cover in A, B, C and D is 10, 25, 50 and 75 percent, respectively.

The illustrations in figure HT-7 represent a 6-foot diameter sampling area with 1 in. and 0.25 in. diameter pieces scattered inside. Try to estimate the percent of vertically projected cover before reading the caption.

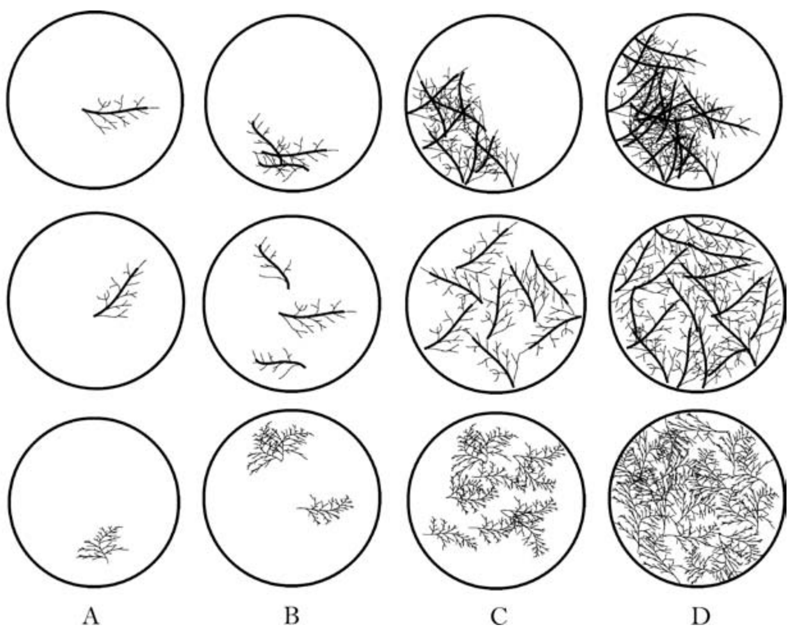

Figure HT-7. Cover illustrations showing levels of dead vegetation. Each circle represents a 6-foot diameter sampling area. Thick lines represent pieces 1 in. diameter and thin lines 0.25 in. diameter. The cover in columns A, B, C and D is 1, 3, 10 and 20 percent, respectively.

Notice that in figure HT-7 the illustrations of branches are two-dimensional representations of three-dimensional entities - that is each illustration shows how much ground the dead branches would cover if they were compressed straight to the ground. In the field, samplers will need to get comfortable with imagining all of the suspended pieces moved to the ground in order to estimate vertically projected cover.

The illustrations in figure HT-8 represent live cover on a 6-foot diameter sample plot. This cover estimate includes both the branches and leaves together. What percent cover would you guess is in each of the illustrations below? Remember, some of the vegetation in the sampling area might be rooted outside the sampling area; however, it is included in your cover estimate.

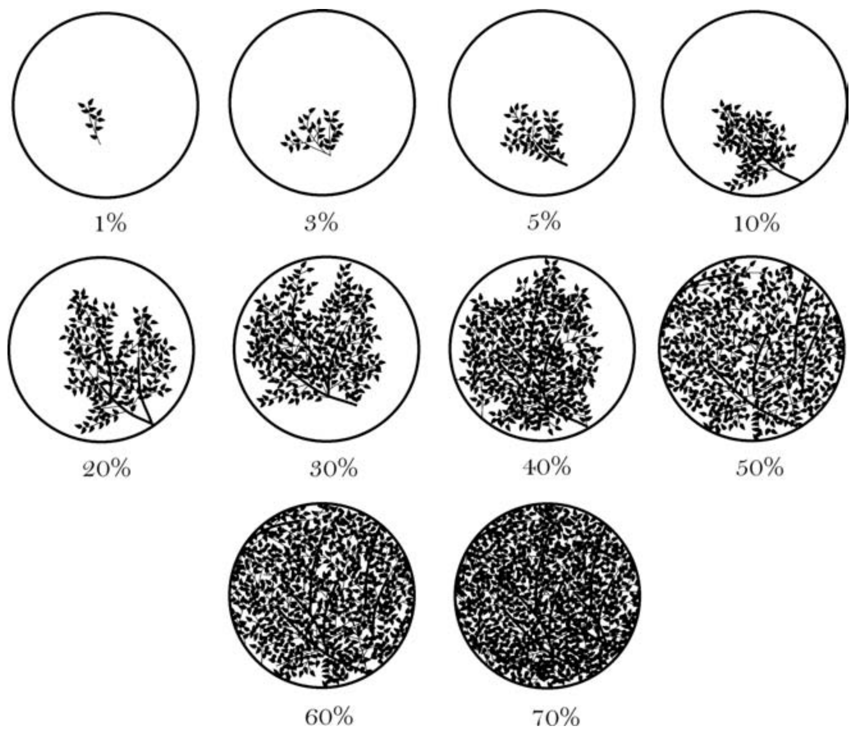

Figure HT-8. Cover of live vegetation on a 6-foot diameter sampling area. The percent cover is indicated under each illustration.

Estimating the cover of multiple entities makes the task of estimating cover more difficult because you have to mentally separate each entity. It is easiest to first make an estimate of the total vertically projected cover on the sampling area, and then estimate cover of the entities from greatest cover to least cover. Figure HT-9 shows two entities, woody and non-woody vegetation, being sampled on the same sampling area. First, the total cover (A) would be estimated, then non-woody cover (B) and, finally, woody cover (C). Because of overlap between entities, the sum of the entities may be greater than the total cover and may sum to be greater than 100.

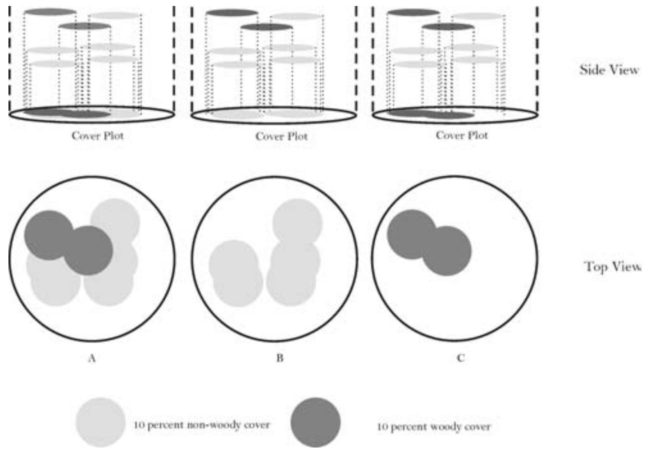

Figure HT-9. In these illustrations each circle, individually, represents 10 percent cover. A) Total cover within the sampling area is about 40 percent. B) Cover of non-woody vegetation is about 30 percent. C) Cover of woody vegetation is about 15 percent. Note that, because of overlap, the sum of cover for the entities will always be greater than or equal to the total cover, and may sum to greater than 100 percent cover. In terms of field data, cover in A, B and C would be recorded as 40, 30 and 20, respectively.

Additional Hints For Estimating Cover When Using the Species Composition (SC) Method

Use the techniques provided above to estimate cover on the SC sampling area. Both the subdivision and grouping techniques may be helpful on a large macroplot. If you are sampling species cover do not include overlap between canopies of the same plant species (figure HT-10). If cover is measured by size class for a plant species estimate the cover for each size class and include canopy overlap between different size classes (figure HT-11).

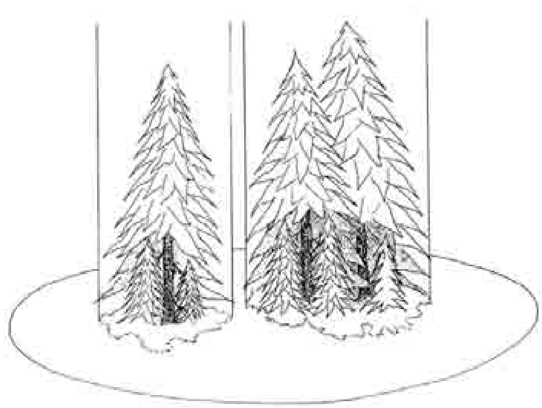

Figure HT-10. In this figure the small trees underneath the canopy of the larger trees are the same plant species. If cover estimates are being made for total cover by species then cover is estimated as the projection of the large tree canopy onto the ground, which overlaps the canopy of the smaller trees.

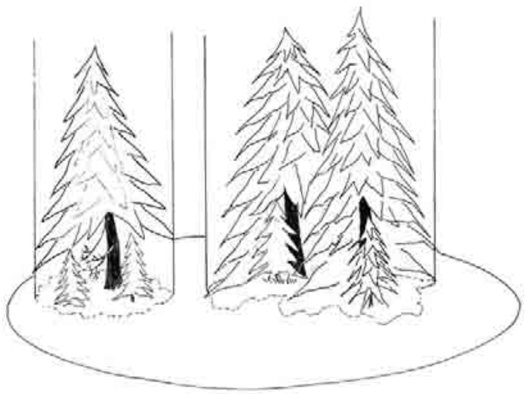

Figure HT-11. In this figure the small trees underneath the canopy of the larger trees are the same plant species but a different size class (e.g. seedlings vs. saplings). If cover estimates are being made by species and size class then one cover estimate should be made for the seedlings and one estimate for the saplings.

Additional Hints For Estimating Cover When Using The Quadrat Cover (CF)

Estimating cover within quadrats is made easier by marking the quadrat frame to indicate subplot sizes and knowing the percent of quadrat area each subplot represents (figure HT-12). Subplots are used to estimate cover for a plant species by mentally grouping cover for all individuals of a plant species into one of the subplots. The percent size of that subplot, in relation to the size of the quadrat being sampled, is used to make a cover class estimate for the species. Cover estimates should include plant cover over the plot even if a plant is rooted outside the plot (figure HT- 13).

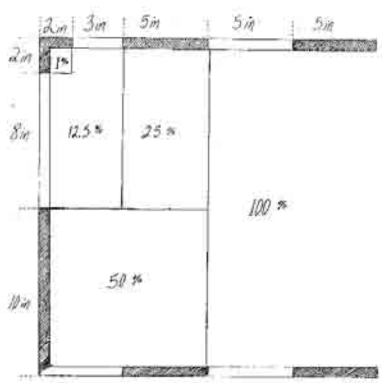

Figure HT-12. Subplot dimensions for the standard 20 x 20 inch (50 x 50 cm) quadrat used for cover/frequency sampling.

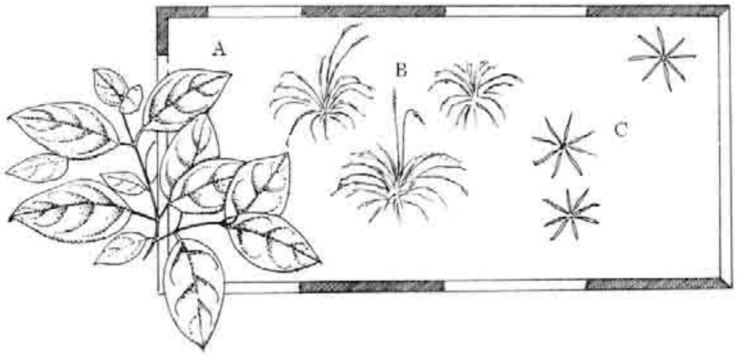

Figure HT-13. Cover from species A is estimated even though this species is not actually rooted within the quadrat.

