Alaska Wildland Fire Coordinating Group

Fire Effects Monitoring Protocol

(version1.0)

ALASKA INTERAGENCY
FIRE EFFECTS TASK GROUP (FETG)
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Front Photo: Fire effects monitoring in Yukon-Charley Rivers National Preserve, 2004 Woodchopper Fire. Photos left to right: 2004 Pre-fire, 2004 post-fire and 2006. NPS Photos.

FIRE EFFECTS MONITORING PROTOCOL
ALASKA INTERAGENCY
FIRE EFFECTS TASK GROUP (FETG)

INTRODUCTION

This document provides basic protocols to monitor and inventory Alaska fuels and/or fire effects. This protocol provides sampling guidance to meet common fire effects monitoring objectives; however, each project lead should consider how well this protocol meets specific project objectives. It may be necessary to include additional methods, or to drop some of the methods here in order to meet your project's objectives. These guidelines for monitoring wildland fires, prescribed fires and mechanical treatments were developed in consultation with the Interagency Alaska Fire Effects Task Group (FETG), NPS Fire Monitoring Handbook (FMH 2003), and USFS FIREMON methods (Lutes et. al. 2006; http://fire.org/firemon/).

> *"Monitoring the effects of wildland fire is critical for (1) documenting fire effects, (2) assessing ecosystem damage and benefit, (3) evaluating the success or failure of a burn, and (4) appraising the potential for future treatments. Objectives for monitoring depend on the type of fire. Wildfire monitoring is necessary to evaluate the possible need for rehabilitation (Hardwick et al. 1998), while monitoring after prescribed fires is required to assess the effectiveness of the treatment. Monitoring data can have far-reaching applications in fire management because it provides the scientific basis for planning and implementing future burn treatments. Measuring post-fire ecosystem response also allows us to understand the consequences of fire on important ecosystem components and share this knowledge in a scientifically based language. Monitoring is the critical feedback loop that allows fire management to constantly improve prescriptions and fire plans based on the new knowledge gained from field measurements."* (FIREMON - Lutes et al., 2006).

Goals and Objectives

The three primary goals for developing an interagency protocol for monitoring fire and fuel treatments effects are:

- To encourage collaboration by providing interagency protocols, thus supporting broader landscape inference by increasing sample sizes within different vegetation communities.

- To meet common needs in monitoring fire and fuels treatment effects by providing a simple monitoring protocol.

- To provide flexible protocols that can be implemented in a "rapid response" situation or can be expanded to provide more in-depth information for specific variables of interest.

** Ecological monitoring must be designed to meet the objectives of each project and therefore the FETG anticipates that this protocol may have components added or deleted in response to specific project objectives.** However, the common cores protocol was developed to address the most common monitoring objectives following fire or fuels treatments. These objectives are to:

- To document changes in vegetation, fuels and soils following disturbance (i.e. fire or treatment) through time.

- To determine vegetation successional trajectories following disturbance.

- To provide input data for fire behavior models and land classification.

A tabular summary of the common objectives that are addressed by individual components of this protocol is included in Appendix A.

Monitoring Levels and Variables

Recognizing the need for basic monitoring methods that would work in Alaska fuels, the FETG initially developed recommendations for minimum variables to monitor fire or treatment effects within a framework of three monitoring intensities (Level 1 – 3). A brief description of the three monitoring levels is provided below:

- *Level 1, Surveillance Monitoring* - This level provides the baseline data that should be collected for all wildland or prescribed fires, and some variables are required for mechanical treatments. Information collected at this level includes such items as RAWS weather data, general description of the fire environment (i.e. topography and fuel types), and fire location or perimeter. Information collected through remote sensing or during overflights is often used to satisfy surveillance monitoring and on-the-ground measurements are not always necessary. For projects with access, photopoints may be included in Level 1. The FETG has previously provided an interagency technical reference on photo points and a sample data sheet in Excel format, available at http://fire.ak.blm.gov under Fire Effects header (fileshare).

- *Level 2, Moderate Intensity Monitoring* - This level of monitoring includes observations of fire behavior (not addressed in this document), fuels, and general effects of wildland fires, prescribed fires or mechanical treatments on vegetation. Information collected at this level includes characteristics of the fire, such as rate of spread, fire behavior, and burn severity, as well as current weather conditions. Fuel conditions would be assessed by determining the fuels array, composition, and dominant vegetation within the burn area, in addition to using vegetation and fuels maps to predict potential fire spread. Information to assess pre and post fire or treatment effects may include photo points, duff depth and moisture measurements, vegetation cover, and tree parameters. Some of the variables monitored at this level would require on the ground measurements of specific sites.

- *Level 3, Comprehensive Monitoring (Short or Long-term Fire Effects)* – This level of monitoring documents the effects of prescribed or wildland fires in greater depth, and may also be used for mechanical treatments. Level 3 monitoring often involves collecting information on fuel reduction, vegetative changes, soil parameter changes, and possibly wildlife utilization. More variables are monitored more rigorously at this level. Variables monitored at this level generally require the establishment of permanent plots.

Suggested monitoring variables for Level 1 through 3 are shown in Figure 1. Levels are cumulative, for instance all variables monitored in Level 1 would be included in Level 2. Level 1 variables are the recommended minimum data collection. Level 2 monitoring is recommended for wildland fire use and prescribed fires, but its use depends on burn objectives, funding, and resources of concern. Additional variables collected at Level 3 also depend on management objectives and the resources of concern, and would remain up to the discretion of the FMO, fuels specialists, resource staff, and fire ecologist. The main difference between Level 2 and Level 3 monitoring is not the variables measured but the measurement scale (qualitative vs. quantitative), which will influence the statistical precision of the estimates and the power to detect differences.

FETG Fire Effects Monitoring Variables

Level 1

- Perimeter
- Coordinates
- Site description
- Fuel types
- Weather (measured or from RAWS)
- Aerial photos or photopoints
- Burn severity maps (optional)

Level 2

- Perimeter
- Coordinates
- Site description
- Fuel types
- Weather
- Photo points
- Fire behavior
- Duff/fuelbed depths
- Duff moisture
- Burn severity class
- Vegetation class (pre- & post-fire)
- Vegetation cover/ composition (qualitative)
- Tree density by species and size class
- Tree canopy height
- Tree canopy closure
- Burn severity maps (optional)

Level 3

- Perimeter
- Coordinates
- Site description
- Fuel types
- Weather
- Photo points
- Fire behavior
- Duff/fuelbed depths
- Duff moisture
- Duff consumption (pins)
- Burn severity class
- Vegetation class (pre- & post-fire)
- Vegetation cover/ composition (quantitative)
- Tree density by species and size class
- Tree heights, diameters
- Tree canopy cover
- Ladder fuel heights
- Active layer depth
- Soil parameters
- Tree ring disks/cores
- Shrub or species specific densities
- Coarse woody debris (Brown's) transects
- Burn severity maps (optional)
- Additional variables as needed

METHODS OVERVIEW

The following section describes a set of Alaska field-tested methods used in a simple "Level 3" monitoring effort. Each plot can be laid out and read by an experienced crew in less than 2 hours. Data can be entered into either of the National fire effects database programs (NPS FEAT or U.S. Forest Service FIREMON). Each of the National programs offers their own field datasheets which can be used, but the attached custom datasheets (Appendix B) will expedite field data collection and already have names of common Alaska species. This reference intentionally limits its scope to Alaska vegetation and field conditions. For simplicity, the myriad of options for modifying and customizing monitoring protocols or plot sizes, levels of monitoring intensity, deciding on the number of plots to use, placement of plots, other variables to include, etc. are not discussed here. It is recommended the user consult many other excellent references on setting up a monitoring study, including Elzinga, et al 1998, FMH, FEAT, and FIREMON user guides. Some general "cheat sheets" and supplemental forms are provided in Appendix C. Data sheets for basic fire behavior are under development and will be distributed in draft form in 2007.

THE OVERVIEW:

1. PLOT DESCRIPTION
   - General plot description, direction to plots (Enter on form A - *SITE DESCRIPTION*)
   - Coordinates (latitude/longitude, datum, and error)
   - General vegetation type/fuel model
   - Photo information

2. VEGETATION COVER
   - Point intercept 30-m transect (60 points, every 0.5-m along 30-m baseline).
   - Stake with chaining pins or permanently stake both ends with PVC conduit, fiberglass survey stakes or buried rebar stakes.
   - Since measurements will be taken at the 30-m mark, **place the end stake at 30.3 m**.
   - Record all trees, shrubs, herbaceous species. Include substrate or groundcover hits at each point: this will involve looking up for canopy hits as well as down. Enter on form B - *VEGETATION COVER-Point Intercept* form)
   - Photograph both ends toward middle.
   - Read on right, walk on left of baseline.
   - Alternatively, or for general plot area description, vegetation cover can be measured by ocular estimation. Use form B.1 – *SITE AND GENERAL VEGETATION*.

3. FOREST MEASUREMENTS
   - 1-m x 30-m belt transect rectangle for all trees >4.5' (1.37 m) in height.
   - Tally trees >4.5' in height by species and diameter size classes: (< 5 cm, 5.1-10 cm, 10.1-15 cm, 15.1-23 cm, >23 cm Diameter at Breast Height (DBH)), and status (Live/Dead). (C - *TREE DENSITY TALLY* form).
   - Tally small trees, including seedlings (<4.5' tall) in 3 subplots, 1-m x 1-m located at 3, 15, & 27-m marks. (C - *TREE DENSITY TALLY* form).
   - For two representative trees of each species and size class record diameter (DBH), height, crown fuel base height (CFBH), and crown radius (see instructions *TREE MEASUREMENT* form D or D.1).

- For all trees > 23 cm DBH record species, DBH, height, crown fuel base height (CFBH), and crown radius (*TREE MEASUREMENT* form D or D.1).

4. BURN SEVERITY
   - Post-burn: Record micro-site specific burn severity index, use 5-class severity codes for substrate and vegetation, every 3 m beginning at 3-m mark, for 10 total points. (Enter on form F - *BURN SEVERITY/ACTIVE LAYER*).

   Additional burn severity options:
   - Duff consumption pins (pre-burn) every 3-m, for a total of 10 points, may be placed along the transect for quantitative data on duff consumption (use form F - *BURN SEVERITY/ACTIVE LAYER*).
   - CBI (Composite Burn Index) is a national method used for overall burn severity score of stands (Lutes, et al. 2006), and particularly for comparison to remotely-sensed burn severity. Pre-burn and post-burn satellite images are computer-analyzed to derive a change value referred to as the D-NBR or normalized burn ratio. A sample field CBI form modified for Alaska is attached in Appendix C.4.

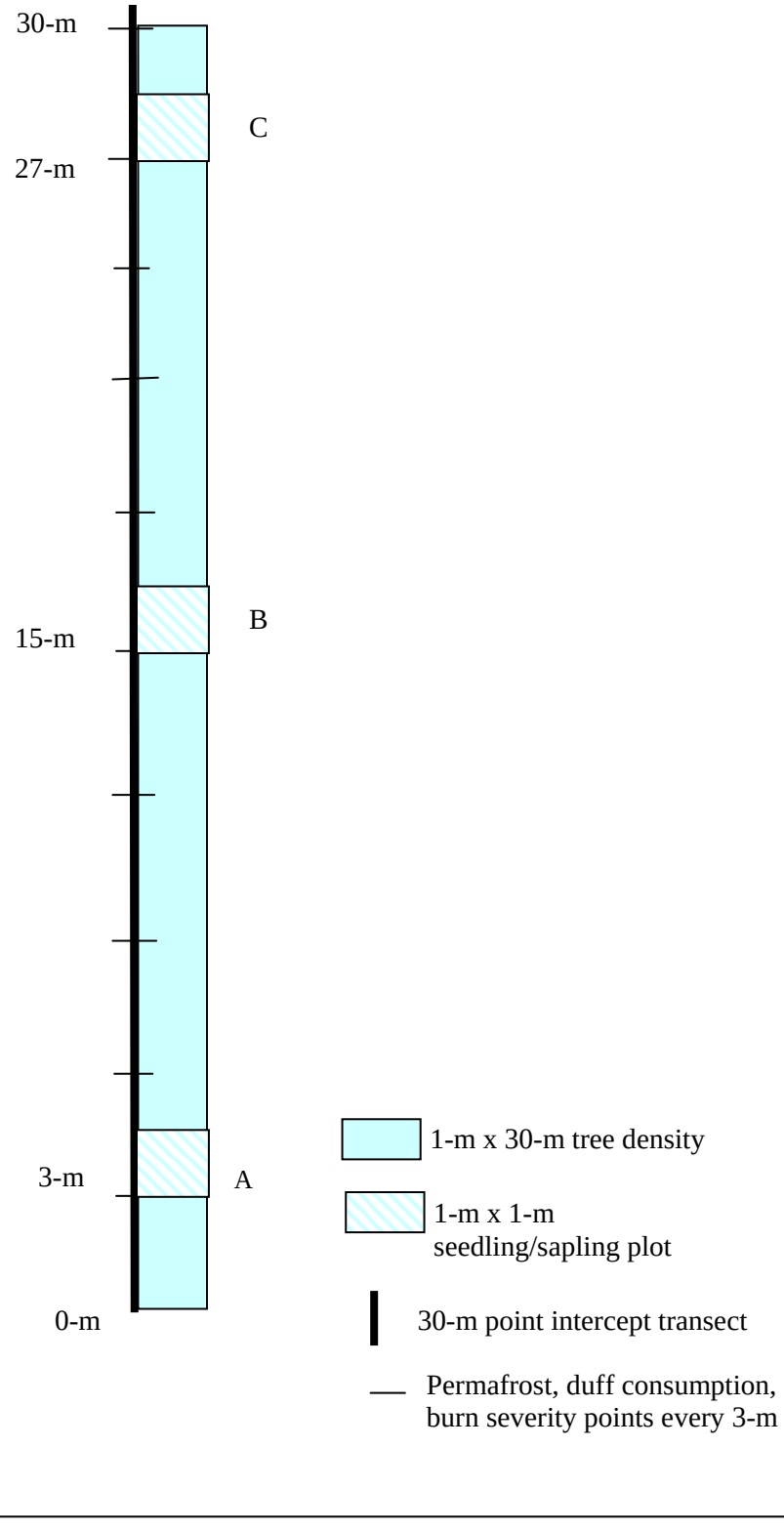
5. PERMAFROST DEPTH
   - Measure the depth of the active layer (organic and soil depth to ice or rock) every 3 m beginning at 3-m mark, for 10 total points. (Enter on form F - *BURN SEVERITY/ACTIVE LAYER*)

6. DUFF & LITTER DEPTH
   - Measure the depth of the forest floor surface material (live moss, dead moss, upper and lower duff layers) at 2 to 4 places displaced at least 1 m off the transect. Sampling sites should have similar characteristics to the forest floor along the transect. (Enter on form G - *DOWN WOODY DEBRIS & DUFF DEPTHS*)

7. DOWN WOODY FUEL LOADING (optional)
   - Coarse woody debris transect (after Brown 1974) along baseline: 2m for 1-hr and 10-hr; 4m for 100-hr, and 30m for 1000-hr fuels. (6.6 ft, 13.1 ft, and 98 ft). (enter on Form G - *DOWN WOODY DEBRIS & DUFF DEPTHS*)
   - If quantitative fuel loading is desired, place additional coarse woody debris transects at 120º and 240º from origin marking the ends with pin flags.

8. SHRUB DENSITY (optional)
   - If quantitative data is desired for woody browse or shrub species, tally individuals (or **stems above ground** for clonal species such as alder, or when it is not possible to distinguish individual shrubs) in the same 1-m x 30-m belt which was used for trees. In very dense brush, it may be necessary to subsample just a 0.5 X 30 m belt, or only the tree seedling plots. (Enter on form H - *SHRUB DENSITY*).

Figure 1. Plot diagram.