HOW TO USE A COMPASS - SIGHTING AND SETTING DECLINATION

Compass headings are used to navigate to plots, determine plot aspect, orient sampling transects, etc. In FIREMON we call the compass heading the *azimuth*. It is extremely important that the field crews are familiar with using a compass so they can walk a course with a known azimuth and find the azimuth of a course where the azimuth is unknown. For example, when describing the directions to new FIREMON plot the crew will have to determine what distances and azimuth to record so that sampling crews will be able to find the plot at the next sampling time. For subsequent sampling visits the crew will follow the directions provided by crew that sampled the plot initially. When you are determining a course, compass use is different than when you are following a course. We recommend that you use a compass that has a sighting mirror and declination adjustment. The parts of a compass are shown in figure HT-14.

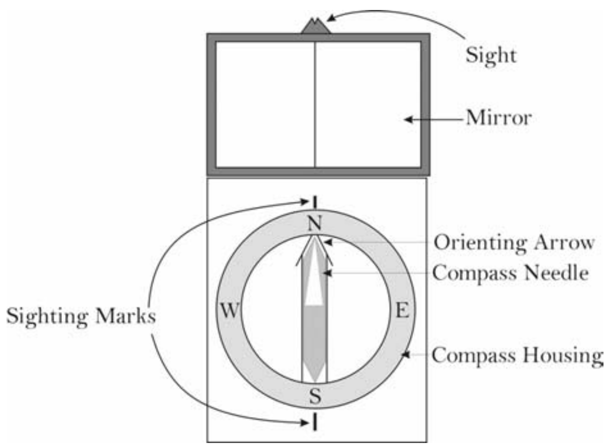

Figure HT-14. The parts of a compass. Azimuth numbers have been left off for readability.

If you want to determine a course between two points, say a flagged tree and the plot, stand at the tree, set up your compass so that you can see the compass face in the mirror, with the sighting line in the mirror and the sight on the compass lined up. Now, with the compass level, hold it out in front of you at eye level so that you can see the plot center in the sight on top of the compass. If the compass is not held level the compass needle will not rotate freely and the azimuth will be wrong. Sometimes there are bubbles in the compass and you can use the bubble's reflection in the mirror to let you know if the compass is not level. With the plot center in the sight and the scribed line on the mirror lined up with the sighting marks on the compass face, hold the compass still and while looking at the compass needle in the mirror use your free hand to turn the compass housing until the compass needle is parallel to the orienting arrow. Make sure that the north end of the compass needle (usually marked red) is pointing the same direction as the orienting arrow or your azimuth will be off 180 degrees. Now you can lower the compass and record the azimuth from the sighting mark closest to the mirror. If the declination is set to zero you will be recording the azimuth in magnetic degrees. If the declination is set to the declination for the sampling area then you will be recording the azimuth in degrees true north.

If the bearing between two points is known and you want to follow that course then set the known azimuth at the sighting mark closest to the mirror. Now hold the compass out in front of you, level and at eye level. Keep the compass in the same position relative to your eye and rotate your body until you see in the mirror that the compass needle is parallel with the orienting needle. Make sure the scribed line on the mirror is lined up with the sights marks or you will be going the wrong direction. With the needles parallel use the sight on the mirror to pick an obvious object, like a rock or tree, that falls in line with the direction you want to go. Pick something that you will be able to see for the entire distance as you are walking and make sure it is distinct enough that you remember which object you are headed toward. For example, don't pick just any tree because many look alike. Instead, pick a tree with a forked crown or other distinctive feature. Once you get to the object you will repeat the procedure. For long distances or in dense vegetation you may have to repeat this sight and walk procedure many times before you get to your destination. When laying out the sampling planes for the FL method you use this technique to guide the sampler pulling the tape. For instance, for the first sampling plane you set the azimuth 090 degrees at the sighting mark closest to the mirror then hold the compass in front of you and guide the other sampler along making sure to keep them on the 090 degree azimuth.

Magnetic declination is the difference between true north (pointing to the north pole) and magnetic north (the direction the needle your compass points). We suggest always using true north degrees and this requires that you set the declination on your compass. The declination for the area you are sampling should be set the same on all the compasses in the project and recorded in the Comments field of the Plot Data table or in the Metadata table. Declination can change substantially as you move from place to place, especially in the northern U.S. and Canada, so be sure that you look up the declination at each of your sampling sites. Probably the best declination values are available from aircraft sectional charts, however those maps may not be immediately available. Ask a pilot friend to give you an old sectional chart when it has gone out of date (usually once a year) and keep it on hand for reference. Declination changes over time so do not use sectional charts greater than 10 years old to get the declination value. Other sources are the people you work with that are familiar with the sampling area or the World Wide Web. For example, the USGS has a coarse scale map of declination on their website. (http://geomag.usgs.gov/usimages.html).

Different compasses have different mechanisms for changing the declination but most use a small screw on the compass housing. Use a screwdriver (usually supplied with a new compass) and turn the declination screw left or right until the mark in the orienting arrow lines up with the proper declination. Be sure that you use the correct declination direction, east or west. In figure HT-15 declination is set to 6 degrees east declination.

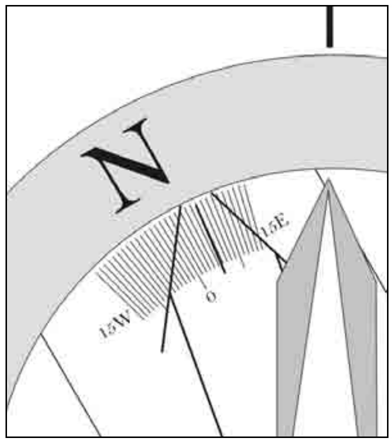

Figure HT-15. The mark in the orienting arrow indicates the compass is set to 6 degrees east declination.

HOW TO ESTABLISH A BASELINE FOR TRANSECTS

The suggested baseline is 66 feet (20 m) long and is oriented upslope with the 0-foot (0 m) mark at the lower point (figure HT-16). On flat areas, the baseline runs from south to north with the 0-foot (0 m) mark on the south end of the baseline. Transects are placed perpendicular to the baseline (across the slope) and are sampled starting at the baseline. Running transects across the slope will help limit the possibility of erosion along paths taken by samplers as they move along the transect. The greatest concern for erosion is on areas with sparse ground vegetation. On flat areas, transects are located west to east.

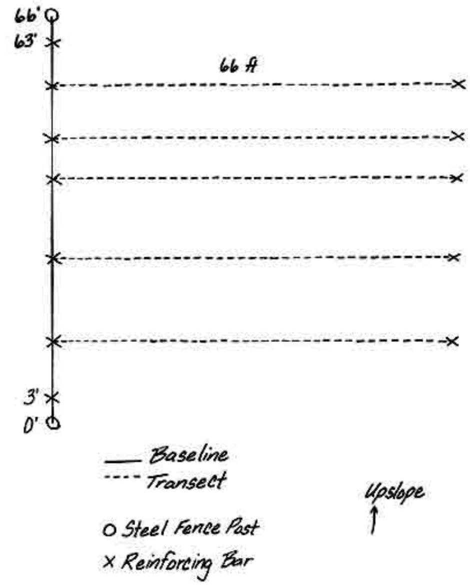

Figure HT-16. Orient the baseline up slope with the zero end positioned at the lower point. Transects are oriented across the slope to limit the opportunity for erosion.

The baseline is established by stretching a tape measure the desired distance between two stakes. Permanently mark the baseline with four markers. In the written description of the plot location record the foot (meter) location of each marker along the baseline. For a 66-foot (20-meter) baseline markers are placed at 0 feet (0 m), 3 feet (1 m), 63 feet (19 m) and 66 feet (20 m). Locating a transect nearer that 3 feet (1 m) to the end of the baseline may mean that portions quadrats will lie outside the vegetation plot. It is not always necessary to permanently mark the 3-foot and 63-foot points but doing so provides a backup in case one or more markers are disturbed. The markers at the start and end of the baseline should be brightly painted or marked with flagging so that they are easy to relocate for subsequent sampling.

In general you should locate the baseline using the most permanent marker available for the situation. In areas not frequented by the public, domestic livestock, hoofed wildlife or areas that won’t see the use of rubber tired skidders; brightly painted steel fence posts or reinforcing bar (rebar) that extend above the understory vegetation make good choices. Rebar is heavy so you don’t want to use it if you are traveling long distances on foot. In these cases metal electrical conduit might be a better choice. If the unit is going to be burned the best identification is by stamping or using casket tags. At the other end of the spectrum, a short wooden 2 x 2 in. (5 x 5 cm) post pounded down to ground level may be the best way to go. Relocation of wooden stakes is easier if two or three bridge spikes are pounded around the stake, below ground level, so that the plot center can be relocated with a metal detector. Generally, spikes below ground level are not disturbed by or do damage to rubber tired skidders. Identify the baseline markers in some way (paint color, tag, stamped identification, etc.) so that they are not confused with other markers on the plot such as the ones used to identify the fuels transects or the plot center. Use a file or other type of permanent marker to display 1, 2, 3, or 4 notches in the appropriate marker with one notch denoting the starting marker and four notches denoting the ending marker along the baseline. Each project is unique and it is up to the crew boss to determine the best method for permanently marking the baseline.

From the starting and ending markers, take a compass bearing and distance to the plot center and record the information on the plot location. Take a compass bearing from the starting marker to the ending marker and record this on the map and on the plot location description. Determine the compass bearing perpendicular to the baseline for each of the transects and record them on the general description map. If permanent transects are established, mark the beginning and ending of each transect with reinforcing bar.

Transect locations are permanently recorded on the general description map and in a written description of the plot layout. Transects are placed perpendicular to the baseline with a compass and tape to insure they are parallel to each other and can be relocated. Such precautions are required if photographs of the transects or quadrats are to be compared over time.

HOW TO LOCATE TRANSECTS AND QUADRATS

The FIREMON Random Transect and Quadrat Locator program (Figure HT-17) selects random starting points for transects along the macroplot baseline. The program also selects random starting points for systematic placement of quadrats along a transect. The numbers are unit-less, so you can enter them in feet or in meters and the result will be in feet or meters.

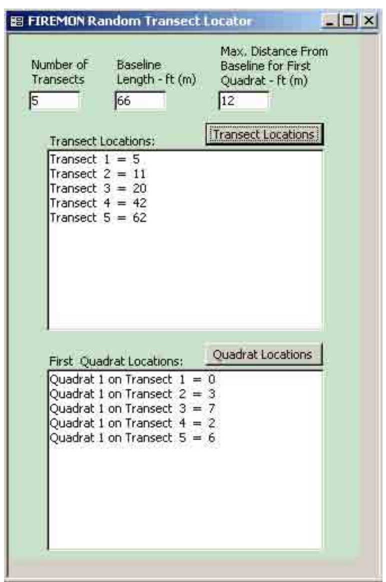

Figure HT-17. FIREMON random transect and quadrat locator.

Enter a seed number for the random number generator. Then enter the number of transects and the length of the baseline in feet (meters). If two or more transects start at the same point or are too close to each other (e.g. less than 1.5 ft. (0.5 m) apart when using quadrats with 20 inch (50 cm) width, press the run button again to generate another set of transect locations. If you are placing quadrats along the transects, you can also generate random starting points for placement of the first quadrat. Enter the maximum distance from the baseline in feet (m) in which the first quadrat on each transect could be placed. For example, if you are placing five 20 x 20 inch (50 x 50 cm) quadrats along a 66-foot (20 m) transect and placing them 12 feet (4 m) apart, the maximum distance would be 12 feet (4 m). If the random starting point equals 10 feet, your quadrats would start at 10, 22, 34, 46, and 58 feet.