PROTOCOL DETAILED METHODS

Plot Setup

See plot figure 1. A 30-m x 1-m plot will be set up based off a random point coordinate. Next determine a random azimuth, using a random number generator or the compass spin method. Establish the 30-m transect by staking the zero end of a 30-m (or 100-ft) tape with chaining pins or conduit and walk out the end of the tape in a straight line in the direction of the random bearing (be sure to record declination used). Drive spray painted 2.5-ft conduit into each end of the plot as marked on the figure. The 30-m end should be staked at 30.3 m to allow for reading vegetation data at the 30-m mark. Tag the zero-end of the transect ("origin") with an aluminum tag displaying the plot number and date. Mark additionally with flagging for easy visual in aerial photo. Avoid walking or trampling on the right side of the transect where the vegetation measurements will be made. For all plots collect a GPS position at the zero end of the tape. Record the waypoint (WP) number or point name and lat/long on the data sheet, as well as noting the error. It is recommended to use the averaging function on the GPS (20 point average or more) if available, to have the highest possible accuracy for the origin coordinates. NAD-83 Datum will be used in the GPS receivers (Standard for DOI agencies).

Site Description and Photo Points

General site information will be collected and recorded for each plot on the Site Description form (Form A, Appendix B). Record additional information for locating plots, plot diagrams, and additional descriptive notes on the form. Definitions of the fields follow:

- **Unit** – Land unit identifier or write out land unit name - (i.e. Steese White Mtns, Yukon-Charley NP) (NPS - four letter park acronym)
- **Project** – Description of project: PPF (pre/post fire), CBI (burn severity), HZF (for hazard fuels), PP (paired plots).
- **Plot ID** – Identifier for the plot within the project. For pre/post fire plots, use the fire number and sequential numbering 01 through x. (i.e. 5Z34 – 01)
- **Field date** – Sample date
- **Fire Name and Fire Date** – Fire name/number or project location, if applicable.
- **Field Crew** – Names of data recorders (first initial and last name)
- **WP number and GPS number** – record the WP number the GPS assigns to the point or your name for the point and the name or number of the GPS used.

- **Lat/Long** – Using a GPS (Garmin V recommended), collect the latitude/longitude. Use averaging if the receiver has this feature. Record in decimal degrees - i.e. Lat: N 65.634891° Long: W 142.982340°
- **GPS Error** - Record the estimated position error (EPE) and units--this needs to be recorded before you save the waypoint in Garmin handhelds.
- **Datum** – GPS datum used for collecting and navigating to plots. The GPS set up menu will tell you which datum is in use. It should be NAD-83 (for practical purposes this is the same as WGS-84).
- **Transect Azimuth** – Record the transect azimuth in degrees facing from the zero end to the 30-m end.
- **Declination used** – Record the declination setting used on your compass. For the initial reading, base your declination on the most recent topographic map or the GPS unit (in the navigation menu under heading). For future reading it's generally best to use the declination used in the original setup, unless a number of years have passed.
- **Transect slope** – Record the percent slope along the transect, using a clinometer
- **Slope** – Percent slope of the general site according to its aspect, using a clinometer.
- **Aspect** – Slope aspect (facing downhill) azimuth in degrees
- **Elevation** – Taken from GPS or maps in feet or meters (record units)
- **Viereck Class** – Using Viereck's (1992) Alaska Vegetation Classification, determine the vegetation class to level IV, or if possible level V for the plot area. Either write it out: Open PICMAR/LEDGRO/HYSPLE or use numeric: I.A.2.f with Labrador tea.
- **Soil** – Estimate of soil drainage: wet, moist, dry.
- **Disturbance** – General note of disturbances, record date estimate if known. This is for the plot and general vicinity.
- **Evidence of fire** – Could be old blackened snags, downed trees, stumps, etc.
- **Photo number, time and camera** – Record the photo number and time of day taken for digital cameras or keep a photo log if standard camera. Also record the type/name of camera used.

A minimum of two photos will be taken for each plot on the ground, and if possible aerial photos should be taken of the plot. The photos will be taken from each end of the vegetation sampling transect, with the end point visible in the photo, looking towards the plot center (see front cover illustrations). Label a dry-erase board with the sample date, unit-project-location-plot ID (i.e.

YUCH-PPF-A324-02), transect azimuth (direction facing) and designate as 0-m ---> 30-m and vice-versa. Hold the board to the edge of the photo view within the first 1.5 - 2 m of the transect with the camera set at a fixed height of 5 ft above the ground (see cover photos). Record the photo number and time of the photo on the site data sheet.

Vegetation and Ground Cover

Two alternative methods of estimating vegetative cover are presented. Point-intercept sampling is more quantitative, but more time-consuming, whereas ocular estimates of cover can be accomplished quickly by a trained observer, and may be all that is required for certain objectives. The ocular estimate method is useful for describing the general plot area (versus just the transect) so may also be added to a level 3 protocol, but it's particularly useful for level 2 monitoring, where vegetation cover, ground cover and canopy data can be quickly estimated without setting up a transect.

If objectives specify detection of very rare species (which could include invasive plants, for example) point-intercept sampling will not provide optimal sensitivity, so it is recommended that the user add a protocol to sample additional area at each plot. Refer to Elzinga, et al 1998 for a discussion on rare species sampling and recommended methods.

Vegetation/Ground Cover - Point-Intercept Sampling - Along the 30-m transect, the point intercept method will be used to determine plant and ground cover. Every 0.5 m along the 30-m transect, all plant species and forest floor surface cover (mosses, lichens, litter) that are intercepted at that point will be recorded. Start at the 0.5 m mark and sample along the right side of transect. We recommend using a sturdy ¼" diameter sampling pole (6 ft fiberglass bike flag), gently lower the pole so that the rod is plumb to the ground (on slopes this will not be perpendicular to the ground). At each point intercept record the species that touch one side of the pole from top to bottom, for example if black spruce was the tallest vegetation at that point hit it would be recorded first, similarly ground cover will always be last. Note that to determine a canopy hit higher than the rod height you will have to project the point upward. A vertical densitometer is recommended for making objective calls of tree canopy hits. GRS (Geographic Resource Solutions, Arcata, California, USA) makes one with an angled sighting mirror and offset leveling vials which is convenient for vertical sampling. Record the species code on the Form B - *VEGETATION COVER-Point Intercept*. Use the standard four letter code for vascular plants, bryophytes (mosses) and lichens. In general the first two letters are the genus (i.e.

Salix) and the last two are the species (i.e. glauca)—for example: SAGL. Consult the USDA-NRCS plants database for most current species codes (http://plants.usda.gov/). Codes for some common species are listed on the back of Form B. Numbers differentiate species with similar codes, if you can't remember the exact code write out the species on the bottom of the sheet and the acronym used for that species. If there are unknown species that are common, collect for identification and record an identifiable acronym and note on the data sheet. For dead standing trees record the species and include D after the species code. If dead branches on a live tree or shrub are hit, record them as though they were alive. For herbaceous material, if detached and lying on the surface the material counts as "litter", whereas if it still attached to a live plant, count it as a live hit of that species. From this data we will calculate the species composition and percent cover by species or substrate.

Vegetation Cover – Ocular Estimation - Instead of point-intercept sampling, ocular estimates of vegetation and ground cover can be recorded on the *SITE AND GENERAL VEGETATION* form B.1 for dominant vegetation and ground cover within the 30-m transect. The cover classes are defined as: 1-9%, 10-24%, 25-59%, 60-74%, and ≥ 75% based on Viereck et al. Alaska Vegetation Classification (1992). Estimate the cover of each species or ground cover and check the appropriate column. Due to overlapping and canopy cover, the total cover can equal more than 100%. Additional species can be added on the second page or by crossing out pre-written species. Estimate the height by height class in meters for all trees and shrubs. Species are listed by layer as described below:

- *TREE LAYERS* - List all the tree species with crown cover within the plot and estimate the percent cover. Willows or alders of tree size are generally not considered trees. Check the box showing the average height of the canopy, estimate average tree diameter, ladder fuel heights and live crown heights. If a single species forms two distinct sub-layers, list it twice.
- *SHRUB LAYERS* - Shrubs are defined as woody plants with multiple stems. For each major shrub species present check the appropriate cover class and height class. If there are newly established shrubs, identify if plants are new seedlings or re-sprouts, otherwise leave the column blank.
- *HERBACEOUS and GROUND LAYER* - Within the herbaceous (non-woody) layer, check the appropriate cover class provided by graminoids (grasses, sedges, rushes), forbs (flowering plants), ferns, and horsetails. In addition, check the appropriate cover class for ground cover provided by bryophytes (mosses, liverworts, and hornworts), lichens, litter

(dead leaves or needle litter), and bare ground or talus. If there are newly established herbs, identify if plants are new seedlings or re-sprouts, otherwise leave the column blank.