Press the Transect Locations button to generate random transect starting points along the baseline. Press the Quadrat Placement button to generate random starting points for quadrat placement along each transect. Tables HT-5 and HT-6 below present five sampling schemes for randomly locating 5 transects, along a 66 foot (20 m). If you were using the FIREMON Line Intercept, Point Intercept, or Density method with only three transects along the baseline, you would use transect locations 1, 3, and 5 in tables HT-5 and HT-6.

Table HT-5. Sample schemes for five randomly placed transects in feet.

	Transect Number				
Sample Scheme	1	2	3	4	5
	Distance Along Baseline (ft)				
1	3	8	14	49	56
2	3	16	20	22	46
3	8	24	34	45	57
4	12	18	22	34	64
5	17	26	30	42	58

Table HT-6. Sample schemes for five randomly placed transects in meters.

	Transect Number				
Sample Scheme	1	2	3	4	5
	Distance Along baseline (m)				
1	2	7	9	16	19
2	1	8	12	16	19
3	4	6	9	16	18
4	2	4	9	15	20
5	1	7	10	14	20

Figure HT-18 illustrates example transect locations and quadrat placement for the recommended FIREMON Cover/Frequency sampling method. Five transects are located along a 66 foot baseline using sampling scheme number 3 from table HT-5. Five quadrats are placed systematically along each transect starting 12 feet from the baseline and placed at 12-foot intervals.

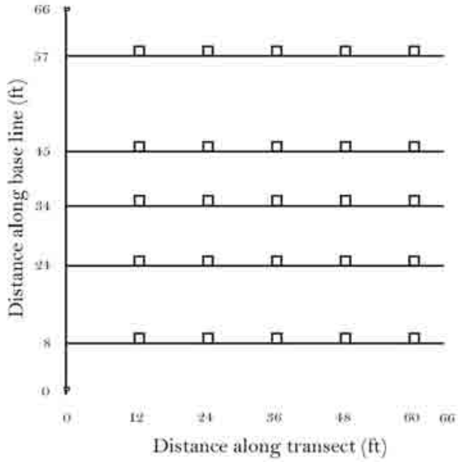

Figure HT-18. Transect and quadrat layout for the recommended FIREMON Cover/Frequency sampling method.

Figure HT-19 illustrates example transect locations, quadrat placement, and belt transect placement for the recommended FIREMON Density sampling method. Five transects are located along a 66-foot baseline using sampling scheme number 3 from table HT-5. Five, 3 X 3 foot quadrats for sampling herbaceous plants are placed systematically along each transect starting 12 feet from the baseline and placed at 12-foot intervals. Three, 6-foot (2 m) belt transects for sampling shrubs and trees are placed along each transect.

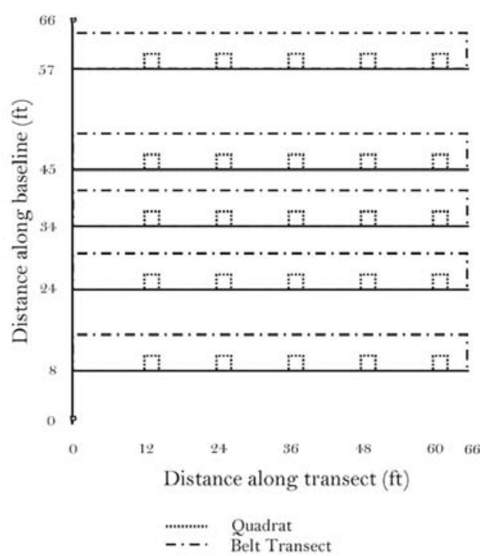

Figure HT-19. Example belt transect (for large shrubs) and quadrat layout for the recommended FIREMON Density sampling method.

HOW TO OFFSET A TRANSECT

If an obstacle, such as a large rock or tree, is encountered along a transect, use the following procedure to lay the transect around it (figure HT-20). First, run the measuring tape from the baseline to the obstacle, and place a permanent marker concrete reinforcing bar (rebar) at this point. Note the distance on the measuring tape. Choose the direction to deviate from the transect, left or right, which gives the shortest offset from the original transect. Next, deviate 90 degrees from the transect until the obstacle is cleared and place a temporary marker at this point. Then run a tape from this point in the same azimuth as the original transect until the obstacle is cleared, and place a temporary marker at this point. Now deviate 90 degrees from this point back to the location of the original transect, and place a permanent marker (rebar) at this point. Add the distance between the two temporary markers to the desired transect length. For example, if you offset 15 feet around a large rock, do not sample on the 15 foot offset, instead extend the transect out to 81 feet (i.e. 66 ft +15 ft). Use the Metadata table or Comments field on the Plot Description form to note the transect modification on the plot.

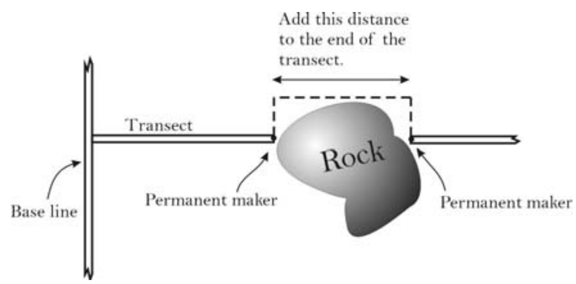

Figure HT-20. If samplers encounter an obstruction offset the transect line around the obstruction and correct for the lost distance by adding on the appropriate amount of transect to the end of the same transect.

HOW TO CONSTRUCT A QUADRAT FRAME

Cover / Frequency Frames

Quadrats are used to provide estimates of canopy cover and frequency by plant species. Subplots within a quadrat frame are used to improve estimates of canopy cover and provide multiple quadrat sizes to measure frequency. Frequency estimates based on subplots nested within a quadrat are commonly referred to as Nested Rooted Frequency. Various types of materials (e.g. wood, metal, or plastic) are suitable for plot frame construction. Large diameter materials should be avoided since they create greater error in estimates of cover and nested frequency than smaller diameter materials. Construction of the standard 20 x 20 inch (50 x 50 cm) quadrat frame for recording canopy cover and nested rooted frequency is described here. Frames having other dimensions can be constructed in a similar fashion.

The 20 x 20 inch (50 x 50 cm) frame used in Cover/Frequency sampling (figure HT-21) has painted sections with alternating colors (e.g. red and white). The alternating colors delineate different sized subplots within the quadrat and are used to help estimate cover. Delineation of these sections is made from the inside of the plot frame. A list of subplot sizes used to estimate cover with the standard 20 x 20 inch (50 x 50 cm) quadrat frame described here is displayed below (table HT-7). The four subplots used to record nested rooted frequency are illustrated and described below (figure HT-22, table HT-8).

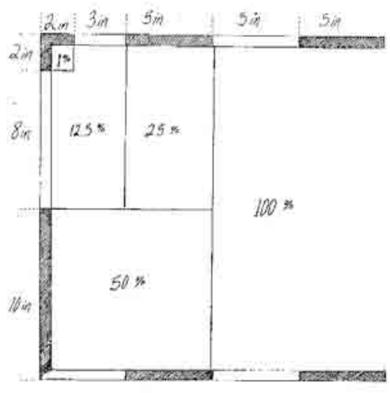

Figure HT-21. Dimensions and color coding conventions for a 20 x 20 inch (50 x 50 cm) quadrat frame. Various subplots are shown with their corresponding percent of the total quadrat.

Table HT-7. Percent of quadrat represented by various subplots within the standard 20 x 20 inch or 50 x 50 cm quadrat.

Size of Subplot (English)	Size of Subplot (Metric)	Percent of Quadrat
2 x 2 in.	5 x 5 cm	1 percent
5 x 10 in.	12.5 x 25 cm	12.5 percent
10 x 10 in.	25 x 25 cm	25 percent
10 x 20 in.	25 x 50 cm	50 percent
20 x 20 in.	50 x 50 cm	100 percent

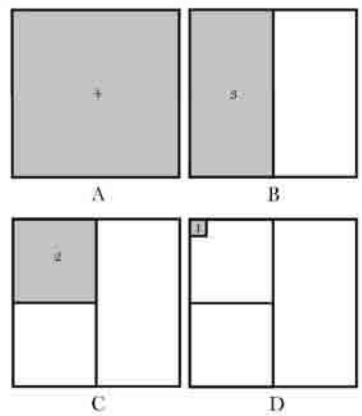

Figure HT-22. The numbers inside the plot frame denote the value recorded if a plant is present in that area of the frame. The number 4 corresponds to the entire quadrat (A). The sampling area for number 3 is the entire top half of the quadrat (B). The sampling areas for the numbers 2 and 1 are the upper left quarter and the upper left corner (1%) of the quadrat, respectively (C and D). Each larger subplot contains all smaller subplots. Subplots aid the sampler in estimating canopy cover by mentally grouping canopy cover for all individuals of a plant species into one of the subplots.

Table HT-8. Percent of quadrat represented by the four subplots used to record nested rooted frequency within the standard 20 x 20 inch (50 x 50 cm) quadrat. Each subplot number includes all subplots with smaller numbers. For example, subplot 3 includes subplots 2 and 1 and is 50 percent of the entire quadrat.

Subplot Number for Rooted Frequency	Size of Subplot (English)	Size of Subplot (Metric)	Percent Quadrat
1	2 x 2 in.	5 x 5 cm	1 percent
2	10 x 10 in.	25 x 25 cm	25 percent
3	10 x 20 in.	25 x 50 cm	50 percent
4	20 x 20 in.	50 x 50 cm	100 percent

Density Frames and Belt Transects

Quadrats and belt transects are used to provide estimates of density for plant species. Quadrats are commonly used to estimate density for grasses and forbs, while belt transects are commonly used to estimate shrub and small tree density. A belt transect is essentially a quadrat with long side, one bounded along the transect, and a narrow side.

For density quadrats we suggest using three folding rulers 6 feet (2 m) in length. Folding rulers work well for delineating density quadrats since they allow for varying quadrat sizes and are easily carried in the field. Depending on the quadrat size and shape, density quadrats are constructed using 1 to 3 rulers. The sampling area can be designated by placing two folding rulers at right angles to the transect tape at a distance equal to the length of the quadrat . The remaining side of the quadrat can be closed with the third folding ruler. If 3 x 3 ft. (1 x 1 m) quadrats are used, then one ruler is folded at right angles and a second ruler used to close the open end of the quadrat. If you anticipate constructing density quadrats longer than 6 ft. (2 m) in length, a long piece of rope may be used to close the long end of the quadrat (figure HT-23).

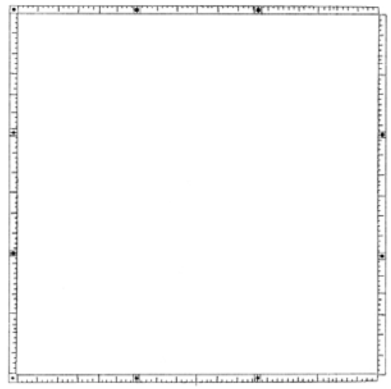

Figure HT-23. Use a folding frame or folding ruler to lay out three sides of the sampling quadrat, slide the under any vegetation and close the quadrat with another yardstick.

Belt transects can be constructed by placing two measuring tapes along the length of the transect and at a distance apart equal to the width of the belt (figure HT-24). The width of the belt is measured at both ends with a folding ruler, 6 ft. (1 m) in length. Instead of stretching parallel tapes to delineate the belt transect, observers may walk along the transect with a ruler the width of the belt transect. The ruler is oriented perpendicular to the transect and one end runs adjacent to the transect. Observers then count individual plants or other items that are within the belt as they walk the length of the transect.

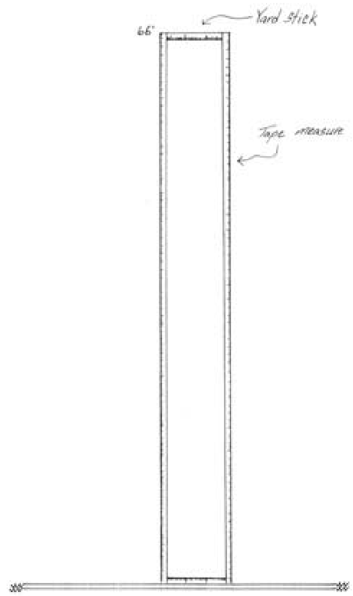

Figure HT-24. Density belt transects can be constructed easily using two measuring tapes and two yardsticks.

HOW TO CONSTRUCT POINT FRAMES AND GRID FRAMES

Point frames are used to provide estimates of plant species cover and ground cover using the Point Intercept (PO) sampling method. Point frames can be constructed out of plastic or metal tubing or wood. The basic concept is to design a free standing frame with 10 holes so that the pins can be lowered vertically (figure HT-25). The point frame should stand far enough above the ground to sample vegetation 3 to 4.5 feet tall (1 to 1.5 m). Pins are commonly placed 3 to 4 inches (7.5 to 10 cm) apart, but spacing is dependent on the size and spacing of the vegetation being sampled.

The PO method may be used in conjunction with the Cover/Frequency (CF) method to sample ground cover by using the CF sampling quadrat as a point frame. A pencil or pen is used to record ground cover “hits” at the four corners and the four midpoints on each side of the quadrat. A total of eight points are recorded for each quadrat.

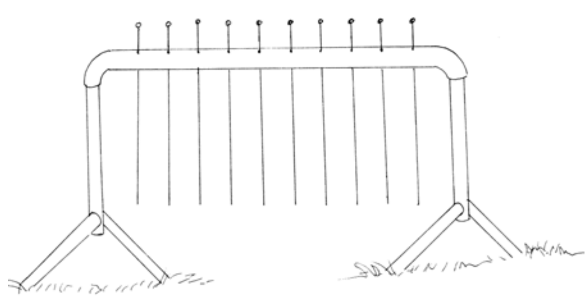

Figure HT-25. Example of a point frame with 10 pins.

Grid frames can be constructed out of metal or plastic tubing or wood. The basic design is to build two square or rectangular frames with wires stretched across the length and width of each frame to form a grid. The grid must have identical spacing for both frames. The frames are placed on top of each other a small distance apart. The entire sighting frame has three to for legs, preferably adjustable type tripod legs (figure HT-26). The two sets of wire grids allow the observer to always have a vertical line of sight when recording point data. The point frame should stand far enough above the ground to sample the vegetation 3 to 4.5 feet (1 to 1.5 m) tall. Cross hairs are commonly placed 3 to 4 inches (7.5 to 10 cm) apart, but spacing is dependent on the size and spacing of the vegetation being sampled.

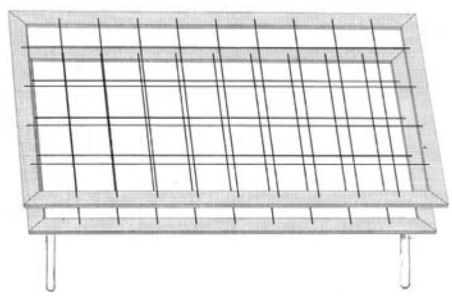

Figure HT-26. Example of a grid frame with 36 points (4 x 9).

HOW TO CUSTOMIZE PLANT SPECIES CODES

FIREMON provides a plant species list from the NRCS PLANTS database (figure HT-27). The NRCS PLANTS codes are the default plant species codes used in FIREMON. We added a field to the table for local plant species codes, so FIREMON users may use their local plant species codes. Enter your local plant species codes in the Local Code field for all plant species sampled on your FIREMON plots. You may search the database by common name, scientific name, or by NRCS PLANTS code by placing your curser in the field you want to search and hitting Ctrl+f. Type the name you are searching in the Find What field. If you are using the NRCS PLANTS code, enter this plant code in the local code field by pressing the Add to Local Code button. If you are using a different code, type it in the Local Code field. (The **FIREMON Database Guide** discusses this procedure in a bit more detail.) The local code field is used to build a reduced plant species list from the NRCS Plants database. All plant species which have a local code are displayed on the drop down menu for plant species on all the data entry screens. This ensures that FIREMON users only view the plant species in their project area.

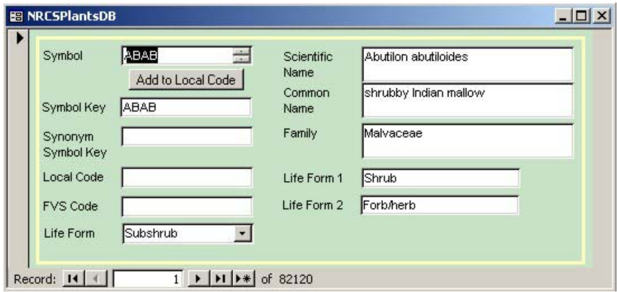

Figure HT-27. NRCS Plants database for FIREMON. Enter your local species code in the Local Code field or enter the NRCS code in this field. NRCS codes are added by clicking on the Add to Local Code button. Plant species may be queried by scientific name, common name, NRCS code, and Local Code once they are entered.

FIREMON also provides a default life form code for each plant species. The default life form code is the first life form provided for each plant species in the NRCS Plants database. Many plant species have two or three life forms. We listed the other life forms for each plant species in the alternative life form fields; Alt_LF_1 and Alt_LF_2. If FIREMON users wish to change the default life form to one of the other life forms, they may use the dropdown menu to select another life form (figure HT-28)

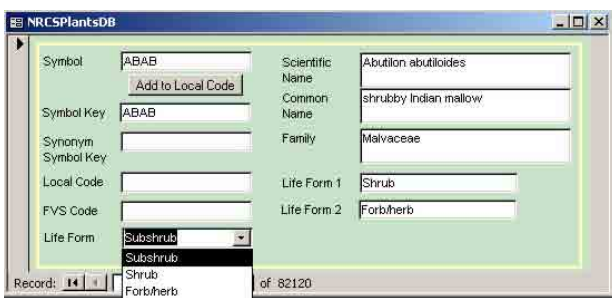

Figure HT-28. Life form codes may be adapted to local situations by replacing the default life form with one of the alternative life form codes in fields Alt_LF_1 or Alt_LF_2.

HOW TO COUNT BOUNDARY PLANTS

Boundary plants are defined as plants that have a portion of basal vegetation intersecting the sampling boundary. The boundary could be a flagged macroplot such as used in the Tree Density sampling method but is more likely to be a quadrat like the one used in the DE method. For different life forms the basal area may be defined differently. For example the basal area of a tree is measured 4.5 feet (1.37 m) above the ground. For shrub species the basal portion is the area beneath the plant were stems grow out of the ground at some predefined density. The basal area of bunchgrasses is where the aerial portions grow out of the ground and is somewhat intuitive (figure HT-29).

Figure HT-29. Bunchgrasses (A), shrubs (B), saplings (C) and trees (D) all have their basal area defined differently. Before any sampling, the crew leader should determine how the basal area will be defined for the different life forms.

Decisions on which boundary plants to count and which ones to exclude must be consistently applied to each quadrat. For example, it is fairly easy to determine if thin, single stemmed plants are in or out of the quadrat, but plants with larger basal diameters (e.g., bunchgrasses) could be partly in and partly out of the quadrat. There are a several ways to count boundary plants, but the easiest way to consistently apply boundary decisions is to count all boundary plants “in” on two adjacent sides of a quadrat and “out” on the other two sides. Figure HT-30 is a top view representation of plants around a quadrat. Some of the plants only have their aerial portion overlapping the quadrat so they are not boundary plants. The plants with their basal portion touching the quadrat are boundary plants. These are the plants that will have the decision rules applied to them. For example, if the rules are that boundary plants on sides 1 and 2 are “in” and the plants on sides 3 and 4 are “out”, then four of the boundary plants in figure HT-30 would be “in” (plants A through D) and four would be “out” (plants E through H).

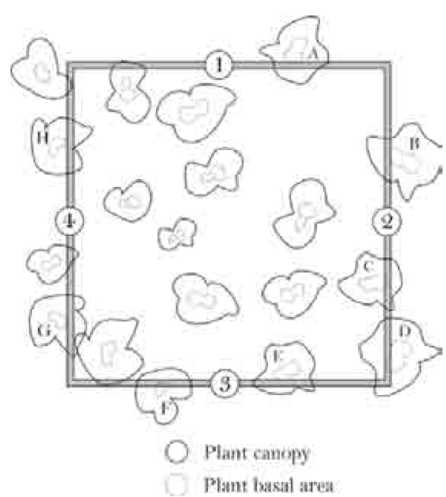

Figure HT-30. Boundary plants are plants with basal portions intercepting the sampling boundary. In this illustration the boundary is a quadrat frame. Using the decision rule to count the boundary plants on sides 1 and 2 as “in” and the plants on sides 3 and 4 as “out” results in plants A through D being included in the survey and plants E through H excluded from the survey.

HOW TO DOT TALLY

Instead of counting items in your head or inefficiently tallying items in groups of five using lines, try using a box tally method where you put a dot for each item. Dot and lines are used to record counts as shown in figure HT-31.

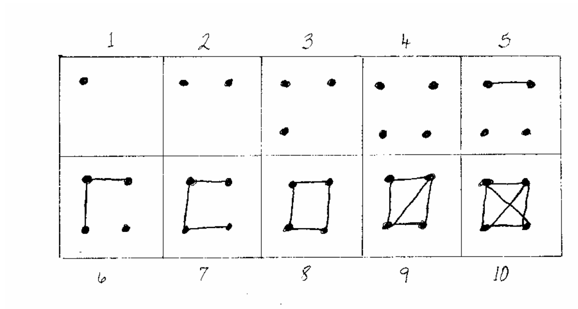

Figure HT-31. Use the dot tally system to record count quickly and accurately.

Each completed box represents 10 items. You will find that this is an efficient and quick method of tallying large numbers of items such as fuel intersects or tree seedlings.

HOW TO MEASURE PLANT HEIGHT

In FIREMON tree or plant height measurement is accomplished using a clinometer, for taller plants, or a yardstick, for shorter plants.

Plants greater than 20 feet (6 m)

First, attach a cloth or logger's tape to the tree or plant at breast height a walk away from the tree, on the slope contour, a distance that you think is about as far as the tree is tall. For example, for a tree that you think is about 30 feet tall, walk out about 40 feet. Once you are in position, read the angle to the top of the tree from the percent scale in the clinometer. Next, take the percent reading from your position to bottom of the tree, where it enters the ground. This angle will usually be negative, which is okay. (figure HT-32).