Forest Measurements

Tally all trees taller than 4.5 ft (1.37 m) that occur within an 1-m x 30-m belt transect on the right side of the point intercept transect by species and diameter size classes (< 5 cm, 5.1 - 10 cm, 10.1 - 15 cm, 15.1 – 23 cm, > 23 cm DBH). These size classes match those employed in the Alaska Natural Fuels Photo Series (Ottmar and Vihnanek 1998). Use a metric measuring tape or folding ruler to determine if trees are within 1-m of the transect line (sampled area will be 30 m^2 or 0.0074 ac). Tally all live trees less than 4.5 ft tall, including seedlings, by species on 3 subplots (1-m x 1-m, Fig. 1) at the 3, 18, and 27-m mark along the base transect (total "seedling" area of 3.0 m^2 or 0.00074 ac). For hardwood species, resprouting is a common means of post-disturbance growth: tally recognizable resprouts (R) separately in the seedling category on Form C – *TREE DENSITY TALLY*. Note that if working in forest types with larger trees or sparse trees, it may be necessary to increase the plot size, but keep in mind how the treatment or burn will affect tallies over time. From FIREMON: "A general rule-of-thumb is the plot should be big enough to capture at least 20 trees on the average across all plots in your project. Though it is not absolutely necessary, extra measures should be taken so that plot sizes are the same for all plots in a project."

Detailed tree measurements will be recorded for all trees larger than 23 cm (9 inch) dbh **and** for two representative smaller live trees (> 4.5 feet tall) of each species and each size class recorded within the tree density plot. In order to randomly select the trees <23 cm to be measured, consider selecting trees that are closest to the mid-point of the tree density belt (15-m point). Take the following measurements: DBH (diameter at breast height), tree height, crown fuel base height, and crown radius and record on form D – *TREE MEASUREMENT DATA SHEET*. Tagging the individual trees with aluminum nails (or wires) and tags is recommended if you plan to repeat the measurements. This data will be used to determine summary data such as basal area, crown bulk density, and average stand height. An alternative data sheet for combining the tree measurements and tallies on a single form (Form D.1) is provided in Appendix B. Definitions of the parameters measured follow:

- **Species** - Record the species of the tree with the standard 4-letter code (see back of form B - *VEGETATION COVER-Point Intercept* for codes). Willows and alders are not recorded here because they are classified as shrubs in Alaska.

- **DBH** - Measure the diameter of the tree in **centimeters** at 4.5 ft (1.37m) above the ground, using the metric logger's tape or small diameter tape. Marking a stick with the 4.5 ft height is recommended to keep the measurements uniform.
- **Tree height** - Measure the tree height in meters to the nearest 0.1 m using a clinometer. Stand a measured distance, usually about 10 – 30 m, away from the tree depending on tree height. Using the percent side of the clinometer, the tree height (m) = distance from tree (m) x (% to top of tree - % to base of tree). Note that if the base % is negative this will be added to the total height. See example diagram in Appendix C.2.
- **Crown Fuel Base Height** - Height above the ground of the lowest live or dead concentration of branches **that have the ability to move fire higher in the tree** (See Appendix C.1). Measure from the lowest point on the branch to the forest floor to the nearest 0.1 m.
- **Crown radius** -Measure the distance to the nearest 0.1 m from the trunk to the edge of the widest part of the canopy (same as the drip-line of the crown).
- **Bole Char Height** – (Record if sampling is within 1 year of fire) Enter the height to the nearest 0.1 m of the highest contiguous char measured on the downhill side of the tree.
- **Percent Crown Scorched**. Enter the percent of crown that has been killed by fire. Include both scorched and consumed foliage.

Active Layer, Burn Severity, Duff/Woody Fuel Loading

Active Layer Depths – Active layer is the depth from the surface of the forest floor to frozen ground or rock. Ten active layer points are located along the baseline at 3-m intervals starting at the 3-m mark and ending at the 30-m mark (Fig.1). At each point, measure the active layer by inserting the bike flag rod until it stops, mark the surface with your thumb, pull the rod out, and measure the depth in cm to the point of permafrost or bedrock against the tape measure. If it is possible to determine that depth is to rock, note this on the datasheet. Record the ground cover at each point (live moss/lichen, dead moss, upper duff, lower duff or mineral) on form F.

Forest Floor Duff Depths and Fuel Moisture – Measuring the depth of the duff and litter layers is standard due to the importance of the forest floor in determining fire behavior and vegetative succession in Alaska. Measure the depth of the forest floor surface material (litter, lichen, live moss, dead moss, upper and lower duff layers) at two to four sites at least 1 m off the transect which appear similar to the transect with respect to forest floor characteristics. Do

not disturb the vegetation along the transect itself. Carefully cut down through the forest floor to mineral soil or permafrost using a compass saw, trowel and/or shovel. After making a slit or a "V" through the layers, compress one side with a trowel and measure the depth of each layer to the nearest 0.5 cm with a ruler on the other side. Use form G - *DOWN WOODY DEBRIS & DUFF DEPTHS* to record duff depths. If permafrost or other obstructions are encountered, measure the layers available and indicate the cause and depth of obstruction. Record "N/A" if a layer is not present.

Removing plugs for weighing and oven drying (the plugs are generally 4 in. X 4 in.) may be added if fuel moisture data is required for the project. For duff moisture sampling use the *FUEL MOISTURE SAMPLE DATA SHEET* form E, record the depths, collect the samples in Nalgene® sampling jars, and record the bottle number. More detailed information on duff layers, moisture sampling and data sheets for destructive fuel sampling in Alaska are available (Wilmore, 2000; Jandt et al., 2005).

Burn Severity & Duff Consumption - Determine the burn severity class (definitions on the back of the form F - *BURN SEVERITY/ACTIVE LAYER DATA SHEET*) for the substrate and vegetation every 3 m for a total of 10 points. For quantitative measurements of duff consumption, place 10 burn pins pre-fire (15-30" welding rods work well) firmly in the ground every 3 meters along the transect. Push the pins in so that the top is flush with the surface. If a pin can't be pushed in flush with the forest floor, either cut it flush with small bolt cutters or record the remaining height above the surface on form F - *BURN SEVERITY/ACTIVE LAYER DATA SHEET*. Duff consumption should be measured as soon as possible post-fire but at least within 1 year of burning. Measure the part of the pin exposed by the fire in cm to get the burn depth and record on form F.

In addition, burn severity for the general plot area (an approximate 30 m X 30 m stand scale) can be determined using the Composite Burn Index methodology (See Lutes et. al. FIREMON 2006 for methods and Appendix C for Alaska-specific form). This option is useful where burn severity is being scaled up to a burn severity map derived from satellite images.

Down woody fuels - Down woody fuel load is often lacking in undisturbed stands of boreal spruce, as it quickly becomes incorporated into the moss layer. When coarse woody debris is an important component of the fuel load it can be measured along the 30-m transect line using the planar intersect method outlined by Brown (1974). Woody debris is classified as follows: 1 hr fuels (0 to 1/4" diam), 10 hr fuels (1/4 to 1" diam), 100 hr fuels (1 to 3" diam) and 1000 hr sound (>3" diam), 1000 hr rotten (> 3" diam). Tally the woody fuels by size class along the point intercept transect baseline: 0 – 2 m for 1-hr and 10-hr; 0 – 4 m for 100-hr, and 0 -30 m

for 1000-hr fuels (6.6 ft, 13.1 ft, and 98 ft respectively) and enter on form G - *DOWN WOODY DEBRIS & DUFF DEPTHS*. If quantitative fuel loading or consumption data on woody debris is desired, place additional woody debris transects at 120 º and 240 º from origin and mark the ends with a pin flag.

Shrub Density (Optional)

If quantitative data is desired for woody browse or shrub species, tally individuals (or **stems above ground** for clonal species such as alder, or when it is not possible to distinguish individual shrubs) in the same 1-m x 30-m belt which was used for trees. Tally the shrubs by life form (mature, resprout, seedling) and size class and enter the data on form H - *SHRUB DENSITY*. Shrub size classes are <20 cm (8 in.), 20 cm to 1.5 m (5 ft), and >1.5 m after Viereck (1992). In very dense brush, you may need to subsample to 0.5-m x 30-m belt instead, or tree seedling plots. Make sure the area subsampled is clearly identified on form H for future field visits. It is recommended **not** to tally non-woody species like rose, raspberry, or spirea in shrub transects as accurate counts are very difficult. Cover of these species was recorded in the vegetation transect.

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SUGGESTED FIELD GEAR LIST

General	Item	Pre/Post Plots
Plot	30 meter tape	1
Plot	Bike flag	1
Plot	chaining pins	2
Plot	Clinometer	1
Plot	Clipboard	2
Plot	Compass	2
Plot	Densiometer, vertical (GRS)	1
Plot	Diameter calipers	1
Plot	Diameter logger's tape, metric	1
Plot	Diameter tape (small), metric	2
Plot	Field vest	1/person
Plot	Folding ruler ≥1 meter	2
Plot	Hand lens magnifier	2
Plot	Horseshoe nail	1
Plot	Paint sticks for marking tally trees	2
Plot	Conduit/plot marking stake	2 per plot
Plot	steel or aluminum tags w/wire	2 per plot
Plot	welding rods (duff consumption)	10 per plot
Plot	white board/dry erase pen	1
duff	4" quilting square	1
duff	compass saw for cutting duff plug	1
duff	duff containers	40
duff	Green duff mat	1
duff	Pruning shears	1
duff	Ruler, centimeter	1
duff	square-tip narrow duff plug shovel	1
Tech	Digital Camera	1
Tech	GPS w/appropriate map coverage downloaded	1
logistic	Handheld radio	1
logistic	Copies of original forms for each plot.	1 set for each year
logistic	Form organizer for plot project w/ data sheets	1
logistic	Maps of plot locations	1
logistic	Satellite Phone	1
logistic	Shotgun w/ammo	1
Personal	Food, Clothing, Shelter	yes

APPENDIX A – PROTOCOL SPECIFIC OBJECTIVES

This Appendix provides a summary of the common objectives for each of the protocol components used in this FETG monitoring protocol.

	OBJECTIVES	METHOD
1	**VEGETATION & GROUND COVER**	Point intercept transect
	Document the percent cover and species composition of common species at any given time period.	
	Provide vegetation species information for land cover mapping and fire behavior modeling.	
	Document changes in species composition and percent cover through time following fire to provide predictions of successional trajectories	
2	**TREE DENSITY**	
	Determine the estimated tree density by species and diameter size class.	Tree Density Belt Transect
	Document tree mortality, colonization, seeding of project area. If resampling occurs, then changes through time can be recorded.	
	Derive inputs for fire behavior modeling (crown base height and ladder fuels) and treatment effectiveness documentation.	

	OBJECTIVES	METHOD
3	**PERMAFROST DEPTH**	
	Document active layer depth and its variability at the site.	Point Intercept (10-points)
	Document changes in the active depth layer following fire or disturbance.	
4	**BURN SEVERITY**	
	Describe the overall burn severity of the sampling plot including its variability within each plot.	Transect (10-points)
	Use an accepted standard index to calculate a mean stand-scale burn severity for the plot area, including vegetation and substrate, which can be compared to maps from aerial or remotely sensed platforms.	Burn Severity Index
5	**DUFF AND LITTER DEPTH**	
	Provide general indices of duff and litter depth to use in fire behavior and fuel models	Forest Floor Samples (duff plugs)
6	**DOWN WOODY FUEL LOADING**	
	Document fuel loading (tons/acre) of coarse and fine woody debris for fire and fuel modeling, risk assessments, and treatment effectiveness monitoring.	Down and woody fuels (Brown's) transect

	OBJECTIVES	METHOD
7	**SHRUB DENSITY**	Shrub Density Belt Transect
	Document shrub density by species to estimate shrub survival, mortality and establishment within the plot area. Data can also be used to estimate forage availability, degree of site conversion, and potential ladder fuels for fire behavior models.	
	Estimate shrub densities through time following disturbance to predict successional trajectories.	

APPENDIX B – DATA SHEETS

A. Site Description

Unit: _____ Project: _____ Plot ID: _____ Field Crew: _____ Date (M/D/Y): ___/___/___

Lat/Long (DD.DDDD): N_____ W_____ GPS Error: ___(m/ft) Datum: _____

Transect Azimuth: _____ Transect Slope: _____ % Declination used: _____

Fire Number _____ Fire Name:_____ Fire Date: _____ Pre or Post ___ yrs

Additional Lat/Longs - Mark the end of transect, landing zones or other information:
GPS Type: _____ GPS Identification: _____ GPS Datum: _____

Description: _____ WP No: _____ Latitude: N_____ Longitude: W_____ GPS Error: ___(m/ft)

Description: _____ WP No: _____ Latitude: N_____ Longitude: W_____ GPS Error: ___(m/ft)

Description: _____ WP No: _____ Latitude: N_____ Longitude: W_____ GPS Error: ___(m/ft)

General Site Information:

Slope: _____% Aspect: _____ Elevation: _____ ft Viereck class: _____

Soil (circle): Wet Moist Dry Disturbance (circle): Fire Wind Insect Other: _____

Evidence of fire: Yes or No; Fire Indicators: *Burn Snags Burned Stumps Fire Scars Charcoal* (circle all that apply)

Photos: Camera used: _____

Photo numbers: _____	Description: _____	Time of photos: _____
Photo numbers: _____	Description: _____	Time of photos: _____
Photo numbers: _____	Description: _____	Time of photos: _____
Photo numbers: _____	Description: _____	Time of photos: _____

Plot Layout and Notes: Provide notes and map on relocating or LZ, burn information and other plot notes as needed below.

B. Vegetation Cover - Point Intercept

Unit: _____ Project: _____ Plot ID: _____ Date (M/D/Y): ___/___/___

Fire/Treatment: _____ Pre or Post ____ yrs Field Crew: _____

Record species codes of trees, shrubs, forbs and groundcover intercepted every 0.5 m, record plants tallest to lowest.

PNT	Meters	*Tallest* SPP 1	SPP 2	SPP 3	SPP 4	SPP 5	SPP 6
1	0.5						
2	1						
3	1.5						
4	2						
5	2.5						
6	3						
7	3.5						
8	4						
9	4.5						
10	5						
11	5.5						
12	6						
13	6.5						
14	7						
15	7.5						
16	8						
17	8.5						
18	9						
19	9.5						
20	10						
21	10.5						
22	11						
23	11.5						
24	12						
25	12.5						
26	13						
27	13.5						
28	14						
29	14.5						
30	15						
31	15.5						
32	16						
33	16.5						
34	17						
35	17.5						
36	18						

PNT	Meters	*Tallest* SPP 1	SPP 2	SPP 3	SPP 4	SPP 5	SPP 6
37	18.5						
38	19						
39	19.5						
40	20						
41	20.5						
42	21						
43	21.5						
44	22						
45	22.5						
46	23						
47	23.5						
48	24						
49	24.5						
50	25						
51	25.5						
52	26						
53	26.5						
54	27						
55	27.5						
56	28						
57	28.5						
58	29						
59	29.5						
60	30						

Common codes:

Trees		**Shrubs**	
Code	*Name*	*Code*	*Name*
PIGL	Picea glauca – White spruce	BENA	Betula nana - Resin birch & Dwarf birch
PIMA	Picea mariana – Black spruce	ALNUS	Alnus spp – Alder , SALIX – willow
BEPA	Betula papyrifera – Paper birch	LEPA11	Ledum palustre – Labrador tea
POTR	Populus tremuloides – Aspen	VAUL	Vaccinium uluginosum – blue berry
POBA	Populus balsamifera – Balsam poplar	VAVI	Vaccinium vitis-idaea – lowbush cranberry