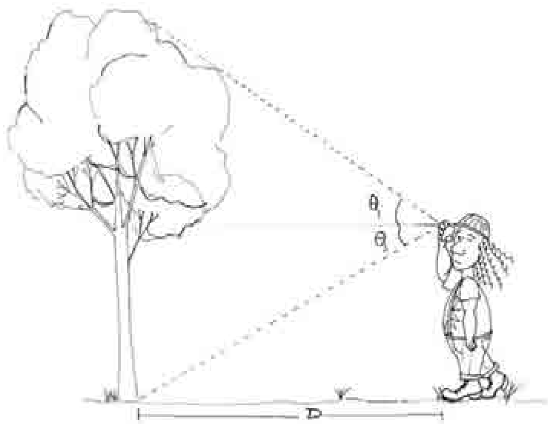

Figure HT-32. Measure the height of tall trees by moving away from the tree a know distance (slope corrected) and measure the percent slope to the top and the bottom of the tree. Use equation HT-1 to calculate height. Units of tree height will be the same as the units on the distance (D) measurement.

Calculate height using the equation:

Eq. HT-1 $$HT = \theta_1\left(D/_{100}\right) - \theta_2\left(D/_{100}\right)$$

where, HT is the tree height in the same units as D.

θ_1 is the angle from the sampling position to the top of the tree, measured in percent slope.

θ_2 is the angle from the sampling position to the bottom of the tree, measured in percent slope.

D is the horizontal distance from the tree in feet or meters.

Note that when the θ_2 is negative you actually add the two angles. If either θ_1 or θ_2 are greater than 100 percent, go out another 20 feet and recheck the angles. Measuring at high angles can cause a lot error. It may be helpful to make a table of tree height as a function of tree angles (total angle from top to bottom of the tree) and distances, to reduce the time spent making height calculations in the field.

Sometimes it is difficult to see the top of the tree because of obstructions or other tree tops. In these cases, have someone shake the tree at DBH which will cause the top to move and perhaps make it more visible. The sampler also might have to move uphill or downhill one or two paces, making sure the distance from the tree is kept constant, to get a better view of the tree top. If you need to move up or downslope, correct for slope using the correction factors in **How to Adjust for Slope.**

Often, the notetaker on the FIREMON plot will be too busy with other duties to hear or record the tree height measurement. Therefore, we recommend that the sampler measuring tree heights take a field notebook into the field and write down the measured heights along with the tree and plot numbers to make sampling go faster.

Depending on the project objective tree height is recorded to the top of the stem or to the highest live foliage; sometimes dead tops are not considered part of the height of the tree. The highest foliage might not be directly above the tree bole, as in hardwoods, so the sampler must be sure to check all lateral branches to make sure the highest foliage is being measured.

If the tree is leaning at an angle measure tree height using the procedure described above even though the tree would measure taller if it were standing up straight.

Plants between 10 and 20 (3 to 6 m) feet tall

Depending on the precision requirements of the monitoring project, these plants can either be measured using a clinometer, for more precise estimates, or they may be estimated. The clinometer method is described in the section immediately preceding this one. Faster, less precise measurements can be made by looking at a tree and moving your eyes up in increments. Most people are about six feet tall so it is easy to think in that scale. Starting at the ground level simply move your eyes up six feet at a time, keeping a mental tally. At first, you should check your estimate using clinometer but with a little practice you will be able to estimate heights of these plants to between 1 and 2 feet, consistently.

Plants less than 10 feet (3 m) tall

Measure these plant heights with a yardstick (meterstick) for the highest precision. You can also measure the height of the top of your boots, knees, hips, head and raised hand, then use those measurements to estimate the plant heights.

Other Height Measuring Tips

Often you will be able to estimate the height of tall trees based on the measured height of another tree that is close by. This can substantially reduce the sampling time because you only need to make four or five height measurements per plot. If the project objectives require high precision then the height of each tree taller than 20 feet should be measured with a clinometer.

Sometimes the sampling methods call for an average plant height across species or life-form. When the plants vary greatly in height this can be tricky because it is hard to estimate an average. One way is to imagine a piece of plastic draped over the plants you are interested in then estimate what the average height of the plastic sheet would be.

When measuring the height of herbaceous plants, measure only to the point that includes approximately 80 percent of the plant biomass. For example, inflorescence height in graminoids is not typically measured.

HOW TO MEASURE DBH

The diameter of a tree or shrub is conventionally measured at exactly 4.5 feet (1.37 meters) above the ground surface, measured on the uphill side of the tree if it is on a slope. Wrap a diameter tape around the bole or stem of the plant, without twists or bends, and without dead or live branches caught between the tape and the stem.

When making the diameter measurement the diameter tape should always be positioned so that it is perpendicular to the tree stem at the point of measurement. If the tree splits above breast height, record as one tree with the diameter measurement made at a representative area below the swell caused by the separation. If the tree splits below breast height then record two trees with diameter measured as close as possible to breast height while still getting a representative measure. If there is a stem deformity at breast height measure the diameter at the closest location above or below that will allow the most representative diameter measurement. (figure HT-33)

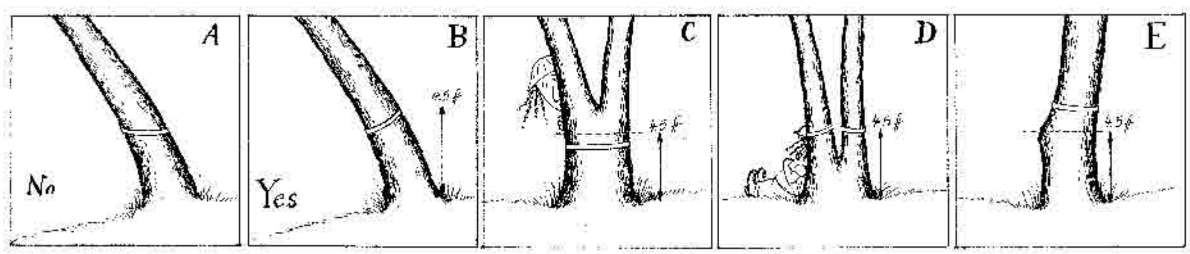

Figure HT-33. DBH measurements. A) Diameter tape is not perpendicular to the tree stem. B) Correct way to measure tree diameter is with tape perpendicular to tree stem. C) If the tree splits above breast height measure tree diameter below any swell cause by the separation. D) If the tree splits below breast height measure as two trees. E) Measure the most representative diameter above or below any deformity.

There may be times when it is necessary to remove problem branches to thread the DBH tape around the tree bole. If so, carefully remove just enough of the unwanted branches so you do not threaten the survival of the tree. (i.e., do not remove excessive amounts of vertical fuel ladders). Sometimes it is impossible to measure DBH with a tape because of protruding branches and other trees. In these rare cases, use a plastic ruler to obtain a diameter (see **How To Measure Diameter with a Ruler**).

If tree you are sampling has multiple stems at breast height then measure the diameter at ground level. This is called the diameter at root crown or DRC. Get the most representative DRC measurement you can of the single stem coming out of the ground. Use the DRC measurement to classify the tree as a mature tree or sapling and mark the Local Code field so you know that DRC was measured. Some studies it is also important to count the number of stems at breast height. The down side to DRC measurements is that they may not give an accurate representation of mortality (counting the number of stems at breast height can overcome this) and basal diameters may not adequately portray canopy fuels for fire modeling.

HOW TO MEASURE DIAMETER WITH A RULER

Using a ruler to measure tree or log diameter can be easier and quicker than with a diameter tape, however, ruler measurements can give biased estimates of diameter if done incorrectly. To measure diameter correctly first, hold one end of the ruler so that it is aligned with the one edge of the tree (at breast height) or log, then, while keeping the ruler in the same position, move your head to the other end of the ruler so that you are looking at the other side of the tree or log at a perpendicular angle to the ruler (figure HT-34). Estimate the diameter to the appropriate precision. With practice you will only need to use the ruler to measure trees that are on the boundary between two classes.

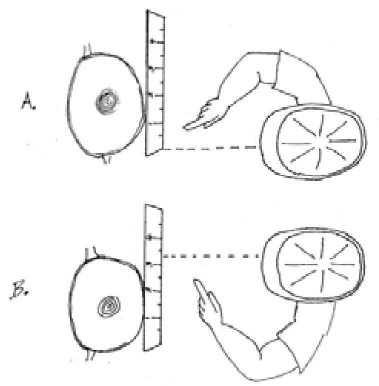

Figure HT-34. To accurately measure tree diameter using a ruler; A) align the left side of the ruler with the left side of the tree then B) without moving the ruler, move your head so that it is aligned with the right side of the tree. The same method can be used for logs.

HOW TO AGE A TREE

Tree age is estimated by extracting a core from the tree at stump height (i.e., about 1 foot above ground-line) on the downhill side of the tree using an increment borer. Stump height is used instead of the conventional height at DBH because it is difficult to estimate the time it takes the tree to grow to DBH, especially in severe environments such as the upper subalpine and woodland ecosystems. In fact, the lower down on the tree, the better the estimate of total age. The increment borer is positioned on the downhill side of the tree at an angle that will ensure that the pith of the tree will be struck as the increment core is drilled into the tree. The pith is required to absolutely estimate the age of the tree at stump height. Tree coring requires a certain degree of experience to consistently obtain the pith. The sampler screws the increment corer into the tree just deep enough to hit the pith, and then inserts the spoon of the corer on the top part of the core (spoon is facing downwards). Then, the sampler unscrews the borer one half turn so that the spoon is facing upwards. The spoon is the tugged gently to remove the core. The sampler should be especially careful because many cores tend to break apart during the extraction process and these pieces need to be salvaged to determine age.

Age is not simply the count of the tree rings from cambium to pith, which is called the stump height age. The number of years it took for the tree to grow to stump height must also be added to the stump height age. This can be done by counting branch whorls on the bole from the ground to stump height, but often branch whorls are difficult to identify and count. Therefore, the sampler must make a best-guess estimate on the years it took the tree to grow to the height where the core was taken. Sometimes, the pith is rotten or difficult to extract, so the sampler must also estimate the number of rings it would take to get to the pith. In that case, three counts must be added to obtain true tree age: (total ring count) + (years to stump height) + (years to pith) = Tree Age.

Once the core is extracted, the sampler can either count the age of the core while the core is still in the spoon, or store the core for ring counting latter in a laboratory or office. If trees are young (< 100 years old) and growth rates are not important, then the sampler should probably count the tree rings in the field and record the age estimate in the appropriate field on the forms. A small magnifying glass is often helpful for counting rings. However, rings on most cores will be difficult to read because they are tightly packed or difficult to distinguish, so it is highly advised that these cores be stored so the rings can be counted at a latter date in an office setting with the proper equipment. Cores can be stored in drinking straws, but it is important that these straws are slit so the core can dry and no mold will form. Or, cores can be mounted on planks. Wood planks or sections of plywood can be grooved with a router using a diameter that corresponds to the increment corer. Then, the core is glued into the groove using wood glue (figure HT-35). The advantage of using the wood mount is that the cores can then be sanded once the glue has dried to heighten the contrast between ring wood to more accurately determine age or growth rate. The disadvantage is that the glue and wood mounts are difficult to transport in the field. It’s best to record plot ID, tree tag number, date, years to stump height, and years to pith directly on the mount or straw.

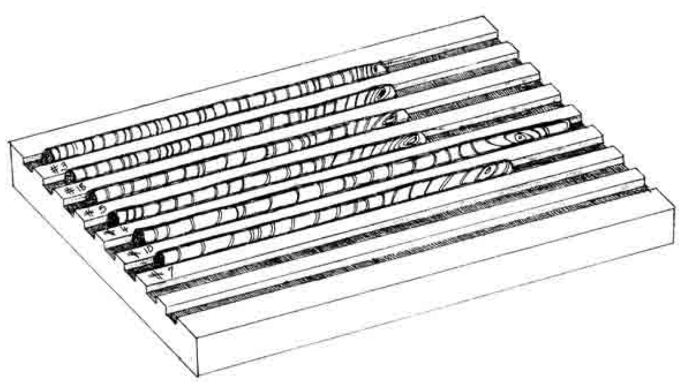

Figure HT-35. A core board is used to permanently store tree cores.