Ground		**Forbs/Grasses**	
Code	*Name*	*Code*	*Name*
FMOSS	Feather moss	CHAN	Chamerion angustifolium – Tall Fireweed (EPAN2)
HYSP70	Hylocomium splendens – Stair step moss	POAL	Polygonum alpinum – Wild rhubarb
SPHAG2	Sphagnum spp (moss)	MEPA	Mertensia paniculata - Tall blue bells
LTR	Litter	LIBO3	Linnaea borealis – Twin flower
WD	Woody debris	EQUIS	Equisetum spp – Horsetail
DUFF	Organic duff	CACA4	Calamagrostis canadensis – blue joint grass
SOIL	Mineral soil		

B.1 Site and General Vegetation Form

Unit: _____ Project: _____ Plot ID: _____ Pre or Post ___ yrs Fire Number _____ Fire Date: _____

Field Date: _____ Field Crew: _____ Fire Name:_____

WP No: _____ Latitude: N_____ Longitude: W_____GPS Error: _____ Datum: _____

SPECIES Tree Layer	Common Name	Cover Class					Height Class					Ht to live crown (cm)	Ht to Ladder Fuel (cm)	Avg DBH (cm)
		1-9%	10-24%	25-59%	60-74%	≥75%	0-3 m	3-5 m	5-9 m	9-21 m	> 21 m			
PIGL	White spruce													
PIMA	Black spruce													
LALA	Larch													
POTR5	Aspen													
POBA2	Balsam poplar													
BEPA	Paper birch													
Shrub layer		1-9%	10-24%	25-59%	60-74%	≥75%	<0.2 m	0.2-1.5 m	> 1.5 m	Seedling	Re-sprout			
ALNUS	Alder species													
BENA	Dwarf/resin birch													
EMNI	Crow berry													
LEPA11	Labrador tea													
ROAC	Prickly Rose													
SALIX	Willow species													
SHCA	Soap Berry													
VAUL	Blue berry													
VAVI	Lowbush cranberry													
RIBES	Currant species													
Herbaceous & Ground Cover		1-9%	10-24%	25-59%	60-74%	≥75%	Seedling	Re-sprout						
ARRU	Bear berry													
LIBO3	Twin flower													
MEPA	Blue bells													
EQUIS	Horsetail													
EPAN2	Fireweed													
GRASS*	Unidentified grass													
CACA4	Northern blue-joint													
CAREX	Sedge													
LYCOP2	Club Moss													
ERVA4	Cottongrass/ tussock													
COCA13	Dwarf Dogwood													
GELI2	Timber berry													
FMOSS	Unidentified feather moss													

Site and General Vegetation Form (Pg 2 of 2)

Unit: _____ Project: _____ Plot ID: _____ Pre or Post ___ yrs Field Date (M/D/Y): ___/___/___

SPECIES Tree Layer	Common Name	Cover Class					Height Class					Ht to live crown	Ht to Ladder Fuel	Avg DBH (cm)
		1-9%	10-24%	25-59%	60-74%	≥75%	0-3 m	3-5 m	5-9 m	9-21 m	> 21 m			

Shrub layer		1-9%	10-24%	25-59%	60-74%	≥75%	<0.2 m	0.2-1.5 m	> 1.5 m	Seedling	Re-sprout	

Herbaceous & Ground Cover		1-9%	10-24%	25-59%	60-74%	≥75%	Seedling	Re-sprout				
CLADI3	Reindeer lichen											
LICHEN*	Unidentified lichen											
HYSP70	Stair-step moss											
SPHAG2	Sphagnum moss											
MOSS*	Unidentified moss											
PEAP60	Freckle pelt lichen											

C. Tree Density Tally

Land Unit: _____ Project: _____ Plot ID: _____ Pre/Post ___ yrs Date (M/D/Y): ___/___/___ Field Crew: _____

●Tally trees taller than 4.5' (1.37-m) by diameter size class and species within the 1-m x 30-m belt transect. Dead trees leaning > 45 degrees are not tallied (counted as fuel). For small "layering" trees, pull trees upright to determine if height is > 4.5'.
●Tally the "seedling/saplings" - *live* trees less than 4.5' tall by species in the three 1-m x 1-m subplots at 3m, 15m and 27m along the transect. If it can be determined, class by resprout (R) or not for hardwood spp. Note, if different size plot is used: Plot length: ____ Plot width: _____

Tree (cm at DBH)	≤ 5 cm	5.1 - 10 cm	10.1 – 15 cm	15.1 - 23 cm	>23 cm	Sapling /Seedlings <4.5 ft 3-m	Sapling /Seedlings <4.5 ft 15-m	Sapling /Seedlings <4.5 ft 27-m
Picea mariana LIVE								
DEAD								
Picea glauca LIVE								
DEAD								
Larix laricina LIVE								
DEAD								
Betula papyrifera LIVE						R:		
DEAD								
Populus balsamifera LIVE						R:		
DEAD								
Populus tremuloides LIVE						R:		
DEAD								

D. Tree Measurement Data Sheet

Land Unit: _____ Project: _____ Plot ID: _____

Pre or Post ____ yrs Field Date (M/D/Y): ___/___/___Field Crew: _____

Record the following information for two live trees (> 4.5 feet tall) of each species for each size class recorded within the tree density plot. Select the trees to be measured, by those closest to the mid-point of the tree density belt (15-m point). Measure the heights in 1/10ths of meters (i.e 15.3 m) and DBH in 1/10ths of centimeters (i.e. 5.3 cm). Note in comments tree damage, insects or disease.

Tree No.	Tree Species	DBH (cm)	Height (m)	Crown Radius (m)	Crown Fuel Base Ht (m)	Bole Char height (m)	Percent Crown Scorch	Comments

D.1 Tree Density and Measurements (optional form version)

Land Unit: _____ Project: _____ Plot ID: _____ Field Date (M/D/Y): ___/___/___

Fire Name/Number: _____ Fire Date: _____ Pre or Post ____ yrs Field Crew: _____

Tally the number of trees taller than 4.5' (1.37-m) by species, status (live/dead), and diameter size class (< 5cm, 5-10 cm, 10-15 cm, 15-23 cm, > 23 cm) within the 1-m x 30-m belt transect plot area. Record the following information for two live trees (> 4.5 feet tall) of each species for each size class recorded within the tree density plot. Select the trees to be measured, by those closest to the mid-point of the tree density belt (15-m point). Measure the heights in 1/10ths of meters (i.e 15.3 m) and DBH in 1/10ths of centimeters (i.e. 5.3 cm), crown fuel base height (CBFH) (m). Note in comments tree damage, insects or disease. **Diameter size classes: < 5cm, 5-10 cm, 10-15 cm, 15-23 cm, > 23 cm**

					Tree 1				**Tree 2**			
Tree Species	Sta-tus (L/D)	Diam. Size Class	Comment	Tally	DBH (cm)	Height (m)	CFBH (m)	Remarks	DBH (cm)	Height (m)	CFBH (m)	Remarks

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E. Fuel Moisture Sample Data Sheet

Land Unit: _____ Project: _____ Plot ID: _____ Field Date (M/D/Y): ___/___/___

Fire Name/Number: _____ Fire Date: _____ Field Crew: _____

Sample #	Type	Fuel Codes	Sample Depth (cm)	Thick-ness (cm)	V/G*	Bottle #	Wet Wt	Dry Wt	Tare Wt		Comments
1	Duff	LM	0-3cm	3	V	23	75.3	58.7	52.9		Example
1	Duff	DM	3-7cm	4	V	22	80.5	58.7	52.9		Example

Fuel Codes: LM=live moss (feather), DM = dead moss, UD = upper duff, LD = lower duff, PIMA = black spruce needles.

Fuel Moisture Sample Data Sheet (continued)

Sample #	Type	Fuel Codes	Sample Depth (cm)	Thick-ness (cm)	V/G*	Bottle #	Wet Wt	Dry Wt	Tare Wt		Comments

V/G identifies a volumetric (sample of known, measured volume) or gravimetric (weight determined, but size may vary) sample.