HOW TO MEASURE SLOPE

Slope measurements are made so that a correction factor can be applied to slope distance to get the horizontal distance. To find the percent slope aim the clinometer at the eye level of sampler at the other end of the line (figure HT-36). Be sure to read the slope off the percent scale in the clinometer. For slope correction use the absolute value of percent slope. If there is a height difference of the samplers adjust the height where you are aiming so that the slope reading is accurate.

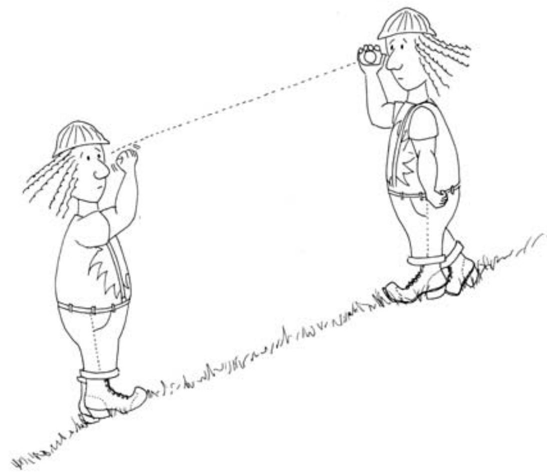

Figure HT-36. Measure the slope of each line by aiming the clinometer at eye level on the sampler at the opposite end of the measuring tape, then reading and recording the percent slope seen on the scale in the instrument.

HOW TO ADJUST FOR SLOPE

Some distance measurements in FIREMON must be corrected to horizontal distance. Examples are macroplot radius and the distance you measure out from a tree when measuring tree height. Table HT-9 shows the correction factor for slope by 10-percent class. Note that the correction factor on slopes less than 30 percent is negligible. To find corrected distance, multiply horizontal distance you need by the appropriate correction factor. For example, when marking the boundary of a macroplot with a radius of 37.2 feet on a site with 50 percent slope you would have to measure the upslope and downslope radius out to a distance of 37.2 X 1.12 = 41.67 feet.

Table HT-9. Correct for slope by multiplying the horizontal distance you need to travel by the appropriate correction factor listed

Slope		Correction	Slope		Correction
Percent	Degrees	Factor	Percent	Degrees	Factor
10	5.71	1.00	100	45.00	1.41
20	11.31	1.02	110	47.73	1.49
30	16.70	1.04	120	50.19	1.56
40	21.80	1.08	130	52.43	1.64
50	26.57	1.12	140	54.46	1.72
60	30.96	1.17	150	56.31	1.80
70	34.99	1.22	160	57.99	1.89
80	38.66	1.28	170	59.53	1.97
90	41.99	1.35	180	60.95	2.06

HOW TO DOCUMENT PLOT LOCATION AND FIRE EFFECTS WITH PHOTOS

Photographs, conventional or digital, are a useful means to document the FIREMON plot. They provide a unique opportunity to visually assess fire effects and document plot location in a database format. Previously established FIREMON plots can be found by orienting the landmarks in photos to visual cues in the field. Photos can be compared to determine important changes after a fire. Lastly, photos provide excellent communication tools for describing fire effects to the public and forest professionals.

Document the FIREMON macroplot location using two photographs taken facing north and east. For the north-facing photo move about 10 feet south of the FIREMON macroplot center then take the photo facing north being sure that the plot center stake or rebar will be visible in the picture (Figure HT-37). Then, move west of the plot center about 10 feet and take a photo facing east, again, being sure that the plot center stake or rebar will be visible in the picture. For these pictures be sure that the camera is focused on the environment surrounding the plot, not the distance or foreground and that the camera is set for the correct exposure and aperture for existing light conditions. A flash might be needed in low-light conditions.

Figure HT-37. Take your plot photos so that they show the plot center and the general plot conditions.

Photos taken with conventional film can be identified by assigning a code that integrates the roll number and/or name and the picture number. For example, picture 8 taken on roll John Smith Roll 1 might be called JSR01P08. Use a consistent system so the plot photos do not get mixed up.

You must label the roll so that you will be able to find the correct photos after the film has been developed. One way is to take a picture of a card with the roll information on it, as your first photo. Or, you can write the roll information on the film canister before you load it into the camera. The first method is the most foolproof. For digital cameras, enter the file name of the digital picture. Film photos will need to be scanned once they are developed and stored on your computer in digital format.

HOW TO RECORD A GPS LOCATION

Basically, there are a number of options today for GPS receivers and ways to acquire locational data. Here are recommend protocols on only a few issues.

Acceptable accuracy

The two-dimensional accuracy of X, Y coordinates reported by the GPS should be less that 10 meters, preferably less than 7 meters. There is no procedural requirement on elevation, or the Z coordinate.

Geodetic Datum

The more accurate and more recent NAD83 should be selected, unless there is strong need to use the data predominantly within a local GIS, *and* the local standard is for some other datum. For example, many National Park Service sites still use NAD27 in order to reference data taken from their older base maps. These were some of the first areas mapped with USGS 1:24,000 quadrangles. In any event, it is very important to note the datum used for plot location, so conversions can be made if necessary.

When digitizing a single point

Y-Code receivers like Rockwell's PLGR, should be set to an averaging mode and allowed to log a number of points until the coordinates stabilize at which time, the plot center is either jotted down or saved in memory. These receivers are only available to approved federal government employees.

P-Code receivers like Trimble's Pathfinder or GeoExplorer, should be treated similarly *only* if "selective availability" is off. If "selective availability" is on, a differential correction should be used. Set the receiver to log and save a hundred or so points for each plot center. There then are options to do differential correction "on the fly" or later, by receiving suitable reference control data from a surveyed base station. You will have to check with GPS-knowledgeable people in your area to find how to access local base station data.

FIREMON
Appendix

Appendix A: NRIS Damage Categories, Agents, Severity Ratings, and Tree Parts

Damage Categories **Code**	**Description**
00	None (default)
10	General insects
11	Bark beetles
12	Defoliators
13	Chewing insects
14	Sucking insects
15	Boring insects
16	Seed/cone/flower/fruit insects
17	Gallmaker insects
18	Insect predators
19	General diseases
20	Biotic damage
21	Root/butt diseases
22	Stem decays/cankers
23	Parasitic/epiphytic plants
24	Decline complexes/dieback/wilts
25	Foliage diseases
26	Stem rusts
27	Broom rusts
30	Fire
41	Wild animals
42	Domestic animals
50	Abiotic damage
60	Competition
70	Human activities
71	Harvest
80	Multi-damage (insect/disease)
90	Unknown
99	Physical effects

Damage Agents

Category	Agent	Common Name
10	**000**	**General Insects**
SEVERITY RATING 101 = minor 102 = severe		
	001	Thrips
	007	Clerid beetle
	009	Green rose chafer
	017	Bagworm moth
	019	Scarab
	021	*Steremnius carinatus*
	023	Wood wasps
11	**000**	**Bark Beetles**
SEVERITY RATING 111 = Unsuccessful bole attack: pitchout and beetle brood absent 112 = Strip attacks: galleries and brood present 113 = Successful bole attack: galleries and brood present 114 = Topkill		
	001	Roundheaded pine beetle
	002	Western pine beetle
	005	Lodgepole pine beetle
	006	Mountain pine beetle
	007	Douglas-fir beetle
	009	Spruce beetle
	012	Red turpentine beetle
	013	*Dryocoetes affaber*
	015	Western balsam bark beetle
	016	*Dryocoetes sechelti*
	017	Ash bark beetles
	018	Native elm bark beetle
	021	Sixspined ips
	022	Emarginate ips
	024	*Ips latidens*
	026	Monterey pine ips
	028	Northern spruce engraver beetle
	029	Pine engraver
	030	Ips engraver beetles
	031	*Ips tridens*
	032	Western ash bark beetle
	034	*Orthotomicus caelatus*
	035	Cedar bark beetles
	036	Western cedar bark beetle
	037	Tip beetles
	038	Douglas-fir twig beetle
	039	Twig beetles
	040	Foureyed spruce beetle
	041	Fir root bark beetle

Damage Agents (cont.)

Category	Agent	Common Name
11 (cont.)	**000**	**Bark Beetles**
	042	*Pseudohylesinus dispar*
	043	Douglas-fir pole beetle
	044	Silver fir beetle
	045	Small European elm bark beetle
	046	Spruce engraver
	048	True fir bark beetles
	049	Douglas-fir engraver
	050	Fir engraver
	053	Four-eyed bark beetle
	054	Hemlock beetle
12	**000**	**Defoliators**
SEVERITY RATING 121 = Light defoliation (1-25%), no topkill 122 = Light defoliation (1-25%), topkill <=10% 123 = Light defoliation (1-25%), topkill >10% 124 = Moderate defoliation (26-75%), no topkill 125 = Moderate defoliation (26-75%), topkill <=10% 126 = Moderate defoliation (26-75%), topkill >10% 127 = Heavy defoliation (76-100%), no topkill 128 = Heavy defoliation (76-100%), topkill <=10% 129 = Heavy defoliation (76-100%), topkill >10%		
	001	Casebearer
	003	Looper
	005	Sawfly
	007	Larger elm leaf beetle
	008	Spanworm
	011	Western blackheaded budworm
	013	Whitefly
	014	Fall cankerworm
	015	Alder flea beetle
	016	Mountain mahogany looper
	018	Oak worms
	020	Western larch sawfly
	021	Fruit tree leafroller
	022	Uglynest caterpillar
	023	Boxelder defoliator
	030	Pear sawfly
	033	Boxelder leafroller
	035	Spruce webspinning sawfly
	036	Two-year budworm
	037	Large aspen tortrix
	039	Sugar pine tortrix
	040	Western spruce budworm
	043	Aspen leaf beetle
	044	Cottonwood leaf beetle
	045	Leafhopper
	046	Poplar tentmaker

Damage Agents (cont.)

Category	Agent	Common Name
12 (cont.)	**000**	**Defoliators**
	047	Larch casebearer
	049	Lodgepole needleminer
	050	Ponderosa needleminer
	051	Black Hills Pandora moth
	052	Pandora moth
	053	Sycamore lace bug
	054	Lace bugs
	055	Oak leaftier
	058	Yellownecked caterpillar
	059	Walkingstick
	060	Spruce coneworm
	061	Introduced pine sawfly
	066	White fir needleminer
	071	Elm leafminer
	072	Geometrid moth
	073	Leafblotch miner
	074	Spotted tussock moth
	077	Brown day moth
	082	Fall webworm
	083	Hemlock looper
	085	Tent caterpillar moth
	086	Satin moth
	087	Willow leafblotch miner
	088	Aspen blotchminer
	089	Gypsy moth
	090	Cottonwood leafminers
	094	Western tent caterpillar
	096	Forest tent caterpillar
	098	Leafcutting bees
	099	Blister beetle
	102	Willow sawfly
	104	Lodgepole sawfly
	106	Pine infesting sawflies
	109	Ponderosa pine sawfly
	115	Hemlock sawfly
	116	Pine butterfly
	117	False hemlock looper
	118	California tortoiseshell
	120	Bruce spanworm
	121	Rusty tussock moth
	122	Whitemarked tussock moth
	123	Douglas-fir tussock moth
	124	Western tussock moth
	125	Spring cankerworm
	135	Aspen leafminer
	136	Yellowheaded spruce sawfly
	137	Tenlined June beetle

Damage Agents (cont.)