F. Burn Severity/Active Layer Data Sheet

Active Layer Depth

Land Unit: _____ Project: _____

Plot ID: _____

Field Date (M/D/Y): __/___/___ Field Crew: _____

Pre or Post ____ yrs

Fire Name/Number: _____

Fire Date: _____

Point	Distance	Active Layer Depth cm	Surface layer fuel code	Comments
1	3-m			
2	6-m			
3	9-m			
4	12-m			
5	15-m			
6	18-m			
7	21-m			
8	24-m			
9	27-m			
10	30-m			

Fuel Codes: LC = lichen; FM = feather moss, SM = sphagnum moss, DM = dead moss, UD = upper duff,LD = lower duff, MIN = mineral

Burn Severity and Duff Consumption

(See back for Burn Severity Codes)

Dates (Pre-fire): _____ (Post-fire):_____

		Post-Fire		Pre-fire	Post-fire	
Point	Distance	Burn Severity Code (Substrate)	Burn Severity Code (Vegetation)	Burn Pin above surface (cm) (A)	Burn Pin Exposed (cm) (B)	Burn Depth cm (B-A)
1	3-m					
2	6-m					
3	9-m					
4	12-m					
5	15-m					
6	18-m					
7	21-m					
8	24-m					
9	27-m					
10	30-m					

Burn severity code matrix

–modified from NPS Fire Monitoring Handbook (2003)

CODES	Forest and ShrubTypes	
	Substrate (S)	Vegetation (V)
5 Unburned	Not burned	Not burned
4 Scorched	Litter partially blackened; duff nearly unchanged; wood/leaf structures unchanged	Foliage scorched and attached to supporting twigs (red needles may have dropped and be found at base of trunks)
3 Lightly Burned	Litter charred to partially consumed; upper duff layer may be partially consumed but not altered over the entire depth; surface appears black; small woody debris is partially burned.	Foliage and smaller twigs partially to completely consumed; branches mostly intact; less than 40% of the shrub canopy is commonly consumed
2 Moderately Burned	Litter mostly to entirely consumed, leaving coarse, light colored ash; duff deeply charred to lower duff or upper/lower duff interface, but underlying mineral soil is not exposed; small woody debris is mostly consumed.	Foliage, twigs, and small stems consumed; some branches (>.5-2.5 cm in diameter) (0.25-1.0 in) still present; 40-80% of the shrub canopy is commonly consumed.
1 Heavily Burned	Litter and duff completely consumed, or within 1 cm of mineral soil, sometimes leaving fine white ash; mineral soil may be visibly altered, sometimes reddish. *Marchantia* and fire mosses may be present.	All plant parts less than 2.5 cm (1 in) in diameter are consumed, only leaving deeply charred major stems or trunks.
0 or N/A Not applicable	Inorganic preburn (i.e. rock or soil unchanged by fire)	None present preburn

G. Down Woody Debris & Duff Depths

Unit: _____ Project: _____ Plot ID: _____ Field Date (M/D/Y): ___/___/___

Pre or Post ____ yrs Field Crew:_____

Record the number of intercepts of woody fuels along the 30-m transect by size class: 0 - 1/4" and 1/4"-1" from 0 to2 m along transect, 1" - 3" diameter from 0 to4 m along transect, and > 3" diameter from 0 to 30 m along transect. Record the actual diameter of fuels >3" diameter. Measure litter and duff depths at each end of the transect. *English-metric conversions: 2-m (6.6 ft), 4-m (13.1 ft), 30-m (98 ft).*

	# of intercepts			Record Diameter (inches) > 3" diam		Litter and Duff Depths (cm)			
Transect	0 – 0.25" 1 hr	0.25 - 1" 10 hr	1 - 3" 100 hr	3"+ solid 1000 hr S	3"+ rotten 1000 hr R	Sample site 1	Depth cm	Sample site 2	Depth cm
						Litter		Litter	
Dir. ____						Lichen		Lichen	
Slope ___						Live Moss		Live Moss	
						Dead Moss		Dead Moss	
						Upper Duff		Upper Duff	
	Total:	Total:	Total:			Lower Duff		Lower Duff	

Transect	0 – 0.25" 1 hr	0.25 - 1" 10 hr	1 - 3" 100 hr	3"+ solid 1000 hr S	3"+ rotten 1000 hr R	Sample site 3	Depth cm	Sample site 4	Depth Cm
						Litter		Litter	
Dir. ____						Lichen		Lichen	
Slope ___						Live Moss		Live Moss	
						Dead Moss		Dead Moss	
						Upper Duff		Upper Duff	
	Total:	Total:	Total:			Lower Duff		Lower Duff	

Definitions & Tally Rules

Downed woody material is dead twigs, branches, stems and boles of trees and shrubs that have fallen and lie on or above the ground.

>Measurement of diameter is taken perpendicular to the central axis of the piece at the point it intersects the sampling plane.
>Measure woody material first to avoid disturbing it and biasing your estimates.
>Do not count dead woody stems and branches still attached to standing shrubs and trees (see below)
>If leaning more than 45 degrees and dead, but still attached at the bole it is counted as down and woody.
>Do not tally any particle having a central axis that coincides perfectly with the sampling plane.
>If the sampling plane intersects a curved piece more than once tally each intersection
>For rotten logs that have fallen apart try to estimate its original diameter
>Tally uprooted stumps and roots not encased in dirt. Do not tally undisturbed stumps.

H. Shrub Density Data Sheet

Land Unit: _____ Project: _____ Plot ID: _____ Field Date (M/D/Y): ___/___/___

Field Crew: _____ Pre or Post ____ yrs

For each shrub species within the 30-m x 1-m belt transect, tally the number of shrubs by interval and life status. Record height class (optional). Refer to intervals and height class codes below.

Inter-val	***Shrub Species***	***Height Class***	***Mature***	***Resprout***	***Seedling***

Interval Classes along Transect:

1	0 – 3 m	6	15.1 – 18 m
2	3.1 – 6 m	7	18.1 – 21 m
3	6.1 – 9 m	8	21.1 – 24 m
4	9.1 – 12 m	9	24.1 – 27 m
5	12.1 – 15 m	10	27.1 – 30 m

Height Class Codes:

1	<20 cm (8in)
2	20.1 cm to 1.5 m (5 ft)
3	> 1.5 m (5 ft)

APPENDIX C – CHEAT SHEETS & SUPPLEMENTAL FORMS

C.1. Tree Crown Measurements

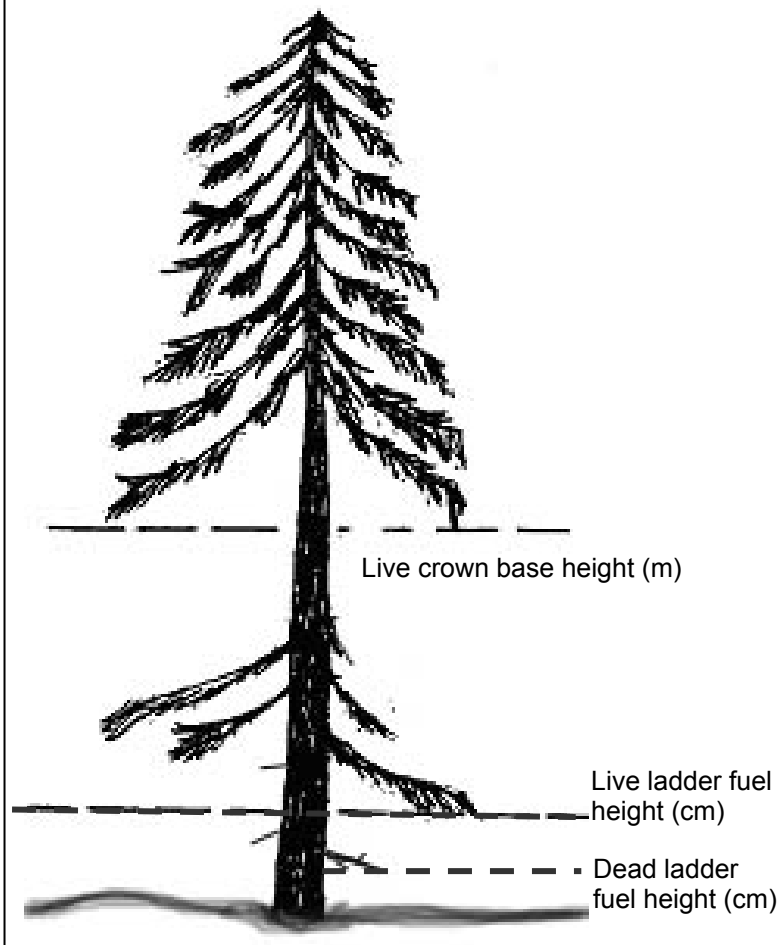

Fig. 1 Tree crown and ladder fuel measurements. (Modified from USFS FMH Manual, 2002.)