Category	Agent	Common Name
12 (cont.)	**000**	**Defoliators**
	138	Japanese beetle
	139	Larch sawfly
	140	Mountain –ash sawfly
	141	Elm leaf beetle
	142	Spearmarked black moth
	143	Giant silkworm moth
	144	Redhumped caterpillar
	146	Larch looper
	150	Spruce needleminer (west)
	154	*Thryridopteryx ephemeraeformis*
	155	Leafroller/seed moth
	156	Willow defoliation
	157	Euonymus caterpillar
	159	Larch bud moth
	160	Pine needle sheathminer
	162	Cottonwood leaf beetle
	164	Saddle-backed looper
	165	Leaf roller
	168	Green-striped looper
	174	Pine looper
	176	*Zadiprion townsendi*
	177	Douglas-fir budmoth
	179	Phantom hemlock looper
	180	Tent caterpillar
	188	Elm sawfly
	189	June beetles/leaf chafers
13	**000**	**Chewing Insects**
SEVERITY RATING 131 = minor 132 = severe		
	001	Grasshopper
	002	Shorthorn grasshoppers
	005	Clearwinged grasshopper
	006	Cicadas
	007	Eurytomids
	008	Cutworms
	010	Pales weevil
	012	Periodical cicada
	013	Migratory grasshopper
	014	Valley grasshopper
	015	Strawberry root weevil
	020	Northern pitch twig moth
	021	Ponderosa pine tip moth
	022	Pine needle weevil
	025	*Thrips madronii*
	026	Ash plant bug
	028	Pitch-eating weevil

Damage Agents (cont.)

Category	Agent	Common Name
14	**000**	**Sucking Insects**
SEVERITY RATING 141 = minor 142 = severe		
	001	Scale insect
	002	Western larch woolly aphid
	003	Balsam woolly adelgid
	004	Hemlock woolly adelgid
	006	Aphid
	008	Western pine spittlebug
	010	Spittlebug
	012	Pine needle scale
	014	Giant conifer aphids
	017	Spruce aphid
	018	Wooly apple aphid
	022	Pine thrips
	026	Lecanium scale
	028	Oystershell scale
	029	Pinyon needle scale
	030	Ponderosa pine twig scale
	035	Treehoopers
	039	Black pineleaf scale
	040	Spruce spider mite
	043	Maple aphids
	044	Spruce bud scale
	046	Pine leaf adelgid
	047	White pine adelgid
	048	Pine bark adelgid
	049	Root aphid
	050	Mealybug
	051	Cottony maple scale
	052	Fir mealybug
	053	Douglas-fir mealybug
	061	Pine tortoise scale
	063	Birch aphid
	068	European elm scale
15	**000**	**Boring Insects**
SEVERITY RATING 151 = minor, 152 = severe		
	001	Shoot borer
	002	Termite
	003	Ponderosa pine bark borer
	004	Bronze birch borer
	006	Bronze poplar borer
	007	Carpenter bees
	008	Flatheaded borer
	009	Golden buprestid
	010	Carpenter ants

Damage Agents (cont.)

Category	Agent	Common Name
15 (cont.)	**000**	**Boring Insects**
	011	Gouty pitch midge
	012	Shootboring sawflies
	013	Roundheaded borer
	014	Flatheaded apple tree borer
	017	Pitted ambrosia beetle
	018	Carpenterworm moths
	019	Poplar and willow borer
	020	Pine reproduction weevil
	021	Douglas-fir twig weevil
	027	Ponderous borer
	029	Western pine shoot borer
	030	Eucosma species
	034	Warren's collar weevil
	035	Powderpost beetle
	036	Tarnished plant bug
	037	*Magdalis spp.*
	038	White pine bark miner
	039	Locust borer
	040	California flathead borer
	041	Flatheaded fir borer
	042	Whitespotted sawyer
	043	Redheaded ash borer
	045	Oberea shoot borers
	048	*Pissodes dubius*
	050	White pine weevil
	051	Lodgepole terminal weevil
	052	Ambrosia beetles
	053	Cottonwood borer
	056	Ash borer
	057	Lilac borer
	058	*Prionoxystus robiniae*
	059	Maple shoot borers
	060	Western subterranean termite
	063	European pine shoot moth
	064	Western pine tip moth
	065	Nantucket pine tip moth
	066	Lodgepole pine tip moth
	067	Southwestern pine tip moth
	070	Saperda shoot borer
	071	Clearwing moths
	073	Roundheaded fir borer
	074	Western larch borer
	075	Western cedar borer
	076	Douglas-fir pitch moth
	077	Sequoia pitch moth
	083	Ottonwood twig borer
	085	Banded ash borer

Damage Agents (cont.)

Category	Agent	Common Name
16	**000**	**Seed/Cone/Flower/Fruit Insects**
SEVERITY RATING 161 = minor 162 = severe		
	001	Douglas-fir cone moth
	002	Lodgepole cone beetle
	003	Limber pine cone beetle
	004	Mountain pine cone beetle
	005	Ponderosa pine cone beetle
	010	Douglas-fir cone midge
	011	Cone scale midge
	012	Pecan
	015	Fir coneworm
	017	Pine coneworm
	019	Ponderosa twig moth
	020	*Dioryctria pseudotsugella*
	021	Dioryctria moths
	022	Lodgepole cone moth
	023	Seed chalcid
	025	Cone maggot
	027	Ponderosa pine seed worm/moth
	028	Spruce seed moth
	029	Boxelder bug
	031	Western conifer seed bug
	033	*Magastigmus lasiocarpae*
	034	Spruce seed chalcid
	035	Ponderosa pine seed chalcid
	036	Fir seed chalcid
	037	Douglas-fir seed chalcid
	040	Roundheaded cone borer
	042	Coneworm
	043	Harvester ants
	048	Coneworm
	049	Prairie tent caterpillar
17	**000**	**Gallmaker Insects**
SEVERITY RATING 171 = minor 172 = severe		
	003	Cooley spruce gall adelgid
	006	Gall midge
	007	Douglas-fir needle gall midge
	008	Gall mite
	009	Spruce gall midge
	013	Gall aphid
	014	Alder gall mite
	015	Psyllid
	018	Gouty pitch midge
	019	Spider mites

Damage Agents (cont.)

Category	Agent	Common Name
18	**000**	**Insect Predators**
SEVERITY RATING 181 = minor 182 = severe		
	001	Lacewing
	002	Blackbellied clerid
	003	Redbellied clerid
	005	Western yellowjacket
19	**000**	**General Diseases**
SEVERITY RATING 191 = minor 192 = severe		
20	**000**	**Biotic Damage**
SEVERITY RATING 201 = minor 202 = severe		
	001	Damping off
	002	Gray mold
21	**000**	**Root/Butt Diseases**
SEVERITY RATING for trees 211 = Tree within 30 feet of tree with deteriorating crown, tree with diagnostic symptoms or signs, or tree killed by root disease 212 = Pathogen (sign) or diagnostic symptom detected - no crown deterioration 213 = Crown deterioration detected - no diagnostic symptoms or signs 214 = Both crown deterioration and diagnostic signs symptoms detected		
	001	Armillaria root disease
	003	Cylindrocladium root disease
	004	Brown crumbly rot
	006	Fusarium root rot
	007	White mottled rot
	009	Ganoderma rot of conifers
	010	Annosus root disease
	012	Tomentosus root disease
	014	Black stain root disease
	015	Schweinitzii butt rot
	017	Laminated root rot
	022	Pythium root rot
	026	Yellow pitted rot

Damage Agents (cont.)

Category	Agent	Common Name
22	**000**	**Stem Decays**
SEVERITY RATING 220 = 0-4% rotten 221 = 5-15% rotten 222 = 16-25% rotten 223 = 26-35% rotten 224 = 36-45% rotten 225 = 46-55% rotten 226 = 56-65% rotten 227 = 66-75% rotten 228 = 76-85% rotten 229 = 86-100% rotten		
	001	Heart rot
	002	Stem rot
	003	Sap rot
	006	Black knot of cherry
	007	Atropellis canker
	012	Black canker of aspen
	024	Gray-brown saprot
	025	Cryoptosphaeria canker of aspen
	026	Cytospora canker of fir
	027	Western red rot
	028	Rust-red stringy rot
	029	Sooty-bark canker
	035	Amelanchier rust
	036	Cedar apple rust
	038	Hypoxylon canker of aspen
	040	Sterile conk trunk rot of birch
	047	Red ring rot
	048	Aspen trunk rot
	051	Phomopsis canker
	057	Cytospora canker of aspen
	059	Red belt fungus
	062	Brown heartrot
	063	*Coniophora puteana*
	064	Tinder fungus
	065	Purple conk
	066	*Leptographium wagnerii*
	067	*Phellimus hartigii*
	068	False tinder fungus
	070	Yellow cap fungus
	071	Oyster mushroom
	074	Cedar brown pocket rot
	075	Lanchnellula canker
	077	Phomopsis blight

Damage Agents (cont.)

Category	Agent	Common Name
23	**000**	**Parasitic**
SEVERITY RATING 231 = Hawksworth tree DMR rating 1 232 = Hawksworth tree DMR rating 2 233 = Hawksworth tree DMR rating 3 234 = Hawksworth tree DMR rating 4 235 = Hawksworth tree DMR rating 5 236 = Hawksworth tree DMR rating 6		
	001	Mistletoe
	003	Vine damage
	006	Lodgepole pine dwarf mistletoe
	008	Western dwarf mistletoe
	009	Limber pine dwarf mistletoe
	011	Douglas-fir dwarf mistletoe
	013	Larch dwarf mistletoe
24	**000**	**Decline Complexes/Dieback/Wilts**
SEVERITY RATING 241 = minor 242 = severe		
	004	Ash decline/yellow
	022	Dutch elm disease
25	**000**	**Foliage Diseases**
SEVERITY RATING 251 = minor 252 = severe		
	001	Blight
	002	Broom rust
	003	Juniper blights
	004	Leaf spots
	005	Needlecast
	006	Powdery mildew
	009	True fir needlecast
	013	Large-pored spruce-laborador tea rust
	014	Ink spot of aspen
	015	Pine needle rust
	019	Cedar leaf blight
	020	Dogwood anthracnose
	022	Elytroderma disease
	023	Fire blight
	027	Brown felt blight
	028	Larch needle blight
	031	Spruce needle cast
	032	Fir needle cast
	033	White pine needle cast
	034	Lophodermella needle cast
	035	Lophodermium needle cast
	036	Marssonina blight

Damage Agents (cont.)

Category	Agent	Common Name
25 (cont.)	**000**	**Foliage Diseases**
	037	Melampsora rusts
	039	Larch needle cast
	040	Dothistroma needle blight
	041	Brown felt blight of pines
	042	Snow blight
	043	Swiss needle cast
	049	Fir needle rust
	050	Douglas-fir needle cast
	052	Rhizophaeria needle cast
	054	Brown spot needle blight
	056	Septoria leaf spot and canker
	058	Diplodia blight
	061	Shepherd's crook
	062	Dothistroma needle blight
	064	Broom rust
	065	Spruce needle rust
	067	Spruce needle cast
	068	Hardwood leaf rusts
	072	Sirococcus shoot blight
	073	Shepherds crook
	074	Delphinella shoot blight
26	**000**	**Stem Rusts**
SEVERITY RATING 261 = Branch infections located greater than 2 feet from tree bole. 262 = Branch infections located between 6 inches and 2 feet from tree bole. 263 = Bole infections or branch infections located within 6 inches of bole. 264 = Topkill.		
	001	White pine blister rust
	002	Western gall rust
	003	Stalactiform blister rust
	004	Comandra blister rust
	011	Bethuli rust
27	**000**	**Broom Rusts**
SEVERITY RATING 271 = minor 272 = severe		
	001	Spruce broom rust
	003	Juniper broom rust
	004	Fir broom rust
30	**000**	**Fire**
SEVERITY RATING 301 = minor 302 = severe		

Damage Agents (cont.)

Category	Agent	Common Name
41	**000**	**Wild Animals**
SEVERITY RATING 411 = minor 412 = severe		
	001	Bear
	002	Beaver
	003	Big game
	004	Mice or voles
	005	Pocket gophers
	006	Porcupines
	007	Rabbits or hares
	008	Sapsucker
	009	Squirrels
	010	Woodpeckers
	011	Moose
	012	Elk
	013	Deer
	014	Feral pigs
42	**000**	**Domestic Animals**
SEVERITY RATING 421 = minor 422 = severe		
	001	Cattle
	002	Goats
	003	Horses
	004	Sheep
50	**000**	**Abiotic Damage**
SEVERITY RATING 501 = minor 502 = severe		
	001	Air pollutants
	002	Chemical
	003	Drought
	004	Flooding/high water
	005	Frost
	006	Hail
	007	Heat
	008	Lightning
	009	Nutrient imbalances
	010	Radiation
	011	Snow/ice
	012	Wild fire
	013	Wind/tornado
	014	Winter injury
	015	Avalanche
	016	Mud/land slide

Damage Agents (cont.)

Category	Agent	Common Name
60	**000**	**Competition**
SEVERITY RATING 601 = minor 602 = severe		
70	**000**	**Human Activities**
SEVERITY RATING 701 = minor 702 = severe		
	001	Herbicides
	002	Human caused fire
	003	Imbedded objects
	004	Improper planting technique
	005	Land clearing
	006	Land use conversion
	007	Logging damage
	008	Mechanical
	009	Pesticides
	010	Roads
	011	Soil compaction
	012	Suppression
	013	Vehicle damage
	014	Road salt
71	**000**	**Harvest**
SEVERITY RATING 711 = minor 712 = severe		
80	**000**	**Multi-Damage (Insect/Disease)**
SEVERITY RATING 801 = minor 802 = severe		
	001	Aspen defoliation (12037,12096, 25036 and 25037)
	002	Subalpine fir mortality (11015, 21001, 21010, 50014) disturbances
90	**000**	**Unknown**
SEVERITY RATING 900 = 0 – 9% affected 901 = 10 – 19% affected 902 = 20 – 29% affected 903 = 30 – 39% affected 904 = 40 - 49% affected 905 = 50 - 59% affected 906 = 60 - 69% affected 907 = 70 - 79% affected 908 = 80 - 89% affected 909 = 90 - 100% affected		

Damage Agents (cont.)

99	000	Physical Effects	How to code Severity (actual %)
These severities do not need to be proceeded by the category code of 99. Only the actual percentage needs to be recorded.			
	000	Unknown	
	001	Broken top	% of missing height
	002	Dead top	% of dead height
	003	Limby (large limbs top to bottom)	% of bole with many limbs/knots
	004	Forked top	% of height above fork
	005	Forked below merch top	% of bole affected
	006	Crook or sweep	% of bole affected
	007	Checks, bole cracks	% of bole affected
	008	Foliage discoloration	% of foliage discolored
	010	Lack of seed source	NA
	011	Poor planting stock	NA
	012	Poor growth	NA
	013	Total board foot volume loss	
	014	Total cubic foot volume loss	
	015	Bark removal	
	016	Foliage loss	
	017	Sunscald	
	018	Uproot	
	019	Scorched foliage	
	020	Scorched bark	
	021	Dieback	
	022	Poor crown form	

Tree Parts

Code	Description
UN	Unspecified
TO	Top
FO	Foliar (Crown)
LI	Limb
BO	Bole, other than Top or Base
BA	Base
RO	Roots
WT	Whole Tree
TT	Top Third of Crown
MT	Middle Third of Crown
BT	Bottom Third of Crown
TA	Above merch top
TB	Below merch top

Appendix B. NRIS Lithology Codes

Primary Code	Primary Lithology	Secondary Code	Secondary Description
IGEX	Igneous Extrusive	ANDE	Andesite
	Igneous Extrusive	BASA	Basalt
	Igneous Extrusive	LATI	Latite
	Igneous Extrusive	RHYO	Rhyolite
	Igneous Extrusive	SCOR	Scoria
	Igneous Extrusive	TRAC	Trachyte
IGIN	Igneous Intrusive	DIOR	Diorite
	Igneous Intrusive	GABB	Gabbro
	Igneous Intrusive	GRAN	Granite
	Igneous Intrusive	QUMO	Quartz Monzonite
	Igneous Intrusive	SYEN	Syenite
	Metamorphic	GNEI	Gneiss
	Metamorphic	PHYL	Phyllite
	Metamorphic	QUAR	Quartzite
	Metamorphic	SCHI	Schist
	Metamorphic	SLAT	Slate
SEDI	Sedimentary	ARGI	Argillite
	Sedimentary	CONG	Conglomerate
	Sedimentary	DOLO	Dolomite
	Sedimentary	LIME	Limestone
	Sedimentary	SANS	Sandstone
	Sedimentary	SHAL	Shale
	Sedimentary	SILS	Siltstone
	Sedimentary	TUFA	Tufa
UNDI	Undifferentiated	MIEXME	Mixed Extrusive and Metamorphic
	Undifferentiated	MIEXSE	Mixed Extrusive and Sedimentary
	Undifferentiated	MIIG	Mixed Igneous (extrusive & intrusive)
	Undifferentiated	MIIGME	Mixed Igneous and Metamorphic
	Undifferentiated	MIIGSE	Mixed Igneous and Sedimentary
	Undifferentiated	MIINME	Mixed Intrusive and Metamorphic
	Undifferentiated	MIINSE	Mixed Intrusive and Sedimentary
	Undifferentiated	MIMESE	Mixed Metamorphic and Sedimentary

Appendix C: NRIS Landform Codes.

Landform	Code	Landform	Code
Alluvial Fan	ALFA	Nivation hollow	NIHO
Alluvial Flat	ALFL	Plateau	PLAT
Avalanche talus	AVTA	Ridge	RIDG
Break	BREA	Stream	STRE
Cirque	CIRQ	Stream Terrace	STTE
Dip slope	DISL	Structural	STRU
Drumlin	DRUM	Structural Bench	STBE
Kame	KAME	Terracette	TERR
Kettle	KETT	Trough floor	TRFL
Landslide	LAND	Trough wall	TRWA
Moraine	MORA	Upland	UPLA
Mountain slope	MOSL		

Appendix D: Rick Miller Method for Sampling Shrub Dominated Systems.

Derived from Miller, R.F., T.J. Svejcar, and J.A. Rose. 2000. Impacts of western juniper on plant community composition and structure. J. Range Manage. 53:574-585.

Macroplot: 40 X 60 meters (figure AP-1)

Plot Layout

1. Permanent macro plot is staked in each corner and the lower left corner GPS'ed.
2. 3, 60-meter transects are located at the 0, 20, and 40 meter points along the 40 meter line.

Tree Measurements

1. Juniper tree counts are recorded along each 60-meter line in a 6 x 60 meter belt (a tape or 3 meter pole is used to measure the width along the belt.
2. Trees are recorded in the following classes: Old Growth, Dominant (75 percent to maximum height), Subcanopy (3 meters to 75percent of maximum canopy height), Sapling (1 to 3 meters), Juveniles (30 cm to 1 meter). Trees < 30 cm are measured in the 2 x 60 meter shrub plot. All old growth trees (separated from younger trees by differences in bark and canopy morphology) occurring with the 40 x 60 meter macro plot are recorded. (Note if there are less than 20 trees >1 meter in height in the macro plot we count all trees within the macro plot.
3. Tree canopy cover is measured along each 60-meter line using the line intercept technique (we use the 3 meter PVC pole to mark the canopy edge where it intercepts the line).
4. If trees are to be aged, cores are collected at 30 cm height for trees >6 to 10 cm in diameter. Trees <6 cm diameter are cut at ground level and a disk collected. The disk is always labeled on the top.
5. Parameters measured for cored trees are:
    a. basal diameter
    b. tree height (estimated using the 3 meter pole)

Shrub Measurements

1. Shrub density is measured along each 60-meter line in a 2 x 60 meter belt (a tape or 1 meter pole is used to measure the width along the belt.
2. Shrub cover is measured along each 60-meter line using the line intercept. Live and dead cover are recorded separately using the 15 cm rule (canopy gaps >15 cm within a single shrub canopy or dead foliage >15 cm within a live canopy are reported as such.

Herbaceous and ground Measurements

Depending on the study we may or may not measure herbaceous cover by species. However, we always do nested frequency and cover by functional groups.

Functional Groups:

1. Deep rooted perennial grasses (PG)
2. Shallow rooted perennial grasses (e.g. *Poa sandbergii*)
3. Annual grasses
4. Perennial forbs
5. Annual forbs
6. Bare ground
7. Rock
8. Biological crusts and mosses

Nested frequency is measured in 0.02, 0.2, and 0.4 m^2 plots every 3 meter along each 60 meter line (n = 60 plots/macro plot)

Herbaceous cover is estimated in 20, 0.2 m^2 plots spaced every 3 meter along each 60 meter line.

Functional group cover is estimated in 20, 0.2 m^2 plots spaced every 3 meter along each 60 meter line.

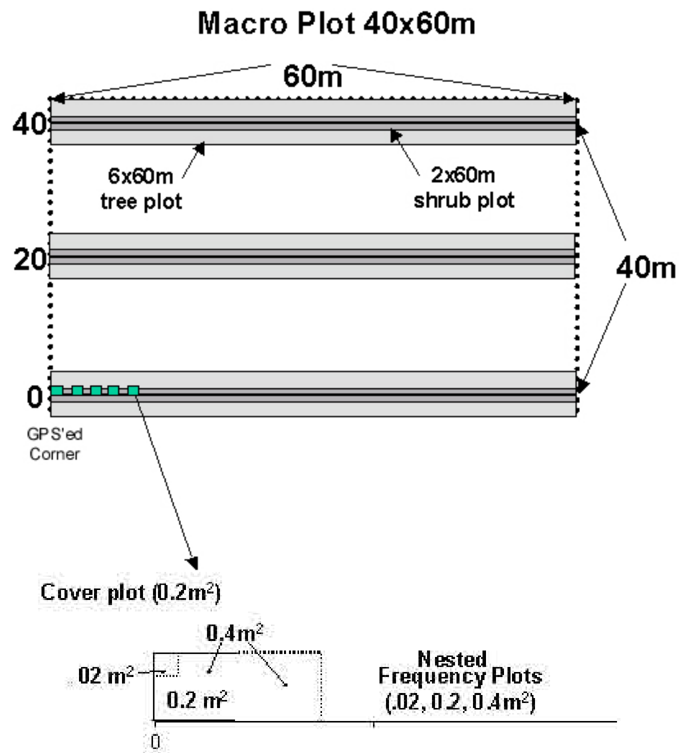

Figure AP-1. Rick Miller plot design for sampling in shrub dominated systems.