In this protocol, we recommend recording a single measurement: **crown fuel base height**. This will usually be the same as crown base height (Fig. 1), except where the tree has extensive dead branches continuous with the live crown. In Fig. 1, due to the gap between ladder fuel and the live crown, CFBH = CBH. If, in the observer's opinion the dead ladder fuel is dense and fine enough to carry fire into the live crown, the lower end of the continuous ladder fuel should be recorded as crown fuel base height. These measurements are intended to provide inputs for fire behavior modeling programs, or in building custom fuel models.

C.2. Tree Height Measurements

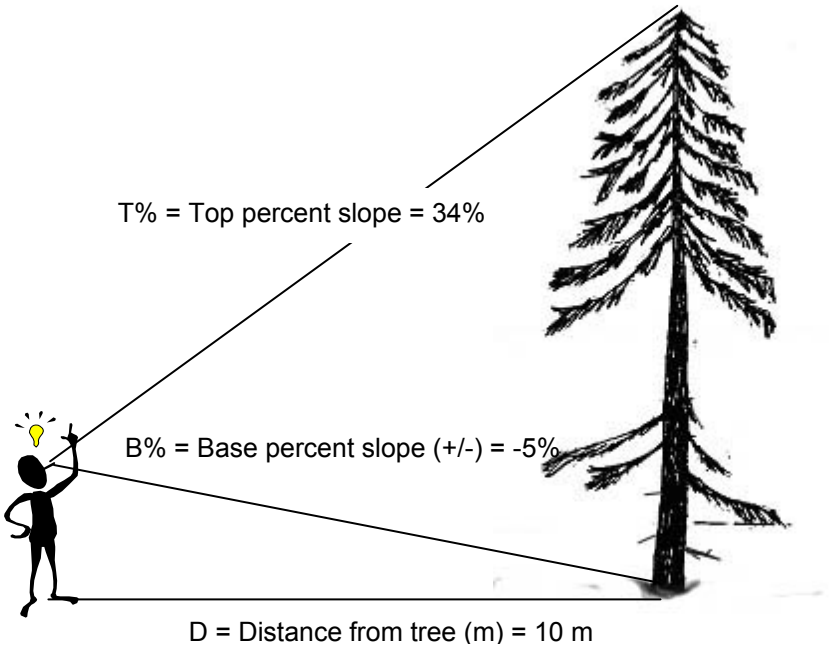

Figure 3. Tree height equals: Height (m) = D x (T% - B%). If the base percent is negative (reading eye-level to tree or on slope above tree DBH), then add B%, if base percent is positive (on slope below tree DBH) then subtract B%. Ht = 20m x (0.34 + 0.05) = 7.8 m

Remember to use percent side of clinometer (right side scale or look for percentage sign at top or bottom of scale) and to move the clinometer up and down, not your head if possible. *Hint:* 10-m and 20-m distances makes easier math, but you must go back far enough to accommodate tree heights.

C.3 Optional Form CBI

BURN SEVERITY -- COMPOSITE BURN INDEX (BI) – Modified for ALASKA 6/8/2005

Plot Description	Examiners:			Fire Name:		
Registration Code		Project Code		Plot Number		
Field Date mmddyyyy	/ /	Fire Date mmyyyy	/			
Plot Aspect		Plot % Slope		Elevation (m)		
Plot Radius Overstory	10 meters	Latitude plot center		GPS Datum		
Plot Radius Understory	10 meters	Longitude plot center		GPS Error (m)		
Number of Plot Photos		Plot Photo IDs and Time				

BI – Long Form	% Burned 20 m Plot =		% Burned 30 m Plot =		Fuel Photo Series =			
STRATA *RATING FACTORS*	**BURN SEVERITY SCALE**							FACTOR SCORES
	No Effect	**Low**		**Moderate**		**High**		
	0.0	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	
A. SUBSTRATES								
% Pre-Fire Cover: Litter = Duff = Soil/Rock = Tussocks =								
Pre-Fire Depth (cm): Litter = Duff = Fuel Bed =								
Litter/ Light Fuels: W. Debris <3" Diam. Fuel Consumed	Nochange	--	50% litter	--	100% litter	>80% light fuel	98% Light Fuel	
Duff	Nochange	--	Light char	--	50% loss deep char	--	Consumed	
Medium Fuel, 3-8 in. **or** Tussocks basal area	Nochange	--	20% consumed	--	40% consumed	--	>60% loss, deep ch	
Heavy Fuel, > 8 in.	Nochange	--	10% loss	--	25% loss, deep char	--	>40% loss, deep ch	
Exposed Mineral Soil Cover	Nochange	--	10%	--	40%	--	>80%	
B. HERBS, LOW SHRUBS AND TREES LESS THAN 1 METER:								
Pre-Fire Cover: Herbaceous/Graminoids = Moss/Lichen= Shrubs < 1m =								
Moss/lichens Cover	Unchanged	--	30%	--	80%	95%	100%	
% Foliage Altered (blk-brn) – shrubs	Unchanged	--	30%	--	80%	95%	100% + branch loss	
Freq % Living/Resprouting	100%	--	90%	--	50%	< 20%	None	
Colonizers – Seed/Spores	Unchanged	--	Low	--	Moderate	High	Low to None	
Spp. Comp. - Rel. Abund.	Unchanged	--	Little change	--	Moderate change	--	High change	
C. TALL SHRUBS AND TREES 1 TO 2 METERS:								
Pre-Fire Cover =								
% Foliage Altered (blk-brn)	0%	--	20%	--	60-90%	> 95%	Significant branch loss	
Freq % Living/Resprouting	100%	--	90%	--	30%	< 15%	< 1%	
% Change in Cover	Unchanged	--	15%	--	70%	90%	100%	
Spp. Comp. - Rel. Abund.	Unchanged	--	Little change	--	Moderate change	--	High Change	
D. INTERMEDIATE TREES (SUBCANOPY, POLE-SIZED TREES) 2-8 meters								
Pre-Fire % Cover = Pre-Fire Number Living = Pre-Fire Number Dead =								
% Green (Unaltered)	100%	--	80%	--	40%	< 10%	None	
% Black (Torch)	None	--	5-20%	--	60%	> 85%	100% + branch loss	
% Brown (Scorch)	None	--	5-20%	--	40-80%	< 40 or > 80%	None, due to torch	
% Canopy Mortality	None	--	15%	--	60%	80%	%100	
Char Height	None	--	1.5 m	--	2.8 m	--	> 5 m	
Post Fire: %Felled = %Tree Mortality =								
E. BIG TREES (UPPER CANOPY, DOMINANT, CODOMINANT TREES) >8 meters								
Pre-Fire % Cover = Pre-Fire Number Living = Pre-Fire Number Dead =								
% Green (Unaltered)	100%	--	95%	--	50%	< 10%	None	
% Black (Torch)	None	--	5-10%	--	50%	> 80%	100% + branch loss	
% Brown (Scorch)	None	--	5-10%	--	30-70%	< 30 or > 70%	None, due to torch	
% Canopy Mortality	None	--	10%	--	50%	70%	%100	
Char Height	None	--	1.8 m	--	4 m	--	> 7 m	

Post Fire: %Felled =	%Tree Mortality =

Community Notes/Comments:	CBI = Sum of Scores / N Rated:	Sum of Scores	N Rated	CBI
	Understory (A+B+C)			
	Overstory (D+E)			
	Total Plot (A+B+C+D+E)			

% Estimators: **20 m Plot:** 314 m^2 1% = 1x3 m 5% = 3x5 m 10% = 5x6 m *After, Key and Benson 1999, USGS NRMSC, Glacier Field Station.*

30 m Plot: 707 m^2 1% = 1x7 m (<2x4 m) 5% = 5x7 m 10% = 7x10 m AK Revised: Version 4.0 June 8, 2005